57 HIGH-POWERED SYSTEMS REVIEWED

BYTE

APRIL 1994

Pournelle's Product Awards

Object-Oriented Databases Come of Age

A Nifty Multiprotocol Print Server for Ethernet LANs

THE MAGAZINE OF TECHNOLOGY INTEGRATION

First PowerPCs

Apple's Power Macintosh and IBM's Power Personal Systems

EXCLUSIVE

IBM's PowerPC product plans, plus Power Mac vs. Pentium benchmark results

SPECIAL REPORT

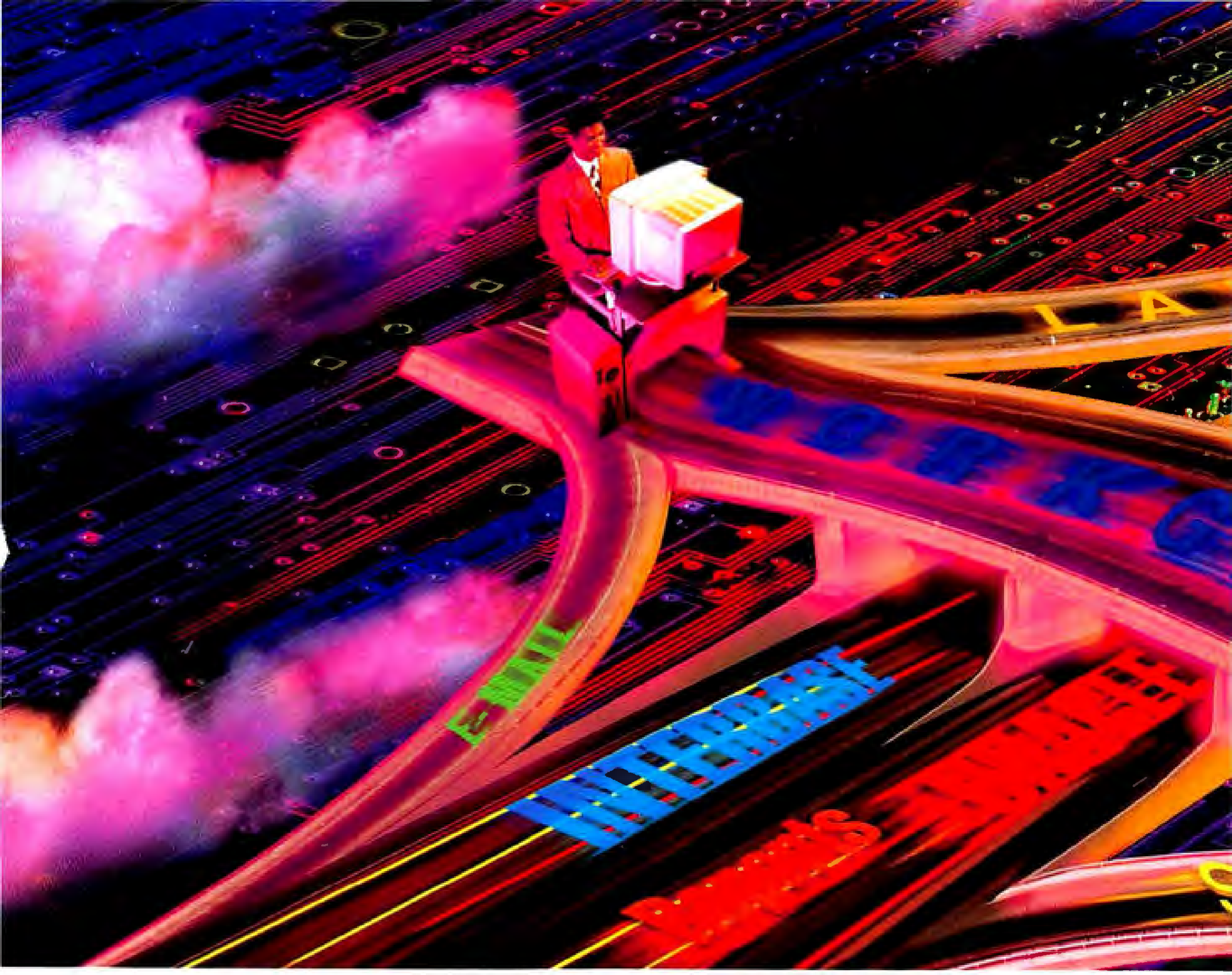
CPU Wars:

Should you move from CISC to RISC?

PLUS

Intel pushes the 80x86 envelope

04
02662
0 440235 0
$3.50 U.S.A./$4.50 IN CANADA
A McGraw-Hill Publication/0360-5280



Best Windows database for all skill levels

Of course, Paradox wouldn't be complete without the powerful and easy-to-use features that have made it the #1-rated relational database. Built-in productivity Experts™ guide you at every step, from linking information in tables to building forms and reports. Object Inspector™ menus provide instant access to capabilities without searching through layers of menus.

And Paradox's ease stays with you as you move up the power curve. Even corporate developers find that ObjectPAL,™ the fully integrated programming language, lets you create custom Windows applications that are powerful, graphical, and deliverable *fast*. Plus, 100% compatibility with Paradox DOS means your existing Paradox data will migrate automatically to your new Windows applications.

So when it comes to workgroup database productivity, nothing will get you where you want to go faster or more easily than the new Paradox Workgroup Edition from Borland.

Welcome to life in the fast lane.

Limited-time offer!

$495 *Suggested retail price for new users.*

$149.95 *Upgrade price for Paradox, FoxPro, Access, Superbase, and Approach users. $20 rebate for Paradox DOS or Windows owners.*

90-day, money-back guarantee

See your dealer today or call
1-800-336-6464, ext. 7853

In Canada, call 1-800-461-3327.

Borland
Power made easy™

Circle 69 on Inquiry Card (RESELLERS: 70).

New Paradox makes your desk a ramp on the data superhighway

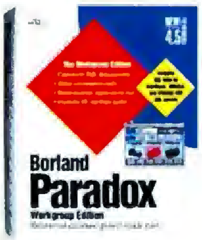
New version 4.5

There's lots and lots of data out there. The trouble is, it has to go to the right place in order to be productive. That's the reason we developed the new Paradox® Workgroup Edition. The only database with superior SQL connectivity and workgroup information sharing.

Share data easily with any workgroup

First we built in support for SQL servers, including Borland's InterBase,™ Sybase/Microsoft,® and Oracle, so you can work with information from corporate databases as if it were on your desktop. But we didn't stop there. We added the Workgroup Desktop to distribute the data where it's needed. Now anyone with a Workgroup Edition of Borland Paradox (or Quattro® Pro) can exchange data over local and wide area networks, or via electronic mail.* You can establish and modify workgroups instantaneously to meet the needs of a given project or organizational structure. And there's no need to buy expensive hardware upgrades or learn separate "workgroup" software. *Everything you need is built-in!*

You can share virtually any type of data—Paradox or dBASE® tables with associated indexes, SQL data, OLE or multimedia objects, forms, reports, and queries, and even non-Paradox files such as WordPerfect documents, or entire applications. You simply "publish" the information to your list of workgroup members. Whenever you update a version of the published data, your selected "subscribers" automatically receive the new information. Everyone is more efficient because everyone is working with the same up-to-date information.



What good is information if you can't get to it . . . or if it can't get to you?

▲ *Keep colleagues up to date quickly, easily. The* ***Workgroup Desktop*** *lets you distribute data over a variety of paths—in a mouse-click.*

▼ *New! SQL connectivity gives Paradox access to the corporate database.*

▲ *Paradox is the Windows database that lets you work with pushbutton ease—so you get your work done faster.*

Dynamic-STN color: Designed with greater contrast and improved c saturation, Toshiba's dual-scan displa noticeably pure and vibrant.

Rugged Design: Rounded corners and a tough lightweight casing are just a few of the details that make this notebook engineered to last.

TURN A LITTLE MONEY INTO A SOLID INVESTMENT.

Satellite

Introducing the Ultra Affordable T1910 Series.

Our new Satellite Series notebook is light enough to go everywhere, yet rugged enough to come back in one piece. You'll find its ergonomic design and engineering make it extremely comfortable to use. A fast 33MHz SL Enhanced i486™SX processor gives you the power to blaze through programs. There's Toshiba's unique 14.5mm Type III PCMCIA slot for the ultimate in expansion possibilities. And a choice of sharp, brilliant displays, either color or monochrome. So get your hands on the new T1910 Series. It's got everything you want in a notebook. Advanced features. A tough, long-lasting design. And a great price. Call 1-800-457-7777 for the Toshiba dealer nearest you.

T1910
- 9.5" dia. monochrome STN-LCD display
- 120MB HDD
- 6.5 lbs.

T1910CS
- 9.5" dia. color Dynamic-STN dual-scan display
- 120/200MB HDD
- under 7 lbs.

BOTH MODELS
- 33MHz SL Enhanced Intel 486™SX, 3.3v
- 4MB RAM, upgradable to 20MB
- 8KB cache
- 14.5mm Type III PCMCIA slot (supports Type I, II, and III cards)
- BallPoint™ Mouse with QuickPort™
- NiMH battery for extended battery life with Toshiba MaxTime™ Power Management

intel inside

Microsoft Windows Ready to Run

In Touch with Tomorrow

TOSHIBA

Circle 138 on Inquiry Card.

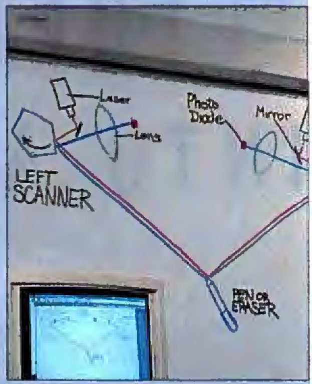
BYTE
APRIL 1994 VOL.19, NO.4

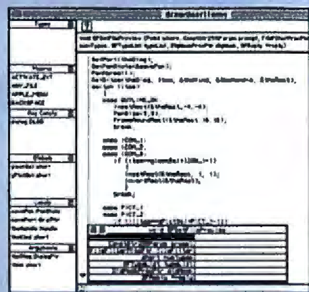
News & Views

Cover Story

SPECIAL REPORT: THE RISC DECISION

Reviews





State of the Art

Opinions

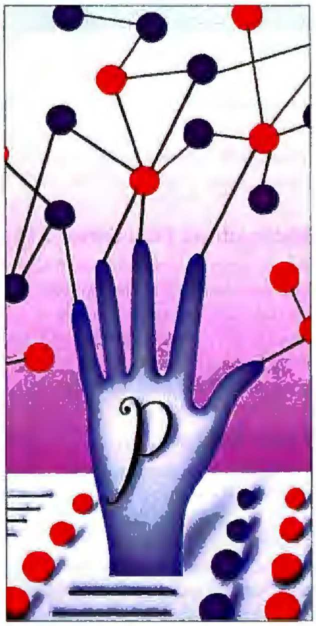
PROGRAM LISTINGS

From BIX: Join "listings/frombyte94" and select the appropriate subarea (i.e., "apr94").

From the UUNET:ftp to ftp.uu.net, log on as "anonymous," and enter your user ID as your password. Type "cd/published/byte" and type "DIR." Files appear in subdirectories arranged by month.

From the BYTE BBS at 1200-9600 bps: Dial (603) 924-9820 and follow the instructions at the prompt.

Hands On



BYTE (ISSN 0360-5280) is published monthly by McGraw-Hill, Inc. U.S. subscriber rate $29.95 per year. In Canada and Mexico, $34.95 per year. European surface mail subscriptions $60, airmail $80. Non-European subscriptions, $60 surface mail or $85 airmail. All foreign subscriptions are payable in U.S. funds that can be drawn on a U.S. bank. Single copies $3.50 in the U.S., $4.50 in Canada. Executive, Editorial, Circulation, and Advertising Offices: One Phoenix Mill Lane, Peterborough, NH 03458. Second-class postage paid at Peterborough, NH, and additional mailing offices. Postage paid at Winnipeg, Manitoba. Canada Post International Publications Mail Product Sales Agreement No. 246492. Registered for GST as McGraw-Hill, Inc., GST #123075673. Printed in the United States of America. **Postmaster:** Send address changes and fulfillment questions to BYTE Subscriptions, P.O. Box 552, Hightstown, NJ 08520.

COVER IMAGE: MARC YANKUS © 1994

BYTE Contents by Platform

Index

THE NEW PINNACLE SIERRA 1.3GB™ OPTICAL HARD DRIVE

It's The Ultimate In Storage!

4500 RPM

19 msec effective access time

2.0 MBytes per sec. data throughput

THE LAST HARD DRIVE YOU'LL EVER NEED

Introducing the Sierra™ 1.3 Gigabyte optical hard drive with speeds faster than most magnetic hard drives and removable media for infinite capacity. With each additional standard optical disk you'll have another 1.3 Gigabytes of capacity to store spreadsheets, databases, CAD/CAM, graphics, multimedia or any data intensive application demanding mountains of storage.

The Sierra™ 1.3 GB is a lightning fast mass storage system with performance that rockets past most magnetic hard disk drives. (see chart)

OPTICAL PERFORMANCE ADVANTAGE

	XCOPY 20MB TO OPTICAL DRIVE/HARD DRIVE	XCOPY 50MB TO OPTICAL DRIVE/HARD DRIVE
PINNACLE SIERRA™ 1.3GB	135.3 seconds	379.5 seconds
SEAGATE ST4766N (630MB)	210.6 seconds	496.8 seconds
FUJITSU M2266SA (1.2GB)	165.5 seconds	375.1 seconds
MAXTOR XT-8760SH (676MB)	178.9 seconds	428.7 seconds

Optical technology has many advantages such as removability, reliability, expandability, and is less expensive than magnetic storage solutions.

OPTICAL PRICE ADVANTAGE

RETAIL COST @	1.3GB	2.6GB	5.2GB
PINNACLE SIERRA™ 1.3GB	$3245	$3495	$3995
HARD DISK DRIVE	$3250	$6500	$13,000

"It has a 19 millisecond access time and outperformed every other device we tested here." Stanley Wszola, *Byte*

With Pinnacle's ASCENT program you can upgrade your Sierra™ 1.3GB to a Pinnacle optical library system that ranges in capacity from 20 Gigabytes to 186 Gigabytes for Novell®.

The Sierra™ ... only by Pinnacle. The optical storage leader. For more info call:

800.553.7070

Ansel Adams Wilderness, Sierra National Forest

Trademarks: Sierra and Sierra 1.3 GB of Pinnacle Micro, Inc. All trademarks and registered marks to their respective owners.
Pricing acquired directly from System Integrators on 9/15/93. Avg. hard drive cost $2.50 per Megabyte. Tests performed by BSL.

PINNACLE MICRO

THE OPTICAL STORAGE COMPANY®

19 Technology • Irvine, CA 92718 • U.S.A. • Int'l (714) 727-3300 • Fax (714) 727-1913

Circle 120 on Inquiry Card (RESELLERS: 121).

Compaq And Microsoft.
The Connection That's Making
"Plug And Play" A Reality.

Just about everyone who's ever used a computer has experienced the same thought: Wouldn't it be great if setting up or upgrading your machine was as easy as turning it on?

The idea is called "Plug and Play." People have been talking about it for years. But now, an ongoing partnership between Compaq and Microsoft, working with other industry leaders, is actually making it happen.

Plug and Play is the result of some very fresh thinking in both hardware and software – an accomplishment that tapped the combined engineering expertise of both companies. Together, Compaq® computers and the next version of the Microsoft® Windows™ operating system (code-named Chicago) will deliver the long-promised benefits of true Plug and Play: easy setup, easy expansion and easy connection to peripherals.

Which means no more configuration headaches. No more hidden switches, cryptic codes or mystery.

Even today, Compaq is shipping computers that will take full advantage of Plug and Play technology as soon as the forthcoming version of Windows is available. So the Compaq & Windows combination will quickly become the standard for Plug and Play computing. A welcome reassurance for people who buy computers.

COMPAQ Microsoft®

Circle 74 on Inquiry Card.

What About Intel?

The King of CISC needs to come up with an adequate response to the RISC phenomenon

With all the talk about the benefits of RISC microprocessors, you have to wonder about the King of CISC, Intel. The RISC architecture has long promised lower cost and higher performance than the CISC architecture. What CISC has going for it, though, is Intel. Specifically, the Intel 80x86 family of CPUs has been the cornerstone of software compatibility.

But a growing number of analysts—including the editors of this magazine—believe that RISC is the future. Higher performance and lower costs count for a lot in this industry. So does compatibility. However, what if software compatibility weren't an issue? In other words, what if you could buy a system with, say, either a Pentium or a PowerPC and be able to run any Windows applications? That's the question you'll face with Windows NT running in native code on PowerPC systems.

Much of the compatibility question simply evaporates because Windows NT will run on PowerPC systems. The point is, if a system can run Windows, it doesn't matter if it's "Intel Inside"—especially if the RISC-based alternative delivers better performance.

That's the scenario using today's paradigm. Let's look beyond that. Apple is shifting its entire line of computers to incorporate the PowerPC, and as a result, the Apple platforms will take on more of the PReP (PowerPC Reference Platform) attributes. IBM will roll out its Power Personal systems later this year, and they will be extensions of PReP, too. We are also likely to see a good number of so-called clone makers roll out their PowerPC systems based on PReP later this year. Pretty soon, the standard of compatibility will be whether a system is PReP-based—not whether it runs Windows.

That has to be troubling to Intel. After the company has poured buckets of money into promoting "Intel Inside" as an assurance of compatibility, the whole compatibility premise as it has applied to Intel may become moot.

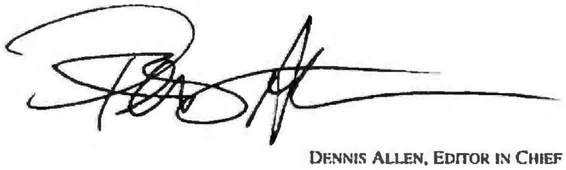
And it's not like Intel has made a lot of loyal PC manufacturing friends over the years, either. In Asia, for example, makers of systems and motherboards are anxiously awaiting an opportunity to end their dependency on Intel. Largely because of Intel's very unpopular chip-allocation policy, Asian PC makers have often found competing difficult because they could not get enough Intel CPUs. An added slap on the face for Asian PC makers was Intel's recent attempt to demand royalties on PCs that used Intel-compatible chips from AMD.

Things may be a little more friendly in the U.S., but the situation is still not good. IBM sells an incredible number of PCs, and IBM is leading the move to the PowerPC. Also, Apple's move to evolve its line into a higher-performance arena will bolster the success of the PowerPC.

These are formidable challenges for Intel. We are on the verge of a mass exodus from the CISC architecture to the RISC architecture. Motorola made the move by getting on the RISC bandwagon with IBM and Apple as part of the PowerPC Consortium. Traditional workstation CPU makers made the commitment to RISC long ago with Alpha, Mips, and SPARC. That leaves Intel and compatible makers Cyrix and AMD as the remaining CISC players. Of those three, shifting gears into RISC will probably be easier for Cyrix and AMD because they have proven themselves to be excellent niche players in the CPU market.

For Intel, on the other hand, it's a different story. Intel has based its CPU business on all the compatibility baggage it has accumulated over the last decade or so. That wasn't the wrong thing to do; we demanded compatibility, and Intel, with the help of Microsoft, supplied it. But that was then, and this is now: The compatibility baggage just weighs too much. To get the performance gains we need in computing, we have to shed some of that chip-level compatibility. Let the operating systems' microkernel take over some of that burden, and let the CPUs run faster.

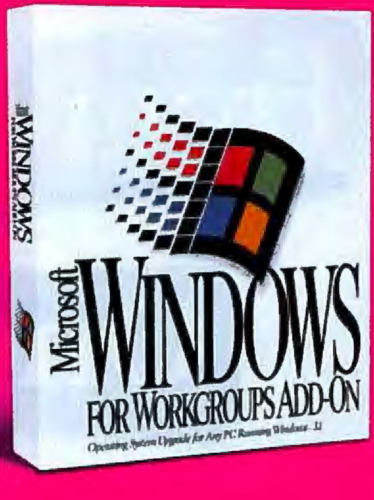
That means that Intel has to find a way out of its 80x86 debacle. Sure, millions of 80x86 and Pentium systems will still be sold, but more and more of the market—and eventually, nearly all of it—will move to RISC. So far, Intel hasn't given any real hints as to what its response will be. The P54C—and, based on sketchy preliminary reports, the P6—are not an adequate response to the RISC phenomenon. Unless Intel mounts a more meaningful response, the King of CISC might become nothing more than king of the hill after all the other players move to another hill. ■



DENNIS ALLEN, EDITOR IN CHIEF
(dallen@bix.com)

MAKE YOUR WINDOWS 3.1 *go faster.*

CHANGE GEAR.



Microsoft® Windows™ for Workgroups 3.11 is fast. Very fast.

In fact it might be more appropriate to call it Microsoft Windows GTI. Because, for local disk access, it's now up to 150% faster than Windows 3.1 operating system. This added speed, powered by 32-bit technology from our "Chicago" project, means applications can be loaded at twice the speed. It also makes searching for files and loading Windows up to 100% faster.*

You'll be happy to hear that this new version of Windows can be used by everyone, whether you're stand-alone, networked, or dialing into your office from the road. Windows for Workgroups just installs what you need and you're off to the races.

Packed with new features like Microsoft At Work™ fax technology and super-fast networking that works with Novell® NetWare®, Windows NT™ and other standards, Windows for Workgroups 3.11 is an essential upgrade for any Windows 3.1 user. But there's only one way to experience this speed and power. Drive it.

Microsoft

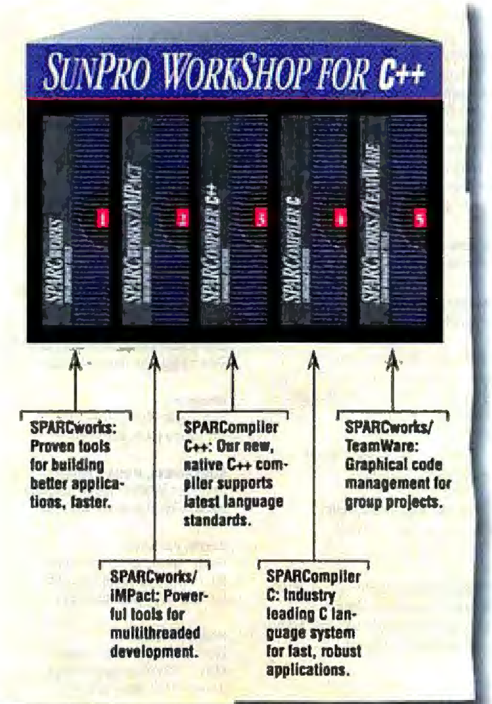
*Performance figures may vary depending on configuration. Ziff-Davis WinBench™ speed tests were average performance runs (100 being baseline avg.) based on a Zenith Znote 425 Lnp+Intel 80386-based computer and an 80846-based computer (both uncompressed and compressed disk volumes used) with 4MB RAM, 200MB hard disk 512 cache and IDE disk controller. Test was run using MS-DOS® 6.2. Test not verified by Ziff-Davis. Microsoft and MS-DOS are registered trademarks and Windows, Windows NT and Microsoft At Work are trademarks of Microsoft Corporation. Novell and NetWare are registered trademarks of Novell Corp. In the 50 United States, call (800) 426-9400. Customers in Canada, call (800) 563-9048; outside the 50 United States and Canada, call your local Microsoft subsidiary or (206) 936-8661.

Using a mixed bag of UNIX® development tools raises a few questions.

Are the tools compatible? Do you have everything you need to complete the job? Will you get home before dawn? Is there a better way?

Definitely.

Introducing SunPro WorkShop.™ For the first time, our best and brightest tools for FORTRAN, C, or C++ development—SPARCworks,™ SPARCworks/iMPact, SPARCompiler,™ and SPARCworks/TeamWare—are now together in one boxed suite. All the core tools you need for faster, smoother, easier Solaris® development.



Each product has been carefully designed to work hand in hand with the others.

You'll save so much time, you can send the coffee machine on a much-deserved vacation.

Yet they're all strong enough to stand on their own.

First, our new SPARCworks development tools feature graphical source and class browsers, a performance analyzer, a make file browser, and a file merge utility.

These tools also include our rather incredible, we're-not-kidding-when-we-call-it advanced Debugger, with enough bells and whistles to fill up another ad. Like Runtime Error Checking to catch problems before they become problems, and Fix and Continue so you can make source code changes on the fly. It's called a debugger, but it acts like an exterminator.

We've beefed up our compilers, too.

Our new SPARCompiler C and FORTRAN language systems compile source files 30-40% faster. Our new SPARCompiler C++ compiles up to 3x faster. And our new code optimizers boost run-time execution performance 10-15%.

Making their first appearance right here on this page are our new SPARCworks/iMPact tools. They're the ultimate for harnessing the power of your multi-processing hardware and feature a thread-aware debugger and automatic parallelizing FORTRAN compiler.

And finally SPARCworks/TeamWare code management tools let you easily distribute and coordinate group projects, so everyone on your team can work well with everyone else.

SunPro WorkShop also features our new ToolTalk™ interfaces that extend our core development tools so you can even add other tools to the mix.

There's simply nothing like our SunPro WorkShop for C, C++, and FORTRAN. And SunPro's the only company that could bring it to you. And at just $2995 for the C++version, it's an unbelievable value.

So let us put our money where your mouse is. Call 1-800-2SUNPRO and we'll send you either a video demonstration or our 30-day Try and Buy CD for evaluation. Ask about our Trade-up Program.

After all, why piece together development tools when you can get them all in one box.

With the SunPro WorkShop.

SunPro
A Sun Microsystems, Inc. Business

Circle 158 on Inquiry Card.

BYTE

EDITOR IN CHIEF
Dennis Allen

EXECUTIVE EDITOR
Rich Friedman

MANAGING EDITOR
D. Barker

ASSISTANT MANAGING EDITOR
Lauren Stickler Thompson

NEWS
Peterborough:
News Editors: David L. Andrews, Carol J. Swartz
Researcher: Martha Hicks
San Mateo/West Coast:
Bureau Chief: Andrew Reinhardt
Senior Editor: Tom Halfhill
New York:
News Editor: Ed Perratore

BYTE LAB
Director: Stanford Diehl
Technical Director: Rick Grehan
Senior Editor: Alan Joch
Technical Editor: Dave Rowell
Testing Editors/Engineers: Howard Eglowstein, Ben Smith
Lab Assistant: Selinda Chiquoine

STATE OF THE ART/FEATURES
Senior Editor: Michael Nadeau
Technical Editors: Russell Kay, Robert M. Ryan, Scott Wallace

SENIOR TECHNICAL EDITORS
At Large: Tom Thompson, Jon Udell, David Vislosky

SENIOR RESEARCHER
Rowland Aertker

ASSOCIATE TECHNICAL EDITORS
Susan Colwell, Cathy Kingery, Margaret A. Richard, Warren Williamson

SENIOR CONTRIBUTING EDITOR
Jerry Pournelle

CONTRIBUTING EDITORS
Stephen Apiki, Barry Nance, Dick Pountain

CONSULTING EDITORS
Nicholas Baran, Raymond GA Côté, Trevor Marshall, Stan Miastkowski, Roberta Pournelle, Ellen Ullman, Peter Wayner

EDITORIAL ASSISTANTS
Office Manager: Peggy Dunham
Assistants: Linda C. Ryan, June Sheldon

DESIGN
Design Director: Roger Goode
Associate Director: Joseph A. Gallagher
Graphics Manager: Doreen Means
Designers: Jan Muller, Sharon Price
Production Manager: David R. Anderson
Editorial Graphics Manager: Virginia Reardon
Graphics Production Coordinators: Barbara Busenbark, Donna Sweeney

PRODUCTION AND FINANCE
Director: Claudia Flowers

ADVERTISING PRODUCTION
Advertising Production Manager: Linda Fluhr
Senior Advertising Services Representative: Lyda Clark
Advertising Services Representatives: Dale J. Christensen, Karen Cilley, Rod Holden
Operations Assistant: Lisa Jo Steiner
Advertising Graphics Manager: Susan Kingsbury
Graphics Production Coordinators: Christa Patterson, Lillian J. Wise

FINANCE
Senior Financial Analyst: Kenneth A. King
Financial Analyst: Kathleen Deguise
Data Processing Coordinator: Diane Henry
Production Assistant/Purchaser: Agnes Perry

MARKETING AND PLANNING
Director: L. Bradley Browne
Administrative Asst.: Arja Neukam
Marketing Communications Manager: Rob Mitchell
Marketing Art Director: Stephanie Warnesky
Market Research Manager: Julie Perron
Copyrights Manager: Faith Kluntz
Reader Service: Cynthia Sands
Marketing Events Coordinator: Carol Sanchioni

CIRCULATION
Director: Glyn Standen
Subscriptions Manager: Paul Ruess
Assistant Manager: Lynn Lagasse
Subscriptions Assistant: Christine Tourgee
Newsstand Manager: Vicki Weston
Assistant Manager: Karen Desroches
Back Issues: Jill Wood
Direct Accounts Coordinator: Ellen Dunbar

PUBLISHER
Ronald W. Evans

Publisher's Assistant: Donna Nordlund

ASSOCIATE PUBLISHER, V.P. SALES & MARKETING
David B. Egan
Administrative Assistant: Carol Cochran

ADVERTISING SALES
NEW ENGLAND
Sanford L. Fibish (617) 860-6344
Patricia Payne (603) 924-2654

EAST COAST
Kim Norris (212) 512-2645
Jonathan Sawyer (603) 924-2665

SOUTHEAST
Mary Ann Goulding (404) 843-4782
Brian Higgins (603) 924-2651

MIDWEST
Kurt Kelley (312) 616-3328
Ed Ware (603) 924-2664

SOUTHWEST, ROCKY MOUNTAIN
Jennifer Walker (214) 701-8496
Brian Higgins (603) 924-2651

SOUTH PACIFIC
Beth Dudas (714) 753-8140
Alan El Faye (213) 480-5243
Brad Dixon (603) 924-2574

NORTH PACIFIC
Bill McAfee (415) 513-6862
Roy J. Kops (415) 513-6861
James Bail (603) 924-2662

INSIDE ADVERTISING SALES
Director: Diane Lieberman
Assistants: Susan Monkton, Vivian Bernier

THE BUYER'S MART (1 × 2)
Margot Swanson (603) 924-2656

HARDWARE/SOFTWARE SHOWCASE
Ellen Perham (603) 924-2598
Mark Stone (603) 924-2695

REGIONAL
Ed Ware (603) 924-2664

BYTE DECK
Susan Rastellini (603) 924-2596

EURO-DECK
Joseph Mabe (603) 924-2533

INTERNATIONAL ADVERTISING SALES STAFF
See listing on page 303.

PERSONNEL
Human Resources Administrator: Patricia Burke
Assistant: Fran Wozniak
Receptionist: Beverly Goss

How to Contact the Editors

We welcome your questions, comments, complaints, kudos, and submissions.
MAIN OFFICE: One Phoenix Mill Lane, Peterborough, NH 03458, (603) 924-9281.
San Mateo: 1900 O'Farrell St. #200, San Mateo, CA 94403, (415) 513-6912.
Los Angeles: 15635 Alton Pkwy., Suite 290, Irvine, CA 92718, (714) 753-8140.
New York: 1221 Avenue of the Americas, New York, NY 10020, (212) 512-3175.
U.K./EUROPE: 34 Dover St., London W1X 4BR, England, +44 71 495 6780.
ELECTRONIC MAIL: On BIX, send to "editors." All BYTE editors and columnists also have individual mailboxes on BIX for easy access.
MCI: 250-0135 BYTE Magazine. Many editors also have individual MCI addresses in their own name.
OTHERS: Many editors also are reachable through uunet, AppleLink, CompuServe, and numerous other services.
U.S. fax: Editorial: (603) 924-2550
Advertising: (603) 924-7507
U.K. fax: +44 71 495 6734

SUBMISSIONS:
Authors: We welcome article proposals and submissions. Unacceptable manuscripts will be returned if accompanied by sufficient return postage. Not responsible for lost manuscripts or photos.
Vendors: We welcome news of your new products; please call the News department or the BYTE Lab at the earliest possible date. We cannot be responsible for unsolicited product samples.

ARTICLE REPRINTS:
For price quotations on customized reprints of BYTE articles, contact Susan Monkton, reprints manager, at (603) 924-2618. (Minimum quantity: 500.)

Subscription Customer Service

Inside U.S. (800) 232-BYTE; outside U.S. +1 609 426 7676. International subscribers may also contact our international customer service facility in Galway, Ireland, by calling +1 353 91 752792 or via fax: +1 353 91 753793. For a new subscription, (800) 257-9402 U.S. only, or write to BYTE Subscription Dept., P.O. Box 555, Hightstown, NJ 08520. Subscriptions are $29.95 for one year, $54.95 for two years, and $74.95 for three years in the U.S. and its possessions. In Canada and Mexico, $34.95 for one year, $64.95 for two years, $87.95 for three years. In Europe, £42 (US$60) for fast surface delivery, £55 (US$80) for air delivery. Non-European countries US$60 for surface mail, or US$85 for air mail. Single copy price is $3.50 in the U.S. and its possessions, $4.50 in Canada. Foreign subscriptions and sales should be remitted in U.S. funds drawn on a U.S. bank. Please allow six to eight weeks for delivery of first issue.

PHOTOCOPY PERMISSION:
Where necessary, permission is granted by the copyright owner for those registered with the Copyright Clearance Center (CCC), 222 Rosewood Dr., Danvers, MA 01923, to photocopy any article herein for personal or internal reference use only for the flat fee of $1.50 per copy of the article or any part thereof. Correspondence and payment should be sent directly to the CCC, 222 Rosewood Dr., Danvers, MA 01923. Specify ISSN 0360-5280, $1.50. Copying done for other than personal or internal reference use without the permission of McGraw-Hill, Inc., is prohibited. Requests for special permission or bulk orders should be addressed to Faith Kluntz, copyrights manager, (603) 924-2525. BYTE is available in microform from University Microfilms International, 300 North Zeeb Rd., Dept. PR, Ann Arbor, MI 48106 or 18 Bedford Row, Dept. PR, London, WC1R 4EJ, U.K.

BIX Interactive On-line Service

MANAGING EDITOR
Christine Taylor

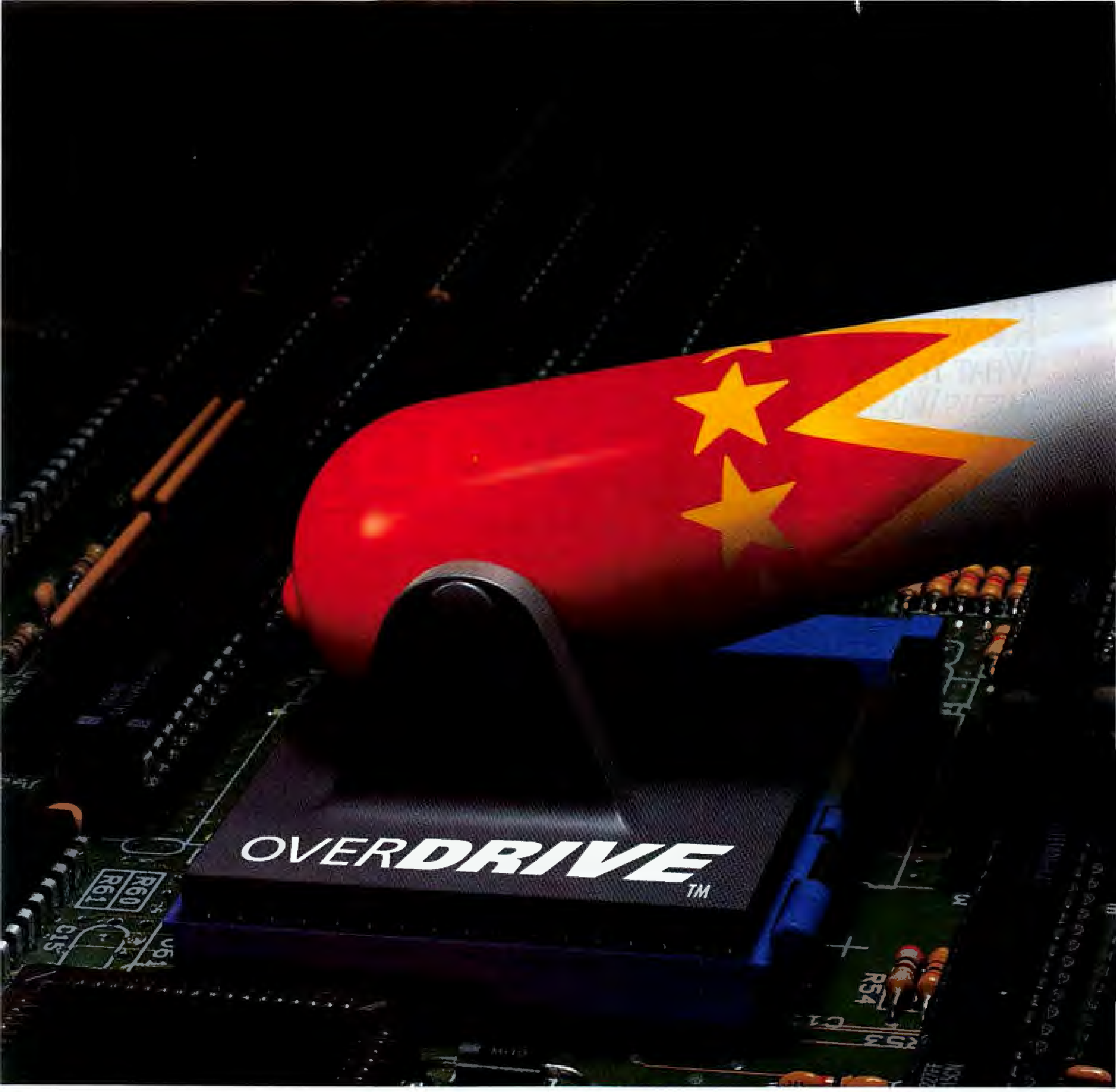
EXCHANGE EDITORS
Amiga Exchange: Joanne Dow
Entertainment and Leisure Exchange: Rich Taylor
IBM Exchange: Barry Nance
Programmers Exchange: Bill Nicholls
Professionals Exchange: David Reed
Tojerry Exchange: Jerry Pournelle
WIX Exchange: Karen Kenworthy
Writers Exchange: Wayne Rash Jr.

TECHNICAL ASSOCIATE
Mark Lavi

MEMBER SERVICES MANAGER
Kevin Plankey

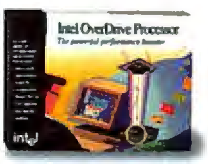
BIX, owned and operated by Delphi Internet Services Corporation, is a worldwide, low-cost, on-line information service featuring industry news, downloadable software, powerful electronic mail, previews of upcoming BYTE articles, the full text of published issues of BYTE, and source and/or executable code for BYTE benchmarks and noncommercial software mentioned in feature articles. BIX also offers unmatched "conferences" on virtually every computer-related topic imaginable, where you can share information with thousands of other computer pros. To subscribe via modem, set your communications software to full duplex, 7 bits, even parity, 1 stop bit, and then call (800) 695-4882 or (617) 491-5410, or telnet to x25.bix.com and type "bix" at the USERNAME prompt. At the Name? prompt, type bix.ville. For more information, call (800) 695-4775 or (617) 354-4137 (voice); send a fax to (617) 491-6642; or send Internet mail to info@bix.com.

OFFICERS OF MCGRAW-HILL, INC.: *Founder:* James H. McGraw (1860–1948).
Chairman and Chief Executive Officer: Joseph L. Dionne; *President and Chief Operating Officer:* Harold W. McGraw III; *Executive Vice President, General Counsel, and Secretary:* Robert N. Landes; *Executive Vice President and Chief Financial Officer:* Robert J. Bahash; *Senior Vice President, Treasury Operations:* Frank D. Penglase; *Executive Vice President, Publication Services:* Norbert Schumacher; *Vice President/Group Publisher, Computer Magazines:* Fritz Landmann.



Give your power-hungry soft

The OverDrive™ processor. The single-chip upgrade that maximizes your PC's performance.



Want to see a spectacular performance? Then add an Intel486™ DX2 OverDrive processor to your Intel486 SX or DX CPU-based system. And watch *all* your power-hungry software take off.

The OverDrive processor improves the performance of all your applications. So you can fly through your overwhelming workload with the greatest of ease.

How does the Intel486 DX2 OverDrive processor do it? Using Intel's innovative DX2 "speed doubling" technology, it runs internally at twice the speed of the rest of your system. So if you had a 33 MHz SX or DX Intel processor, you would now have a 66 MHz DX2 Intel processor.

*For European inquiries, call +44 (0) 793 431155, and ask for infopack IOD2.

Compression Woes

Having just read "How Safe Is Data Compression?" (February), I feel somewhat validated in my concerns. I have used all but the latest releases of Stacker and both DOS releases of DoubleSpace, and I have suffered catastrophic data loss with all of them—on five different computer systems.

I, too, had long assumed, as author Tom R. Halfhill claims, that "the real problem isn't data compression, though; it's how well the technology is implemented in the operating environment." Accordingly, I have always striven to limit the number of software vendors I've bought products from and always paid the premium for brand-name, U.S.-made hardware. Yet I continue to suffer catastrophic data loss. The common factors among all my difficulties have been the use of compression and the MS-DOS operating system.

My experiences with compression are wide and varied. Yet I am far from being an expert in the field. How could I hope to become one when even the technical-support staffs and engineering personnel are stumped?

Gregory D. Miller
Stanford, CA

Managing the Mac SCSI System

I work in the ROM/OS group at Apple Computer and am coauthor of the SCSI Manager 4.3. I recently read Tom Thompson's review of the Mac Quadra 840AV in BYTE ("New Mac Blazes Technology Trails," January) and noticed what I believe are a few inaccuracies regarding the SCSI Manager.

File system I/O on an 840AV is slower than on previous Macs, but not because of the SCSI Manager; rather, this is due to a bug in the file system. Future revisions of the System software will fix this problem.

Second, the Mac OS does take advantage of asynchronous I/O. True, the file system is not multithreaded, which would help in disk-to-disk copies, but it is asynchronous. The big problem is that most applications don't use asynchronous I/O because hard disks aren't asynchronous. If applications writers started using the time that they get back from the operating system to do screen updates, decompression, and so forth, they could realize a big performance win.

Clinton Bauder
Apple Computer
Cupertino, CA

I stand corrected. Thanks for pointing out that the real problem lies with a bug and not the SCSI Manager itself. It will be interesting to see if developers take advantage of the asynchronous calls.
—Tom Thompson

Much Ado About Richard III

Doesn't anyone in your editorial offices have an education in something other than computer science? Not to be personal or insulting, but I cannot imagine a literate adult publishing the specious, babbling nonsense written in your January Commentary on Richard III. Really, folks, the trite, pompous comparison of Shakespeare's second most complex character to your average hardware, software, or network guru is beyond comprehension and trying of patience.

Richard Shorr
Paris, France

The members of our editorial staff have diverse educational backgrounds, with degrees in electrical engineering, physics, mathematics, geology, journalism, architecture, English, and so on. As a matter of fact, one of us studied Shakespeare intensively for three years and thus, if nothing else, was able to write the headline that appears above your letter.
—Eds.

I read with great interest the January Commentary written by Thornton A. May comparing an MIS director with Shakespeare's Richard III. While the subtitle of the article did not differentiate between a dramatic character and a historical one, May was careful to make note of the fact that it was indeed Shakespeare's fictional character, and not the actual king, that he was writing about. May is to be congratulated for making this distinction.

Far from being the bloodthirsty tyrant of the play, Richard III was in fact an enlightened monarch and was responsible for a great deal of farseeing legislation. The subsequent blackening of his reputation by the Tudor dynasty that followed him was due to the fact that Henry VII had to justify an extremely slim claim to the throne.

Margaret Gurowitz
Richard III Society
New Orleans, LA

Cover to Cover

I want to compliment everyone at your organization for producing such an outstanding periodical. Over the past week I have perused four different magazines that devote their coverage to PCs. BYTE was the only one that I read cover to cover. In fact, I am now rereading several of the pieces in the January issue dealing with advanced operating systems and CPU architecture. I was impressed with the depth and detail of these articles. Keep up the good work.

C. L. Morrison
Panama City, FL

Fixes

In "Best of Comdex Awards" (February News&Views), we did not mention that VRex and its µPol technology, a finalist in the Most Significant Technology category, also won the Best Rookie award. We apologize for the omission.

Mathematica (Lakeland, FL), the company whose product was a finalist in the Best Multimedia Software category in BYTE's Best of Comdex awards, was at press time waiting to emerge from Chapter 7 bankruptcy proceedings. The Windows-based CD-ROM premastering and mastering program for CD-ROM recorders that was formerly published by Mathematica is now being sold by American Infoscience ((800) 382-3766 or (512) 440-1132) as CD Producer, at a price of $1995. ■

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

Choosing a True Color Accelerator

It is no longer necessary to give up performance or high resolution to have rich photographic colors. Some valuable information to help you select a true color accelerator follows:

Performance = 64+24

True color (referred to as 24-bit, or 16.7M colors) requires a graphics board to process three to four times more information than it would for 256 colors. Fast 64-bit graphics chips with complete hardware-assist functions for 24-bit acceleration are best suited for fast true color use. Some accelerators offer only 32-bit graphics engines or limited 24-bit color drawing functions. When comparing graphics performance, be sure to ask your vendor for results in true color mode, not just in 256-color mode.

Don't Reboot Windows

Conventional 2MB graphics cards force you to choose between high resolution graphics at 1280x1024 with only 256 colors or true color with only 800x600 resolution. Since you can't have high resolution mode for detailed text work and true color mode for rich photographic colors at the same time, you have to compromise.

To switch modes, conventional boards require you to leave the application and then restart Windows. This process is inconvenient and time consuming. Look for features like ATI's WinSwitch, which allows you to quickly and conveniently toggle between high resolution mode and true color mode using a simple keystroke without closing your applications or leaving Windows.

VRAM Really Matters

Only VRAM memory guarantees stable performance in true color modes because of their dual port design. Most DRAM accelerators may look fast in 256-color mode, but will offer only a fraction of the performance of VRAM accelerators in true color mode. Avoid DRAM memory for serious true color work.

Watch for new helpful information......

GRAPHICS AND MULTIMEDIA ACCELERATOR • GRAPH

Attack of the Killer Pixels

There's millions of them, and they're moving fast to infest every PC with deadly precision and terrifying speed. The hordes of killer pixels from ATI's GRAPHICS PRO TURBO will turn your PC into an amazing hive of graphics activity.

accelerated by mach64 ATI TECHNOLOGIES INC.

64-Bit Stinger

Stirred up by our 64-bit *mach64* accelerator chip, the GRAPHICS PRO TURBO sends your applications swarming across the screen at fantastic velocities – over 100 million Winmarks*. Work faster not harder, even in demanding high resolution, true color applications.

GRAPHICS PRO TURBO outperforms other accelerators.

GRAPHICS PRO TURBO is the ideal card for today's hot PC architectures. With up to 4MB of memory for 1280x1024 graphics in 16.7 million colors, VRAM ensures consistent performance across all display modes. And unlike a lot of other accelerators, the GRAPHICS PRO TURBO is frantically fast not just in Windows, but in DOS and other environments as well.

True Killer Color

ATI's new strain of pixels is not only fast, it's vibrantly colored as well. GRAPHICS PRO TURBO gives you accelerated 24-bit true color that never stops working, even at resolutions as high as 1280x1024. In fact, it runs in 16.7 million colors as fast as other cards do in just 256. Our exclusive software keeps all that color under control. Color calibration software provides a perfect match for graphic arts applications. Plus

News & Views

PROCESSORS

Intel Pushes the 80x86 Envelope

In terms of sheer processing power, Intel is behind the RISC curve. Its next-generation Pentium, the P6, may only keep the gap from widening even further. But for Intel, that may be enough.

BY DAVE ANDREWS

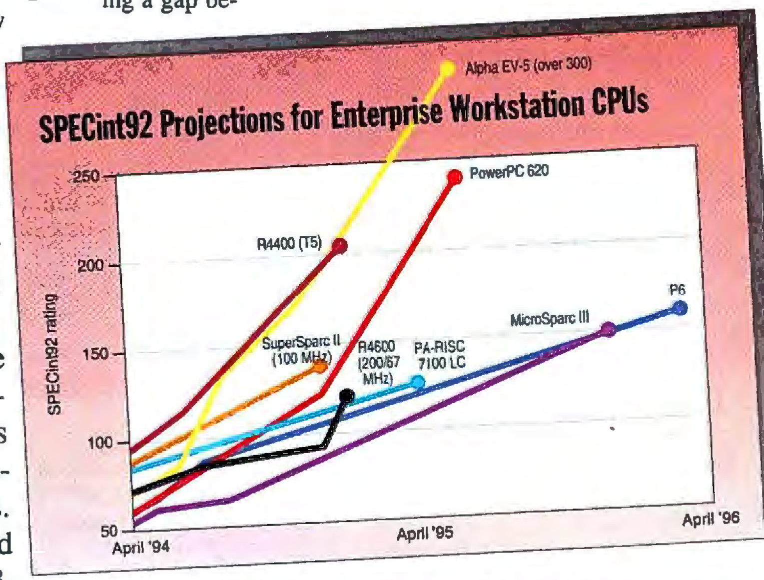
On April 1, Intel will reduce the price of its 66-MHz Pentium chip from $871 to $750 each in quantities of 1000, company officials say. Given that chip's optimized SPECint92 rating of 67.4, that means a system vendor will pay about $11.12 per SPECint92 for a 66-MHz Pentium at the new price. By comparison, Sun Microsystems' MicroSparc II processor running at 70 MHz delivers a 54-SPECint92 rating at a volume price of $400 each, or about $7.40 per SPECint92. And the PowerPC 601 chip, running at 66 MHz, delivers a rating of 60 SPECint92, for about $6.45 per SPECint92—roughly half the cost of the 66-MHz Pentium.

Industry experts and analysts agree: In the microprocessor war, Intel has lost the price/performance battle to RISC. Intel's response? It's getting more aggressive on pricing and is accelerating the introduction of new processors. It was expected to introduce in March 90- and 100-MHz versions of a new 0.6-micron, 3.3-V Pentium family, code-named the P54C, that analysts expect will offer a 30 percent to 50 percent performance boost over today's Pentium.

Intel's other recent processor introductions include the DX4/100, a 486 processor that operates at 100 MHz internally and is about 50 percent faster than a 486DX2/66, neatly filling a gap between the fastest 486 and the slowest Pentium. Says Lew Paceley, marketing director for the P6 line at Intel, "We just keep driving our engine harder and harder."

Intel says its next-generation 80x86 processor, code-named P6 and slated to start appearing in late 1995, will deliver roughly 300 MIPS, compared to the approximately 100 MIPS that you get from a 60-MHz Pentium today. Such an accomplishment—if Intel can meet that goal within that time frame—means the company will have reduced the amount of time between the introduction of its successive next-generation microprocessors by about a year. A late-1995 rollout of the P6 will represent an elapsed time of only 33 months after the first Pentium was announced in March 1993; 44 months passed between the introduction of the first 486 and the debut of the Pentium.

But by late 1995, Motorola



Projections are based on interviews with company officials and industry analysts. In addition to the cost of the microprocessor, other factors influencing overall cost of a system include level of processor integration, operating-system RAM requirements, chip die size, availability of low-cost peripherals, and application prices. Because many enterprise applications will rely more on integer than floating-point performance, processor SPECfp92 ratings are not shown.

and IBM expect to be deep into volume production on the PowerPC 620, which Motorola says will deliver four times the performance of today's PowerPC 601. Sun expects to deliver by the end of 1995 its next-generation MicroSparc III processor, which will achieve a rating of 150 SPECint92. Other companies, including Hewlett-Packard, DEC, Mips, and their partners, are pushing their RISC architectures up the performance curve as well (see the chart, below left).

"Even though the P6 looks impressive, it's still going to be well behind the performance of the PowerPC and other RISC chips," notes Linley Gwennap, editor in chief of the *Microprocessor Report* (Sebastopol, CA). "The rule of thumb is that RISC is either twice the performance at the same [chip] price as Intel, or the same performance at half the price." Gwennap also says that Intel is investigating multichip-module packages for the P6 that can increase performance and reduce footprint but would also be much more expensive than stand-alone CPUs.

Pure processing power is not the only way to measure the strength of a particular computing platform, however. Platforms are also measured by the breadth of available applications that are written by ISVs (independent software vendors). The 80x86 architecture, unlike RISC, runs thousands of DOS and Windows applications at native speeds without having to resort to slower software-emulation solutions such as Wabi or Insignia Solutions' SoftWindows. "The PowerPC and other RISC guys need to work on the software problem," Gwennap says.

Until more ISVs introduce 32-bit applications that run native on a given RISC platform, Intel will have a strong argument to stay with its 80x86 architecture. If you are looking for full compatibility and the fastest possible execution of today's Windows applications, the 80x86 architecture is for you. Indeed, the Framingham, Massachusetts–based International Data estimates that over 36 million PCs were sold worldwide in 1993, versus about 1 million workstations.

But fast execution of 16-bit Windows applications is not the chief objective of these new RISC PCs. Companies such as DEC, HP, and IBM, together with their system partners, are developing low-cost RISC-based PCs for a new emerging market of low-cost enterprise workstations. The enterprise workstation arena should see the most intense competition between RISC and CISC.

Enterprise workstations integrate high-performance CPUs with 32-bit operating systems such as Unix, Windows NT, and OS/2 and run applications that manage processes that directly affect a company's bottom line. These applications, according to Frost & Sullivan, a Mountain View, California–based market-research firm, include customer information systems, client/server databases, production, and R&D programs.

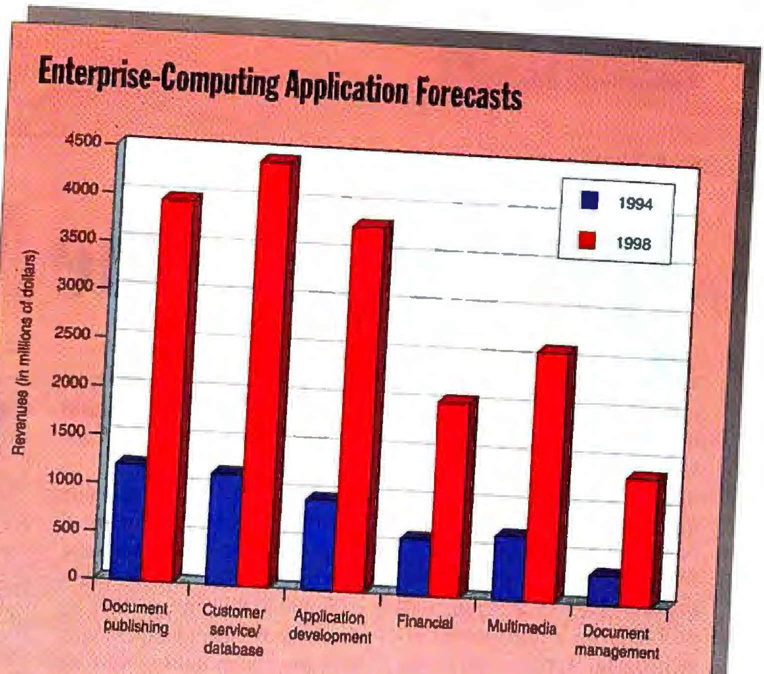
"The enterprise desktop is a market that is primarily business-operations-oriented," says Andrew Allison, consultant and editor of *Inside the New Computer Industry* (Carmel, CA), a newsletter that focuses on this new breed of PC. "It's far from clear that Intel has any software advantage in that market."

By their very nature, enterprise-critical applications have to run on operating systems that offer the stability and fault tolerance that are not available in today's fragile DOS-based environment. Intel's overall system-price advantage is eroding as well: This year, you can expect to see a wave of high-performance desktop RISC workstations selling in the \$3000-to-\$4000 range (e.g., HP's Series 700 systems, which start at \$3995).

Start-up companies such as Deskstation Technology (Lenexa, KS) are banking their future on developing low-cost, high-performance, RISC-based Windows NT PCs for companies that are downsizing their business operations. For example, Deskstation is now shipping its v4600, a low-cost workstation based on IDT's R4400-compatible R4600 processor running at 100 MHz internally. It comes with 16 MB of RAM and a 240-MB hard drive and costs \$2995.

Don Peterson, Deskstation president, says that over the next two years the company will deliver a range of systems designed to satisfy the needs of customers using everything from desktops to data centers; by the end of the year, the company plans to offer multiprocessor systems that will run demanding database applications. "We believe we'll be able to deploy low-end servers for under \$10,000 that will offer performance that's better than [that of] a two-processor Pentium," Peterson says.

The degree to which Intel can convince customers to purchase Pentium-based enterprise workstations that offer RISC-like performance depends in large part on Microsoft and how well Chicago, the next generation of Windows, succeeds in integrating 16-bit DOS and Windows in a 32-bit multitasking operating system that runs well on 8-MB-RAM PCs. If businesses decide that Chicago doesn't offer a compelling enough platform to run their applications, they will closely examine the new breed of RISC PCs, which will have the horsepower to run the next generation of sophisticated, layered 32-bit operating systems, such as Windows NT and CPU-hungry videoconferencing, database, and 3-D graphical applications.



Document publishing includes producing in-house brochures, layouts, and camera-ready documents.

Customer service/database includes credit-card inquiry, executive information, and on-line transaction processing.

Application development includes CASE and in-house development tools.

Financial includes accounting, modeling, and forecasting.

Multimedia includes authoring, training, and videoconferencing.

Document management includes the storage, query, and sending of proposals, reports, and other documents.

Databases will be a key application for enterprise workstations as companies turn to these programs to manage their high-volume, real-time data-entry and update needs, according to market-research firm Frost & Sullivan. Database applications do not generally require excellent floating-point performance, unlike complex financial-modeling and 3-D graphics applications.

OPERATING SYSTEMS

Apple Opens the Mac OS

After years of carefully guarding its Macintosh system software, Apple (Cupertino, CA) is taking steps to spread the Mac OS to several different platforms, including the unprecedented step of licensing System 7 to third-party clone makers. However, there will probably be a few strings attached, and Apple is still working out the details.

One catch is that System 7 will be licensed only for systems and devices that are based on the PowerPC. Another is that Apple is unlikely to sanction Mac clones that compete head-to-head against genuine Macs in Apple dealer channels. Instead, Apple suggests, clone makers will be encouraged to explore new global and vertical markets that aren't central to Apple's hardware business.

This is similar to Apple's strategy for licensing Newton technology. Although Newton partner Sharp (Japan) sells a hand-held PDA (personal digital assistant) that's almost identical to the Apple MessagePad, other Newton licensees are working on a variety of devices, ranging from digital cable TV set-top boxes to intelligent fax machines.

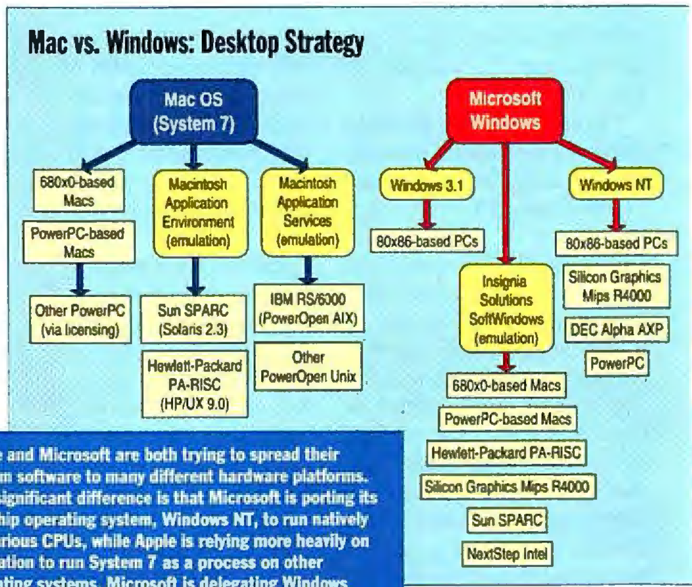
Why won't Apple license the Mac OS to run on Intel 80x86-based PCs? Because when Apple approached several potential licensees, says an Apple spokesperson, there was little interest in putting System 7 on PC clones. Instead, the vendors expressed more interest in building new PowerPC-based systems.

As with Apple's Power Macs, future "clone" systems could run the latest PowerPC Mac programs as well as existing Mac software, thanks to the 680x0 emulation built into the PowerPC version of System 7. An 80x86 version of the Mac OS would either require developers to port their software to that CPU or require Apple to add equally powerful 80x86 emulation to System 7. Neither task is trivial.

Another problem is that true Mac clones would require additional hardware not found in PCs, such as the ADB (Apple Desktop Bus) and Apple's implementation of SCSI. Although Apple hasn't worked out all the details, licenses might include rights to proprietary Apple hardware as well as system software.

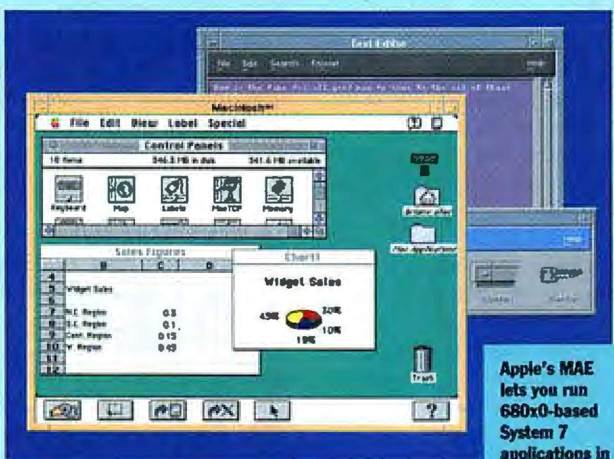
"This exercise is as much an art as a science," says Apple spokesman Frank O'Mahoney. "We're trying to make a marriage between two different business models—Apple's internal business model and those of our partners—and between two different technologies—our operating system and our partners' hardware."

—Tom R. Halfhill



Apple and Microsoft are both trying to spread their system software to many different hardware platforms. One significant difference is that Microsoft is porting its flagship operating system, Windows NT, to run natively on various CPUs, while Apple is relying more heavily on emulation to run System 7 as a process on other operating systems. Microsoft is delegating Windows emulation to a third party (Insignia Solutions).

APPLE'S 680X0 EMULATION FOR UNIX



Apple's MAE lets you run 680x0-based System 7 applications in an X window.

Licensing System 7 to third parties isn't the only part of Apple's spread-the-Mac strategy. On March 14, Apple also announced the Macintosh Application Environment, or MAE, a new Mac-on-Unix emulator that runs a System 7 session in an X Window System window on Sun SparcStations and Hewlett-Packard Series 700 workstations. MAE (see the photo) will allow 680x0-based Mac applications to retain their original look and feel while running under HP/UX 9.0 or Solaris 2.3 with either Motif or Open Look.

However, don't confuse MAE with MAS (Macintosh Application Services), Apple's previously announced Mac-on-Unix solution. Both are based on similar emulation technology (see "Emulation: RISC's Secret Weapon" on page 119). But MAS runs both 680x0 and PowerPC Mac software on PowerOpen-compliant versions of Unix, such as IBM's forthcoming revision of AIX. MAE is limited to 680x0 emulation on HP/UX and Solaris, although future versions may support AIX and even PowerPC emulation on other RISC platforms.

—T.R.H.

WATCOM VX•REXX is an award winning, easy to use visual development environment for creating OS/2 applications with rich graphical user interfaces. VX•REXX combines a project management facility, visual designer and an interactive source-level debugger to deliver a very approachable and highly productive visual development environment.

Design Applications Visually

Create rich graphical applications quickly and easily using the visual design environment. With the visual designer, you can graphically create CUA'91 Presentation Manager interface objects, quickly customize their properties, and easily attach REXX procedures using powerful drag-and-drop programming techniques.

Integrated Development Environment

Build, test and debug your application without leaving the development environment. Then package your application as an EXE file or PM macro for royalty-free redistribution. The power of the integrated development environment and debugger can also be used with your existing REXX applications.

Powerful Open Environment

Enjoy the simplicity of event-driven programming together with the global editing capabilities essential for professional project management. WATCOM VX•REXX is open and extensible through IBM's object-oriented System Object Model (SOM) technology. You can access all standard REXX API's including DB2/2, because VX•REXX is based on the OS/2 2.x standard system REXX.

Experts Agree...

"All in all, VX•REXX stands out for ease of use, versatility, and power. And at $199, including free tech support and free application distribution, it's also a sensational value."
PC Magazine, February 8, 1994.

"(VX•REXX) applications can be multithreaded and REXX is probably the easiest language in which to learn the OS/2 thread model."
Software Development, November, 1993.

"VX•REXX is a great tool; it's fun and productive."
PC Techniques, Dec/Jan. 1994.

Introductory Offer: $99*

Until March 25, 1994

Version 2.0 Highlights

- 26 Objects including CUA'91 Containers, Notebooks, Pop-up Menus and more
- Integration and control of existing applications through DDE, keystrokes or REXX API's
- Easy to learn event-driven programming model with complete on-line documentation
- Powerful drag-and-drop programming techniques simplify programming
- Develop professional multi-threaded, multi-windowed and drag-and-drop enabled applications
- 700 page manual packed with examples and sample programs
- Include OS/2 style help and hints in your applications
- Advanced interactive source-level debugger
- Support for the Q+E database library included
- Royalty-free run-time
- Package your applications as EXE files or PM macros
- Integrated console window support simplifies migration of existing REXX programs

Ready! for OS/2

PC MAGAZINE EDITORS' CHOICE February 8, 1994 Watcom VX-REXX Version 1.01

OS/2 PROFESSIONAL "The best new development tool of 1993"

WATCOM

1-800-265-4555

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

*Prices and specification are subject to change without notice. Price does not include freight and taxes where applicable. Prices quoted in US dollars. WATCOM, the Lightning Device, and VX•REXX are trademarks of WATCOM International Corporation. Other trademarks are the properties of their respective owners. ©Copyright 1994 WATCOM International Corporation.

There's a woman in San Francisco who carries 14 or 15 hearts inside her purse. Most beat strong. One needs repair. And one will soon find its way into a little girl named Katie.

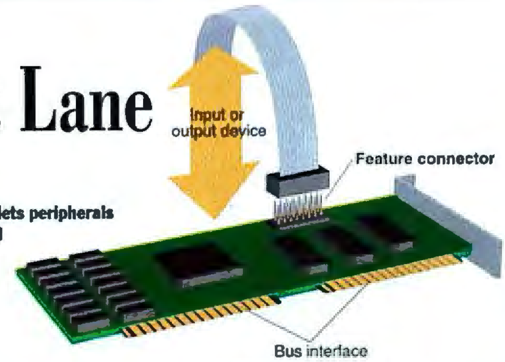
Their rightful owners are the patients of Pamela Robinson, a cardiac surgeon. She stores their information in a safe place, of course. One that can withstand 600 Gs of shock: a *Mobile*Max™ 105 MB PCMCIA hard drive. Astounding. So much data on a portable drive not much bigger than a credit card. It's one of the new products from Maxtor that have completely changed the way Dr. Robinson works. Like many professionals, there are several computers in her life: office, home and one for the road. A data nightmare for some. But not for the good doctor. With Maxtor's *Mobile*Max, she

can take her entire computing environment on one little drive. No bulky hardware. No leaning tower of floppies. She simply plugs her *Mobile*Max drive into any Type III PCMCIA slot. And if she meets a computer without a slot, a *Mobile*Max DeskRunner™ reader/writer from Maxtor provides full PCMCIA capability. Incidentally, Dr. Robinson isn't the only one concerned about prolonging life. *Mobile*Max drives use very little battery power. Which means she can go on working to her heart's content.

*Mobile*Max. It's where work is going.

PC VIDEO ACCELERATORS

Video Acceleration in the Fast Lane



A feature connector lets peripherals such as graphics and video cards communicate and share information over cables.

When designing multimedia PCs, systems engineers face a number of factors that conspire to make digital-video-capable PCs pricey while limiting their digital-video playback to quite unexciting, often postage-stamp-size movies. The price problem is due to a duplication of components in which PCs have two RAMDACs; two frame buffers; and two controllers, one each for video and graphics. The small-size movies and dropped frames are caused by architectures that can't transfer video at a fast enough rate.

Two coalitions offer new graphics standards to speed digital video across the desktop. The first, VESA (Video Electronics Standards Association), offers two solutions: VAFC (VESA Advanced Feature Connector) and VMC (VESA Media Channel). The other coalition, an Intel-ATI pairing, offers SFBI (Shared Frame Buffer Interconnect).

All three standards will require new graphics board designs and associated drivers to implement their promised speed boost. These new boards will plug into ISA, EISA, VL-Bus, PCI (Peripheral Component Interconnect), or Micro Channel slots. The first boards for VL-Bus and PCI are expected to be announced by the time you read this.

VAFC is a 32-bit replacement for the old and sadly out-of-date 8-bit VGA connector. While the old VGA feature connector supported a video in a window with a resolution of only 640 by 480 pixels and 8-bit color, VAFC supports video at much higher resolutions and in better color (up to 1024 by 768 pixels at 256 colors with a 75-Hz refresh rate).

VMC, like VAFC, offers a 32-bit data path. But VMC supports up to 15 video streams simultaneously and offers a more long-term solution for video computing than VAFC. One developer described VMC as "a video superhighway that bypasses the already-crowded system bus." Since VMC is a dedicated channel for real-time video, peripherals can communicate independently and without slowing the system CPU. VMC decouples the memory subsystem from the video transfer specification, allowing graphics board manufacturers to offer a variety of boards with differing types of graphics memory—DRAM, VRAM (video RAM), synchronous DRAM, RAMBUS, and other future memory standards.

Hossein Yassaie, vice president of engineering for VideoLogic, says that adding VMC capabilities to a system increases the cost to the consumer by \$10 to \$30. He adds that the cost to add videoconferencing hardware to a VMC-equipped system would be about \$600, compared to the \$3000 or so that the hardware costs today.

Intel-ATI's SFBI combines frame buffers and memory used by each multimedia subsystem into a single, shared memory pool of up to 8 MB, with a protocol for arbitrating among devices attempting to tap into that memory. The design goal is to keep all components on one board while reducing board cost by eliminating duplicated memory among multiple devices. However, unlike VMC, SFBI currently mandates using either VRAM or DRAM.

SFBI is faster than VAFC and VMC, offering a top-end transfer rate of 200 MBps, but that rate is for a 64-bit datapath implementation. In 32-bit mode, SFBI offers closer to 100-MBps data transfer. To tweak the speed further, SFBI includes SynchroLink, a channel that coordinates video and sound sources without accessing the host processor.

Although the SFBI scheme provides no external feature connector, you can connect an SFBI card to another SFBI card over the host bus or, if you have an interface on the SFBI card that can connect to a VMC or VAFC card, you can connect the two cards that way. Indeed, Don Fraser, ATI product manager of video components, contends SFBI complements, rather than competes with, VAFC and VMC.

At press time, three companies had announced boards that are based on one of the new standards and illustrate the benefits of these new video architectures. For example, Matrox's \$649 MGA Ultima-VAFC for PCI allows video playback at resolutions of 1280 by 1024 pixels at 30 frames per second. Matrox ((514) 685-2630) plans to introduce the MGA Video-Pro, a PAL and NTSC video-encoding board with a VAFC connector, in the second quarter of this year.

ATI's Video-It video-capture board offers real-time compression of video from a camcorder or a VCR, as well as live video in a window display at any resolution. ATI ((905) 882-2600) says it will release Video-It in mid-April for \$499.

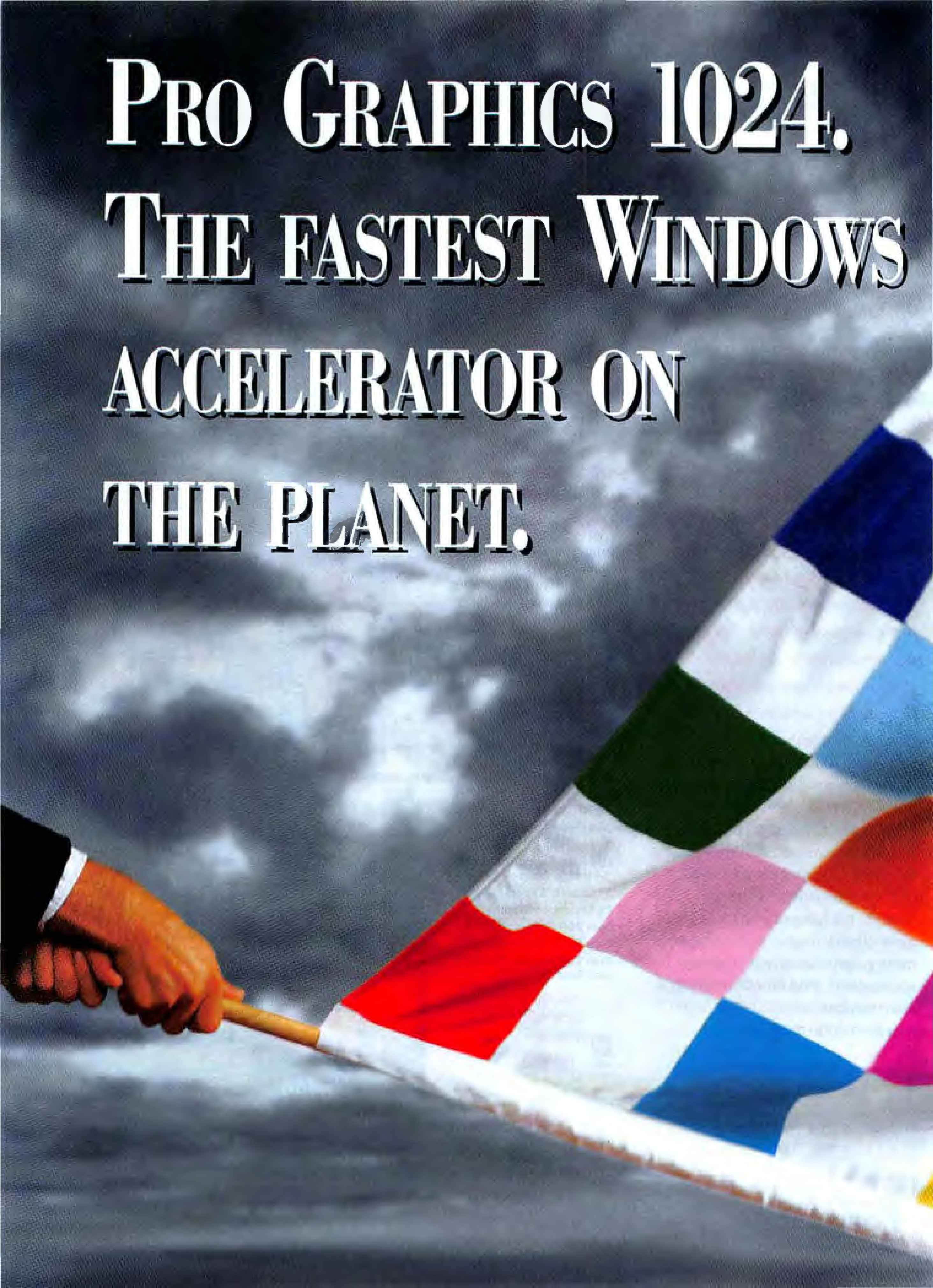
VideoLogic's 928Movie (from \$349), a multimedia accelerator board developed jointly with IBM, combines graphics acceleration with VideoLogic's custom ASIC PowerPlay Digital Movie Accelerator. VMC add-ins from VideoLogic ((617) 494-0530) for MPEG video capture and playback are scheduled for release in the second quarter of this year.

Other vendors are sure to release board products throughout the year.

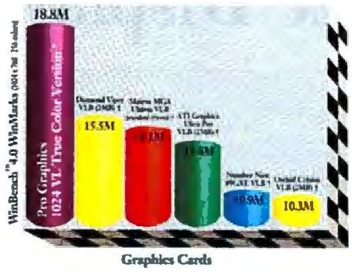
—Russ Lockwood

VIDEO FAST-LANE LINEUP

VESA Advanced Feature Connector	VESA Media Channel	Shared Frame Buffer Interconnect
A short-term solution for video overlay in high-resolution graphics modes	A separate channel that merges graphics and video	Predominantly a single-card solution; merges graphics and video
150-MBps transfer rate	Maximum 132 MBps in 32-bit mode	Up to 200 MBps in 64-bit configuration
Eliminates RAMDAC duplication	Eliminates RAMDAC, frame-buffer duplication	Eliminates RAMDAC, frame-buffer duplication
No shared frame buffer	Designed for current and future RAM technologies	RAM and DRAM only
N/A	Supports any codec	Currently supports Indeo codec only


PRO GRAPHICS 1024.
THE FASTEST WINDOWS
ACCELERATOR ON
THE PLANET.

Break through the barrier. With Pro Graphics 1024 by Media Vision. Conceived and created as a new standard for Windows™ accelerators around the world, Pro Graphics 1024 sets the record for speed. And it's no wonder when you see what we've put into it.



For starters, consider Pro Graphics 1024's superior 72-bit engine. Specifically designed to increase your graphics speed, it makes the difference between just getting by and lightning speed.

In fact, most other Windows accelerators can't even come close to giving you 16.7 million colors and 1024 x 768 resolution at the same time. Nor can they give you a photo-realistic display with command of a larger Windows desktop. And a 76Hz refresh rate that makes "flicker" a thing of the past.

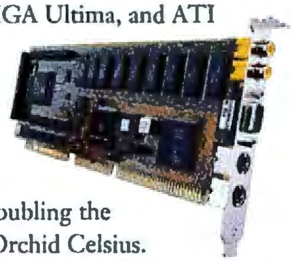
And superior speed and power.

Plus, Pro Graphics 1024 is multimedia upgradeable. So by adding a Media Vision video daughter card you can display video from any source, capture it, and play it on your screen, T.V. or record it on your VCR. Bottom line, Pro Graphics 1024 adds a whole new dimension to your multimedia experience.

Moreover, the Pro Graphics 1024 includes FastFilm™, a unique hardware feature that accelerates Video for Windows playback and eliminates missed frames and jerky AVI replay. Pro Graphics 1024 is also VGA and Super VGA compatible. It comes complete with display drivers for Windows 3.1, Windows NT, OS/2 and AutoDesk ADI which makes Pro Graphics 1024 compatible with all your applications, right from the start.

So what does this all mean when you put Pro Graphics 1024 up against other Windows accelerators? Well, we did a comparison test to answer that question.

The results? Pro Graphics 1024 performance emerged with an unprecedented WinBench® 4.0 Graphics WinMarks™ of over 18 megapixels per second. Blowing past the former champion Diamond Viper VLB, and all other competitors including Matrox MGA Ultima, and ATI Graphics Ultra Pro. And even coming close to doubling the speed of Orchid Celsius.



So as you can see, Pro Graphics 1024 not only outperforms other Windows accelerators, it pushes your graphics over the line. The finish line, that is.

MEDIA VISION

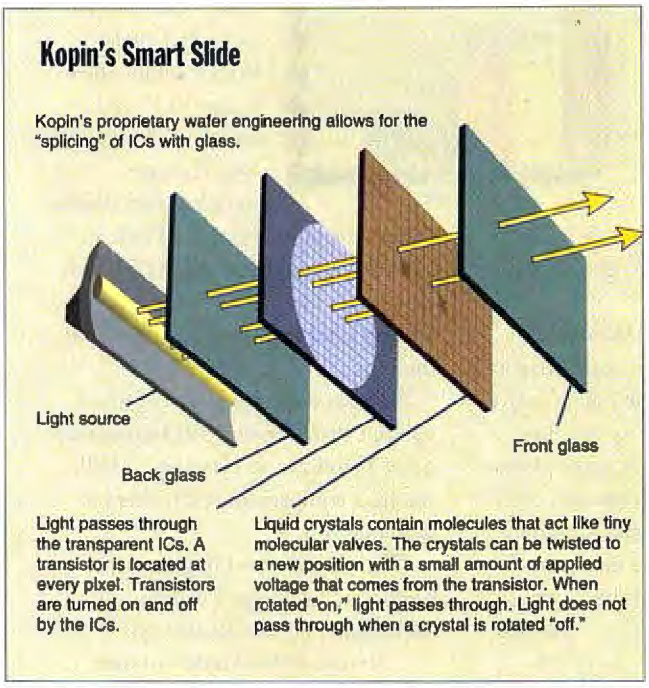
Now, that's multimedia!

Test performed using Ziff Davis Labs' WinBench® V4.0. * Test conducted by Media Vision without independent certification from Ziff Davis. Based on Micronics VL motherboard, Intel 486DX2/66 CPU, 8MB RAM, 256K cache, Western Digital Caviar 2250 IDE hard drive, MS-DOS 5.0 and Windows 3.1 enhanced mode. All products are shipping versions. † Benchmark results as published by Ziff-Davis in PC Magazine December 7, 1993 issue. Based on Micronics EISA/VL motherboard, 486DX2/66 CPU, 8MB RAM, 256K cache and 153MB hard drive. All products are shipping versions. 47300 Bayside Parkway, Fremont, CA 94538. (510) 770-8600. Pro Graphics 1024 is a trademark of Media Vision, Inc. Any other trademarks and registered trademarks are owned by their respective holders.

Circle 146 on Inquiry Card.

DISPLAY TECHNOLOGY

35mm-Size Display Has VGA Resolution



Kopin's Smart Slide imaging device consists of a thin-film, transparent IC containing the active matrix, the drive circuitry and other logic, and the liquid crystal, which is sandwiched between two glass panels.

It may not be long before you can wear a head-mounted display that's about the size of a 35mm slide yet sports 640- by 480-pixel VGA resolution. The technology behind the so-called Smart Slide from Kopin (Taunton, MA) is the ability to place active-matrix display circuitry on a single-crystal silicon wafer. The top layer of the silicon wafer, which contains the pixel array and integrated circuitry, is lifted and transferred to glass, leaving a transparent IC.

According to Dr. John Fan, Kopin's president and CEO, one of the major advantages of placing the display circuitry directly on silicon is that standard IC-fabrication techniques and facilities can be used rather than the specialized equipment used for the typical (and expensive) "silicon-grown-on-glass" LCD-fabrication method.

The limitation of this technique is the size of the silicon wafer. Although silicon wafers are available in sizes of up to 12 inches, it is more economical to use projection, since this technique allows a pixel resolution of 2000 lines per inch or even better, Fan says. "There are many ways to enlarge an image from a small display," he says. Therefore, the company is focusing on miniaturized displays and on projection systems that project the image from the Smart Slide to a larger screen.

Fan says that the Pocket Pro compact projection system, Kopin's first commercial product, will be available for $1500 in "a few months" and that once mass production starts, the price will drop steeply.

—Nicholas Baran

DISPLAY TECHNOLOGY

Motif Offers Variation on LCD Theme

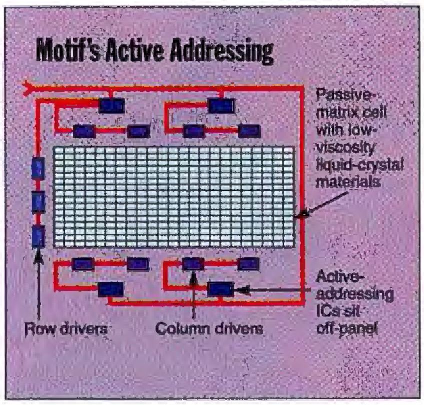
It's been a scant eight months since the Clinton administration repealed the antidumping tariff on imported active-matrix LCDs. But in the meantime, a potentially less expensive display technology has surfaced as a threat to active-matrix color.

Active addressing, developed by Motif (Wilsonville, OR), a company jointly owned by Motorola and In Focus Systems, uses much of the design of less expensive passive-matrix displays but with the response rates of active matrix. The cost of active-address display technology should fall somewhere between the prices for passive- and active-matrix screens. Motif recently showed BYTE a prototype screen that had a slight muddiness compared to an active-matrix screen. But its response rates matched those of active matrix during the playing of a digital video movie clip.

According to David Lunsford, director of advanced portable technology for Dell Computer, active addressing's improvements over dual-scan STN (supertwist nematic) could potentially bring down the prices of higher-end color notebooks.

The first products implementing active addressing could be announced by late this year. Display-product marketing manager Joel Pollack of Sharp Microelectronics (Camas, WA), Sharp's LCD engineering division, praises Motif's accomplishments. But he claims that by the time active addressing becomes as bright as TFT and attains VGA and higher resolutions at standard notebook LCD sizes, Sharp's investment in LCD technology will have begun to pay off in the form of less expensive TFTs. If this proves to be true, Motif will find its niche—but at the expense of passive- rather than active-matrix screen technology.

—Ed Perratore



With active addressing, proprietary ASICs (application-specific ICs) that sit off the panel can address many rows simultaneously. The ASICs take the image from the graphics card and quickly calculate in real time where voltages need to be applied to the crystals. According to Motif, this technique provides near-TFT performance at a slightly higher cost than passive matrix.

PLUG INTO

Plug into Supra for price and performance.

Plug into state-of-the-art technology — the revolutionary new SupraFAXModem 288 moves data at a blazing 28,800 bps, offering the fastest speeds ever! With error-free compression throughput can be as high as 115,000 bps!

Plug into value — SupraFAXModems are worlds ahead of similarly-priced modems. You'll get more features you can depend on, without spending more money.

Plug into dependability — each SupraFAXModem comes complete with cables, top-rated software, easy-to-read manuals, a generous five-year warranty and free support!

So go ahead. Plug into performance, dependability and value. Plug into Supra today!

For instant information, call Supra's FaxBack system at: 503-967-0072

Supra Corporation

For a Free Modem Catalog, or a Reseller near you: 1-800-727-8647

PRODUCT	PC	MAC	DESCRIPTION
SupraFAXModem 24/96i	$79.95	—	Internal 2400 bps data, 9600 bps send/4800 receive fax
SupraFAXModem PLUS	$139.95	$149.95	External 2400 bps data & 9600 bps fax
SupraFAXModem 144i	$149.95	—	Internal 14,400 bps data & fax
SupraFAXModem 144LC	$169.95	$189.95	External, low-cost 14,400 bps data & fax
SupraFAXModem 144PB	—	$269.95	Internal 14,400 bps data & fax for PowerBooks

PRODUCT	PC	MAC	DESCRIPTION
SupraFAXModem V.32bis	$229.95	$249.95	External 14,400 bps data & fax with display
SupraCOMcard 144	$349.95	—	PCMCIA 14,400 bps data & fax
SupraFAXModem 288i	$349.95	—	Top-of-the-line, internal 28,800 bps data & 14,400 bps fax
SupraFAXModem 288PB	—	$399.95	Internal 28,800 bps data & 14,400 bps fax for PowerBooks
SupraFAXModem 288	$399.95	$399.95	Top-of-the-line, external 28,800 bps data & 14,400 bps fax

7101 SUPRA DRIVE SW • ALBANY, OR 97321 USA • PHONE: [illegible] • FAX: [illegible] • [illegible] GmbH • CARL-FRIEDRICH GAUSS STRASSE 7 • [illegible] PULHEIM-BRAUWEILER • GERMANY [illegible]


Why is this
MULTIMEDIA
fan mellow ?
She just bought a CD-ROM-ready
AMBRA
Now she can simply sit back and enjoy the show!

Get set for SOUND and MOTION, save yourself time and trouble.

AMBRA™ multimedia systems arrive READY to ROLL!

SUPER POWER

DP60/PCI/MM

- Intel® Pentium™ processor, 60 MHz
- 64-bit CPU-memory-cache data path
- 256KB L2 and 16KB L1 cache
- 8MB RAM, max: 128MB
- 4 ISA, 2 PCI, 1 PCI/ISA slot
- 540MB (12ms) IDE hard disk
- 6 drive bays
- Fast PCI IDE controller
- PCI graphics accelerator, 2MB
- 15" FST-NI color monitor, LR
- 3.5" 1.44MB diskette drive
- Double-Speed Multisession Multimedia Kit
- Lexmark™ PS/2®-style 101-key keyboard
- MS-DOS® 6.2, Windows™ 3.1, mouse

$3,099

SUPER PERFORMANCE

D466DXA/MM

- 486DX2, 66 MHz
- Upgradable to Pentium technology
- 128KB L2 cache, max: 256KB
- 8MB RAM, max: 36MB
- 5 16-bit ISA slots
- 540MB (12ms) IDE hard disk
- 5 drive bays
- Local bus IDE controller
- Local bus graphics accelerator, 1MB
- 15" FST-NI color monitor, LR
- 3.5" 1.44MB diskette drive
- Double-Speed Multisession Multimedia Kit
- Lexmark PS/2-style 101-key keyboard
- MS-DOS 6.2, Windows 3.1, mouse

$2,349

SUPER VALUE

S450DX/MM

- 486DX2, 50 MHz
- Upgradable to Pentium technology
- 128KB L2 cache, max: 256KB
- 4MB RAM, max: 36MB
- 3 16-bit ISA slots
- 340MB (15ms) IDE hard disk
- 3 drive bays
- Local bus IDE controller
- Local bus graphics accelerator, 1MB
- 14" SVGA-NI color monitor, LR
- 3.5" 1.44MB diskette drive
- Double-Speed Multisession Multimedia Kit
- Lexmark PS/2-style 101-key keyboard
- MS-DOS 6.2, Windows 3.1, mouse

$1,948

THESE SYSTEMS ARE SOUNDBLASTER-COMPATIBLE AND SUPPORT MULTISESSION PHOTOCD.

MAKE AMBRA YOUR DIRECT SOURCE OF THE BEST AND LATEST TECHNOLOGY (MULTIMEDIA AND MORE) FOR LESS!

Our product line covers the complete range of computing needs: desktops to towers to easy-traveling notebooks. Besides marvelous multimedia, we build systems with the latest in processing and local bus technology. We offer a full selection of sizzling graphics accelerators and high-capacity hard drives, too.

LET US CUSTOM-BUILD A COMPUTER FOR YOU!

With AMBRA, you don't have to install multimedia options — we do it for you. But maybe you want something else? Whether it's extra memory or a modem, higher disk capacity or a different chassis, we'll custom-configure to your exact specs — at no extra service cost!

Special Bonus! "Try and Buy" software sampler on CD.[1]

AMBRA

For more systems and a superbuy on CD packs, read on!

1-800-200-3184

Pick a pack of CDs!
5 discs for just $79![2]

Business Bundle
Macromedia Developers Pack
Allegro Business Library
Sound Effects Library
Multimedia Business 500
PhoneDisc USA Business

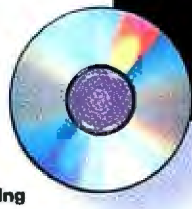
Pastimes Pack
Multimedia Audio Collection
Beethoven's 5th
Supersonic
Return to Zork
Video Hound

Home/Health/Holidays
Better Homes Cookbook
Complete House
Mayo Clinic Family Health
Chessmaster 3000
National Parks

Students' Helpers
Multimedia Encyclopedia
1993 Time Almanac
Mavis Beacon Teaches Typing
Monarch Notes
How Things Grow

Just for Kids (K-5)
Dr.T's Sing-A-Long
The Legends of Oz
Teddy's Big Day
Dandy Dinosaur
Macmillan Dictionary

AMBRA systems come at MONEY-SAVING prices — with MULTIMEDIA or without!

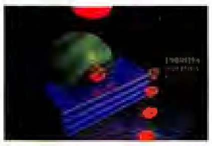


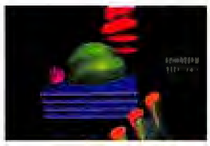
PENTIUM AND PCI TECHNOLOGY

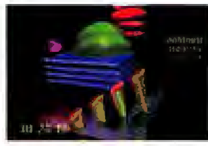
DP60/PCI

- Intel Pentium processor, 60 MHz
- 64-bit CPU-memory-cache data path
- 256KB L2 cache
- 8MB RAM, max: 128MB
- 4 ISA, 2 PCI, 1 PCI/ISA slot
- 540MB (12ms) hard disk
- 6 drive bays
- Fast PCI IDE controller
- PCI graphics accelerator, 2MB
- 14" SVGA color monitor, LR
- 3.5" 1.44MB diskette drive
- Lexmark PS/2-style 101-key keyboard
- MS-DOS 6.2, Windows 3.1, mouse

$2,679







GET ANY OF THESE DESKTOPS OR MINITOWERS PRECONFIGURED WITH AMBRA'S OPTIONAL CD-ROM AND MULTIMEDIA KITS!

DOUBLE-SPEED DRIVE KIT

- 2X CD-ROM drive
- Motorized tray
- Multisession PhotoCD compatible

$199

DOUBLE-SPEED BLASTER KIT

- 2X CD-ROM drive
- SoundBlaster™-compatible 16-bit sound card with CD-ROM interface
- 2 desktop speakers

$320

DRIVE AND SOUND KIT

- CD-ROM drive
- ProAudioSpectrum 16-bit sound card
- 2 desktop speakers

$179
(limited quantity)

STEREO SOUND KIT

- ProAudioSpectrum 16-bit sound card
- 2 desktop speakers

$159

DP60/PCI w/CD-ROM

- 16MB RAM
- Double-Speed Multisession CD-ROM drive
- 15" FST-NI color monitor, LR

$3,338

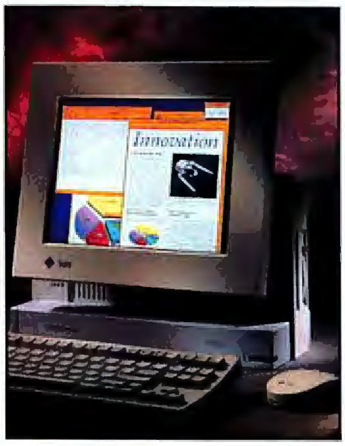
In Canada,[4] call 1-800-363-0066, Ext. 3184

CALL 1-800

[1] With purchase of multimedia- or CD-ROM-equipped system. [2] In order to offer the hottest CD Packs, AMBRA may substitute individual titles in a given bundle. Call for details. [3] Please call for details regarding AMBRA's money-back guarantee, limited warranty and Executive warranty, and IBM optional onsite warranty. Return shipping and insurance charges are the responsibility of the customer. Onsite service may not be available in certain locations. [4] Offerings may differ in Canada.

PORTABLES

Sun Aims High in First "Mobile" System



Until now, Sun Microsystems has been content to let companies such as RDI Computer (San Diego) and Tadpole Technologies (Cambridge, U.K.) sell portable, Sun-compatible systems. But with the new SparcStation Voyager, the Mountain View, California–based company is finally offering its own workstation-class portable. The catch is that this system is far from svelte: It weighs 13 pounds (5.9 kg).

Built around a 60-MHz MicroSparc II processor from Fujitsu, the SparcStation Voyager (see the photo) offers performance that's benchmarked at roughly 43 SPECint92 and 47 SPECfp92, says Sun. Prices are expected to range between $10,000 and $15,000.

Desktop replacement could turn out to be a key application for the Voyager because it faces stiff competition in the mobile arena. If Sun is serious about competing in the mobile RISC-computing arena, it needs to channel the engineering achievements of the Voyager into even more aggressive designs.

—Andy Reinhardt

Six Accomplishments of AI

1. AI software, and software in general, is now much faster, more accurate, and more logical than most humans. For example, an expert system at DEC uses hundreds of IF...THEN rules to configure DEC computers for customers far faster than any human could.
2. Expert systems are now standard tools at many of the Fortune 500 companies, and neural networks are gaining in popularity, especially on Wall Street. One firm, which prefers to remain unnamed, makes most of its profits automatically by computer, locating tiny discrepancies in futures pricing.
3. Industrial robots are now more or less standard in Detroit, and they can be considered a mature AI technology with huge payback. The vast majority of General Motors cars are painted automatically by robot (a dirty and unhealthy task for a human). In the field of medicine, delicate hip operations are now performed entirely by software-controlled "robot surgeons."
4. American Express, located in Boca Raton, Florida, has standardized on neural network technology to read millions of charge slips each day. The neural networks can gradually improve their ability to read handwritten numbers and letters.
5. The phrase *artificial intelligence* is now starting to sound reasonable, as opposed to the old connotation of *hype*. Intelligent people expect computers to gradually become more intelligent by supporting voice control and other advanced technologies.
6. Deep Thought, a computer program now sponsored by IBM, has won at least one chess game against a grand master.

—Joseph Weintraub (joweintraub@delphi.com)

CODE TALK

RICK GREHAN

Mad Macs and the Code Warrior

Lately, a great deal of attention has been focused on all the new CPUs supporting (or promising to support) Windows and Windows NT. As wonderful as the multiple-CPU support sounds, it hides a tough decision facing developers: Recompile for each CPU, or hope that the emulation is up to snuff. Mac developers are in the same boat, of course, as the arrival of PowerPC-based Macs draws nigh. Time to recompile for the PowerPC? If so, with what?

Enter MetroWerks' ((514) 747-5999) Code Warrior, a C/C++ development package for both 68K (i.e., 680x0) and PowerPC Macs. Code Warrior possesses—and extends—many of the features that have made Symantec's Think C such a popular and enjoyable C/C++ compiler. Forget hand-built make files; simply open a new project, select the source files you need, and add them to the project window.

It's easy to see that the architects of Code Warrior have done plenty of programming themselves. For example, from an open project window, you can open a pop-up window that contains a list of all the include files referenced by a particular source file. Double-clicking on any filename opens an edit window on the file. The pop-up window also carries a "touch" entry; activating it issues a "touch" operation on the source file. That means it will be recompiled the next time you rebuild the project, whether or not you've made any editing changes on the file.

Of course, as with other modern compiler packages, you get more than just a compiler. Code Warrior's symbolic debugger runs native on either 68K Macs or PowerPC Macs. (The developer version we tested still had some rough spots; for example, you could only view a variable, not modify it.)

Code Warrior's PowerPlant is a C++ class library tailored for building Mac applications. Because PowerPlant's class members support Apple Events, you can build Mac programs that can be controlled by scripts or through recorded macro commands. You also get Toolserver (a kind of stripped-down MPW shell that lets you run MPW tool programs) and Sourceserver, a version-control and source management package. Finally, MacApp developers will be happy to know that Code Warrior is MacApp-compatible.

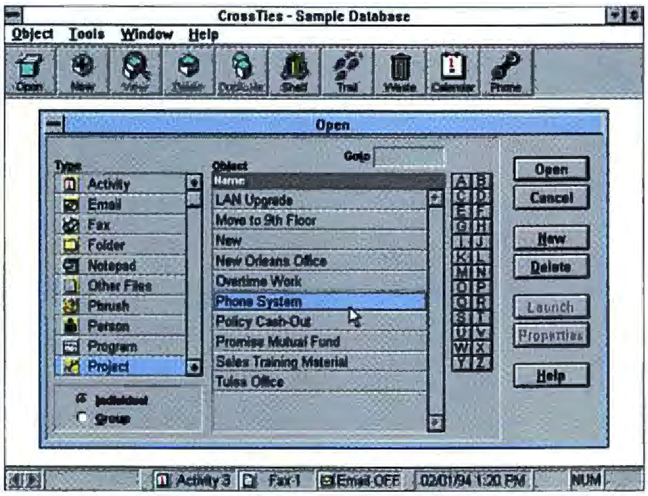
Ultimately, Code Warrior will be available in three versions: Bronze (which emits code for 68K Macs), Silver (which emits PowerPC code), and Gold (which emits code for both Mac platforms). The Bronze and Gold versions are available now in developer-release form. Silver's developer release is due to appear when the first PowerPC Macs appear, and the general release of all three versions will coincide with the World Wide Developer's Conference in May.

Pricing at the time of this writing places the Bronze version at $199, Silver at $299, and Gold at $399. That's quite good, especially considering how much software it buys you. Not only do you get C and C++ compilers, you also get a Pascal compiler, as well as the PowerPlant application development system and the other tools mentioned earlier. Furthermore, the MetroWerks compilers and tools are "fat binaries"; that is, each executable program contains both 68K and PowerPC code and will therefore run native on both 68K and PowerPC Macs.

While working with the developer version, it became apparent to me that Code Warrior still has a way to go. For now, it represents a substantial value for anyone developing for both 68K and PowerPC Macs.

SOFTWARE TRENDS

CrossTies Breaks New PIM Ground



A harbinger of the object-oriented future of the user interface, CrossTies insulates you from data files and applications and lets you concentrate on the work you need to do.

In an industry riddled with buzzwords, the term *object-oriented* is one of the most abused. Most accurately described at the programming level as self-contained and reusable modules of code, objects have become the darlings of marketing managers and the cause of no end of confusion for users. In fact, John Faig, senior research analyst at the META Group (Westport, CT), calls it "a disaster as a term, thrown about with abandon."

Still, a product that its maker describes as object-oriented is causing a stir in industry circles. CrossTies for Windows ($149) from CrossTies Software (Carrollton, TX) goes beyond the usual PIM (personal information manager) approach of calendars, phone books, and to-do lists by insulating users from Windows' familiar, albeit frustrating, Program and File Managers. (As this went to press, WordPerfect announced InfoCentral, a $149 information manager that also lets you classify people, things, and events as linkable objects.)

CrossTies for Windows lets you create multiple links among all sorts of computer-based information, which the company calls "objects." You can link applications and data to people, projects, and activities. The software also allows information to be named with up to 256 characters. More than just a PIM posing as a Windows shell, CrossTies is intriguing because it doesn't force you into one way of getting your work done. You can customize it as much as you desire, although that freedom comes with a relatively steep learning curve.

Industry analysts who have used CrossTies—and generally praise it—caution that calling it a true object-oriented product is perhaps a marketing stretch. Hugh Bishop, an analyst at Boston's Aberdeen Group, calls it "more object-like," but stresses that CrossTies' biggest strength is its ability to organize information in a way that's most comfortable to individual users.

Those who have followed the object-oriented saga might be wondering what happened to Hewlett-Packard's NewWave, the closest thing to a true object-oriented shell for Windows, which was introduced with huge fanfare back in 1989. HP has repositioned NewWave as a "desktop manager" with nary a mention of object orientation. Mike Webb, NewWave marketing manager, says the company's research revealed that users "didn't understand and didn't care about objects, but they did like things like long filenames and color-coded folders."

—Stan Miastkowski

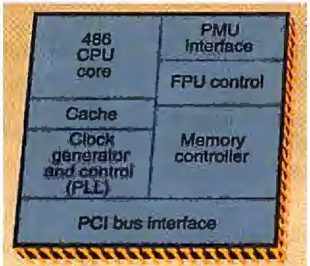
NOTEBOOK PROCESSORS

TI Charges into the Notebook CPU Wars

What do you want from a notebook chip set? Texas Instruments is betting that it's PCI (Peripheral Component Interconnect) bus speed combined with 3.3-V, clock-doubled 486 power and extremely low power consumption. TI says Rio Grande–based notebook PCs should start appearing this fall.

At the heart of the Rio Grande is a TI486 CPU that comes in external/internal clock-speed versions of either 25/50 MHz or 33/66 MHz. Because it's on the same silicon as the CPU, the integrated memory controller allows memory accesses at the chip's full internal speed.

Unlike Intel's 486SL chip family, which integrates an ISA bus controller, the Rio Grande integrates a PCI controller. By placing this controller on the same low-powered chip as the CPU, TI enables manufacturers to bring local-bus, high-bandwidth devices, such as high-performance IDE drives, to laptops and notebooks.

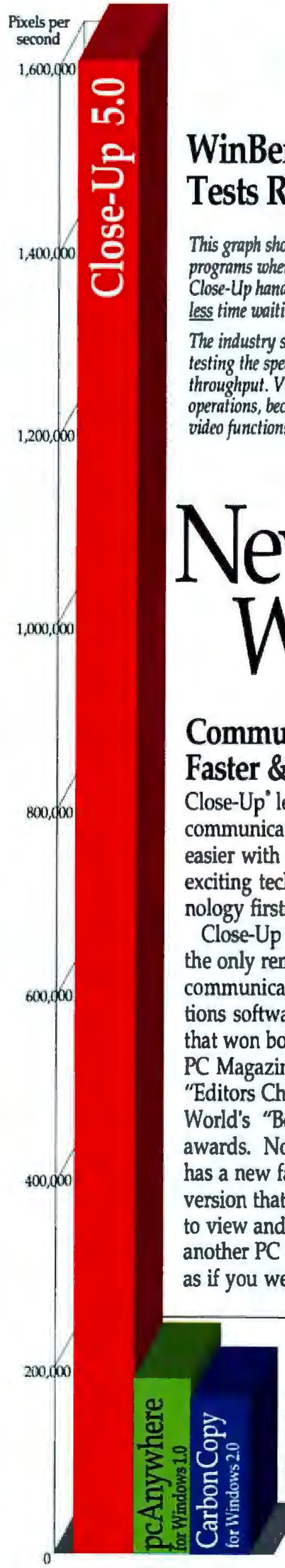


TI packs many devices into its Rio Grande chip set, but perhaps the most intriguing is the Power Management Unit (PMU) interface. TI says its 486 can turn off and on between keystrokes by switching the CPU off and on in 2 percent of the time required by rival active power management systems. TI hopes this feature will double a notebook PC's battery life.

Like the 486SX, the Rio Grande does not include an FPU, although it has an FPU interface. TI also includes a PCMCIA bus controller on the chip, which manages two PCMCIA slots and bridges the gap between the PCMCIA bus and the PCI bus with a four-level, 32-bit buffer.

Linley Gwennap, editor in chief of the *Microprocessor Report* (Sebastopol, CA), says that a potential benefit of the Rio Grande to system makers is that the chip's projected cost premium of approximately 20 percent over a 486DX chip is much better than the 80 percent higher manufacturing cost incurred by Intel in its now-discontinued 486SL line of processors.

—Alexis Tannenbaum



WinBench™ 3.11 by Ziff-Davis Labs Tests Remote Windows™ Speed

This graph shows the speed of the three leading remote control programs when transferring Windows screens. As you can see, Close-Up handles more pixels, faster, meaning you spend less time waiting for Windows screens.

The industry standard test, WinBench 3.11, is perfect for testing the speed of remotes. It is an accurate measure of video throughput. Video throughput is the limiting factor in remote operations, because remote programs must transmit Windows video functions from one PC to the other.

New Remote Software Sets Windows Speed Record

Communicate Faster & Easier

Close-Up* lets you communicate faster & easier with five exciting technology firsts.

Close-Up is the only remote communications software that won both PC Magazine's coveted "Editors Choice" and PC World's "Best Buy" awards. Now Close-Up has a new faster & easier version that allows you to view and control another PC by modem as if you were there!

WinBench scores (average of 10 runs):
Close-Up 1,613,118
pcAnywhere 194,093
CarbonCopy 168,397

Why Is Close-Up So Fast?

Close-Up learns as it works. It uses AI (Artificial Intelligence) to compress all Windows video function calls. That's why Close-Up does so well in Windows Benchmark tests (see WinBench 3.11 chart).

Technology Firsts

1. *AI Video Compression*
2. *Photographic Memory*
3. *Non-Intrusive Technology*
4. *Expert System*
5. *Video Translation*

Close-Up uses its revolutionary Photographic Memory™ so that once Close-Up has seen all or part of a Windows screen, it's memorized. Then as screens change, Close-Up only transmits new unmemorized data. Incredibly, with this technology ***Close-Up gets faster & faster the longer you use it.***

What Remote Companies Haven't Told You

Other remote programs permanently slow Windows and usually reduce your video resolution and depth of color, even when they are not in memory. That's because they permanently change your system.ini file. Close-Up's breakthrough Non-Intrusive Technology does not modify any of your sensitive Windows files including the system.ini. Close-Up is the only remote that when not in use, allows Windows and your PC to run at normal optimal levels.

Expert System Makes Communications Easy

You don't have to be a communications expert to get the results of one. Close-Up has an Expert System that automatically analyzes system components and configures your system for optimal speed.

Video Translation

With Close-Up, dissimilar PCs can easily connect, because Close-Up senses the video capabilities of both PCs and automatically displays Windows in a video mode compatible with both sides.

RISK FREE GUARANTEE MONEY BACK

Risk-Free Offer!

Try Close-Up. If you're not absolutely convinced that Close-Up 5.0 is the fastest remote program, we'll give you your money back!* Order Close-Up Host & Remote, a complete system, for only **$199.95**

Upgrade your current or competitive remote program to new Close-Up 5.0. Get both sides, Host & Remote, for only **$69.95**

Order Today 805-964-6767

Norton-Lambert

We invite you to reproduce this test. We used two identical Gateway 4DX2-66V's with 66-MHz Intel 486DX2-66 CPUs, 16 MB RAM, 256KB RAM cache, 340 MB HD, IDE controller, no hardware disk cache. Video: Local Bus ATI Ultra Pro with 2MB VRAM, 640 by 480 pixels, 16 colors, VGA.DRV dated 3/10/92. Monitor 72 Hz. MS-DOS 5.0, SMARTDRV 2 MB cache. Modems: two 14,400 baud V.32bis. Test performed without verification by Ziff. All products are shipping versions. WinBench trademark of Ziff Communications Co. Windows trademark of Microsoft Corp.

*60 day money-back guarantee if purchased directly from Norton-Lambert. Offer expires 6/30/94. All prices in US Dollars. Prices exclude shipping.

Circle 107 on Inquiry Card.

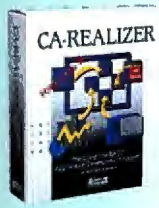
800-445-7899

Programmer's Paradise®

C++/Views 3.0
by Liant Software Corp.

The best object-oriented application framework for developing multi-platform, native GUI programs using C++. Includes a library of 100+ C++ classes that solve a broad range of software development problems including interface design, data management, event processing, & more. Includes C++/Views Constructor, a unique development tool that lets you work visually with the C++/Views class library. The Constructor unites an Interface Builder for creating portable resources & a Browser so you can switch from drawing & archiving your portable resources to editing the code that calls these resources. No royalties or RT fees. Source code is free.

List: $749 ***Special*** **Ours: $565** **FAX*cetera* #: 1952-0021**



CA-REALIZER for Windows & OS/2
by Computer Associates

Defines a new generation of development tools that handles the mechanics of event-driven programming, message passing, process sharing and other complexities behind the scenes. Combines a structured superset of BASIC extended to access Windows and OS/2 objects and resources, a visual development tool and Programmable Application Tools. CA-Realizer will help you create spreadsheets, charts, text editors, animation, graphics tablets and user-friendly forms from tools that can be created and manipulated by simple commands.

List: $295 **Ours: $79** **FAX*cetera* #: 1004-0008**

WindowsMAKER Professional 5.5
by Blue Sky Software

NEW VERSION!

If you're serious about C/C++ Windows development, WindowsMAKER™ Professional 5.5 is the most powerful Prototyper and C/C++ Code Generator for Windows, Win32 and Windows NT. This award-winning product offers more functionality & ease-of-use than any other tool. Create full-featured Windows Applications: MDI, Toolbars, Status bars, Templates, On-line Help, Graphical 3D buttons, Edit During Preview & much more. TrueCode™ technology ensures that user code is 100% preserved during code regeneration. Supports ANSI C, MFC C++, OWL C++ & more. Uses Switch-It™ Code Generation Modules for generating code for specific platforms, allowing migration between languages, C++ libraries & platforms. Highly recommended!

List: $995 **Ours: $875** **FAX*cetera* #: 2602-0003**

PRODUCT OF THE MONTH

Borland C++ 4.0
by Borland International

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

	List: $499	**Ours: $329**
Upgrade	**List: $199**	**Ours: $189**

FAX*cetera* #: 1861-0016

c-tree Plus®
by FairCom

FAIRCOM® since 1979

DOS • WINDOWS • NT • UNIX • OS/2 • SUN • RS6000 • HP9000 • MAC • QNX • BANYAN • SCO. This well known, highly portable data management package has become established as the tool of choice for commercial development. Offering unprecedented data control, programmers may choose from direct low level access, ISAM level convenience, or SQL access with the FairCom Server. Single User, MultiUser, or Client/Server. ANSI Standard.

List: $595 **Ours: $505** **FAX*cetera* #: 1381-0008**

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

IntegrAda for Windows
by Aetech Inc.

Complete Ada Programming Support Environment (APSE) for Windows, adding a language sensitive editor; automatic code generation & error checking; interactive error correction; pop-up menus to completely customize the environment to the standard Windows features. Allows you to quickly code, correct, compile, & link your Windows programs using Ada. Includes environment, libraries, validated Ada compiler, Ada Windows Libraries, Header Files, Resource & Help compilers, & MS Linker. (ACVC 1.11 validation pending). No RT Royalties!

List: $995 **Ours: $895** **FAX*cetera* #: 2358-0003**

Janus/Ada 9X Professional Development System
by R.R. Software

New! Ada 9X for the PC

The leader in PC-based Ada, proudly introduces the first comprehensive Ada 9X programming systems. Ada 9X brings the latest in Object-Oriented programming to Ada, and you can get it today complete with numerous professional tools. Special introductory pricing is good only until July 31, 1994.

MS Windows NT or 32-Bit DOS Extender:
List: $995 **Ours: $625** **FAX*cetera* #: 1876-0001**

Symantec C++ Professional 6.1
by Symantec

The new version 6.1 not only enhances product stability and reliability but also brings new features that 6.0 customers asked for. Now you get: full template debugging; improved hierarchical project manager; customizable color-syntax highlighting; & enhanced 32-bit support with 32-bit MFC 2.0 on the CD-ROM. So don't wait. Try Symantec C++ 6.1 and find out why the critics are raving about this new breakthrough in programming systems.

Competitive Upgrade for Borland or Microsoft customers $189.

	List: $499	**Ours: $299**
Comp. Upg.:	**List: $199**	**Ours: $189**

FAX*cetera* #: 2132-0038

Programmer's Paradise® Italia
Phone: 39-2-480-16053
FAX: 39-2-480-16039

Best Sellers

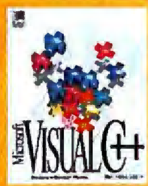
Call for a FREE Catalog!

Network C Library
by Automation Software Consultants, Inc.

NEW VERSION 3.0!

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

List: $395 **Ours: $355** **FAX*cetera* #: 1004-9201**



Microsoft Visual C++ Development System v1.5
by Microsoft Corporation

Master the power of OLE 2 & the database access flexibility of ODBC with MS Visual C++ v1.5, Prof. Edition. V1.5 allows you to create high-performance database apps & powerful reusable OLE 2 components. Includes Visual Workbench, App Studio, and MS Foundation Class Library 2.5.

MS Visual C++ 1.5	**List: $599**	**Ours: $379**
w/Chinon CD-ROM Drive	**List: $749**	**Ours: $699**
1.5 Upgrade	**List: $ 99**	**Ours: $ 89**
w/Chinon CD-ROM Drive	**List: $519**	**Ours: $479**
Visual C++ 16/32 bit Suite	**List: $199**	**Ours: $185**

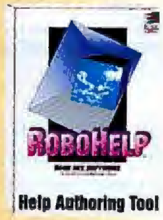
FAX*cetera* #: 1269-0056

WATCOM FORTRAN 77[32] Version 9.5
by WATCOM

32-bit optimizing FORTRAN 77 compiler and tools for DOS, Novell NLM, OS/2 2.x, Windows NT, Win32s, & Windows 3.x. Comprehensive language support with FORTRAN 90, DEC VAX & IBM VS language extensions. Advanced processor optimizations including 486 & Pentium instruction scheduling. Multi-platform toolset includes linker, debugger, profiler, royalty-free DOS extender with VMM & more.

List: $599 **Ours: $349** **FAX*cetera* #: 1683-0005**

RoboHELP® 2.6
by Blue Sky Software

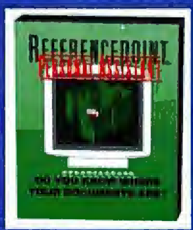


RoboHELP® 2.6, the best-selling Help Authoring Tool for Windows & Windows NT, offers full document to Help system conversion & vice versa. Turns Word for Windows into a fully functional hypertext authoring system capable of producing Windows Help files as easily as it does plain text. Fill in the actual Help text when prompted. RoboHELP takes care of generating the RTF, HPJ & H files. Link tester allows you to simulate your design before you compile. Full support of Word 2.0 & Word 6.0, & all features in the Windows Help Engine, such as macros, secondary windows, & multiple hotspot graphics.

List: $499 **Ours: $439** **FAX*cetera* #: 2602-0005**

NEW THIS MONTH

ReferencePoint Personal Assistant
by ReferencePoint



ReferencePoint Personal Assistant automatically makes an index of any information that you create or modify anywhere on your computer system, so that you can find any file, instantly, whether from a word processor, database or spreadsheet. So, type what you want to find, and Personal Assistant will locate every file in the computer containing those words. ReferencePoint Royalty Free SDK for DOS, Windows, Mac, OS/2 and UNIX also available from Programmer's Paradise. Call for pricing.

List: $99 **Ours: $ 79** **FAX*cetera* #: 1008-5001**

WATCOM™ C/C++32 v9.5
by WATCOM

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

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

Mwave™ Developers Toolkit with IBM WindSurfer™ Bundle
by Intermetrics, Inc.

What once was multiple products and toolsets is now bundled in one multimedia PC add-in card and Toolkit. The Mwave WindSurfer Communications Adapter is a "works out of the box" data/FAX modem, sound, voice messaging and telephone answering card with application software. It is bundled with the Mwave Developers Toolkit so you can build software that takes advantage of the Mwave digital signal processing (DSP) platform that drives WindSurfer. Try out the magic of a software upgradeable and programmable Mwave PC solution. You'll be developing for the future and using it today! And you can do it for an incredibly low price!

List: $900 **Ours: $495** **FAX*cetera* #: 1012-4601**

Circle 102 on Inquiry Card.

GUARANTEED BEST PRICES! (Call for Details)

To order call: 800-445-7899
Corporate (CORSOFT): 800 422-6507
FAX: 908 389-9227
International: 908 389-9228
Customer Service: 908 389-9229
Programmer's Paradise Italia: 39-2-480-16053

For more information on the products featured on these pages call FAX*cetera*®: (201) 762-1378

Programmer's Paradise®
1163 Shrewsbury Avenue
Shrewsbury, NJ 07702

• All prices are subject to change without notice.
Call for details on return policy and shipping charge.

800-445-7899

WINDOWS DATABASES

New Access Targets Wider Audience

Access's ease-of-use features should appeal to end users and developers alike. For example, to create a table, you can either use a Table Wizard or write a SQL statement in a data-definition query. Microsoft has added FoxPro's efficient Rushmore technology to make set queries execute much faster than in Access 1.1.

Although Access 1.0 did an admirable job of allowing developers to write applications without having to delve into code, Microsoft's $99 introductory price tag attracted many end users who were overwhelmed by the program. Microsoft has added ease-of-use features to Access 2.0 for end users and developers alike while also improving its programming capabilities. Access 2.0 is what Microsoft wanted Access 1.0 to be: an easy-to-use, full-featured, relational database for Windows.

Although Wizards and Builders guide the creation of tables, forms, and queries, Access 2.0 is not a simple program. Yes, Access targets end users, but it also serves power users and developers. Based on my use of a preliminary version of Access 2.0, the new ease-of-use features will be welcomed—and needed—by less-technical end users.

For the first-time database user, I still lean toward Lotus Approach for Windows: It's less intimidating, and its learning curve is not as steep as Access's. But Access 2.0's ToolTips, Wizards, and cue cards have narrowed the end-user gap significantly. And, with Access 2.0, Microsoft's adherence to the menu structure found in other Microsoft Office Windows applications is paying off. Users familiar with other Office products will be able to perform basic commands immediately.

Lotus and Borland both target a narrower segment of the database audience with their respective Windows databases than does Access: Approach targets end users who want to create applications without having to confront programming tools, and Paradox targets developers. However, Lotus plans on eventually adding its own programming language, LotusScript, to Approach. And Borland will add tools to make Paradox easier to use for end users, says Vince Casarez, product manager for Paradox. But if you want a Windows database today that offers both power and ease of use, the nod goes to Access 2.0.

—Selinda Chiquoine

Access 2.0 Highlights for Programmers

Subforms

Although not new to Access 2.0, the subform feature lets you show an embedded subform on a main form. This type of display is convenient for showing one-to-many relationships, such as line items on an invoice. The main form can show an invoice's number and date, while an embedded form shows the invoice line items.

Control Wizards

Control Wizards make it possible to add command buttons, list boxes, combo boxes, and option groups by responding to a sequence of dialog boxes. These Wizards make it easy for developers to assign actions, such as running queries and opening tables, to controls. Developers can subsequently edit the code that Control Wizards build automatically.

New Macro Capabilities

New macro actions enhance object manipulation and interoperability. For example, the OutputTo action allows a developer to output a Datasheet with its formatting in an RTF format and then invoke Word for Windows so that it opens the RTF file.

Rich Event Model

A new Build Event shortcut menu in the Design window makes it easy to program actions in response to default events, such as mouse-clicks, the loading of a form, or the passage of time. Developers can edit the event that invokes a procedure or macro in the Properties window. This window lists the subset of events that pertain to each object (e.g., a command button or form).

OLE 2.0

OLE 2.0 implements OLE Automation, the new technology that lets you manipulate an application's objects from outside that application. For example, you can print a Word 6.0 document through the click of a command button in Access 2.0. Unfortunately, the rules for implementing this kind of automation vary slightly, depending on whether you are manipulating objects from Word 6.0 or Excel 5.0. Access 2.0 is both an OLE container and an object controller, but it is not a controllable object from outside the Access application via OLE. **—Rick Mara**

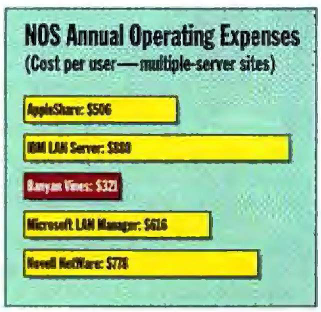
NETWORKS

Banyan Breaks Out

Banyan is expanding beyond the NOS (network operating system) business and bringing its Enterprise Network Services to other leading platforms. Banyan has already ported ENS to Novell NetWare, SCO Unix, and HP-UX; the company plans to port it to SPARC and AIX platforms in 1994.

"Banyan has built a substantial legacy of excellent network services," says Greg Cline, director of network integration and management at Business Research Group (Newton, MA). "The company is moving beyond network operating systems [and getting] into the network services arena." Banyan is also getting into the client business: The company recently acquired Beyond, which is known for its E-mail filtering and forms technology.

A recent report by the Business Research Group (Newton, MA) shows that in multiserver sites with over 100 users, Banyan Vines has the lowest maintenance cost per user. Although Vines was overall the most expensive network to operate, the survey notes that Vines servers also had the highest average number of users (1059) per multiple-server site. Cost calculations are based on the percentage of time an administrator with an annual salary of $55,400 devotes to supporting the network.



INTEL TECHNOLOGY BRIEFING

PLUG AND PLAY

MAKING ADD-IN CARDS PLAY AUTOMATICALLY

Now playing: Automatic card configuration.

Since add-in cards first appeared over a decade ago, they've given users a lot of different ways to improve their PCs—and given them a lot of installation headaches. In this brief, we'll tell you how Intel, together with industry leaders, has spent years developing Plug and Play technology to make add-in cards both easier to use and install.

Trial and Error Configuration.

Never before has the PC had as many capabilities as it does today. That's due in part to the large number of add-in cards available, like those for multimedia and fax-modems. Yet, as more cards are added to a PC, their installation can become quite complex. Installing a card can be a time-consuming and technical process, and there's no guarantee it will even work the first time. Sometimes the user must configure the card manually, which means selecting a variety of system resources for each card. These include Interrupt Requests (IRQ), I/O and memory addresses, and Direct Memory Access (DMA) channels.

Every PC has a limited number of these resources available, and each card is designed to use a small group of them. Assigning these resources means opening the computer and physically setting the jumpers and DIP switches. And since no standard has been set to determine which cards can use which resources, numerous conflicts can arise between cards. Often, it's a process of trial and error to determine which resources aren't already being used by other cards.

Looking for a Solution.

Since the ISA bus was introduced, several new bus architectures have followed to solve the resource allocation problem. For example, the MCA* and the EISA bus standards both defined a mechanism where add-in cards were configured somewhat automatically. These bus architectures allocated the resources, but the process wasn't always flexible and still required some manual intervention. And they still left the current ISA cards without a solution.

Plug and Play Technology.

Plug and Play technology, co-developed by Intel and other industry partners, consists of hardware and software components that card, PC, and operating system manufacturers incorporate into their products. With this technology, the user is responsible for simply inserting the card. Plug and Play makes the card capable of identifying itself and the resources it requires. The system's software automatically sets up a suitable configuration for the card.

Newly developed PCI and Plug and Play ISA cards are all built to eliminate user intervention during the installation process. Newly designed PCMCIA* cards can also be inserted or removed without powering down the system.

Plug and Play-enabled systems also make the installation process easier for the millions of non-plug and play ISA and EISA cards that currently exist.

Plug and Play Partnerships.

Intel is working with the computer industry to make Plug and Play happen on a couple of fronts.

First, we helped define and develop the PCI local bus standard to improve I/O performance and to allow for automatic configuration of PCI-compliant add-in cards.

Secondly, using the PCI standard as the model for auto configuration, Intel is working with OEMs and add-in card vendors to add a similar capability to ISA bus-based systems and cards. Intel is also working with operating system vendors to assure current and future OS support, including Microsoft's Windows* 3.1. Users will get Plug and Play capabilities when manufacturers pre-install the necessary software on their PCs and cards.

PLUG AND PLAY

1. CARD IDENTIFICATION.

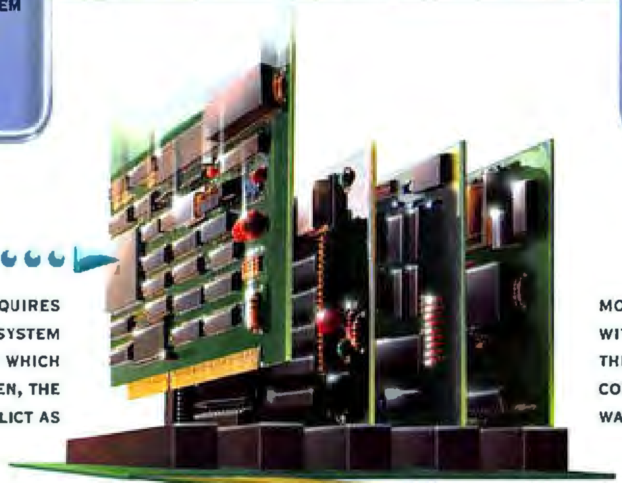
PLUG AND PLAY HARDWARE LOGIC, BUILT INTO PCI AND ISA CARDS, ENABLES THE CARDS TO COMMUNICATE TO THE SYSTEM EXACTLY WHICH RESOURCES THEY ARE CAPABLE OF USING.

2. RESOURCE ALLOCATION.

EACH TIME THE PC IS BOOTED UP, THE PLUG AND PLAY SOFTWARE EXTENSIONS IN THE SYSTEM BIOS LOOK AT ALL THE CARDS AND DEVICES INSTALLED. NEXT THEY GO THROUGH A PROCESS TO DETERMINE WHICH RESOURCES ARE BEST USED WHERE, AND THEN COMMUNICATE TO EACH CARD WHICH TO USE. CONFLICTS NOT RESOLVED BY THE BIOS ARE HANDLED BY A HIGHER LEVEL SOFTWARE COMPONENT CALLED THE CONFIGURATION MANAGER.

3. CARD CONFIGURATION.

ONCE THE RESOURCES ARE ALLOCATED, THE CARD'S HARDWARE LOGIC ELECTRONICALLY SETS THE CARD CONFIGURATION, ELIMINATING THE NEED TO MOVE JUMPERS AND DIP SWITCHES. (EG. IRQ3, DMA2, ETC.)



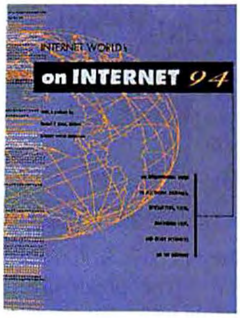
EACH ADD-IN CARD REQUIRES ONE OR MORE SYSTEM RESOURCES, SOME OF WHICH ARE SHOWN BELOW. OFTEN, THE REQUIREMENTS CONFLICT AS MORE CARDS ARE INSTALLED. BUT WITH PLUG AND PLAY TECHNOLOGY, THE RESOURCES ARE DYNAMICALLY CONFIGURED BASED ON THE HARDWARE PRESENT AT BOOT-UP.

AN IRQ, OR INTERRUPT REQUEST, IS A SIGNAL WHICH ALERTS THE CPU THAT AN ADD-IN CARD REQUIRES ATTENTION. (FOR EXAMPLE, WHEN A FAX BOARD HAS AN INCOMING CALL.) THE PC HAS 16 IRQS, BUT TYPICALLY EIGHT OR MORE ARE USED FOR STANDARD SYSTEM FUNCTIONS.

THE I/O ADDRESS TELLS THE CPU WHERE THE CARD IS LOCATED ON THE EXPANSION BUS, ALLOWING IT TO TRANSFER DATA TO AND FROM THE RIGHT LOCATIONS. OFTEN HUNDREDS OF I/O ADDRESSES ARE AVAILABLE, BUT CARDS TYPICALLY USE THE SAME ONES, CAUSING CONFLICTS.

DIRECT MEMORY ACCESS (DMA) CHANNELS PROVIDE AN EFFICIENT MECHANISM FOR TRANSFERRING DATA DIRECTLY BETWEEN A PERIPHERAL AND MEMORY WITHOUT BURDENING THE CPU. A TYPICAL SYSTEM HAS 4 DMA CHANNELS.

Internet Resource Guide



DAVE VISLOSKY

On Internet 94 claims to be the most authoritative and comprehensive guide to resources on the Internet, and I wouldn't dispute the claim. Because of the fluctuation of the Internet's contents—mail lists, discussion forums, and databases are being added or wiped away daily—the prospect of a single guidebook listing every current address is unreasonable. However, with over 6000 listings, *On Internet 94* is certainly a useful reference, even if it is not precisely up to date.

The guide provides addresses, descriptions, and access information to all categories of electronic journals, newsletters, texts, discussion lists, and mailing lists available across the Internet. Also included are listings of Usenet newsgroups and databases accessible by WAIS (Wide-Area Interconnect Service). If you're new to the Internet, the introduction gives a few helpful hints on how to join discussion lists, access electronic journals and databases, and use the `telnet` and `ftp` functions.

When using resource books like this, I find myself constantly using the subject index. Unfortunately, for all the effort expended to include a vast number of useful and interesting Internet resources, the subject index did not receive the attention it deserves.

For example, if you're interested in computer science, flip to the back of the book where the subject index resides. Find the subject "computer science," and you're faced with over 100 listings. Here's where the guessing game begins. We could assume that Info-Pascal is a discussion list on Pascal programming, which it is. But I have trouble discerning the meaning of Mossba, which, incidentally, is the Mossbauer spectroscopy discussion list. If you want to find a discussion forum on legumes, however, you're in luck. There's only one forum listed under legumes, Bean Bag.

I would have been much happier if this Internet resource guide had added more detailed subjects to the index. Also, some of the indexed address listings, albeit very few, are followed by brief descriptions, something that would have been helpful next to every listing. Not to mention that each address listing is followed by the chapter rather than the page where it resides: Find your listing, find the chapter, and find the address listed alphabetically in the chapter. This is not the most efficient method when using a resource guide. However, even with a few shortcomings in the subject index, *On Internet 94* provides a wealth of Internet addresses that will be of interest to both beginning and professional Internet explorers. ■

ON INTERNET 94

Tony Abbott, ed.
Mecklermedia
ISBN 0-88736-929-4

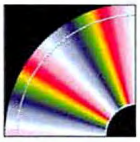
$45

Dave Vislosky is a BYTE senior technical editor at large. You can contact him on the Internet or BIX at visco@bix.com.

COMPUTER DESIGN

CONCEPTS IN COMPUTER DESIGN: A PROFESSIONAL PERSPECTIVE by Dawn Erdos and Leslie Singer **MIS Press, ISBN 1-55828-297-1, $34.95**

The bookshelves in my home office are overflowing with all the how-to books I've collected covering desktop publishing techniques and software. *Concepts in Computer Design: A Professional Perspective*, however, is the kind of book I tend to keep by my bedside for quiet perusal during downtime. While



USEFUL REFERENCES

PATENT EXPLORER CD-ROM **Research Publications, 1921 Jefferson Davis Hwy., Arlington, VA 22202, (703) 413-5050, $1995**

INFORMATION USA MULTIMEDIA CD-ROM FOR WINDOWS **Infobusiness, 887 South Orem Blvd., Orem, UT 84058, (801) 225-0817, $69.95**

Software developers may lose huge amounts of R&D dollars, or be forced to pay royalties, if they are not aware of existing patents of competitive products. Patent Explorer CD-ROM provides full-text descriptions of more than 10,000 software patents from 1972 to 1993. The CD-ROM does not rely on the U.S. Patent and Trademark Office's classification of software patents because that classification assigns many software patents to categories other than software. Instead, Patent Explorer CD-ROM has grouped software patents into clusters based on the technology each patent contains.

The full text of the software patent is provided, which may vary from a few paragraphs to several pages of description. A natural-language engine can search on full sentences in addition to individual keywords. In an age in which we're seeing more and more litigious behavior—witness Compton New Media's, Lotus's, and Borland's patent infringement lawsuits—this reference disc is an excellent source of existing software patents.

In the same vein, the U.S. government is a vast repository of useful information. The catch is that this information is difficult to find. The Information USA Multimedia CD-ROM for Windows aptly fills this void. It includes video, audio, and textual information on all 1261 Federal Domestic Assistance programs administered by 51 agencies, including contact addresses and telephone numbers. Subjects include educational grants and scholarships, labor statistics, market studies and research findings, tax advice, sources of loans, lists of surplus property, and more.

You can search on every word, print information in a variety of formats, write and edit notes within the software, and, in short, save a bundle of time and frustration getting information from the U.S. government.

—Rich Friedman

Books & CD-ROMs

it doesn't offer specific how-to information or in-depth technical coverage of desktop publishing considerations, it does provide a broad summary of where the industry is today, along with specific case studies of creative projects.

Each chapter features an in-depth look at how a real-world product is produced and how some of the newest technologies are being employed. The authors cite examples from the entire spectrum of professional applications of desktop publishing, including daily newspapers (*USA Today*), magazines (*Wired*), brochures (Ben & Jerry's), advertising, and package design. Interviews with people involved in the creation of these products provide insight into where the industry is going and what some of the pitfalls are.

The book also includes detailed lists of equipment and software used for each project and mentions the extent to which desktop publishing is used. Some operations are 100 percent desktop produced; others, for practical reasons, have had to devise hybrid systems that let them move slowly into the desktop arena. If I might paraphrase, desktop publishing is 90 percent perspiration and 10 percent inspiration. This helpful book provides the 10 percent needed to get the job done.

—Roger Goode

BOOKS FOR SORE HANDS AND WRISTS

REPETITIVE STRAIN INJURY, A COMPUTER USER'S GUIDE by Emil Pascarelli and Deborah Quilter John Wiley & Sons, ISBN 0-471-59533-0, $12.95

PREVENTING COMPUTER INJURY: THE HAND BOOK by Stephanie Brown Ergonome, ISBN 1-884388-01-9, $19.95

Repetitive strain injuries are on the upswing, according to the U.S. Department of Labor. *Repetitive Strain Injury, A Computer User's Guide* thoroughly explains the causes of the injury, describes what the authors believe is good treatment, and emphasizes prevention of the disability. This is done in a knowledgeable and accessible manner. The authors cite the epidemiology of this condition and explain who is most at risk. The book presents multiple checklists for recognizing the problem and its risk factors, along with advice on how to cope with the emotional component of the injury. From a physical therapist's point of view, the recommended program is good practice.

Preventing Computer Injury: The Hand Book describes and illustrates exercises that can be used to prevent repetitive strain injuries. It discusses hand positions and motions to avoid and suggests appropriate substitutes. The author does not go into any depth of medical description. Instead, she concentrates on the clearly defined and pictured preventive exercises and hand and body postures. Brown writes in a simple, accurate, and easily understood manner; this book will be helpful to anyone who sits at a keyboard. ■

—Lee Zaslow

Lee Zaslow teaches physical therapy at Hahnemann University in Philadelphia, Pennsylvania. You can reach her on BIX c/o "editors."

QEMM 7 finds room nobody else can.

Sooner or later, you'll get an "Out of Memory" message. Whether you have 1 megabyte or 16.

TSRs and network utilities need memory right where your programs need it, too. It's called 'lower' or 'conventional' memory.

Adding RAM to your PC just gives you more expanded or extended memory — accessible to some programs, but not to TSRs like fax utilities, device drivers or network utilities like Novell NetWare. Fortunately, there's an easy software solution to "out of memory" problems.

NO VACANCY

Have your cake and eat it, too.

The more memory you have, the more flexibility and reliability you can enjoy. Thanks to our patent-pending 'Stealth' technology, QEMM finds as much as 96K more high memory than other memory managers.

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

QEMM™ puts the maximum memory right where your favorite programs need it so you can run them and TSRs without 'out of memory' problems or conflicts. That keeps your PC running smoothly and performance at its best.

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

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

Protect your productivity; keep your work safe.

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

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

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

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

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

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

VACANCY

Quarterdeck

Circle 124 on Inquiry Card.

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

How we got the chart numbers: CPU—486/33 ALR Power/business VEISA machine equipped with 16 megs of RAM and running MS-DOS 6. Comparisons were done using the following memory managers: QEMM 7, QEMM 6.02, MS-DOS 6 MemMaker. In addition to the driver (or drivers) required by each memory manager, the following drivers, DOS resources and programs were loaded for all comparisons: in the CONFIG.SYS file: SETVER.EXE, DOS=HIGH, FILES=20, BUFFERS=10, STACKS=0,0, MVSOUND.SYS, SNDBK12.SYS, SLCD.SYS, DOS SHELL= statement, in the AUTOEXEC.BAT file: VSAFE, MSCDEX, UNDELETE, LSL.COM, NE2000.COM, IPXODI.COM, NETX OR EMSNETX, MOUSE.COM, SMARTDRV.COM, PRTSCCAP.COM.

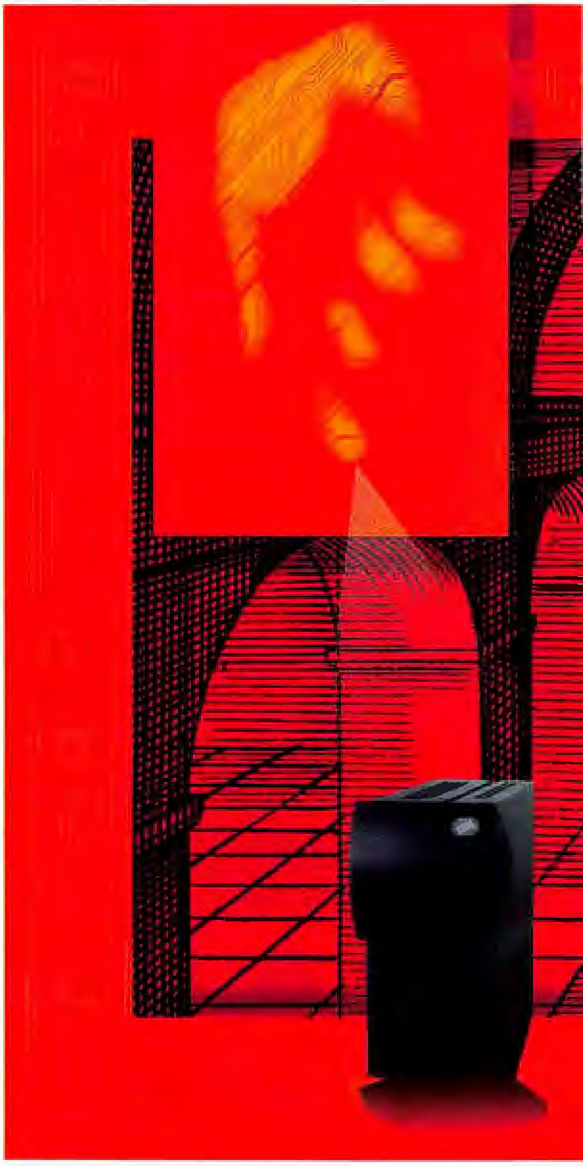
APPLE, IBM BRING POWERPC TO THE DESKTOP

Apple and IBM want to change your concept of the desktop PC. Specifically, they want to throw out the notions that you pay a premium for going to the next performance level, that you are locked into one operating system by the hardware, and that the term *PC* automatically refers to an 80x86, CISC-powered system. To them, the PC as we know it is dead.

But long live the new PCs. Apple and IBM will introduce the first PowerPC systems this year. Preliminary benchmarks show that these systems will offer better-than-Pentium performance, in some cases at lower-than-Pentium prices. They discard the 10-year-old IBM AT architecture in favor of more flexible, open designs. And most obviously, they replace the venerable Intel 80x86 CPU with the RISC-based PowerPC.

Significantly, they accomplish this while providing compatibility for the huge installed base of existing CISC-processor software under both DOS/Windows and System 7. Yet portions of the underlying hardware and software are designed to enable totally new classes of applications that were simply not possible before because of performance constraints. On March 14, Apple started shipments of Macs based on the PowerPC 601. In the second half of this year, IBM plans to release desktop and notebook computers based on the PowerPC 601 and PowerPC 603, respectively.

continued



The first-generation PowerPC desktop systems from Apple and IBM have arrived. They offer blazing performance and unique features at affordable prices. The downside? Few native applications, slow software emulation, and unfinished system software.

TOM THOMPSON AND BOB RYAN

POWERPC ON THE DESKTOP

Apple's Power Macintoshes

- Three PowerPC 601–based desktop models running at 60, 66, and 80 MHz
- Prices starting at $2100 for a fully equipped system
- True Mac look and feel, plus a high degree of compatibility with existing applications
- A nanokernel allows the Power Macs to support both the PowerPC and emulated 680x0 architectures

IBM's Power Personal Systems

(see page 60)

- An attempt to establish a new standard architecture for the PC
- Eliminate hardware dependencies by separating the operating system from the hardware
- Planned support for OS/2, Windows NT, AIX, Solaris, and Taligent
- "Human-centered" user interface will eventually provide voice control, handwriting recognition, and agents

ILLUSTRATIONS: MARC YANKUS © 1994

A New Breed of Mac

Apple's PowerPC systems are called Power Macs. Unless you happen to notice the PowerPC logo on the housing, a Power Mac looks just like a regular Mac. It behaves like a regular Mac, too—except that it's much faster. Three systems are available, representing three price/performance levels. The Power Mac 6100/60 uses a 60-MHz 601 processor and costs $2209 complete with a keyboard and monitor—that's slightly less than what you would spend for a fully equipped Pentium PC when this was written. The Power Mac 7100/66 fills the midrange at 66 MHz and costs $3379. Finally, the Power Mac 8100/80 runs at 80 MHz and costs $4869.

Apple was able to achieve some cost savings by basing the Power Mac systems on existing 680x0 Mac chassis. This strategy also gives current 680x0 Mac owners the opportunity to upgrade to a Power Mac system by a main-logic-board swap.

Bundled with these Power Macs is system software that includes the QuickTime extension for multimedia support, PlainTalk text-to-speech and voice-recognition software, and AppleScript, which is a scripting language that uses high-level events to automate tasks and customize the operation of applications. More important, these systems also ship with Insignia Solutions' SoftWindows, an emulation package that can run DOS and Windows software. So, these systems offer you a choice of operating systems, a feature found in other RISC-based computers.

The Power Macs provide much of the AV Macs' capabilities in that the telephony, fax modem, and digital speech software is bundled with these computers. If you need the video capabilities, an AV Technologies card is available. It provides two S-video connectors and a DB-15 monitor connector. This AV card provides 24-bit video on the monitor and uses a new video chip set for video capture and scaling. It also has the DAV (digital audio video) connector found in the AV Macs.

For those who already own Macs, there are a number of upgrade options. If you have a Mac with the same chassis type as the Power Mac, a main-logic-board swap is available. For owners of other Macs, Apple offers a Power Mac Upgrade Card ($700) that plugs into a 68040 PDS (Processor Direct Slot). It has a 601 processor, Power Mac ROMs, and 1 MB of level 2 cache SRAM (static RAM) on it. The Upgrade Card uses a PLL (phase-locked loop) that doubles the clock speed of the host Mac's bus clock (i.e., an Upgrade Card plugged into a 33-MHz Quadra 800 runs at 66 MHz). The PLL circuit also helps keep the plug-in board's bus synchronized to the computer's CPU bus, which reduces data transfer delays between the two. DayStar Digital (Flowery Branch, GA) will also offer PowerPC accelerator boards for all color Macs.

With the Power Macs, the Mac OS is reborn, shedding the vestiges of its decade-old design so that it can grow in new directions. Gone are the segmented application architecture and single-mode operation. Now there's a nanokernel, supervisor and user modes, and DLLs, so the Mac OS can become a preemptive multitasking operating system. Future Power Macs will incorporate the PCI (Peripheral Component Interconnect) bus, a growing industry standard for computer peripherals. Finally, with Apple planning to license the Mac system software to other PowerPC systems designers, at long last the Mac will become a truly open standard (see "Apple Opens the Mac OS" on page 24). Apple intends to promote the unique features of the Mac OS—such as peer-to-peer file sharing, multiple network protocol stacks, color matching for output, and plug-and-play architecture—as the new operating-system standard for RISC computers.

Meet the Macs

The 6100/60 uses the same "fat" pizza-box chassis found on the Macintosh Centris 610/Quadra 610. The 8 MB of RAM is expandable to 72 MB by using 32-MB SIMMs.

Faster versions of the 6100 and other Power Macs will use the same name; only the trailing digits, representing clock speed, will change. This eliminates the product-line confusion created by Apple's previous naming scheme, where minor changes to existing Macs begot whole new model names. It also explicitly states the processor speed, which is useful when comparing systems.

The midrange Power Mac 7100/66 uses the Mac IIvx/Centris 650/Quadra 650 chassis. It has four 72-pin SIMM sockets that allow RAM to be expanded to 136 MB. Interestingly, the 601 PDS holds a display board containing 1 MB of VRAM (video RAM) that's expandable to 2 MB. This means that the 7100/66 comes out of the box ready to support a second monitor. With 2 MB of VRAM on the board, you can have 16-bit-deep video on 21-inch monitors.

One caveat is that the Power Mac's VRAM display board uses the old DB-15 video connector, while the built-in video port uses the new HDI-45 connector. The HDI-45 has extra lines to handle voice input and stereo sound I/O on Apple's AudioVision monitor. You'll need an adapter to plug an existing monitor's DB-15 cable into the built-in video connector, but not the VRAM display board.

The Power Mac 8100/80 is based on the Quadra 800/Quadra 840AV mini-tower design, with a 200-W power supply and internal bays for three hard drives. Eight 72-pin SIMM sockets can expand RAM from the standard 8 MB to 264 MB. Like the 7100/66, the 8100/80's standard configuration supports a second monitor. The VRAM display board plugged into the PDS comes with 2 MB of VRAM and is expandable to 4 MB. With 4 MB of VRAM, a second monitor attached to the VRAM display board supports 24-bit color on 21-inch monitors, making the system ideal for professional graphics and high-end imaging work.

Be aware that on these systems you're not required to use the built-in video. You can opt to connect a single

Power Macintosh Vital Statistics

Power Macintosh 6100/60
60-MHz PowerPC 601
160-MB hard drive

Power Macintosh 7100/66
66-MHz PowerPC 601
250-MB hard drive

Power Macintosh 8100/80
80-MHz PowerPC 610
250-MB hard drive

■■■ One Processor Direct Slot
■■■ 8 MB of RAM
■■■ 16-bit stereo sound I/O
■■■ Microphone
■■■ Built-in 16-bit video
■■■ SCSI bus
■■■ LocalTalk
■■■ Built-in Ethernet
■■■ Cache SIMM socket
■■ Three NuBus slots
■ Fast SCSI-2 bus

Left to right: the Power Mac 7100/66, the Power Mac 8100/80, and the Power Mac 6100/60. The systems are shown with an optional CD-ROM drive. A plug-in board provides AV capabilities.

monitor to the VRAM display board. The 8100/80 supports two SCSI buses (internal and external). The internal SCSI bus uses a fast SCSI-2 controller. Combined with the SCSI Manager 4.3 (first used in the Quadra 840AV), the controller enables SCSI-2 fast transfers of up to 10 MBps on the internal bus. To wring the best possible performance out of the 8100/80, its cache slot contains a SIMM that implements a level 2 cache with 256 KB of 14-nanosecond, synchronous SRAM.

Interiors

All the Power Macs use a common design, with only a few modifications for specific systems. They have 4-MB 100-ns ROMs mounted on a SIMM socket. The SIMM socket allows the possibility of upgrading the system software at a later date. These ROMs are twice the size of those found in the Centris 660AV and Quadra 840AV. They contain new features and some operating-system code that was formerly stored on the hard drive.

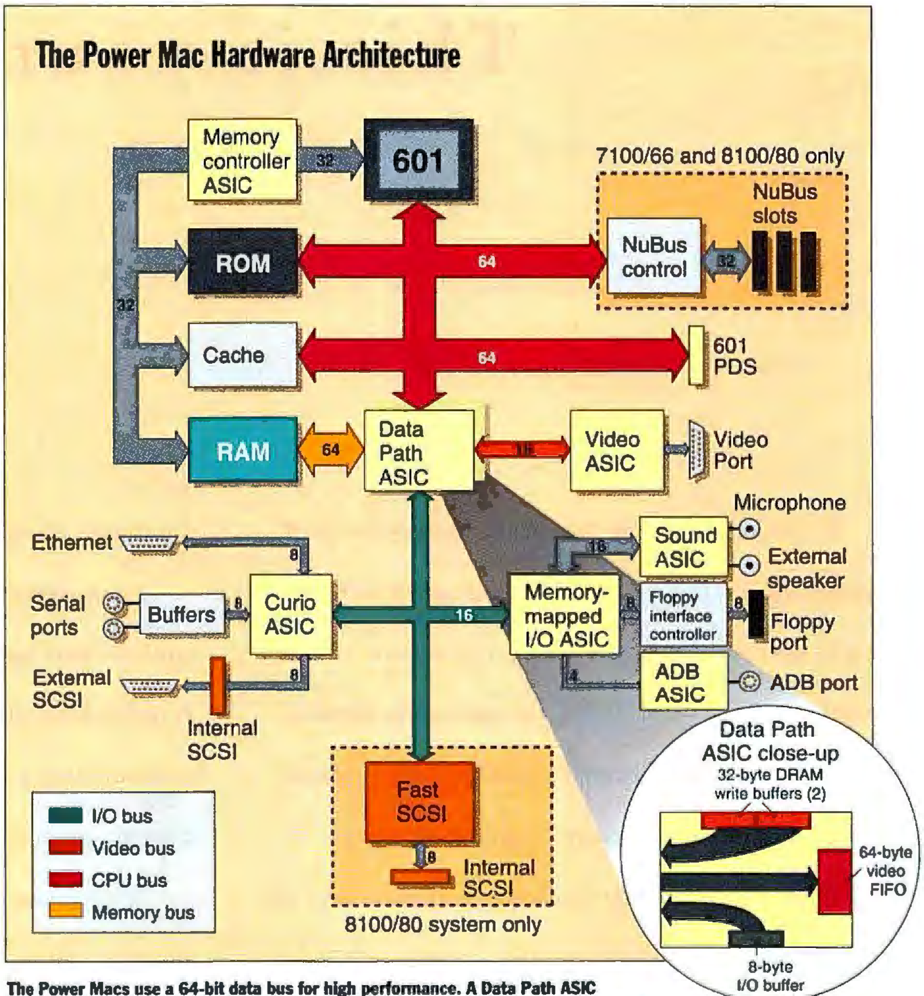
A 64-bit data bus links the 601 processor to the ROM, RAM, cache slot, and expansion slots (i.e., PDS and NuBus). The design supports a level 2 cache that's from 128 KB to 1 MB in size. The memory subsystem uses one- (up to 64 bits, or 8 bytes) or four-cycle (32 bytes) burst transfers to feed the ravenous appetite of the 601 processor. However, this subsystem does not support any of the 601's extended protocol-bus transactions that provide bus snooping to maintain memory coherency.

All three systems use 80-ns DRAM, which reduces system costs. Also, the CPU bus is clocked at half the rate of the processor (in other words, when the processor is clocked at 66 MHz, the CPU bus operates at 33 MHz). This lets the Power Mac design borrow existing 33- and 40-MHz components used in the Quadra 800 and 840AV. However, this design also exacts a performance penalty, because the memory subsystem injects a lot of wait states when accessing this slower DRAM.

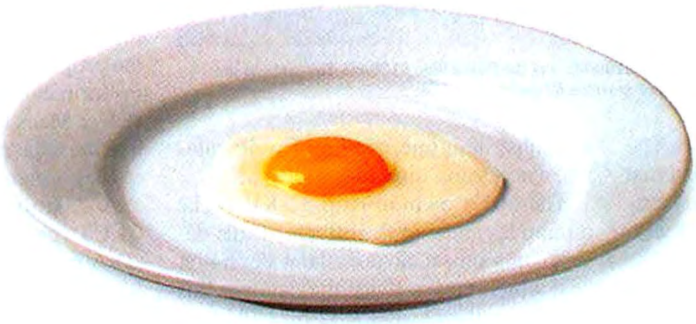
The 601's own on-chip 32-KB cache minimizes some of the effects of this design compromise. So does the wider 64-bit bus, which moves twice the data per bus cycle than the Quadra's 32-bit CPU bus. Because of the wider bus, when you add extra memory to a Power Mac, the RAM SIMMs must be of the same size and added in pairs.

Placing faster RAM in the SIMM sockets won't boost performance because the memory-controller ASIC (application-specific IC) that controls memory accesses runs at fixed speed. It's possible to reprogram the timing on this ASIC to handle faster DRAM, but because the 8 MB of RAM on the main logic board is soldered down, any timing changes would be detrimental to this slower memory. However, the programmability of this memory controller means that you'll find it in future Power Macs that use faster memory. Unlike the Quadra 800 and 840AV, the Power Mac's memory is not interleaved.

A custom video ASIC integrates a CLUT (color lookup table) and a DAC (D/A converter) to implement the Power Mac's built-in video. For 14-inch monitors (640 by 480 pixels), the built-in video



The Power Macs use a 64-bit data bus for high performance. A Data Path ASIC buffers the video data and blasts it to the 16-bit video bus in eight cycle bursts. Another buffer handles processor writes to DRAM. The Data Path ASIC can manage two bus operations in parallel: While it fetches data from DRAM and pumps it to the video ASIC, it simultaneously handles processor accesses to the I/O bus or memory. Notice that the 64-bit ROMs, expansion slots, and cache slot reside on the CPU bus, isolated from DRAM by the Data Path ASIC. This lets the 601 access these devices without bus contention.



This is your career.

If you're a desktop developer hungry for new opportunities, Powersoft is serving up something you're sure to like. A $249* desktop version of our award winning PowerBuilder,™ the application development software that's helped thousands of companies make the transition to client/server computing.

With PowerBuilder Desktop you get many of the same ingredients in our Enterprise edition in portions that make sense for the desktop-class databases already residing on your network.

For starters, you can create your own client/server applications using a common object technology. A technology that lets your programs, as well as your programming know-how, be scaled to run against any database from .DBF to DB2.®

With PowerBuilder Desktop you also get to take advantage of hundreds of built-in functions to access and manipulate data, perform calculations, and

This is your career on new PowerBuilder Desktop. Any questions?

*Introductory Price: $249**

communicate with other applications. Something you'll appreciate very quickly once you realize how much time it saves.

Of course you'll want more on your plate than that. So there's also our "SQL Smart" DataWindow™ to build applications without coding SQL. A built-in data dictionary to increase productivity and ensure standards. And the full 32-bit relational power of the WATCOM™ SQL database.

If we still haven't whet your appetite, consider our one-day comprehensive client/server training class for only $399 that includes your personal copy of new PowerBuilder Desktop. Just call Powersoft at 1-800-946-3500 for dates and a location near you. Or if you want to get your career cooking even sooner, call your corporate reseller, stop by CompUSA, or call Powersoft at 1-800-642-1421 today.

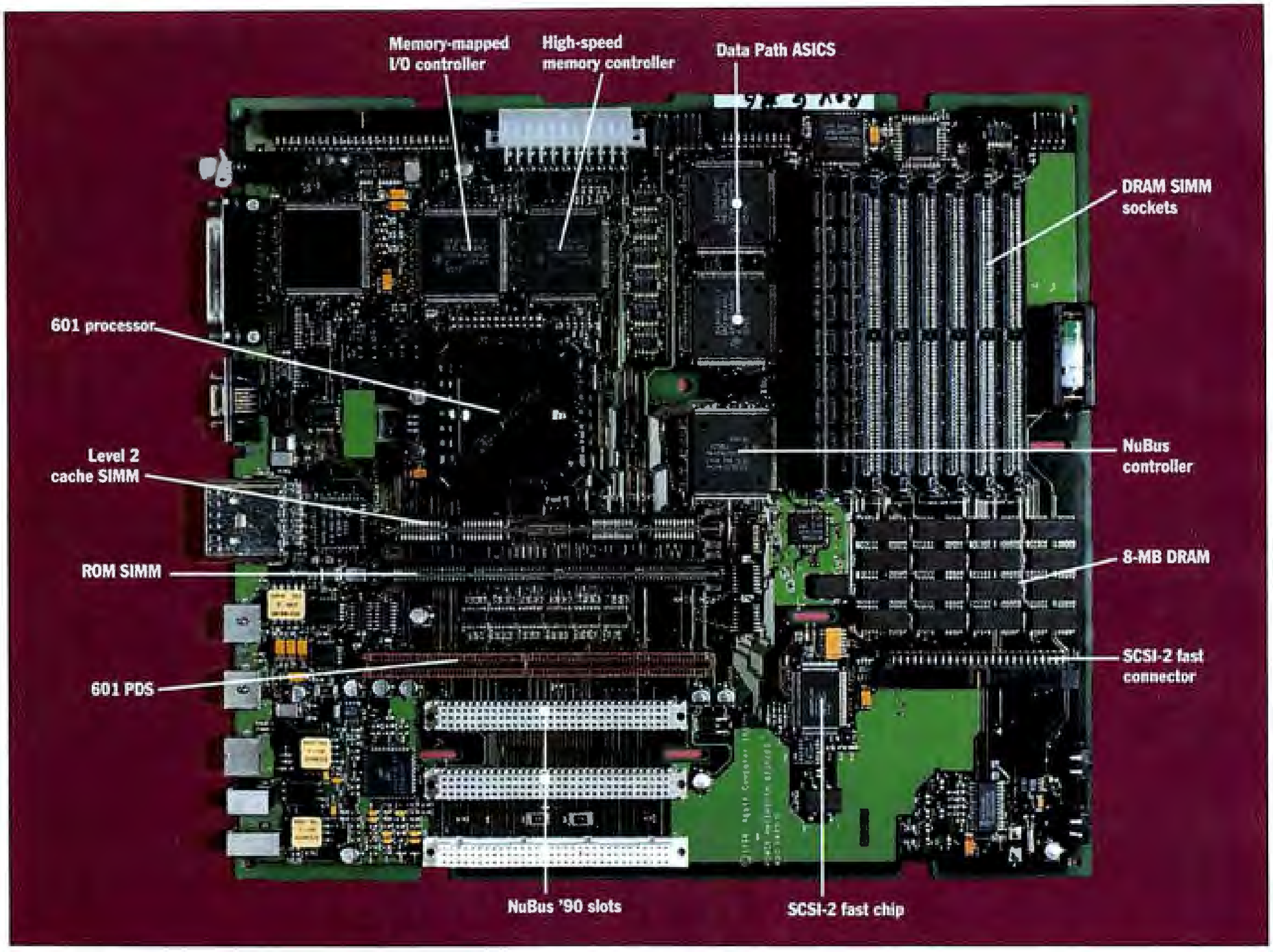
Powersoft

Building on the power of people.

*Introductory price; suggested retail price: $695. Powersoft Corporation, 70 Blanchard Road, Burlington, MA 01803
Powersoft Europe, Thames House, 1 Bell Street, Maidenhead, Berkshire, SL6 1BU, United Kingdom

 Prices listed do not include sales tax, shipping and handling. 30-day money back guarantee.

Circle 152 on Inquiry Card.



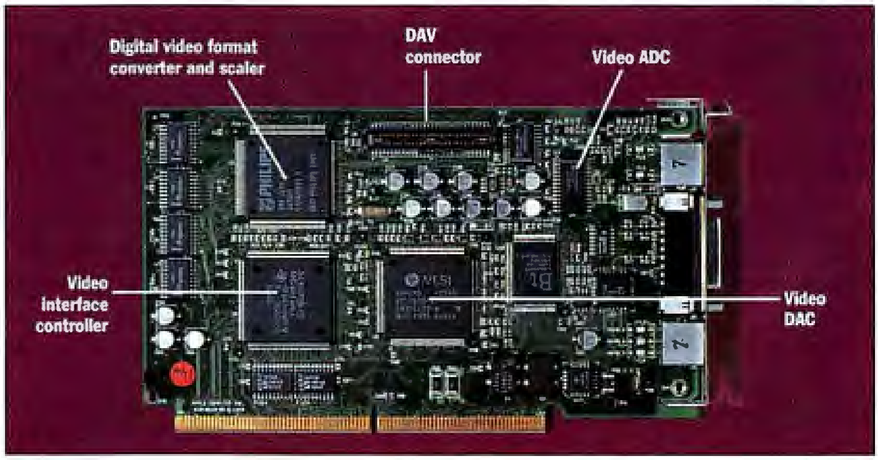
The main logic board of the Power Mac 8100/80. The ROMs are 4 MB in size and contain both 680x0 code and PowerPC code.

supports a color depth of 16 bits. For 16-inch monitors (832 by 624 pixels), the color depth is 8 bits. The cost compromise here is that the built-in video's frame buffer resides in main memory and consumes 600 KB. As with previous Mac systems that used this design, there's a performance hit when both the processor and the video circuitry contend for access to DRAM.

Apple's solution to this problem is another custom ASIC, called the Data Path. Two of these Data Path ASICs sit squarely in the middle of four buses: the CPU bus, the I/O bus, the memory bus, and the built-in video bus. These Data Path ASICs handle byte lane routing between the 64-bit buses and 8- and 16-bit I/O devices. They also buffer transfers among the CPU, I/O, memory, and the video bus.

Because the 601 spends most of its time accessing ROM code or the cache, this design minimizes any bus collisions when the built-in video is in use. Of course, there are a few pathological situations where a program might copy off-screen video data to the frame buffer, which defeats this design. On the plus side, owners of the 7100/66 and 8100/80 can opt to use only the VRAM display board, thus eliminating use of the built-in video and avoiding its performance penalty. The Data Path ASICs in this instance still minimize bus contention among the processor, memory, and I/O subsystems.

For high I/O throughput, the Power Macs have a custom I/O ASIC that handles Ethernet, serial, and SCSI I/O. It provides two 8-byte FIFO (first-in/first-out) buffers for serial I/O. The I/O ASIC implements an NCR 53C94 SCSI-2 controller chip and has a maximum transfer rate of 5 MBps. On the Power Mac 8100/80, a second SCSI-2 controller chip, the NCR 53CF96-2, is connected to an internal 50-pin SCSI bus. By using SCSI-2 fast transfers, this



The AV Technologies card provides digital video capture and manipulation functions.

SINCE OUR UPS COSTS LESS, LET'S FORGET ABOUT PRICE FOR A MINUTE...MAN

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

SO LET'S TALK ABOUT FEATURES...

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

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

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

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

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

MAKE THE COMPARISON YOURSELF

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

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

$25,000

yes NetWare Tested and Approved

MICROSOFT LAN MANAGER VERSION 2.1

MINUTEMAN
UNINTERRUPTIBLE POWER SUPPLIES
1-800-238-7272

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

1455 LeMay Drive
Carrollton, Texas 75007
214/446-7363 Voice
214/446-9011 Fax

Circle 114 on Inquiry Card (RESELLERS: 115).

internal bus can attain a transfer rate of 10 MBps and would be useful for implementing internal RAID arrays. The I/O ASIC also has a 50-pin internal connector that handles slow internal devices like the optional CD-ROM drive.

The Power Macs provide the usual two serial ports. Both ports use the new nine-pin GeoPort connector that is plug-compatible with existing mini-DIN-8 connectors. Either port can be configured for GeoPort modem/telephony or AppleTalk protocols (i.e., the LocalTalk network connection is no longer restricted to the printer port, and the GeoPort connection is no longer limited to the modem port).

Another custom ASIC melds a waveform amplifier with a 16-bit digital sound encoder/decoder to handle the Power Mac's sound I/O. This sound ASIC manages 16-bit, 44.1-kHz stereo sound I/O and sound input through the Power Mac's built-in microphone. The ASIC also assists the system software with PlainTalk speech-recognition and speech-generation software.

For maximum compatibility with the existing installed base of NuBus expansion boards, the Power Macs offer NuBus slots. Future Power Macs will employ the PCI bus when PCI expansion boards become plentiful. The NuBus slots on the Power Mac 7100/66 and 8100/80 follow the NuBus '90 specification, supporting 20-MHz transfers between NuBus boards. The NuBus controller ASIC that connects these slots to the CPU bus can act as a bus master. NuBus block transfers between boards are supported. On the 8100/80, the NuBus ASIC supports block transfers to and from the CPU bus. The controller enables direct access between RAM or ROM and the NuBus boards, but not to I/O devices.

A custom memory-mapped I/O controller ASIC provides the control and logic signals for most I/O devices in the system, except the built-in video. It provides DMA channels for Ethernet I/O (two channels), the floppy drive, the serial ports (four channels), sound I/O (two channels), and SCSI (two channels—one for the regular SCSI bus, and one for the fast SCSI). The DMA can relieve the 601 processor of the chore of transferring data between memory and these devices and allow it to spend processing power on more crucial tasks.

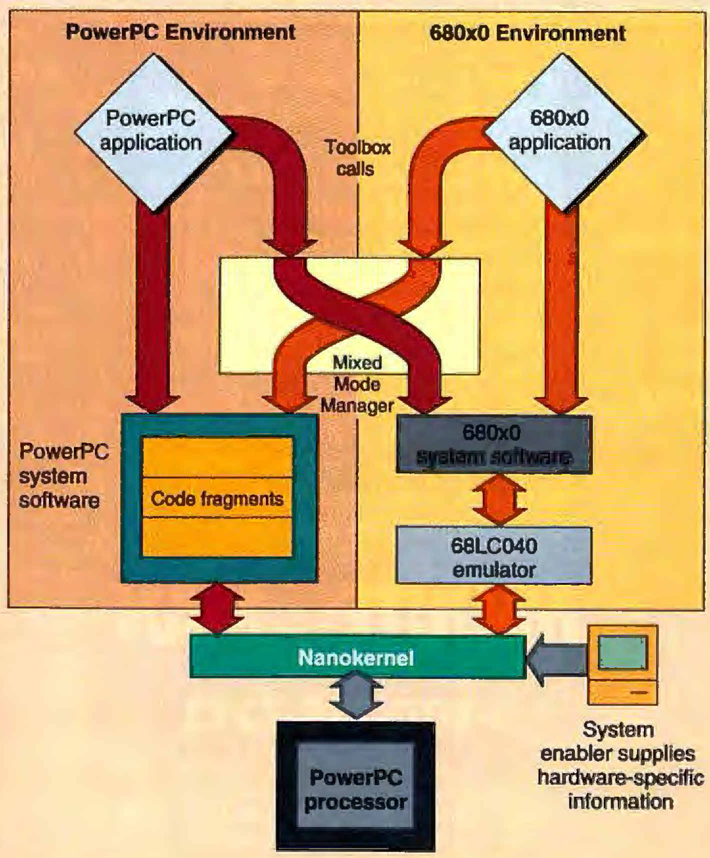
It's important to note that because the serial ports use DMA, this also provides DMA support for LocalTalk transfers. Previous LocalTalk implementations required extensive processor overhead to reliably manage AppleTalk packet transfers. The Power Mac DMA design leveraged off the experience gained from the AV Macs, which were the first Macs to extensively use DMA channels to manage device I/O.

Note that while the Power Macs have DMA channels, they can't be used effectively at this time, because most drivers and applications currently use synchronous I/O calls (i.e., the driver or function waits until the requested I/O operation completes). If the software is retooled to use asynchronous calls, applications will be free to perform other tasks while the I/O operation occurs. When the operation completes, the driver calls the application's completion function so that it can deliver a buffer of data (e.g., a read operation) or a status value.

The AV Macs use a DSP (digital signal processor) to handle voice-recognition preprocessing (i.e., echo cancellation from the walls of the room and other acoustic effects); sound generation; and modem, fax, and telephony functions. On the Power Macs, the PowerPC processor handles these tasks. A demonstration showed the 8100/80 handling a 2400-bps fax transmission while still recognizing voice commands. This is a distinct improvement over the Quadra 840AV, where you can use the modem/fax functions or the voice recognition, but not both. While the 601 appears to have plenty of power to bear on these sorts of things, you'll have to wait and see if this is the best solution, especially for the 6100/60 and 7100/66.

Apple has made some intelligent compromises in the first-generation Power Mac design. Cost-driven decisions like the slow RAM are partially canceled out by performance-driven choices like the wider data bus and burst transfers. There's room for faster systems with the basic hardware. According to Jonathon Fitch, one of Apple's PowerPC hardware managers, the custom ASICs "were designed to be compatible with the 603 and 604 buses."

Power Mac Processor Support



The Power Mac supports two different processor architectures simultaneously. The nanokernel provides a hardware abstraction layer, which the PowerPC system software and a 68LC040 emulator use. A Mixed Mode Manager handles context switches between the two environments.

System Software

A Power Mac presents no surprises to the seasoned Mac user. It boots like a 680x0 Mac, using the prerequisite System enabler file tailored for the Power Mac's hardware, and runs System 7. However, this resemblance is only superficial, because the core system software is fundamentally different. These changes go far beyond recompiling the system software for a different processor. The system's run-time architecture has been completely revamped. It provides a simple and clean design that will ultimately support a future microkernel-based operating system. However, it also supports the existing 680x0 application architecture.

continued

Power Packed Upgrades.

POWER SUPPLIES

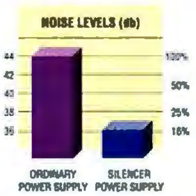
"The premier power-supply maker"
John Dvorak, *PC Magazine*, March 30, 1993
"The only company to go to for a power supply"
Jerry Pournelle, *Byte*, April 1993

STANDARD UNITS

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

STANDARD 205 SLIM $89
STANDARD 220 DESK/TOWER $89

ULTRA-QUIET UNITS



Unrattle your nerves with an ultra-quiet **Silencer** power supply. Appreciated by users **since 1986**, their high-efficiency fans and low-turbulence circuitry reduce noise by up to 84%! A must for home office or *multimedia* applications.

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

HIGH-PERFORMANCE UNITS

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

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

SOLID-STEEL CASES

Give your computer a professional, high-tech look with one of our premium-quality, **USA-made**, all-steel cases. They're rigid—unlike light-weight imports—so the PC's components are always properly aligned and grounded. You'll enjoy easy system access, and with room for up to **18 drives**, there's real expandability!

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

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

REDUNDANT POWER

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

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

TWIN-POWER 900 .... $995

OVER-TEMP ALARM

1" x 1.5"

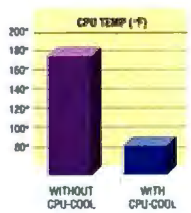
Don't wait for the acrid smell of burnt components! With our new **110 Alert**, you'll know if your PC is overheating *before* damage occurs. Should the computer's temperature reach 110°F, a loud alarm warns you that a fan has failed or that the cooling system is inadequate to handle that extra hard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

110 ALERT $29

CPU COOLERS

It's a fact. 486 chips run hot, often exceeding 185°F! Now, you can cool your 486 to a safe 85°-95°F with our popular **CPU-Cool**. It prevents random system errors and other heat-related problems. Consists of a mini-fan embedded in a die-cast heat sink that easily mounts on the CPU. Powered by a spare drive connector. Effective, inexpensive insurance!

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



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

PC POWER & COOLING, INC.

5995 Avenida Encinas, Carlsbad, CA 92008 • (619) 931-5700 • (800) 722-6555 • Fax (619) 931-6988

We accept Visa, MC, COD, or PO on approved credit. Warranty period: Five years for Twin Power and Turbo-Cool 450. Two years for Turbo-Cool (except 450), Silencer, and CPU coolers. One year for all others (except 110 Alert). Hours: 7 a.m. - 5 p.m. (PT) Mon. - Fri. Silencer, Turbo-Cool, TwinPower, CPU-Cool, PentaCool, and 110 Alert are trademarks or registered trademarks of PC Power & Cooling, Inc.

Circle 116 on Inquiry Card (RESELLERS: 117)

How the Power Macs Measure Up

BY TOM THOMPSON

While Apple's Power Macs represent a tremendous technical achievement in providing compatibility with the existing software base, the question everyone will ask is: How fast are they? Answering this question required running the BYTE low-level and application benchmarks (which test the 680x0 emulator), the BYTE native benchmarks (which test native performance), and two Windows applications (which check the 80x86 emulation). These results were on preliminary systems, and Apple plans a system software release this summer that will make more of the Toolbox code native.

Power Mac performance ranges from that of a IIci (which uses a 20-MHz 68030) to better than that of a Quadra 840AV (which uses a 40-MHz 68040), depending on how much native Toolbox code the application uses during the course of operations. The application benchmark results are skewed downward, because Excel and Mathcad, upon detecting the lack of an FPU (because the emulator reports that it's a 68020), did their own computations. This kept execution in the emulator, impairing performance. The word processing test, which makes heavy use of native QuickDraw code, shows better results: The low-end 6100/60 outgunned a Quadra 950 (a 33-MHz 68040 system), and the 8100/80 did better than the Quadra 840AV.

Native results showed that the 6100/60 and 7100/66 trailed the RISC systems BYTE tested (see "Windows on RISC" on page 109), but this was because they lacked the level 2 cache that most of the other RISC systems possessed. (An optional level 2 cache SIMM is available for these Power Macs.) The 8100/80, with a 256-KB level 2 cache as standard equipment, fared much better, posting an overall index close to that of the Sun SparcStation 10.

Windows emulation, supplied by Insignia Solutions, was on par with other RISC systems—slow. Excel 4.0 and Word for Windows 2.0 benchmarks indicate that even lacking the level 2 cache, the 6100/60 and 7100/66 were in the middle of the RISC pack on word processing tasks. The 6100/60 trailed the pack on spreadsheet operations, while the 7100/66 did as good as the DEC Alpha, and the 8100/80 was on par with the 200-MHz Carrera Cobra. Considering that the prices of the RISC pack range from $4000 for a basic system up to $25,000, the Power Macs do an impressive job.

Again, remember that performance is a moving target here. The Power Macs will get faster in the future as Mac applications are ported to native code, which eliminates the overhead of the emulator. Also, Apple plans to keep moving more of the Toolbox to native code, and these changes will be distributed periodically with system software releases.

MAC LOW-LEVEL AND APPLICATION INDEXES

LOW LEVEL	QUADRA 840AV	POWER MAC 6100/60	POWER MAC 7100/66	POWER MAC 8100/80
CPU	7.11	2.96	3.34	4.08
FPU	57.64	26.22	29.98	36.32
Disk	2.85	2.51	2.53	3.28
Video	7.62	4.48	5.86	7.29
APPLICATION				
Word Processing	2.61	2.25	2.45	3.68
DTP	4.50	2.11	2.28	3.32
Database	6.28	3.84	4.21	5.98
Development	4.25	2.83	3.09	3.58
Graphics	4.57	2.50	2.63	3.37
Scientific	14.25	6.29	6.62	9.20
Spreadsheet	13.23	2.36	2.62	3.78
Overall	49.69	22.18	23.91	32.89

SPREADSHEET AND WORD PROCESSING PERFORMANCE INDEXES UNDER EMULATION

	SPREADSHEET	WORD PROCESSING
IBM PowerStation 250 (Wabi)	0.14	0.14
DeskStation Tyne v4633v (Wabi)	0.21	0.21
Sun SparcStation 10 (SunPC)	0.21	0.25
Sun SparcStation 10 (Wabi)	0.08	0.19
HP 900 Series 700 (SoftWindows)	0.21	0.28
HP 900 Series 700	0.21	0.47
DEC Alpha 200 AXP	0.14	0.32
NEC RiscServer	0.24	0.47
Carrera Cobra	0.18	0.29
PowerMac 6100/60 (SoftWindows)	0.12	0.34
PowerMac 7100/66 (SoftWindows)	0.14	0.31
PowerMac 8100/80 (SoftWindows)	0.18	0.45

NATIVE PERFORMANCE INDEXES

Carrera Cobra	3.61
DeskStation Tyne v4633v	2.88
NEC RiscServer	2.73
IBM PowerStation 250	2.57
HP 900 Series 700	2.36
DEC Alpha	2.22
Sun SparcStation 10	1.96
PowerMac 8100/80	1.90
PowerMac 7100/66	1.50
PowerMac 6100/60	1.37

The Power Macs compare favorably with other RISC systems on the Windows emulation. Native performance was lower, but the 6100/60 and 7100/66 lacked a level 2 cache, as did the IBM PowerStation 250 and HP 900 Series 700. The native benchmarks were compiled using a beta version of the MPW PowerPC compiler. On all results, a higher number indicates better performance.

Inside the 4-MB ROMs, you find the usual suspects: Toolbox code (i.e., functions that provide application interface services like window creation and menu selection), operating-system functions (e.g., file I/O, allocating memory, and device drivers), and QuickDraw (i.e., the imaging engine). There are also some new features, such as a 68LC040 emulator and the Mixed Mode Manager (used to handle context switches between 680x0 emulated code and PowerPC code).

SCOTT PARKER, AVIS STUDIO © 1994

"How will [RISC PCs] interface with our Banyan Vines network?"

— Bruce Smith MIS Director EVSR Consulting and Engineering

Last but not least, these ROMs also contain a nanokernel. This nanokernel acts as a thin hardware-abstraction layer that provides low-level interfaces for interrupts, exception handling, and MMU (memory management unit) operation. It's also responsible for booting the system and initializing the 68LC040 emulator. The nanokernel's interfaces are private and are used only by the operating system.

Significantly, the nanokernel is the only supervisor-mode code in the Power Mac, while everything else—including the operating system—runs in user mode. Previously, nearly all Mac software, including applications, ran in supervisor mode. This probably simplified the system software design for early 680x0 Macs, but it created problems in making improvements to the system software later.

Because applications ran in the same mode as the operating system itself, it made implementing memory protection difficult. Also, there was nothing to prevent an application from executing privileged operating-system-level instructions. Because only the nanokernel runs in supervisor mode, it provides core functions that will evolve into a microkernel that supports preemptive scheduling, multiple address spaces, task synchronization, message passing, and other sophisticated operating-system services.

The run-time architecture of system software and applications has seen a dramatic change . Instead of the 32-KB segmented code structure used in 680x0 applications, the Power Mac uses *code fragments*. A code fragment is the basic unit of executable PowerPC code and its associated data. Code fragments can be any size; native Power Mac applications are actually single code fragments. Code fragments can export or import symbols that represent functions or data. Portions of the ROM code are shared-library code fragments that export symbols for use by the operating system and applications. At run time, on the launch of an application, a Code Fragment Manager resolves these symbols into physical addresses, a process that is called *dynamic linking*.

This setup allows applications to easily access information. Under the 680x0 architecture, timing tasks, plug-in modules, and extensions required programmers to write assembly language code to access data within an application or the operating system. Now you simply export or import the data and functions that you need from within the high-level programming language.

Code and data are handled as separate objects by the dynamic linking mechanism. This design enables the operating system to perform some rudimentary memory protection. Because the code portion of a fragment isn't segmented and contains no data, the operating system treats it as a read-only object. With virtual memory on, a fragment's code gets loaded into memory that the MMU then marks as read-only. If an errant application attempts to write to this portion of a fragment, it immediately generates an exception error.

Because a code fragment's variables are frequently updated, they reside in an area of memory with read/write access. Bogus writes to data variables can't be detected with this scheme. Nevertheless, the current memory-protection scheme in the Power Mac goes a long way toward making the operating system more robust.

While the current virtual memory implementation was grafted onto the existing 680x0 Mac architecture, the Power Macs have virtual memory designed into them from the ground up. The separate code and data sections of the code fragments enable a faster, more efficient virtual memory system. When more memory is required, because the code sections of the fragments in RAM are read-only objects, they are simply discarded. Only the data portions of the code fragments have to be written to the virtual memory's disk swap file. Also, a new Memory Manager that's fine-tuned for RISC processors has been implemented for the Mac OS. For compatibility, the Memory Control Panel lets you run the Power Mac using the old CISC-tuned Memory Manager as may be necessary.

Mixed Mode and Emulation

As mentioned earlier, the Power Mac ROMs contain a 68LC040 emulator and Mixed Mode Manager to support existing 680x0 application binaries. The emulator implements all of the 68040 user-mode instruction set. With an assist from an ASIC, the emulator can queue and handle 680x0 processor interrupts.

However, for compatibility with the widest range of 680x0 applications and drivers, the emulator uses a 68020 exception stack frame. It doesn't support any MMU or FPU instructions. That's because MMU operations are the responsibility of the operating system, and floating-point calculations can be handled by using either the Mac's hardware-independent SANE (Standard Apple Numeric Environment) API or PowerPC 601 floating-point instructions.

The emulator is comprised of two components: a lookup dispatch table and a code block that contains functions pointed to by the dispatch table. When a 680x0 instruction is processed, it goes through the dispatch table. If a single 601 instruction can handle the 680x0 instruction, that instruction is found in the dispatch table. Otherwise, the dispatch table points to a sequence of PowerPC instructions that emulates the 680x0 instruction.

The dispatch table also contains entries for *A*- and *F*-line 680x0 processor trap instructions. Because Apple uses the *A*-line trap as a mechanism to implement the entry points into the Mac Toolbox and OS, this feature allows an emulation of the original 680x0 trap dispatch tables used by the Mac software (not to be confused with the PowerPC emulator's dispatch table). It also enables existing 680x0 extension files—which add enhancements to the system software by patching the trap table—to function.

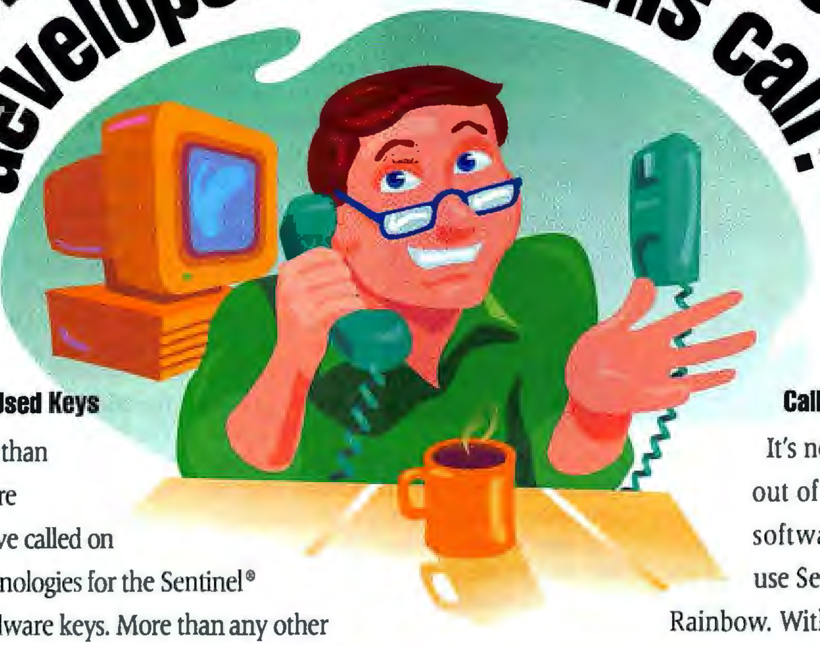
While the lookup-table design makes for faster instruction processing, let's face it: Emulation does exact a performance

All over the world software developers are looking for solid solutions to piracy protection and revenue enhancement for their software applications. They're looking for secure solutions that are reliable, compatible and transparent. And that's why they call Rainbow Technologies — the worldwide leader in software and revenue protection.

Technologically Superior

Sentinel keys are supported by the largest R&D department in the software protection industry — renowned for technological innovations like the world's smallest key. And they guarantee support for virtually any language as well as future technologies like Chicago and even Cairo.

Why did 10,000 software developers make this call?



Most Widely Used Keys

It's true, more than 10,000 software developers have called on Rainbow Technologies for the Sentinel® Family of hardware keys. More than any other in the world. In fact, there are over 4,000,000 Sentinel keys in use today. That's because they are the most technologically sophisticated. Take the SentinelSuperPro™, for example. Featuring next generation ASIC technology, this key provides the highest security and most flexibility available. Anywhere. It's just one in a family of keys that support virtually any computer platform including Windows, NT, WIN32S, UNIX, OS/2, open systems and Macintosh.

DON GALL

Call For Yourself

It's no wonder seven out of the ten largest software companies use Sentinel keys from Rainbow. With direct support from offices and distributors in 41 countries worldwide, no one else can match Rainbow's reputation for service. Want to know more? Call Rainbow today. Ask for a free copy of *The Sentinel Guide To Securing Software.* And while you're at it, ask about our complete line of Sentinel Evaluation Kits.

CALL
800/ 852-8569
FOR YOUR FREE GUIDE
TO SECURING SOFTWARE

SENTINEL
Securing the future of software

Some call it a dongle. Those who know, call it Sentinel.

yes NetWare Tested and Approved

RAINBOW TECHNOLOGIES

9292 JERONIMO ROAD, IRVINE, CALIFORNIA 92718 ■ 714/ 454-2100 ■ fax 714/ 454-8557

NORTH AMERICAN UNIX DIVISION 800/ 843-0413 ■ RAINBOW LTD./U.K. 44 932 570066 ■ RAINBOW FRANCE 33 1 47 38 21 21 ■ RAINBOW GmbH/GERMANY 49 89 32 17 98 0

MICROSOFT WINDOWS COMPATIBLE

Circle 126 on Inquiry Card (RESELLERS: 127).

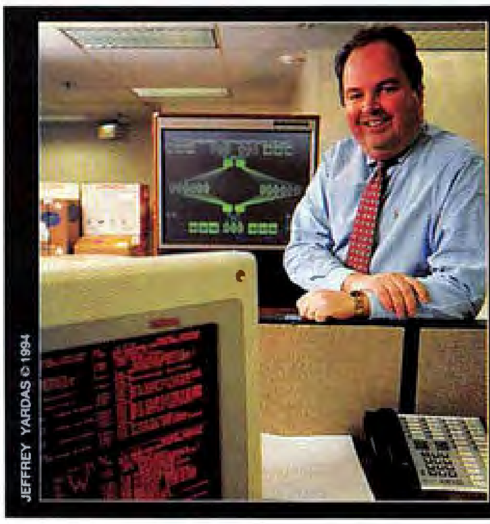
penalty. Apple did code profiling of Mac applications and determined that they spent 60 percent to 80 percent of their time in Toolbox code. Thus, if the Toolbox code could be written as PowerPC code, the result would be that emulated 680x0 applications would run faster than expected because the application would spend more time in PowerPC code than in the emulator.

Apple therefore rewrote about 16 percent of the most heavily used Toolbox calls in PowerPC code so that 680x0 applications could benefit from this characteristic of the run-time environment. The Toolbox calls rewritten for the first Power Macs include portions of the following: QuickDraw, the Font Manager, TrueType, QuickTime, the Resource Manager, the Memory Manager, fixed-point math, SANE, and the Script Manager (for foreign-language support). Again, not all the calls in these managers were ported, only the most heavily used ones.

Apple's reason for not rewriting all the Toolbox code is twofold. First, rewriting it would delay getting the Power Macs onto the market. Second, it could introduce compatibility problems. Apple plans to rewrite more of the Toolbox over time, so Power Macs will become faster as system software upgrades are introduced.

This setup does introduce the complication that the Mac OS must maintain two radically different instruction-set architectures as the software executes. A Mixed Mode Manager handles the context switches between the two environments. It uses new header information embedded in the Toolbox calls, known as *routine descriptors*, to take the arguments passed to the function, massage the PowerPC stack appropriately, and transfer control to the appropriate code fragment. On return from the PowerPC code, the Mixed Mode Manager adjusts the stack again (so the function results appear in the appropriate emulated 680x0 processor registers) and restarts the emulator. The overhead of a context switch is roughly 50 to 100 680x0 instructions.

This overhead incurred by the Mixed Mode Manager doesn't seem bad. However, many Toolbox functions call other Toolbox functions, which in turn call still other Toolbox functions. These "call chains" can execute rapidly as long as no context switches occur. Unfortunately, when Apple rewrote some of the Toolbox code, certain Toolbox functions actually became slower because the call chain these functions threaded caused two or more instruction-set-architecture context switches.



"[RISC PCs] will be an improvement for the knowledge makers, the decision-making process, and the decision makers."

—Joe Correira
VP of Technology
The Travelers, Inc.

The solution was to write critical Toolbox functions in both PowerPC and 680x0 code, creating a "fat trap." Because the Mixed Mode Manager knows what instruction-set architecture the software is currently in, and Toolbox routine descriptors describe the instruction-set architecture of the next function, it can keep a call chain in the current instruction-set architecture when necessary for maximum performance. All these efforts are usually hidden from software developers, unless they're writing special programs (e.g., plug-in modules, I/O completion functions, or extensions). In this case, the only extra code the programmer writes is routine descriptors that describe the function's arguments and the instruction-set architecture it uses to the Mixed Mode Manager.

Works As a Mac Should

Compatibility with 680x0 software was simply superb. After extensive testing with dozens of applications, we discovered only a handful of applications that didn't work on a Power Mac. Some applications (e.g., Aldus PageMaker 4.0 and Microsoft Word 4.0) that crashed or ran erratically on Quadras worked without a glitch on the Power Macs.

Even more amazing was that all the usual Control Panels and extensions worked, even those that patched the 680x0 trap table heavily. For example, Shiva's networked modem software, which patches the serial interface, and Adobe Type Manager 3.6, which patches QuickDraw so that it can rasterize PostScript fonts on the fly, continued to work.

The real potential of the Power Macs appeared in our limited tests with beta versions of native applications. For example, we used Adobe Photoshop 2.5 and a native beta version of Photoshop to perform some editing tasks on a 15.7-MB 24-bit-color scanned image. On a Power Mac 8100/80, the native application was twice as fast as the 680x0 application. In certain situations, the native application was even faster. An unsharp mask-filter operation on the file took 335 seconds using the 680x0 application, while the native application finished the job in 85 seconds—easily four times faster.

BYTE's cross-platform benchmarks show that the Power Mac 6100/60, with an index of 1.37, delivers Pentium-caliber performance. The Gateway 2000 P5-60, Ambra DP60E/VL, and ALR Evolution V, all 60-MHz Pentium systems, posted native averages of 1.41, 1.33, and 1.45, respectively. Of course, the Power Mac 7100/66 and 8100/80 had higher indexes.

The Winds of Change

The Power Macs deliver plenty of horsepower, especially in the area of floating-point calculations, to enable a host of new applications. Adobe, Aldus, and Macromedia are retooling some of their graphics applications to take advantage of the PowerPC's strengths. Multimedia applications, which process a lot of digital video and sound, especially stand to benefit. There's also power to spare for *agents*—which could be AppleScript programs or other programmable applications—that quietly operate in the background or are started with a PlainTalk voice command. These agents might search databases or retrieve and sort the day's E-mail as you work.

Then there's the fact that you can have Windows running simultaneously with System 7. This is particularly true of the Power Mac 7100/66 and 8100/80, where you can have two monitors, each one dedicated to a different operating system.

RISC PCs such as the Power Macs "will be an improvement for the knowledge makers, the decision-making process, and the decision makers," says Joe Correira, vice president of applied technology at The Travelers Insurance Companies (Hartford, CT). The extra processing power on the desktop will let it perform data analysis that is traditionally handled by mainframes or minicomputers, he says.

continued

We wrote the book on CD-ROM drives. And we want you to have it.

Compare Ordinary "Double Speed" CD-ROM Drives To Plextor's DoubleSpeed PLUS.

CONFIGURATIONS AVAILABLE
Internal, External, Bundle, Kit & Tower

DATA TRANSFER RATE
335Kb/sec

AVERAGE ACCESS SPEED
240ms

INTERFACE
SCSI-2

MTBF
50,000 Hours

COMPATIBILITY
MPC-2™
Multisession Kodak Photo CD™
NT & OS/2
SUN
SGI
NetWare/UniWare

TOLL-FREE TECH SUPPORT
Unlimited

WARRANTY
1-Year

OVERALL VALUE
"Best Buy"
Compute, September 1993

You've decided to enter the exciting world of multimedia. But with all the CD-ROM drives to choose from, how do you know which is the right one for you? This comprehensive, yet easy-to-read, booklet will help guide you through the multimedia maze. It addresses several major concerns, including: SCSI vs. proprietary interface? Caddy vs. tray loading system? 8-bit or 16-bit interface?

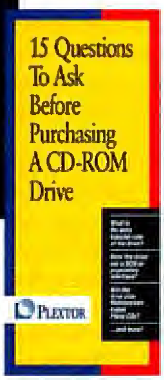
DoubleSpeed ***PLUS***™

When it comes to CD-ROM drives, speed is everything.

The most important factor when considering a CD-ROM drive for your computer system is the data transfer rate. Simply put, you need a drive that can keep up with your applications. One that offers the speed and performance that lets you clearly see multimedia in all its blazing glory.

The fastest way to bring your multimedia applications to life.

As the table shows, Plextor *DoubleSpeed PLUS*™ CD-ROM drives feature the fastest data transfer rate among all "double speed" drives. And unlike some of our competitors, we don't sacrifice access time or quality to achieve high data transfer rates. All of which makes us your best choice for those demanding multimedia applications that combine audio, video, graphics and animation.



Hurry! Call 1-800-886-3935 now for your FREE copy.

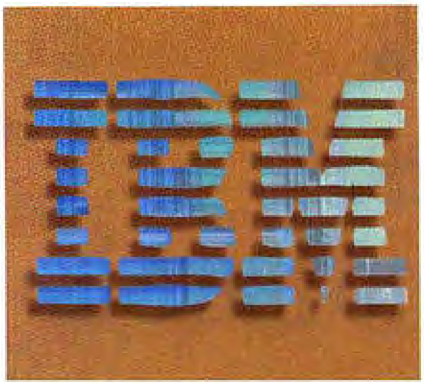
The more you know about CD-ROM drives, the less confusing they get. For more information on Plextor *DoubleSpeed PLUS* CD-ROM drives, and the location of your nearest dealer, call today. We'll respond with everything you need to make a smart decision. And fast!

Plextor DoubleSpeed PLUS CD-ROM drives are available in internal, external, bundle, kit, and tower configurations.

PLEXTOR

4255 Burton Drive
Santa Clara, CA 95054
408.980.1838
FAX: 408.986.1010
800.886.3935

Circle 167 on Inquiry Card (RESELLERS: 168).



IBM Power Personal Strategy

If anything, IBM's plans for the PowerPC are more ambitious than Apple's. IBM wants nothing less than to create a new PC standard around the PowerPC family of chips.

In this context, the term *PC* requires some explanation. At the most basic level, a PC is a system that runs DOS and Windows on an 80x86 processor. The software communicates with the processor through a specific, well-defined hardware and firmware interface. This interface was defined de facto in the design of the original IBM AT in 1984 and is perpetuated in the BIOS and interface chip set contained in every PC-compatible computer. It is now so complex that the definitions of its different functions fill a 1200-page reference book (*PC Interrupts, Second Edition: A Programmer's Reference to BIOS, DOS, and Third-Party Calls,* by Ralf Brown and Jim Kyle, Addison-Wesley, 1994).

In addition to the design definition, however, the term *PC* also implies a functional definition. A PC is a computer you use to run widely available, shrink-wrapped personal-productivity applications and to connect to departmental and enterprise-wide shared resources. Workstations, by way of contrast, are used more as scientific and engineering tools and are considered incomplete if they don't come with a compiler. By this definition, the Mac also qualifies as a PC.

It is this second definition that IBM is targeting with its PowerPC-based systems. It wants to create a flexible platform definition for systems that function as PCs. It wants to stimulate a robust, independent market for third-party hardware, operating-system, and applications-software developers. IBM intends to compete at many levels in this market—as a component, system, and operating-system vendor—but the company fully realizes that a PC standard that isn't available from multiple vendors and subject to competitive pressures can't hope to make major inroads against the Intel-based DOS/Windows juggernaut.

To create such a standard—and to develop such a market—IBM has launched the IBM Power Personal Systems Division, with development facilities in the following locations: Austin, Texas; Boca Raton, Florida; and Yamato, Japan. In addition to developing IBM's PowerPC-based PCs, the division is also charged with establishing the standard for such systems and developing technologies to advance the standard. The Power Personal Systems Division publishes the definition of standard PowerPC systems in the PReP (PowerPC Reference Platform) specification.

The PReP Minimum Requirements and Goals

Requirements

Processor: PowerPC

Memory: 8 MB, 16 MB recommended minimum

Other memory: system ROM for the start-up code, 4 KB of nonvolatile RAM for configuration information, and a memory-mapped I/O system

Mass storage: 80 MB; 200 MB is recommended

Hard drive controller: IDE or SCSI

Floppy drive: 3½-inch 1.44-MB MFM

CD-ROM (optional): ISO 9660; SCSI bus recommended

Input devices: keyboard or other alphanumeric input device and a pointing device, such as a mouse, connected with either the Intel 8042AH or Apple Desktop Bus

Audio: 16 bits at CD audio sample rates

Graphics: 8 bits, 640 by 480 pixels; higher-resolution, higher-color graphics recommended

I/O ports: EIA-232C serial port supporting at least 19.2-Kbps and bidirectional Centronics parallel port; IEEE P1284 Enhanced Capability Port recommended

Expansion bus: none required, but PCI, ISA, or PCMCIA strongly recommended

Other: real-time clock, DMA, interrupt controllers, timers, and configuration registers, with the DMA subsystem being capable of addressing 32 bits

Goals

- **Create an open standard.**
- **Target traditional types of systems.**
- **Use readily available components.**
- **Support standard buses and interfaces.**
- **Allow differentiation while maintaining compatibility.**
- **Keep hardware details hidden from software.**
- **Promote operating-system-based power management.**

Inside PReP

First published in alpha form in late 1993, PReP defines the devices, interfaces, and data formats that make up a PReP-compliant system. Its purpose is to let vendors create systems that, when accessed via the hardware-abstraction layer of supported operating systems, will be compatible with all other PReP systems. PReP also contains recommendations for the minimal functionality of different types of systems: notebooks, desktops, servers, and so on. Vendors can add value by building on this minimum specification.

The common ingredient in any PReP system is a PowerPC processor. The PowerPC architecture was jointly defined by Apple, IBM, and Motorola; the instruction set demonstrates its PC bias. For example, one of the features of the instruction set is its multiply-accumulate instruction, which makes it relatively easy to implement DSP functions on the PowerPC. Signal processing, of course, is the core technology used to implement sound and video processing on PCs.

This multimedia slant is carried through into the chip implementations. In the 601, for example, the performance of single-precision, floating-point operations is optimized at the expense of double-precision performance. The rationale is that multimedia signal processing doesn't need double precision. Fast double-precision performance is required by scientists and engineers—the types of people who buy workstations, not PCs. In fact, although the 601 is fully IEEE-754-compatible, it also implements a fast "sleaze" mode that can be used by applications that don't require the iron-plated protection of the IEEE floating-point specification.

A memory-mapped I/O system lets the processor communicate with I/O devices using load/stores. The I/O subsystems must be able to translate load/store addresses in the memory space of the processor into I/O addresses that the external devices can understand. Optionally, a PReP system can have I/O devices that have their own memory—a graphics buffer is the most common example—and a level 2 cache.

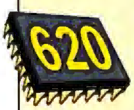
In addition to hardware requirements, the PReP specification sets down some architectural rules. PReP systems have a layered topology, with the processor, level 2 cache, and system memory connected to the processor bus, and I/O subsystems connected to I/O buses. These I/O buses

The PowerPC Family

First PowerPC
Architecture: 32-bit
Superscalar: 3-issue
Clock: 50, 66, and 80 MHz
Performance: 85 SPECint 92, 105 SPECfp 92 at 80 MHz
Available: Now

Power-Managed
Architecture: 32-bit
Superscalar: 3-issue
Clock: 66 and 80 MHz
Performance: 75 SPECint, 85 SPECfp at 80 MHz
Available: Now

Fast Double-Precision Floating-Point
Architecture: 32-bit
Superscalar: 4-issue
Clock: Not available
Performance: Not available
Available: Second half of 1994



Will Challenge DEC Alpha
Architecture: 64-bit
Superscalar: 6-issue
Clock: Not available
Performance: Not available
Available: First half of 1995

can be cascaded onto one another, with bridges connecting them to one another and to the processor bus. Other architectural issues covered in PReP include bi-endian support, word alignment, multiprocessing, memory maps, configuration and testing, and power management. PReP recommends that all systems be power-managed and defines five system states—Full On, Enabled, Standby, Suspend, and Off—and the power characteristics of each.

The PReP ROM

An important aspect of the PReP specification is the ROM. Here, IBM defines how PReP systems present a compatible interface to supported operating systems.

As IBM—and almost everyone else—sees it, the biggest problem with the AT architecture is that it is defined in hardware. It is thus difficult to evolve the architecture as technologies evolve and at the same time maintain compatibility with the software base. IBM avoids this problem in the PReP specification by keeping the supported operating systems at arm's length from the hardware. PReP relies heavily on hardware abstractions in both the operating system and its own ROM to eliminate hardware dependencies in the operating system.

Unlike the AT, where the system ROM is accessed for as long as your system is turned on, the PReP ROM is designed to initialize the hardware, pass system information to the operating system, and get out of the way. After booting, the PReP ROM is never accessed again.

The start-up process consists of the following steps. First, when you turn the power on, the processor begins execution at address 0xFFF00100, the initial location of the system ROM. This is the entry point for the start-up code and the only "hard-wired" address in a PReP system.

The start-up code makes sure the processor is working and configures base memory. It then copies itself to base memory and continues execution from there. Once in RAM, the start-up code initializes the system console—which is usually the video adapter—so that it can display messages on the screen. It will usually find information about the console, and later about the boot device, in nonvolatile RAM. The next step in the start-up is configuring and testing the rest of system memory, followed by initialization of the interrupt subsystem, CMOS real-time clock, keyboard, and mouse. The start-up code also asks for your password.

The final step in the start-up is booting the operating system. The start-up code first configures and initializes supported boot devices to the point where it can load the boot record and image. Other configuration and device-driver binding is left to the operating system. Boot devices that are supported at start-up may include hard drives, floppy drives, CD-ROM drives, or network adapters.

The code searches the devices for a valid operating-system boot record. When it finds one, the start-up code loads it and discovers the location of the boot image. It then loads the load-image portion of the boot image and passes control to it. The operating system then takes control, overwriting the start-up code in memory. The boot record and image are extensions of their PC counterparts, ensuring that PC and PowerPC media are both compatible and interchangeable.

The current boot process is not the final word in how PReP start-up code will operate. One of the strategic objectives of PReP is to support Open Firmware, the IEEE P1275 standard for boot firmware (see the text box "Open Firmware Provides CPU Independence" on page 62). One of the reasons that IBM put the start-up code of its PReP-compliant systems into flash ROM is to be able to upgrade easily to Open Firmware.

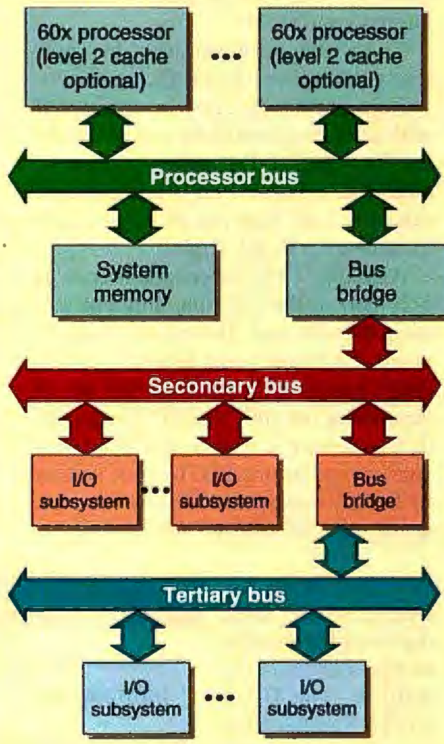
Abstraction to Abstraction

While the boot process does overwrite the start-up code, it doesn't overwrite the residual data structure created by the start-up code in nonvolatile RAM. This data structure contains configuration information about the system, and this information is made available to the hardware-abstraction layer of the operating system. Some operating systems will use these structures directly; others may translate them into a more compatible format.

The PReP specification defines the minimal amount of system information that an operating system must be able to abstract in order to be PReP-compliant. PReP doesn't care how this abstraction is handled by the operating system, only that the operating system handle it.

The operating system must be able to abstract general information such as system memory size, type, and location. It must be able to construct an I/O map that lists the location and type of all buses and of all devices on those buses, and information about the system processor. It must be able

PReP Topology



PReP systems can incorporate many different bus types into a hierarchical structure. At the top is the processor bus, which connects one or more processors and their caches to both system memory and system I/O. Connection to system I/O comes via a bus bridge to a secondary bus; in most PReP systems, this secondary bus will be PCI. The secondary bus can then bridge to a tertiary bus, such as ISA, and so on.

Open Firmware Provides CPU Independence

RICK GREHAN

Suppose for a moment that you're an adapter card. You get plugged into a PCI (Peripheral Component Interconnect) bus and powered up. You have no idea what kind of CPU your host is, but you're expected to (among other things) provide code to the CPU so it can initialize whatever device you're controlling, determine characteristics of the device, and perhaps even boot from the device. What are you gonna do?

Well, you could have your ROM crammed with executable code for every conceivable processor and provide a table that tells the host: "If you're an Intel 80x86, your code is over *there*; if you're a Mips, your code is over *there*; if you're an Alpha, your code is over *there*," and so on. What happens, however, when you get plugged into a system with a brand-new CPU (they're appearing all the time these days) that your designers didn't know about when they burned your ROM?

The above scenario describes precisely the problem that is facing peripheral designers today: They're confronted with platforms hosted by a growing diversity of CPUs. The answer, of course, would be a kind of CPU-independent machine code that can be placed into the adapter's ROM. Right?

Actually, CPU-independent code is only part of the solution, although it's an important part. Both CPU motherboard and adapter-card designers need a clear, agreed-upon set of specifications describing not only the CPU-independent software's syntax, but what services should be provided by code written in that software so that the host has all it needs to get devices up and running.

An Open Solution

One solution is nearing completion even as this article is being written. The IEEE P1275 Standard for Boot Firmware working group, called Open Firmware for short, is chaired by Mitch Bradley of FirmWorks, who did much of the early work on what is now the Open Firmware specification while working for Sun Microsystems. A prototype Open Firmware system first appeared in the SparcStation 1.

The Open Firmware specification consists of three interface definitions: a device interface, which defines the CPU-independent code described above; a client interface, which defines procedures that start-up code (usually an operating system or an operating-system loader) can call to acquire firmware services (e.g., reading data from a boot device); and a user interface, which allows human interaction with the firmware for the purposes of altering the booting process or performing device testing and debugging functions.

The device interface is perhaps Open Firmware's most interesting component. Not only does it provide the mechanism whereby adapter cards achieve CPU independence, but it is made possible thanks to a language that only longtime BYTE readers may be familiar with: Forth.

Why Forth?

Forth is a programming language developed by Charles Moore in 1971. At the lowest level, you can think of Forth as the "assembly language" for an abstract stack-based machine. A small set of primitive instructions take their arguments from and leave their results on a stack; Forth's abstract machine has no registers.

Forth source code is a sequence of text words that list, in left-to-right order, the operations to be performed. You can define new words as sequences of existing words. This ability to extend Forth makes it difficult to characterize it as either a high-level language or a low-level language. Rather, Forth is a language that scales to fit a wide range of needs. In addition to the primitive words, a typical Forth system includes utility words for console and mass-storage I/O, command parsing, memory display, and so forth.

Forth is interactive; you simply type a series of Forth words and they will be executed. By using Forth as the firmware's command interpreter, a complete integrated toolkit can fit easily in a typical ROM. The Open Firmware user interface specifies Forth words for hardware and software debugging, system configuration management, and support packages for various communications protocols. Because these functions are integrated seamlessly into the Forth environment, you can use Forth language facilities to write macros to automate sequences of these operations.

The code in an adapter ROM is a predigested form of Forth source code called FCode, in which the text words are replaced by integers encoded as 1 or 2 bytes each. The execution of an FCode program is functionally equivalent to interpreting Forth source code. The Forth interpreter resides on the host CPU.

How It Works

In response to a hard reset—usually just after power is applied—the host CPU begins executing Open Firmware code stored in ROM on the motherboard. This code initializes the system's internal environment (e.g., checks for available memory, initializes stacks, and determines the configuration of on-board hardware devices).

Next, the code directs the system to explore the devices attached to the expansion bus. The system examines each device's ROM, looking for a signature that indicates the presence and location of FCode. Note that a single ROM might contain multiple code components of differing nature. Typical AT-style BIOS code can be stored alongside FCode, enabling a single board to operate in

Open Firmware Highlights

- **Expansion devices contain processor-independent configuration information.**
- **Forth interpreter in system ROM interrogates the expansion devices, configures the system, and boots the operating system.**
- **User interface lets you interact with the system ROM to select the boot device or perform system testing.**

either an AT-architecture system or a system supporting Open Firmware.

Once the host locates FCode, the FCode interpreter within the host's system ROM begins executing the FCode program. In function, the FCode is just a general-purpose program. It isn't restricted to any particular activity. In most cases, however, the code will probably initialize the board to some state, identify and describe the board, create driver routines for controlling the board, and make those routines available to the system firmware.

This process continues for all adapters attached to the host. In fact, it can even extend to adapters not directly attached. Specifically, Open Firmware lets designers build bridge cards that link one bus to another and thereby permit expandable bus architectures. In practice, the host is directly connected to one bus, but that bus is straddled by a bridge card that links it to another bus. The bridge acts as an intermediary, passing information back and forth between the buses and allowing the secondary bus to be "booted from a distance." This structure can be arbitrarily complex, with a primary bus bridged to secondary buses bridged to tertiary buses, and so on.

Ultimately, the success of Open Firmware depends on its ability to gain a foothold as a standard. Currently, Apple, IBM, Motorola, and Sun head the list of corporations jumping on the Open Firmware bandwagon. Although Open Firmware has been in use on SBus cards for some time now, and there's no reason it can't be applied to other bus architectures (e.g., Futurebus), it appears that real success hinges on how well the PCI architecture fares. The PCI specification for adapter-card ROM contents includes Open Firmware's FCode as one of the possibilities, and the only possibility that provides real CPU independence.

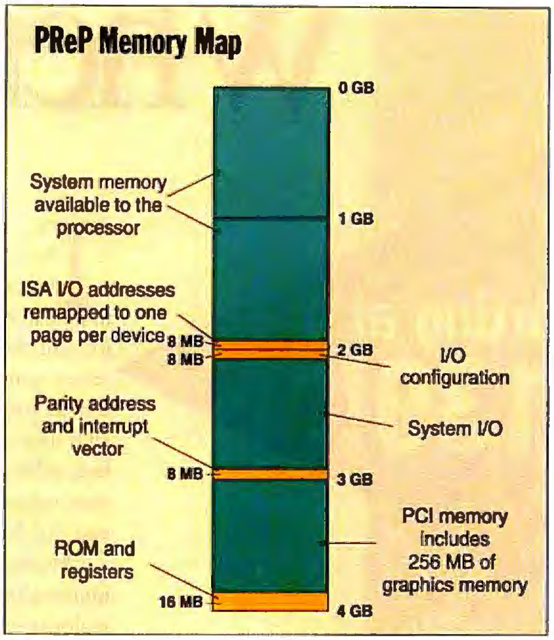
ACKNOWLEDGMENT

Thanks to Mitch Bradley, chairman of the IEEE P1275 working group and founder of FirmWorks (Mountain View, CA), for his help.

Rick Grehan is technical director of the BYTE Lab. You can reach him on the Internet or BIX at rick_g@bix.com.

to provide services to the operating-system kernel, such as multiprocessor initialization, I/O buffer completion, instruction- and data-cache coherency, and TLB (translation lookaside buffer) flush and reload. It must be able to virtualize all external interrupts.

The operating-system abstractions layer must be able to isolate devices you want to access directly from any physical-address dependencies and provide a set of function calls for devices that will be accessed indirectly. It must provide DMA services that aren't specific to a particular DMA device. It must be able to read and write nonvolatile RAM, perform power management, and handle hardware faults and errors.



To the PowerPC processor, the memory of the PReP reference implementation is divided into a number of distinct areas. Accesses to the first 2 GB of memory are decoded by the memory controller as memory accesses to system memory. Accesses between 2 GB and 3 GB are run as I/O cycles with the MSB (most significant bit) of the address set to 0, indicating that the access is to the system I/O range. An access between 3 GB and 4 GB has the memory controller run an I/O memory cycle with the 2 MSBs of the address set to 0. Specific areas within the I/O areas have special functions.

In addition to the above system abstractions, a PReP-compliant operating system must use device drivers to interface with peripheral devices. These drivers should use the abstractions and services provided by the system abstractions to avoid dependencies on a specific device location, DMA controller, or interrupt structure.

PReP uses abstractions to such a degree for two reasons. First, it supports not only shrink-wrapped applications, but shrink-wrapped operating systems and device drivers as well. Second, it seeks to avoid any hardware dependencies that could keep the hardware platforms from taking advantage of new technologies. Present-day PCs are pretty much constrained to implement DMA and interrupt controllers in a way compatible with the IBM AT. Abstractions let vendors differentiate their hardware without imperiling software compatibility.

The Reference Implementation

The largest section of the PReP specification is devoted to a detailed description of a PowerPC 601–based desktop computer. Essentially, this section describes the 601-based desktop system that the IBM Power Personal Systems Division will deliver in the second half of this year. The PReP specification also describes portable, medialess, technical workstation, server, and multiprocessor systems, but none in the detail of the reference implementation.

The reference implementation has three buses: processor, PCI, and ISA. ISA was included because PCI doesn't yet have a broad array of available adapters. Notable by their absence are the Micro Channel architecture and EISA. While it is certainly possible to build PReP-compliant machines using these or other buses—such as VME or Futurebus—neither has the performance of PCI or the vendor support of ISA.

One of the problems with implementing ISA is that ISA adapters are built to operate in the upper 360 KB of the 1-MB address range of an 80x86 processor in real mode. The reference implementation offers two solutions to this address hardwiring. In the first, the 64-KB ISA address space is remapped to a contiguous space in the PowerPC memory map. In the second, called *discontiguous memory mapping*, each ISA base address is mapped to a distinct page of the PowerPC I/O memory.

While the first method is simpler and less expensive, it does not offer protection between conflicting device drivers. The second method takes advantage of the fact that the basic granularity of memory coherency in PReP is the page by reserving a page for each ISA device. Thus, each device takes up the first 32 bytes of a 4-KB page, and the attendant drivers can take advantage of hardware memory protection. The reference implementation's memory map also defines system-interrupt assignments, PCI configuration registers, the

Back-UPS® prevail

"All other brands of UPS die regularly in this lightning prone environment. My APC won't die!" said Paul Sisilli, Systems Analyst, City of Port St. Lucie. "With other brands, users don't find out until it is too late. The power interruptions here are very hard to live with. The other brands are dying off. Typically they last just beyond their warranty period. My Back-UPS is going on three years...no other brand is as reliable."

Don Traux knows first hand about Back-UPS reliability: "It ought to be against the law to buy a computer without an APC Back-UPS 250. I recently had a direct lightning hit right outside the house...my computer never blinked. Each morning I get a surge down the line and both APC's hate it - they simultaneously 'holler 'n clamp' while my 'Brand T' quietly sleeps in. I've relegated that unit to non-critical household stuff like my VCR."

Andrew Wargo, Manager at Baxter Land Company, tried two other brands before Back-UPS. "One lasted a few days, a second one went up in smoke after 48 hours, a third lasted less than 24 hours! I then bought my Back-UPS for less than half of what I had paid for the others. We've purchased three more Back-UPS and for the past 14 months they've been just hummin' away on the same power line that was eating the other brands alive!"

virtually all separate surge suppressors. Surge performance is even backed by a $25,000 Lifetime Equipment Protection Guarantee.

If you're protecting a network server, a communications interface port (on models Back-UPS 400 and higher) provides the security of an automatic shutdown to all major OS including NetWare, Windows, Windows NT, LAN Server, LAN Manager, LANtastic, SCO Unix, OS/2, Banyan Vines, AppleShare/System7 and more, so your data is safe whether the system is attended or not. (PowerChute software and interface kits sold separately.)

MADE IN [USA]

And since data processed on networked clients needs protection too, the $139 Back-UPS 250 provides an economical solution for all your LAN workstations.

Discovering how essential Back-UPS protection is can be hard...if you wait for the next storm to roll through. But discovering how afforable it has become is easy...

Call today and find out (the easy way) why more than 1,000,000 satisfied users bank on Back-UPS from APC. With more awards than all other brands combined, field-proven reliability, and a two year warranty, Back-UPS are power protection you can purchase with confidence.

Back-UPS (R to L)	Application	Sugg. List
250	LAN nodes, internet hardware, POS	$139
400	Desktop 486, 386 systems, servers	$229
450	Tower 486, 386 systems, servers	$279
600	Heavily configured systems, CAD/CAM workstations	$399
900	Multiple systems, longer runtime applications	$599
1250	Multiple systems, LAN hubs, small minis, telecom equipment	$799

More than... 1,000,000 Satisfied Users

APC has won more awards for performance and reliability than all other UPS vendors combined...including four consecutive LAN Times *Readers Choice awards...*

PC World Top 20 Upgrade · Windows Mag. Readers Choice · LAN Times Readers Choice 1995 · Reseller News Editors' Choice

Microsoft Windows Compatible · yes NetWare Tested and Approved · Artisoft Compatible LANtastic · SCO OK · Available and Ready · Microsoft · Solaris

AWARD-WINNING FEATURES

Instantaneous backup power beats blackouts and brownouts

Unmatched lightning (tested to UL1449) and surge protection for maximum hardware safety

Network-grade line conditioning and EMI/RFI filters prevent glitches

LAN Interface (on Back-UPS 400 and up) provides automatic shutdown to all major OS: Windows, NT, NetWare, LAN Server, LAN Manager, LANtastic, Unix, OS/2, Vines, AppleShare/System7 and more.

Site diagnostics automatically spot missing ground and reversed polarity, two common miswirings which usually require an electrician's visit to diagnose.

Option switches allow you to customize transfer voltage and alarm settings.

Test Switch for ongoing peace of mind

2 year warranty and full safety approvals

$25,000 Lifetime Equipment Protection

APC™

AMERICAN POWER CONVERSION

800-800-4APC

PowerFax Info (800)347-FAXX

APC EUROPE (+33) 64625900 / ASIA/PACIFIC FAX: 401-789-1631 / L. AMERICA FAX: 401-789-9771 / Compuserve: GO APCSUPPORT

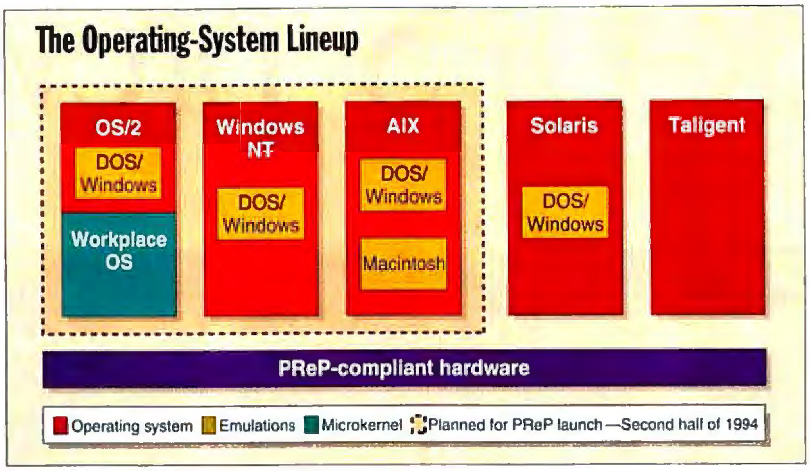
Circle 65 on Inquiry Card.

Dept. A2

location of I/O memory, and DMA assignments.

Beyond the memory map, the reference implementation details the parts and specifications of the system. The processor is a 601 running at 50, 66, or 80 MHz; the memory controller/PCI bridge is IBM's 27 82650; the flash ROM is implemented with the AMD 29F040-120; SCSI comes from the NCR 53C810; the Intel 82378IB bridges PCI and ISA; and so on. Wherever possible, IBM has used commodity components to implement the system. The idea is to leverage the technology and dynamics of the current PC components' market.

One interesting aspect of the platform is the 200-pin upgrade slot. You can use this upgrade slot to implement a look-aside level 2 cache or, later on, you can upgrade the system to one that's based on a PowerPC 604. The initial 604 is expected to provide at least twice the performance of the 66-MHz 601.



To be PReP-compliant, an operating system must be able to abstract information about the underlying hardware, which leaves out DOS/Windows. However, you can run 80x86 binaries on PReP systems by taking advantage of the emulation technologies offered by the different operating system.

Operating-System Issues

The IBM Power Personal Systems Division intends to have three operating systems available for its systems when they start shipping: AIX, Windows NT, and Workplace OS with OS/2 personality. Given that none of the three was yet in beta testing in late January, a second-half release is very optimistic. According to Mark Dean, Power Personal Systems Division director of architecture and hardware reference platforms, AIX and NT won't require extensive beta-testing periods because they are not new operating systems, just new ports.

Workplace OS is a new operating system, although IBM has been working on it for years and has extensive experience

Human-Centered Computing

One critical area where IBM's Power Personal Systems Division is providing key technologies to operating-system vendors and ISVs (independent software vendors) is in value-added software extensions that take advantage of the capabilities of the PowerPC processor. The most important of these extensions enable what IBM calls human-centered computing.

In one sense, Power Personal systems are a triumph of technology transfer from IBM and university research labs to IBM products. For example, RISC processors like the PowerPC trace their heritage back to John Cocke's work on the Model 801 at IBM's Thomas J. Watson Research Center (Yorktown Heights, NY) in the mid-1970s. Research for IBM's instruction-set-translator technology comes from its Haifa, Israel, labs, and the notebook design is being done at the company's Yamato facility in Japan. IBM is also relying heavily on its own research into the areas of speech recognition and AI.

The idea behind human-centered computing is simple: Make computers easier to use by having them conform to how you communicate, and not the other way around. The goal is to have users concentrate on the task at hand as opposed to operating the computer. IBM has married two trends to achieve this goal: Enabling the computer to understand a wider range of natural inputs, and enabling it to use richer data types such as high-quality audio and full-motion video.

Key to human-centered computing is enabling the computer to understand a range of inputs—what Karl Karlson, manager of the Human Centered Conversational Group (Boca Raton, FL), calls multimodal input. For example, when using a spreadsheet, it may be more appropriate to use touch to resize a window or speech to select a range of cells. Unlike today's keyboard-and-mouse interfaces, the human-centered paradigm doesn't constrain you to one method of input.

Not only does human-centered computing enable a range of inputs—voice recognition, handwriting recognition, pointing, pen input, and touch—but it can make intelligent inferences about the inputs. This type of intelligence is supplied by *agents*, software modules that use technologies to understand your spoken or written requests and comply with them.

Called variously an actor or a conversational surrogate, Charlie is an output device that provides a focal point for interacting with your system. Shipping versions of Charlie are expected to be less realistic to be less computationally intensive and less intimidating.

At first, agents will be constrained in their understanding to perhaps command and navigational tasks. As the technology progresses, however, they will develop the ability to perform complex tasks based on your input. One example Karlson uses is telling the computer to "call my wife." The agent would have to infer that *call* refers to making a telephone connection and equate *wife* with a specific entry in your address-book database. It may also need to decide, depending on the time of day, whether to with it on Intel platforms. With over 400 people working to bring it up on Power Personal hardware, IBM thinks it can include Workplace OS with the initial systems. However, IBM won't let a delay in one of the three initial operating systems keep it from announcing and shipping hardware that runs under the other two.

The operating-system count won't stop with the initial three, however. Both the Taligent operating system and Solaris are being actively ported to the PReP platform, although neither is expected to be available at launch. The Power Personal group is also trying to interest other vendors in the platform. Target operating systems are NetWare, UnixWare, Motorola's Unix System V implementation, SCO Unix, a microkernel-based version of System 7, and NextStep.

Supporting five operating systems is a Herculean task, so the Power Personal Systems Division avoids it. Separate divisions within IBM support their own operating systems, as do outside vendors like SunSoft. The role of the Power Personal Systems Division is to define a systems standard and to sell systems that can run all the operating systems.

In two critical areas, however, Power Personal is active in supporting all operating systems. The first is emulation. One goal of Power Personal is that every system, no matter what the operating system, should have the capability to run DOS/Windows binaries. Such support has two components: an API remapper and a binary translator. For example, Solaris uses Wabi to map Windows API calls to the X Window System library and an underlying emulator to translate 80x86 instructions into native RISC instructions.

At the API level, IBM is actively supporting Wabi, as well as continuing development of its Windows capability within OS/2. At the emulation level, IBM has developed an instruction-set translator that in effect compiles blocks of 80x86 code into blocks of PowerPC code on the fly and performs optimizations in the background. This instruction-translation technology can underlay any API remapping technology and is being offered for license by IBM to any operating-system vendor (see "Emulation: RISC's Secret Weapon" on page 119). IBM is also rumored to be integrating parts of its emulation technology into a future variant of the PowerPC. Such a chip would significantly boost the performance of 80x86 software on Power Personal systems.

Software for Hardware

IBM has three general software technologies for use on Power Personal systems. The first is human-centered computing, (see the text box on page 66). The other two are SoftGL and SoftDSP.

SoftGL is a software library that lets a Power Personal system run applications developed for OpenGL, Silicon Graphics' standard 3-D graphics API. SoftGL lets your standard video adapter run OpenGL programs, enabling compelling 3-D applications on even entry-level systems.

Many communications and compression functions are based on digital-processing algorithms. PCs normally require special hardware to run these algorithms effectively, but the PowerPC is different. Because the instruction set includes the basic signal-processing multiply-accumulate operation, PowerPC processors can effectively operate as DSPs. IBM has created a standard library named SoftDSP that enables applications to seamlessly take advantage of the PowerPC's DSP functions. All PowerPC-based systems are thus assured of having a minimum level of signal-processing functionality.

In the future, IBM will use these and other technologies to enable applications that will incorporate digital videoconferencing, integrated telephony, and other communications-oriented functions. These will enable a new level of collaborative computing, with PReP systems at the core.

First Look at IBM's Power Personal Systems

IBM's Power Personal Systems Division says it will release its first three PowerPC systems in the second half of the year. One will be a desktop/deskside system based on a PowerPC 601 running at 66 MHz, while the other two—a power-managed desktop and a portable—will use a 75-MHz 603. All systems are expected to ship with 16 MB of RAM, SCSI-2, a CD-ROM drive, and a full array of interface ports. They will include high-quality graphics and sound.

The most fully fleshed-out system at the time of this writing is the 601-based desktop. Essentially, it is a realization of the PReP reference implementation. The system features a 64-bit processor bus and

place the call to a business or home phone.

Eventually, agents may need to communicate with other agents. Telling your computer to "set up a managers' meeting for early next week" may result in your agent contacting agents on other systems and negotiating a time and date that can fit into the schedules of the other managers. Such capabilities would require that agents be able to learn about your preferences, and this is a key point to the human-centered paradigm—the computer learns about you, as opposed to you learning about the computer.

The visible manifestation of agents is actors—graphical representations that provide a point of contact between you and the human-centered technologies. Actors are output devices that use speech as well as visible clues to indicate the progress of agents in carrying out your requests.

At Comdex in Las Vegas last November, IBM demonstrated Charlie, a 3-D actor that provided feedback from the system. The actors shipped initially with Power Personal systems will probably be visually simpler than Charlie, both to save processing cycles and to present a less intimidating image to end users. Thus, the first actors may resemble Fred Flintstone more than they do Max Headroom. Some people may find actors a distraction, so IBM will provide an easy way to turn them off.

The Power Personal Systems Division is making the various human-centered technologies available to all operating-system vendors and will create an architecture for ISVs that will let their applications interact with the human-centered actors and agents available on a system. ISVs will also be able to create their own services. At this time, it is too early to tell the level at which different operating-system vendors will support the human-centered technologies, or how they will integrate them into their GUIs. IBM reports, however, that operating-system vendors are generally supporting the human-centered technologies.

Karlson expects that the integration of these technologies into operating systems and applications will be an evolutionary process. The technologies may first appear as a distinct operating-system layer and only gradually become more seamlessly integrated with the operating system.

The Power Personal Systems Division has said that the human-centered technologies are a defining element of their Power Personal systems. However, they have not said when specific technologies will appear, except that speech recognition will be included in the first systems.

a 33-MHz PCI bus, which should ensure that its performance at least matches that of its faster-clocked brethren. It also will come with four open expansion slots and an upgrade slot that can house a secondary cache or, eventually, a PowerPC 604 processor. Its architecture reflects the cascading-bus concept that characterizes PReP systems.


The 603-based desktop can drive flat-panel displays, as well as standard CRTs.

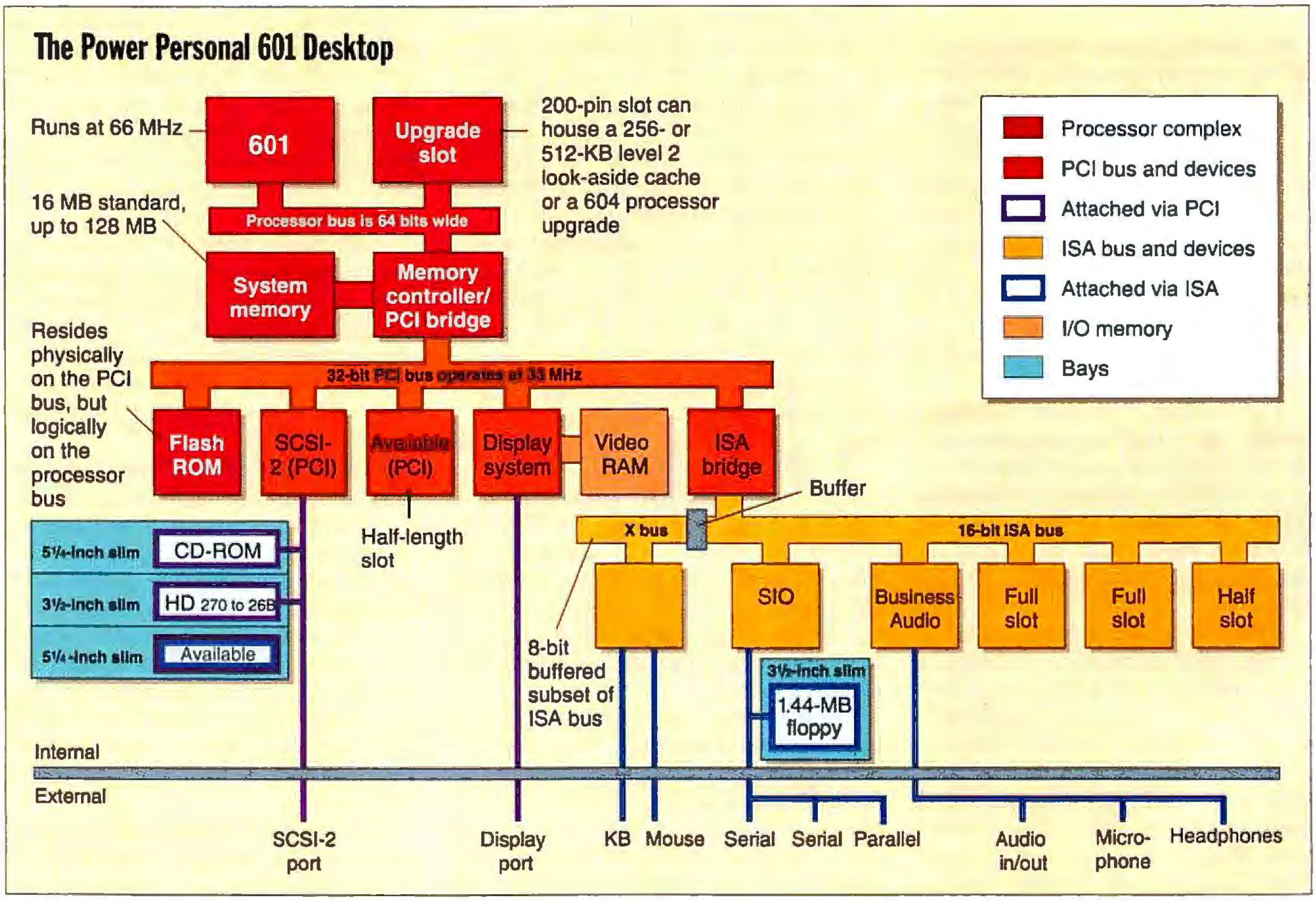
At the time of this writing, 603-based systems were not as solid as the 601 desktop. Both use a CPU bus/PCI/ISA hierarchy, but neither is expected to offer bus-expansion slots. Instead, each hangs PCMCIA slots off the ISA bus—two in the notebook, and four in the desktop.

The 603-based systems will run the processor at 75 MHz and the PCI bus at 25 MHz. IBM intends to clock the processors in its Power Personal systems at integer multiples of the PCI bus, which can run at either 25 or 33 MHz. This simplifies system timing. Unlike the 601-based desktop, the 603-based systems will use 32-bit processor buses.

IBM has said nothing about availability beyond the fact that the systems will ship in the second half of the year. Much depends on the availability of the various operating systems. The systems are as yet unnamed. Pricing at this point is up in the air, although given IBM's desire to create a PC standard to compete with the 80x86 standard, you can expect its pricing to be fairly aggressive.

Critical to the eventual success of PReP in general and Power Personal systems in particular is the widespread availability of applications software. At first, there will be a good deal of native software available for Power Personal systems running AIX and less native software for Windows NT and Workplace OS–OS/2. Porting NT software will require little more than a recompilation for ISVs (independent software vendors), while OS/2 developers will first have to ensure that their applications are 32-bit before they can recompile for Power Personal systems. IBM reports that major ISVs have committed to the platform, but the company refrains from preannouncing anyone else's software. "I hope existing applications get rewritten to take advantage of the new systems," says Barry Coleman, senior economist at Texaco (White Plains, NY).

Undoubtedly, in the early stages, most of the personal-productivity software that's available for Power Personal systems will



The basic system in the Power Personal desktop line runs a 601 processor at 66 MHz. The system employs the basic PReP topology of a hierarchy of buses connected by bridges. Most of the components used in the system are commodity components available on the open market.

Endless possibilities. Unlimited supply.

Endless? Unlimited? Okay, in our excitement, maybe we've exaggerated a bit.* But the truth is that we've reduced the prices up to 26% on selected Server 85 and 95 models. And we've prepared enough stock to keep them flying out of here. But don't wait forever.

With their bottleneck-eliminating SynchroStream™ controller, IBM PS/2* Servers can take full advantage of their Pentium™ 66 MHz or 60 MHz chips and 256KB of L2 Cache. What's more, the PS/2 Server Array models feature a high-performance RAID controller, so you don't sacrifice speed for reliability.

Which all means that when it comes to your workload, the possibilities are, well, *almost* endless.

Plus the whole PS/2 line comes with a three-year on-site warranty with four-hour average response time.**

For more information about the PS/2 Server 95 and entry-level Server 85 models, call 1 800 772-2227.

And find out more about the servers that are *almost* limitless.

IBM

*Please call for model availability. **Available from IBM, M–F, 8 A.M.–5 P.M. in your time zone. Copies of IBM's statement of limited warranty are available upon request, by calling 1 800 772-2227. IBM and PS/2 are registered trademarks and SynchroStream is a trademark of International Business Machines Corporation. Pentium is a trademark of Intel Corporation. © 1993 IBM Corp.

Circle 93 on Inquiry Card.

be DOS/Windows applications running under emulation. This is why emulation technology is critical to IBM; it is the bridge that will provide a software base until faster native applications arrive. DOS users may find emulation unacceptably slow, but Windows applications will probably perform adequately on the Power Personal systems. That performance will only improve as the PowerPC line moves to faster clock speeds and more powerful processors.

PHILLIP MINOTT. TEXACO © 1994

"I hope existing applications get rewritten to take advantage of the new systems."

— Barry Coleman
Senior Economist
Texaco

Future Directions

Beyond the initial systems, the IBM Power Personal Systems Division plans to "churn" the product line on a regular basis—perhaps every six to eight months—to keep current with technology advances and market forces. The 601 desktop will evolve into a line of systems that take advantage of evolving PowerPC processor technology. The original machine will be upgradable to a 604 when that chip ships, and follow-up products will incorporate 604s as well as faster 601 processors. At some point, the desktop line will also include a low-end 50-MHz 601 that some IBM people call their "*Computer Shopper* special."

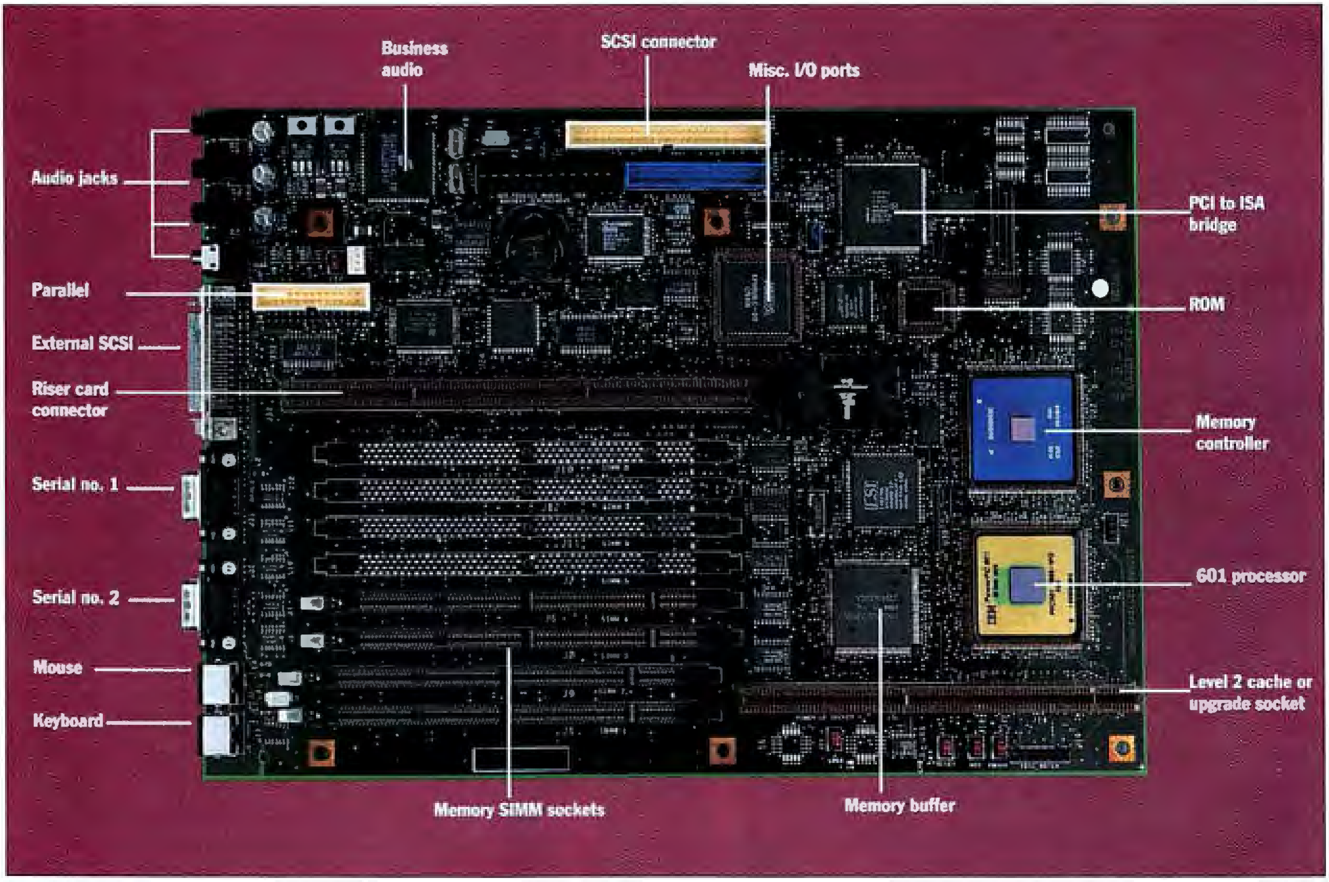
In 1995, IBM will add a server line to the Power Personal line. The servers will incorporate 604- and 620-based machines running at 120 to 150 MHz and include multiprocessors. To meet the expansion needs of servers, the systems will support multiple PCI buses.

On the low end, the notebook line will evolve to keep pace with enabling technologies. As-yet-unannounced types of PowerPC processors will be used in handheld devices.

Perhaps the most interesting evolution awaits the 603 desktop. Here, IBM plans to break from the standard desktop form factor. The 603 desktops will drive flat-screen displays as well as CRTs. Future 603s will appear in tablet and other forms as well as in traditional system-keyboard-display configurations. Integrated videoconferencing will likely first appear here in the Power Personal line. In addition, the 603 will eventually be available in higher clock speeds, and a variant will integrate a PCI controller, memory controller, and level 2 cache controller. The desktop 603 line will be the focus of IBM's human-centered computing efforts.

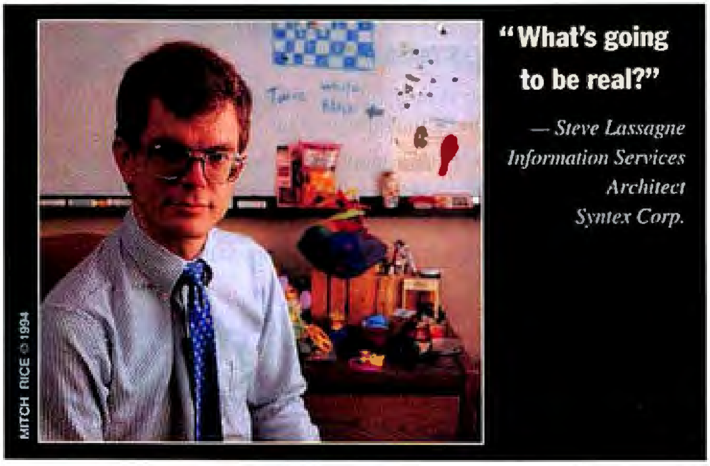
IBM on the Move

It is too soon to speculate about the eventual impact of PReP and Power Personal systems. The actual systems will not ship



The 601-based desktop from the Power Personal Systems Division is made up primarily of standard parts. Even the custom memory controller will be made available from IBM Microelectronics.

for months, the operating systems are not done, and the applications software will be slow in coming. IBM has set a strategic direction and supplied information about how it is moving in that direction. Success or failure is far down the road.

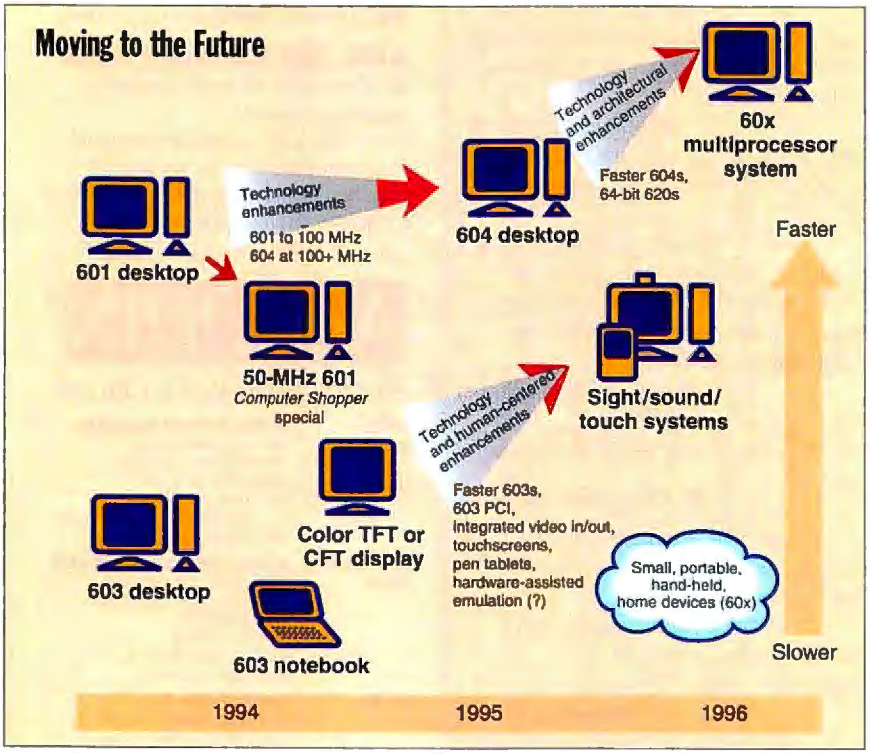


"What's going to be real?"

— Steve Lassagne Information Services Architect Syntex Corp.

The direction, however, is exciting. IBM wants to leverage a lot of different technologies to bring new power and functionality to PCs. Some of these technologies—such as PReP systems' hardware and 80x86 DOS/Windows binaries—are proven and readily available. Others—advanced microprocessors, fast emulators, and operating systems capable of abstracting the underlying hardware—are more on the cutting edge. The combination is a platform with a high comfort level that supports hardware differentiation and can evolve as quickly as the underlying technologies change. This is the great promise of Power Personal systems, and the advantage they have over 80x86 PCs.

IBM hopes that 1995 will be the year that Power Personal and other PReP-compliant systems begin to make a significant impact in the PC marketplace. Such a projection is probably too optimistic; the PC clone market, after all, wasn't built in a year. But 1995 will be indicative of the eventual success or failure of PReP systems. If by mid-1995 such systems are available from multiple sources, and if more operating-system vendors have signed on, and if native applications begin appearing at an ever-increasing frequency, you'll know that the takeoff is only a matter of time.



Speculation about the future evolution of systems that haven't been shipped is fraught with risk, but IBM has provided a general outline of where the Power Personal line is going. Some systems will concentrate on performance, while others will broaden the offerings to include different form factors and human-centered capabilities. The dates given are tentative—even speculative—in nature.

Excitement and Caution

The development of the PowerPC has recreated much of the excitement that surrounded the arrival of the first IBM PC and Mac systems, and with good reason. It has the potential to change how you work with and think about PCs.

Intel and other manufacturers of 80x86-class CPUs are not going to stand still in the meantime, of course. By midyear, Intel will introduce the next Pentium, known as the P54C. In addition, Intel says it has accelerated its development schedule for its next-generation processor, code-named the P6. Intel will release no information on the P6 other than to claim that it will deliver 300 MIPS, or performance that's about three times faster than that of today's Pentium processor.

The price/performance ratio on Pentium-class processors is dropping, too. Intel recently lowered the price of the Pentium by 15 percent. Cyrix's 80x86-class M1 processor is expected to deliver somewhat greater performance than the Pentium at a lower price when it debuts later this year. These trends, plus the enormous installed base of 80x86 PCs, guarantee an uphill battle for these PowerPC desktop systems.

Power Personal and Power Mac systems will try to make inroads against formidable competition from 80x86-based PCs. Potential customers have been hearing about the benefits of the PowerPC and RISC for years, but many remain skeptical. "What's going to be real?" asks Steve Lassagne, an information-systems architect at Syntex (Palo Alto, CA). Before Lassagne considers any RISC PC, he wants to see it work successfully in other businesses. Still, he sees the potential for PowerPC systems to eventually replace his company's existing high-end Intel-based PCs and Macs.

Apple and IBM and their partners will have to convince the world that the long-term advantages of RISC processing power, compatible differentiation, and new paradigms for interacting with computers are worth the short-term pain of emulation and platform upgrades. RISC is on the desktop. ■

CONTRIBUTORS

BYTE senior technical editor Dave Vislosky and senior news editor Tom R. Halfhill also contributed to this story.

Tom Thompson is a BYTE senior technical editor at large, and Bob Ryan is a BYTE technical editor. They wrote the first in-depth look at the PowerPC in the August 1993 issue of BYTE. You can reach them on the Internet or BIX at tom_thompson@bix.com and b.ryan@bix.com, respectively.

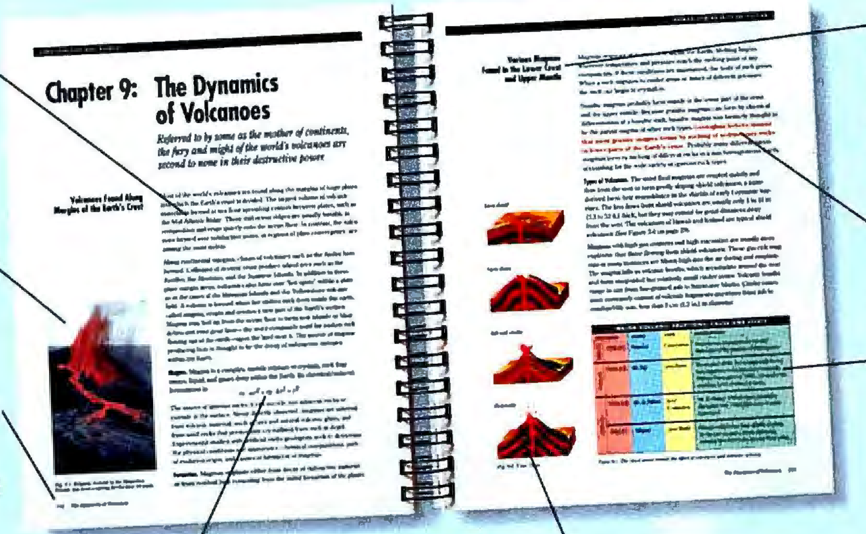
INTRODUCING FRAMEMAKER 4

We wrote & published, edited & organized & designed, formatted & indexed, cross-referenced & distributed the book on writing and publishing.

Writing is a breeze with our high-speed WYSIWYG word processor, which includes a spell checker and thesaurus.

Create custom colors with CMYK, RGB, HLS, and PANTONE® color palettes, and produce 4-color process or spot color separations.

Build complex documents easily using automatic hypertext markers, multichapter cross-referencing, running headers and footers, plus multiple indices and tables of contents.



Page layout tools enable rotated text and graphics, dashed and dotted lines, multiple columns, auto side heads, even portrait and landscape pages in the same document.

Conditional text lets you store or display multiple versions of a document in a single file.

Our advanced table editor lets you build multipage tables with unlimited paragraphs, straddled cells, rotated text, even graphics.

A sophisticated math editor lets you create and edit everything from simple arithmetic to calculus equations.

Create your own graphics with a full set of drawing tools, or import 24-bit color images.

Frame Technology presents the best way to write and publish demanding business and technical documents: Introducing new FrameMaker® 4. FrameMaker 4 dramatically increases your productivity because it automates much of the publishing process. Which makes it faster and easier to produce everything from simple business reports to complex multichapter manuals. Only one program handles it all, FrameMaker 4. Which means you don't have to switch back and forth between word processing, graphics, and page layout programs, and you won't lose any of your data or formatting. FrameMaker 4 is loaded with over 100 new features including context-sensitive help, automatic side heads, document compare, even ad hoc formatting. Best of all, you can share your FrameMaker 4 documents with your colleagues across the most popular hardware platforms. Including Windows, Macintosh, and X/Motif. So when you need to write, publish, design, edit — the works — make sure you use the one program that does it all: FrameMaker 4. **For a free guide to writing and publishing, or information on our special upgrade offer, call 1-800-U4-FRAME, Ext. 926.**

Frame®

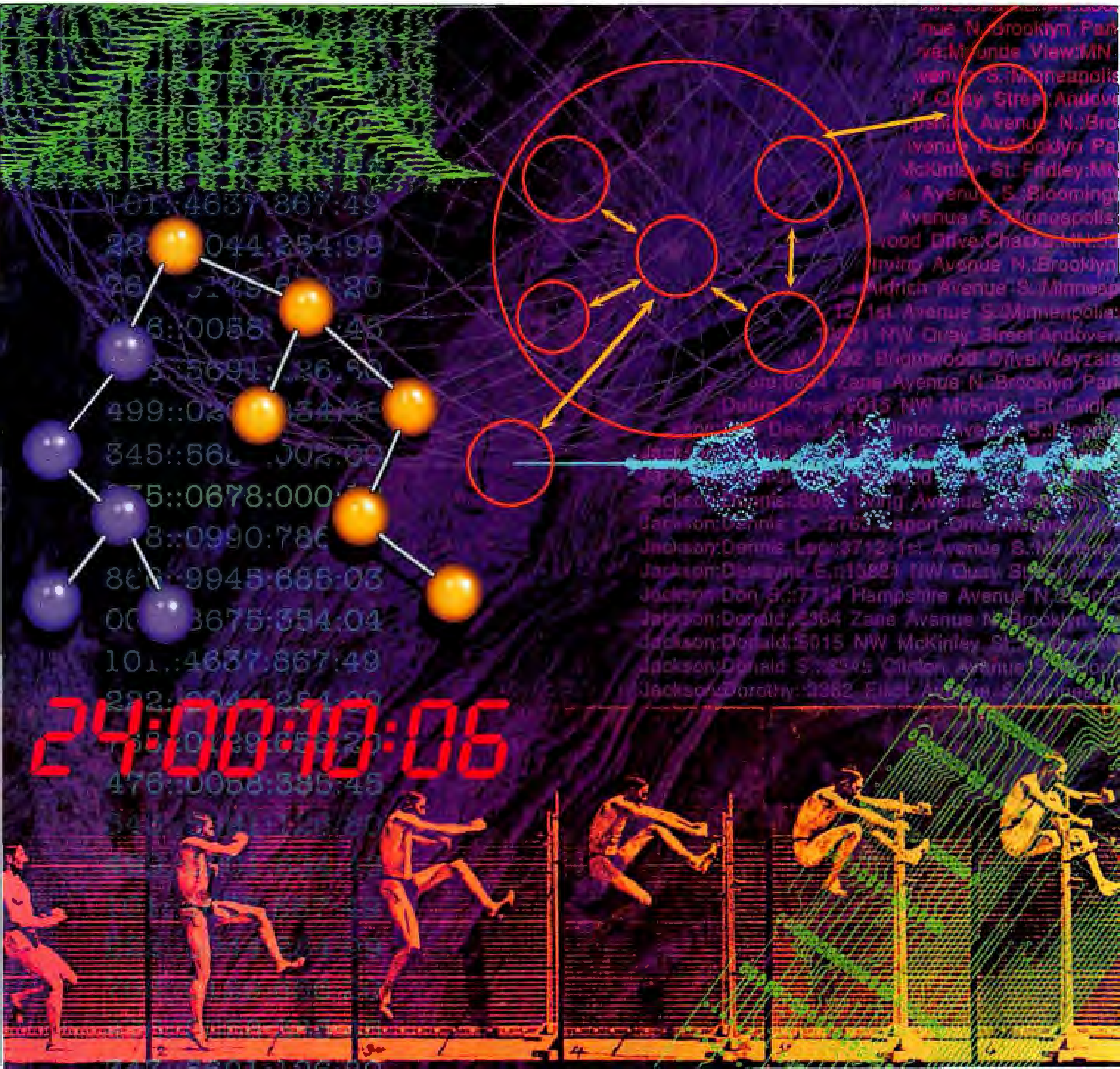
Circle 84 on Inquiry Card.

State of the Art

Object Databases

The best way to store the complex data used in object-oriented systems is with a DBMS that understands objects—something that relational databases don't do well

RICHARD MARLON STEIN



Object-oriented database management systems, or ODBMSes, represent the latest addition to the modern software engineer's toolbox. So many new applications are being designed with object-oriented techniques and programming languages—primarily C++ and, to a lesser extent, Smalltalk. These applications get much of their power from manipulating objects that include multiple, complex data types and associated methods and functions.

But what happens to that data when the application is not running? Only the ODBMS knows for sure. The synergy between OOP (object-oriented programming) and ODBMS interfaces generates a powerful and expedient mechanism with which to express, manipulate, and store—in what can be called an *objectbase*—the complex objects that are routinely created today. (A sampling of object-based applications using ODBMSes is presented in "Objects in Use" on page 99.)

Why Objects?

One of the principal reasons developers are turning increasingly to the object approach is that older techniques—procedural languages and relational databases—simply can't handle complex data very well. Developers have long recognized the shortcomings of the relational data model and commercial RDBMS (relational database management system) products with multimedia applications; economic models; document management systems; cooperative groupware products; client/server systems; and CAD, engineering, and manufacturing systems. These applications require the definition and manipulation of complex, abstract, articulated entities that defy representation with the relational data model.

RDBMSes lose their efficacy as storage systems when objects must be explicitly and tediously transformed (often losing some of their attributes and certainly their methods) before an object-oriented application program can store or retrieve them. (See reference 1. Also, for more information on the problems of mapping object data onto a relational database, see "The Great Debate" on page 85.)

ODBMS technology has gained momentum with the industry's recent adoption of the ODMG-93 standard (see the text box "The Object Database Standard" on page 82). The existence of an ODBMS standard simplifies the process of making applications portable, much as the SQL standard has let software developers migrate many applications between platforms without having to rewrite them.

Integrity, Reliability, and Consistency

Integrity and reliability are important concerns for any database user. Commercially available ODBMS products satisfy these needs, though sometimes with a reduction in overall performance. But the advantages of the object approach mean that both mission-critical and noncritical applications of ODBMS technology frequently pay a small performance penalty in return for reduced application engineering and maintenance costs.

The integrity of ODBMS transactions is essential. A transaction here is characterized as an inviolable sequence of operations—that is, all the operations that constitute a transaction either execute completely or not at all. An ODBMS transaction implies that an object is committed to storage and confirmed as stored.

Reliability refers to how the storage system retains objects in the event of computer malfunction. Under some high-stress conditions, an ODBMS may degrade unpredictably. In a multimedia system, the component object attributes (e.g., sound, video, graphics, and text) may differ substantially in their respective extents; one attribute stream may be much larger than the others. For a synchronized playback to occur, all media streams must be uniformly retrieved and recorded. Reliable ODBMS storage operations ensure that objects reach the storage system even if an error condition interrupts normal services.

ODBMSes store objects' attributes, not the methods that affect object state. Executable images for object methods are typically loaded by an ODBMS client, which retrieves ODBMS objects from the server through a tightly coupled network protocol, similar to an RPC (remote procedure call). The server provides lock management to prevent object inconsistencies from contaminating the objectbase. Access to an object's attributes is afforded by its methods. Each method possesses a *signature* that identifies the names and types of the arguments, as well as the names and types of any return values. Method signatures are specified for objects by the ODBMS's object definition language.

Persistence

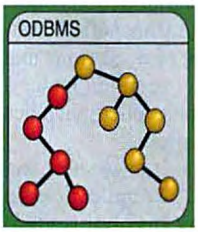
ODBMSes implicitly support the notion that objects have a definable lifetime that can extend beyond an executing program (see reference 2). This persistence characteristic is important for applications that may interact with objects over varying spans of time.

For example, an economic forecasting model may require objects that reflect instantaneous stock-market conditions. The state of a stock-market object, as described by its attributes (e.g., the Dow Jones or Wilshire 5000 indexes), may persist for a few seconds at most before being superseded. But monthly economic indicators, such as the consumer price index and number of housing starts, have much greater longevity. Fundamentally, persistent objects outlive the procedures and processes that create them.

Object persistence is declared as part of the ODBMS schema. The ODMG-93 standard specifies three types of persistence attributes, one of which is assigned to an object when it is declared, and this persistence attribute is immutable during the object's lifetime.

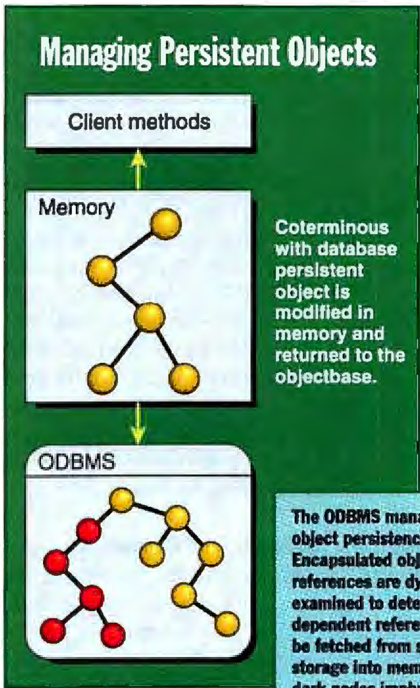
The most ephemeral persistence type, or lifetime, is called *coterminous with procedure.* Object storage for this lifetime is obtained from the run-time call frame stack and is similar to an automatic variable. When the procedure returns, the object

Object Databases
Object database management systems provide smart data storage. 74



The Great Debate
Overcoming the impedance problem between object and relational data.....85

Objects in Use
Real-world applications of ODBMS technology
.................99



The ODBMS manages object persistence. Encapsulated object references are dynamically examined to determine if dependent references must be fetched from secondary storage into memory. The dark nodes imply recently modified object attributes; the clear nodes imply no changes to other objects.

passes out of scope and is deleted.

The next type of lifetime is *coterminous with process*. The application assigns memory resources for a particular object instantiation and returns them to the heap when the process exits.

Last, objects that have *coterminous with database* lifetimes are stored on disk under ODBMS run-time control. These tenacious objects remain in the store until the database is deleted.

An ODBMS can implement object persistence with a file system, although accessing disk media is far slower than reading memory. Also, a persistent object may contain references to other objects through a pointer. This is typical for a complex model that represents a highly articulated system or a collection of behaviors inherited from multiple objects. For optimal performance in accessing attributes, therefore, an object and any references it possesses must be resident in memory (see the figure "Managing Persistent Objects").

An efficient ODBMS will fetch the entire object, including dependent references, from secondary storage and place it in a cache; RDBMSes perform an analogous operation by loading whole tables in response to certain queries. Persistent-object cache management is partially controlled by the particular object's lifetime as declared by the ODBMS schema definition. The host operating system lies underneath any cache management strategy.

Keeping Track of Objects

Each time an object is created, a unique OID (object identifier) is added to the ODBMS identifier table. The OID is independent of the object's state. Coherent operation of the ODBMS hinges on the maintenance of this table, which retains and tracks OIDs as objects evolve. Currently, the ODMG-93 standard specifies that the OID table is a single flat structure that precludes, for the time being, any extensions into distributed tables. Future generations of the ODMG-93 standard will eventually support distributed ODBMS structures.

When an application references an object via its OID, the ODBMS must convert this into a virtual memory address before any object attributes can be modified. This conversion of OID to a memory address or address to an OID is called a *swizzle* (see reference 3).

Swizzle operations are important for efficient storage and application access. An ODBMS swizzles object pointers to speed access to data in memory. Because an object hierarchy includes pointers to other objects, the use of swizzles speeds retrieval and facilitates the update of object attributes.

Object Locks and Concurrent Use

As with any database system, sharing objects by multiple users raises the important issue of maintaining consistency among the user copies. If two or more users simultaneously access an object and add to or alter any of the object's attributes, inconsistencies will arise unless the transactions are serialized, ensuring that a consistent, predictable order is applied to the modification of stored objects. Concurrency control mechanisms prevent interleaved transactions to the same object. Exclusive write-lock mechanisms are applied to object storage and usually suffice to prevent changes by more than one person at a time.

Unfortunately, locking mechanisms can also impede the normal use of a database for which long-duration transactions dominate. In many cases, a transaction consists of a short sequence of operations that are completed in a few seconds or less. This is typical of automatic teller machines or credit-card authorizations.

But not all applications are so short and sweet. For example, CAD applications in IC manufacturing may involve several

teams of engineers working simultaneously on different parts of a chip design. Some of the chip's cells will undoubtedly cross workgroup boundaries, and it may take weeks for the different teams to figure out how to route wires and position the cells to minimize signal propagation delays, power dissipation, and electrical impedance.

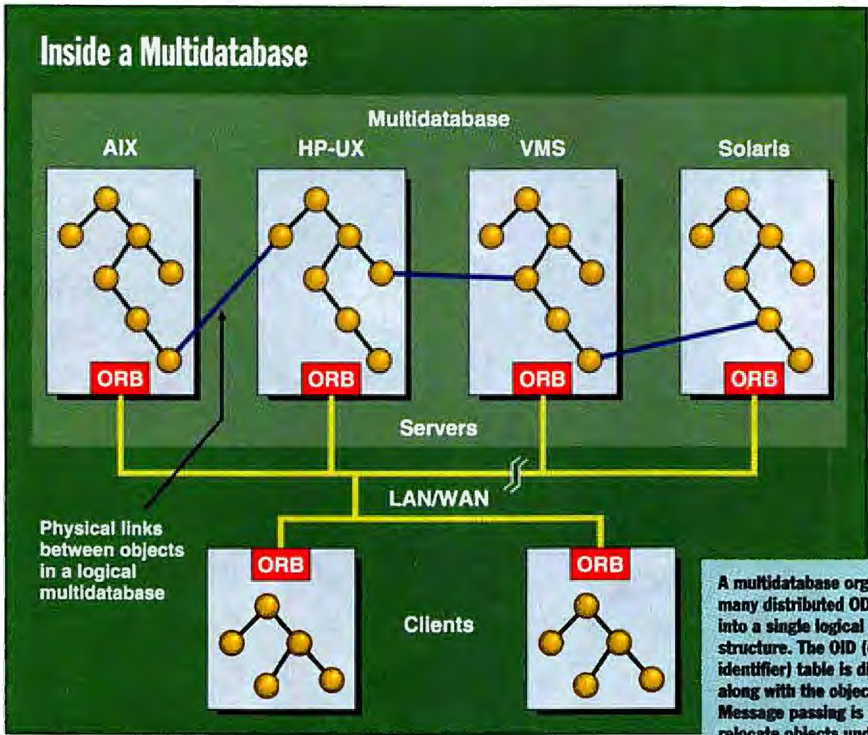
During this protracted development period, other groups of engineers may need to update their design data for a write-locked cell held by a particular user. In this case, the ODBMS must provide the capability to queue up a lock request—and perhaps notify the current lock holder to allow the current changes—or provide the option to abort the lock-request operation. The ODMG-93 standard is silent on the object-locking issue; each ODBMS vendor furnishes its own set of locking options and capabilities.

Distributed Objects—Data in ORBit

Another goal of most ODBMS technology is the notion of a multidatabase (see the figure "Inside a Multidatabase"), which can transparently integrate physically distributed ODBMSes into a single logical structure. To achieve this, the ODBMS must maintain the OID table as a distributed entity (see reference 4). Message passing is used to convey OIDs between peer tables to ensure consistency and to exchange objects between processes for distributed processing. The system addresses the multidatabase as a logical, global entity; the user has no knowledge of the underlying object distribution.

What makes the multidatabase concept work is the ORB (object request broker), which mediates client access to distributed objects. The ORB must perform many of the functions and capabilities found in current operating systems, in addition to network administration and communications, object format conversions between different processors, heterogenous access control, native memory access, security via encryption and decryption, and memory allocation (see the figure "Object Request Brokers").

An ORB executes a client request by effectively trapping all references to an OID issued by a method or ODBMS primitive (i.e., function). If the object is local, the method will operate on a cache-local object; a remote object will force the process to suspend until the object is relocated to the client's address space. Since network messages are generally slower



A multidatabase organizes many distributed ODBMSes into a single logical structure. The OID (object identifier) table is distributed along with the objects. Message passing is used to relocate objects under control of an ORB (object request broker).

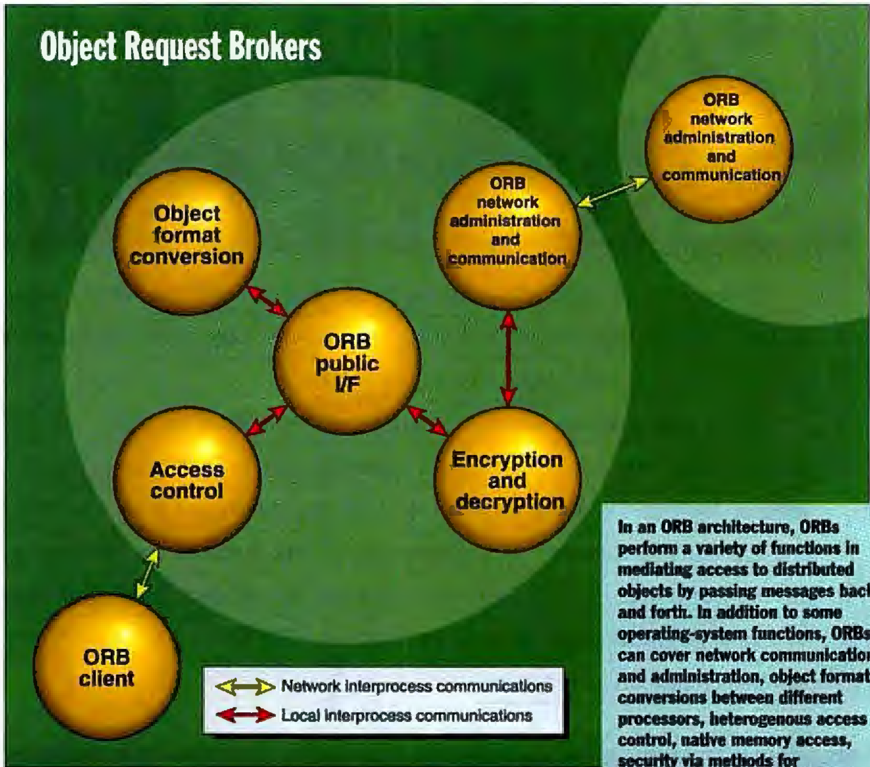
than local memory accesses, large objects will require more time to relocate than smaller ones. One way to minimize a process's latency is to organize multiple client threads. If the object possesses many attributes, you could dedicate separate threads to fetch each of the object attributes simultaneously. By overlapping computation with communication, the process idle time is reduced and a better load balance is achieved.

Client/servers operating over WANs, such as airline and hotel reservation systems, may be among the first types of applications to avail themselves of the multidatabase/ORB mechanism. Here, relatively fine-grained objects will be communicated between ORBs located on separate processors interconnected by a network. The amount of information needed to represent a single hotel or airline reservation is quite modest. A customer who phones to inquire about a reservation will then wait for the reservation object to move from some host computer system to the clerk's workstation.

Once at the workstation, the clerk may alter the reservation object by changing, say, the time-of-departure attribute for the customer's outbound flight. When completed, a local transaction will confirm the reservation object. Another workstation or mainframe might request all reservation objects periodically—say at the end of each business day—to compute daily income or other corporate measures.

The ORB model mimics the dynamic load-balancing techniques already familiar to practitioners of massively parallel computing. The principal difference is that an ORB facilitates the relocation of coarse-grained objects—instances that consume several megabytes of storage—whereas massively parallel systems are better suited to finer-grained messages—10 to 100 KB. ORBs are clearly better suited to highly asynchronous application domains, where object relocation is either infrequent—less than 10 object relocations each second—or the object attributes are divisible into smaller chunks and can be retrieved by multithreaded client ORB recipients. The message traffic associated with object relocation will subside after it arrives in the requesting ORB's address space.

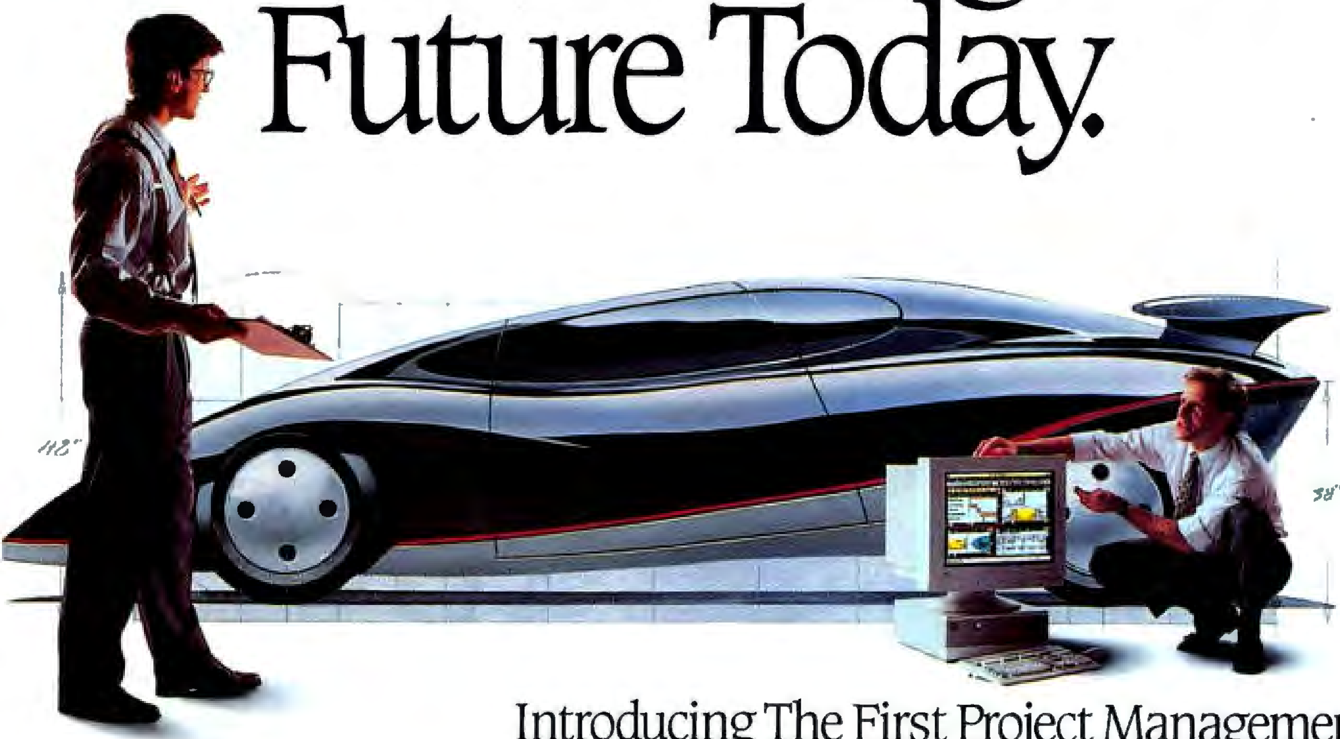
NASA plans to incorporate ORBs into its Earth Observing System Data and Information System, or EOS-DIS. This data archive and distribution system will be used by space and environmental scientists to access and analyze the 300 GB per day expected from 18 satellites examining global warming, greenhouse gases, ozone depletion, and natural resource exploitation (see reference 5). Several DAACs (distributed active archive centers) will be established to serve scientists and provide data to public



In an ORB architecture, ORBs perform a variety of functions in mediating access to distributed objects by passing messages back and forth. In addition to some operating-system functions, ORBs can cover network communications and administration, object format conversions between different processors, heterogenous access control, native memory access, security via methods for encryption/decryption, and memory allocation.

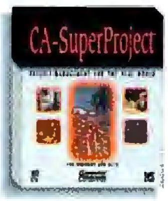
Switch To CA-SuperProject For $149 And Get TimeSheet Professional® For Free. For A Limited Time. Save More Than $600.

How To Manage The Future Today.



Introducing The First Project Management Software Everyone Can Use.

Beginners Love It Because It's So Easy.

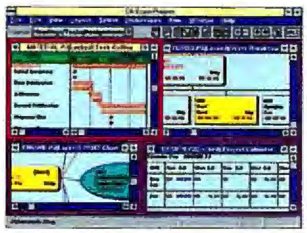


Only CA-SuperProject™ offers a special Beginner Configuration with simple, easy-to-understand menus and an on-line "PM Assistant" that walks you through procedures and teaches the basics of project management. Lots of sample data and excellent tutorials make it fun to learn and super easy to use.

1993 W 100 WINDOWS MAGAZINE ANNUAL WIN AWARD

Experts Love It Because It's So Powerful.

CA-SuperProject has all the flexibility and power you need to manage extensive projects without any constraints. It's more sophisticated, more effective and, according to NSTL *(Software Digest)*, it's the "best program for users who require a very powerful project manager with the most complete tools for modeling and managing resources, analytic functions and the most efficient resource leveling available."*



MICROSOFT WINDOWS COMPATIBLE

Buy one version, get the other FREE.

To Order, See Your Local Dealer Or Call 1-800-225-5224, Dept. 62500.

Call now to find out how you can manage your projects efficiently. CA-SuperProject and TimeSheet Professional from TIMESLIPS Corporation – the best way to manage your future today.

COMPUTER ASSOCIATES® Software superior by design.

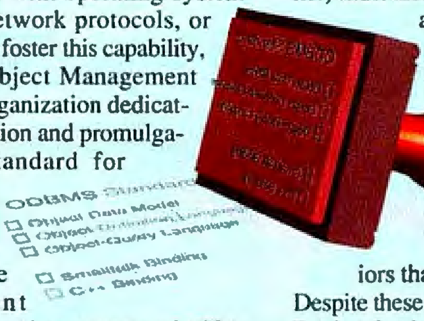
New CA-SuperProject 3.0

*Software Digest, Vol. 10, No. 4, 1993. Software Digest is a registered trademark of NSTL, Inc., a McGraw-Hill Co. Dealer prices may vary.

Circle 76 on Inquiry Card.

The Object Database Standard

To minimize cross-platform migration costs, software developers require some degree of feature standardization across ODBMSes (object-oriented database management systems), just as with operating-system interfaces, network protocols, or compilers. To foster this capability, the OMG (Object Management Group), an organization dedicated to the creation and promulgation of a standard for ODBMSes, started the ODMG (Object Database Management Group) during the summer of 1991. ODMG participants include representatives from the workstation and object-oriented database industries. The participating ODBMS vendors represent over 80 percent of the total marketplace.



This group has developed ODMG-93 1.0, the Object Database Standard. Although the ANSI standards committee does not endorse ODMG-93, ANSI has efforts directed at object-information systems (ANSI X3H7) and managed objects (ANSI X3T5.4). The ODMG will propose the adoption of ODMG-93 as an ANSI/ISO standard in the near future.

What's in the Standard?

This current object-database standard proposal specifies an ODM (object data model), ODL (object-definition language), OQL (object-query language), and C++ and Smalltalk language bindings for an ODBMS API. An ODBMS that conforms to ODMG-93 must supply tools that implement the ODM, ODL, and OQL.

While not yet an official part of the standard, the OMG sponsors the CORBA (Common Object Request Broker Architecture), a service that provides a platform-independent mechanism for transparent access to distributed objects. To supply this capability, CORBA implementations must harness communications protocols and a scheme for portable object representation similar to Sun Microsystems' XDR (External Data Representation) library.

Further, the ORB (object request broker) must also mediate concurrent read and write access among competing clients. Coherent maintenance of any distributed entity is not a trivial task; these systems exhibit nondeterministic behaviors that compromise reliability. Despite these potential obstacles, CORBA is a fundamental technology for the next-generation, object-oriented operating systems currently under development (see "Objects on the March," January BYTE).

The principal feature of the ODM is that it establishes the object as its basic primitive. The ODMG-93 standard defines a built-in set of types that can be used to create and instantiate composite structures that mirror real-world entities. The ODM permits the definition of arbitrary objects, an advantage that the relational data model does not expediently afford. The ODM furnishes an abstract and powerful semantic structure for representing complex systems.

Constructing an Object Database

An ODBMS schema is created with an ODL specification. The ODL specification is based on a Backus-Naur Form grammar that is similar to OOP language constructs. The ODL is used to define objects and create interfaces to them. The ODBMS furnishes an ODL precompiler that translates this specification into source code (either C++ or Smalltalk) for subsequent compilation by the platform compiler. The ODL precompiler also generates an `include` specification that lists data structures, class definitions, and method signatures identified by the input ODL specification. However, it is up to the ODBMS developer to furnish the source code to implement the method definitions that the ODL precompiler generates.

The method body will contain ODBMS API primitives for setting and getting object attributes, in addition to any logic needed to implement specific data model behavior. In the case of a multimedia application, for example, methods for accessing audio, video, graphics, and text streams will most likely invoke the standard ODBMS `select` operator to retrieve these items from object storage. When the multimedia document is first created, the ODBMS `create` primitive is used to insert the various streams into the object store.

Unlike the relational data model, an ODM has no rigorous mathematical underpinning. `Join` and `sort` operations are not strictly defined for an object, but an object's attributes can be subjected to relational semantics. In other words, you can't sort objects, per se, but you can sort them based on the value of an attribute.

Querying the Database

OQL furnishes a SQL-like query mechanism for operating on objects and their attributes. You can join and sort objects of different types with the set operators `intersect`, `union`, and `except` by accessing an object's attributes. You can also compare object attributes with =, <, >, and other Boolean operators.

OQL is designed to execute queries on articulated models that can only be represented via objects. Unlike SQL, which is restricted to tabular organization of tuples and that often requires a substantial number of join operations to reconstruct or extract data from a "flattened" object model, OQL primitives operate directly on objects and their attributes. Relational inferences between literal data item (e.g., floats, integers, and so on) attributes are obtained with standard mathematical methods.

MultiPro CTV MultiPro CTV is the newest output solution in AITech's line of VGA-to-TV encoders. Whether you use a PC or Macintosh, MultiPro CTV lets you record, edit and playback audio and video for your training materials or just plain entertainment. Other features include: ◆ Built-in RF modulator for compatibility with most TVs ◆ Freeze feature that allows TV image to be frozen at any time for independent computer usage ◆ Overscan and underscan control ◆ On-screen vertical adjustment The MultiPro CTV is easy to use and easy to install—just plug and play.

ProPC/TV Plus AITech's ProPC/TV Plus is an external pocket-size encoder. Its portability and easy installation make it a perfect companion for giving traveling computer presentations, educational training, computer slide shows or playing computer games on TV. The ProPC/TV Plus also includes: ◆ TV/VGA concurrent display ◆ VGA Hi-color and True color mode support ◆ An advanced hotkey and TSR software program that allows you to activate and control the output of your TV screen or computer screen.

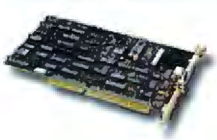
audioSHOW AITech's audioSHOW combines the ability to display your computer's output on a TV or VCR with full-featured 16-bit stereo sound capabilities. You can record your VGA screen to videotape and add a music soundtrack consisting of CD music, MIDI synthesizer orchestrations, sampled sound effects and narration. Adding greater impact to your presentations, training videos and other computer activities. AudioSHOW also gives you: ◆ Built-in SCSI CD-ROM interface ◆ Compatibility with SoundBlaster Pro, ProAudio Spectrum, AdLib, Microsoft Windows and Video for Windows ◆ Stereo 16-bit ADC/DAC for high-fidelity sound reproduction.

gamePlayerTV Maximize your PC game-playing excitement by playing them on a larger TV screen with gamePlayerTV. Now you can sit in front of your 20" TV playing your favorite computer game and for the first time, see and hear the power of 24-bit computer graphics. GamePlayerTV is also well-suited for business presentations, video recording and all home and business audio applications. With gamePlayerTV you get: ◆ High-quality digital audio record and playback capabilities for all your Windows Sound System, SoundBlaster and AdLib games and educational and business software ◆ An easy and user-friendly on-line TV adjustment screen ◆ Sound editing software.

Four easy ways to get your ideas on TV.

AITech has the most complete line of VGA-to-TV encoders for the PC and Mac markets. Whether you are developing or giving presentations or training programs, recording back to video, or just enjoying playing PC games on your TV screen, AITech has an encoder to fit your needs and budget. All of our encoders convert to NTSC or PAL signals, provide S-VHS and flicker-free output for enhanced TV viewing and video recording, and are Windows compatible.

For information on AITech's products, call your local dealer or call us at 1-800-882-8184 or 1-510-226-8960, or fax 1-510-226-8996. From outside the U.S., call 1-510-226-9169.



AITech offers several full-motion video capture boards including VideoBlender, VideoSurge and WaveWatcherTV.

AITech International
47971 Fremont Blvd., Fremont, CA 94538

AITech

Vision for Multimedia

Circle 64 on Inquiry Card.

and private interests. The gigantic volumes of data, expected to reach petabytes (10^{18} bytes) by mission completion, will most easily be accessed from DAACs via computer networks aided by ORB agents.

The trickiest aspect of CORBA (Common Object Request Broker Architecture) lies in assuring the delivery of all messages that describe objects. Nondeterminism arises from the asynchronous nature of communicating sequential processes; two communicating ORBs exemplify this configuration. But interspersed between the processes' network I/O connections are additional processes dedicated to encryption, access control, accounting, and so on. Each process has the potential to interject an exception condition between the two ORBs, and this exception may corrupt the data transmission or force one of the peer ORBs to terminate, thereby creating a state of unrecoverable deadlock.

Tomorrow's Objects

ODBMSes possess a rich set of operations and primitives that couple seamlessly into the semantics of OOP languages. ODBMSes simplify the design process through their enhanced modeling capability. Developers who incorporate an ODBMS into their products are likely to realize substantial savings from reduced software maintenance and engineering costs.

ODBMSes and their ORBs can produce scalable, reusable architectures that map easily onto client/server topologies, where enterprise-wide multiprocessor object servers distribute and manage objects over a LAN. However, the ORB mechanism may impede ODBMSes from efficient exploitation by message-passing parallel computer systems such as the Cray T3D, KSR1, or nCUBE-2. Background message traffic is required to maintain a coherent OID table for distributed environments.

Nonetheless, these computation systems will inherit a leadership role in information commerce. ODBMS vendors should recognize this important opportunity and begin to engineer CORBAs that minimize message traffic. ■

Commercial ODBMS Packages

DEC Object/DB
Digital Equipment Corp.
55 Northeastern Blvd.
Nashua, NH 03062
(603) 884-0828
fax: (603) 884-0828
Circle 976 on Inquiry Card.

GemStone
Servio Corp.
2085 Hamilton Ave.,
Suite 200
San Jose, CA 95125
(408) 879-6200
fax: (408) 369-0422
Circle 977 on Inquiry Card.

IDB Object Database
Persistent Data Systems
P.O. Box 28415
Pittsburgh, PA 15238
(412) 963-1843
fax: (412) 963-1846
Circle 978 on Inquiry Card.

Itasca ODBMS
Itasca Systems, Inc.
7850 Metro Pkwy.
Minneapolis, MN 55425
(612) 851-3155
Circle 979 on Inquiry Card.

M.A.T.I.S.S.E.
ADB, Inc.
238 Broadway
Cambridge, MA 02139
(617) 354-4220
fax: (617) 354-5420
Circle 980 on Inquiry Card.

O_2
O_2 Technology, Inc.
7, rue du Parc de Clagny
78035 Versailles Cedex,
France
+33 1 30 84 77 98
fax: +33 1 30 84 77 90

Scientific Services, Inc.
10001 Derekwood Lane,
Suite 204
Lanham, MD 20706
(301) 577-3606
fax: (301) 577-0831
Circle 981 on Inquiry Card.

Objectivity/DB
Objectivity, Inc.
800 El Camino Real
Menlo Park, CA 94025
(800) 767-6259
(415) 688-8000
Circle 982 on Inquiry Card.

Object Skipjack
MAK Software Consultants
1 East Chase St., Suite 1113
Baltimore, MD 21202
(800) 625-7547
(410) 783-2913
fax: (410) 783-2912
Circle 983 on Inquiry Card.

ObjectStore
Object Design, Inc.
1 New England Executive Park
Burlington, MA 01803
(617) 270-9797
fax: (617) 229-2451
Circle 984 on Inquiry Card.

ODBMS 2.0
VC Software, Inc.
3 Christina Centre
201 North Walnut St.,
Suite 1000
Wilmington, DE 19801

VC Software
Construction GmbH
Petritorwall 28
38118 Braunschweig,
Garmany
+49 531 24 24 0-0
fax: +49 531 24 0-24
Circle 985 on Inquiry Card.

Ontos DB
Ontos, Inc.
3 Burlington Woods
Burlington, MA 01803
(617) 272-7110
fax: (617) 272-8101
Circle 986 on Inquiry Card.

OpenODB
Hewlett-Packard Co.
P.O. Box 58059
Santa Clara, CA 95052
(800) 637-7740
Circle 987 on Inquiry Card.

Poet
Poet Software Co.
4633 Old Ironsides Dr.,
Suite 110
Santa Clara, CA 95054
(800) 950-8845
(408) 970-4640
fax: (408) 970-4630
Circle 988 on Inquiry Card.

Raima Object Manager
Raima Corp.
1605 Northwest
Sammamish Rd.
Issaquah, WA 98027
(800) 327-2462
(206) 557-0200
fax: (206) 557-5200
Circle 989 on Inquiry Card.

Tensegrity OO Database for Smalltalk
Tensegrity
1091 Industrial Rd.,
Suite 220
San Carlos, CA 94070
(415) 592-6301
fax: (415) 592-6302
Circle 990 on Inquiry Card.

UniSQL/X Database Management System
UniSQL, Inc.
9390 Research Blvd., II-20
Austin, TX 78759
(800) 451-3267
(512) 343-7297
fax: (512) 343-7383
Circle 991 on Inquiry Card.

Versant Object Database Management System
Versant Object
Technology Corp.
1380 Willow Rd.,
Suite 201
Menlo Park, CA 94025
(800) 837-7268
(415) 329-7500
fax: (415) 329-2380
Circle 992 on Inquiry Card.

ACKNOWLEDGMENTS

My thanks to Drew Wade of Objectivity, Inc. (Menlo Park, CA), and Won Kim of UniSQL, Inc. (Austin, TX), for their assistance during the preparation of this article.

REFERENCES

1. Loomis, M. E. S. "Hitting the Relational Wall," *Journal of Object-Oriented Programming*, January 1994.
2. Loomis, M. E. S. "Making Objects Persistent," *Journal of Object-Oriented Programming*, October 1993.
3. Moss, J. Eliot B. "Working with Persistent Objects: To Swizzle or Not to Swizzle," *IEEE Transactions on Software Engineering*, Vol. 18, No. 8, August 1992.
4. Wade, Andrew. "Distributed Client-Server Objectbases: ORBs, Objectbases, and Tools," *Object Magazine*, March 1994. Also, Wade, Andrew. "Distributed Client-Server Objectbases: Architecture for a Single Logical View," *Object Magazine*, May 1994.
5. "Panel to Review EOSDIS Plans, Final Report," National Research Council, Washington, D.C., January 1994.

Richard Marlon Stein is a freelance writer and multicomputer systems technologist with the Parallel Software Group of Santa Clara, California. You can reach him on the Internet at rms@well.com or BIX c/o "editors."

THE GREAT DEBATE

Force-fitting objects into a relational database just doesn't work well. The impedance problem is at the root of the incompatibilities.

CRAIG S. MULLINS

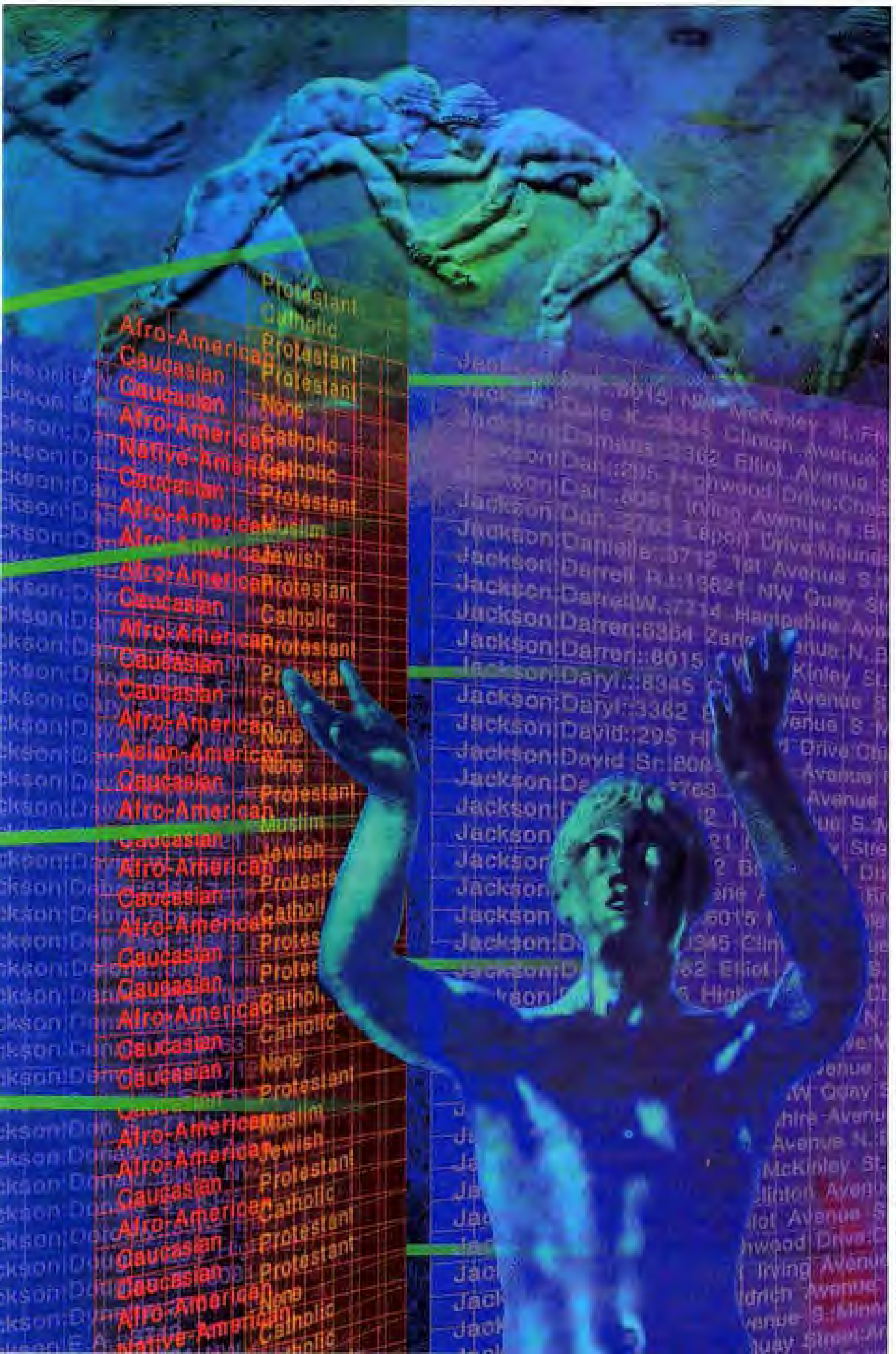


ILLUSTRATION: PAM BELDING © 1994

The relational model has been king of the database hill for the past 10 to 15 years. During this period, few development projects that required a database used anything other than a relational system. But the times they are a-changin'. Object-oriented DBMS products are gaining wide acceptance for their ability to handle complex data in ways that relational products simply can't.

Defining the Paradigms

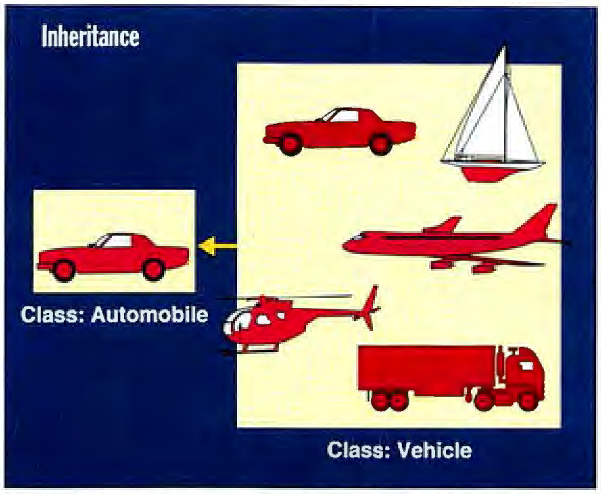
By definition, a *paradigm* is an example that serves as a pattern or model. A *paradigm shift*—a term increasingly seen in the computer trade press—refers to a fundamental change in the basic methods used to accomplish a task.

Most people connected with computer systems realize that the industry changes daily. New technologies are constantly being developed, but most of these merely provide better ways of doing something you have always done. When a paradigm shift occurs, what changes is the essential core of how a task is performed—and perhaps defined.

The object-oriented model represents the latest paradigm for computer programming, after procedural languages and rule-based programming (e.g., in languages such as Prolog). Object-based languages—including Smalltalk, Eiffel, and C++—are based on manipulating objects, which encapsulate complex data structures and processes (usually called *methods*) for manipulating that data. To invoke a method, a message must be sent to the object in which the method is encapsulated. Because each object contains its own methods, most procedural code is eliminated. The object-oriented paradigm, while currently a hot topic in the computer world, is hardly new. The first OOPL (object-oriented programming language), Simula-67, arrived on the scene in 1967.

continued

State of the Art The Great Debate



The class Vehicle can include objects of many different subclasses, each with its own special data attributes and methods. Automobile is only one subclass of Vehicle.

Object Database Management Systems

To handle the data that OOPLs create and manipulate and to provide all the fundamental benefits of a DBMS to object-oriented applications, ODBMSes (object-oriented database management systems) were introduced. Benefits of an ODBMS include persistent data, data sharing, concurrent data access, and recovery control.

ODBMS products are designed to supplant relational DBMS products within an object-oriented development environment. Their architectures are designed to understand and utilize object-oriented techniques such as complex objects, abstract data types, encapsulation, and inheritance.

Object vs. Relational

What is the difference between an ODBMS and an RDBMS (relational database management system)? The primary difference is the ability of an ODBMS to support complex objects in an efficient and easy-to-manipulate form. A complex object consists of data and processes that manipulate that data. In contrast, RDBMS products provide access to their data only in terms of rows and columns. And, other than triggers, an RDBMS can't store processing logic at the table level.

Other examples of complex objects include bill-of-materials hierarchies, CAD diagrams, and multimedia BLOBs (binary large objects). An ODBMS is ideally suited to store and manipulate these types of objects. Although some relational databases can process these types of objects, it is seldom easy or efficient to do so. Imagine using SQL Server to explode a bill-of-materials hierarchy from a fully normalized table. While technically possible, it is not truly feasible in terms of ease of use or performance.

Greater Abstraction

Abstraction is a key component of everyday life. People understand concepts such as an automobile, a light bulb, freedom, and trouble. Automobiles and light bulbs are concrete things, but you need not have them physically present to visualize them. Freedom and trouble are concepts that you can't see or touch, but you understand them in the abstract.

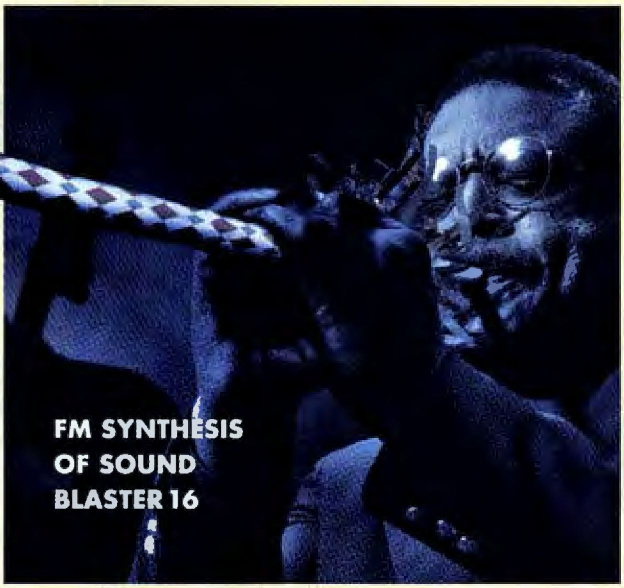
An ODBMS raises the level of abstraction. Objects stored in an ODBMS are organized more closely to the way in which you view and use them in the real world. For example, consider the objects vehicle and automobile. All automobiles are vehicles, but not all vehicles are automobiles. In an ODBMS, you can implement an object of class Vehicle and subclass Automobile that inherits the methods and structure of Vehicle (see the figure "Inheritance"). Using an RDBMS, you would have to implement two separate tables, one for Vehicle and another for Automobile. The Vehicle table can't be used to define Automobile because an RDBMS lacks inheritance. In addition, different algorithms would have to be coded to access each subclass.

The Impedance Mismatch Problem

ODBMS products are sometimes touted as a solution to a problem encountered with RDBMS products. The problem is called *impedance mismatch* and refers to the difference between the declarative, set-level operation of relational-database query languages and the procedural, record-level operation of a typical 3GL (third-generation language). There are two components to impedance mismatch:

1. The difference between the set-at-a-time data manipulation language of the DBMS (e.g., SQL) and the record-at-a-time programming language (e.g., C or COBOL). When the declarative database language is embedded within the procedural language, the system can return multiple rows to a programming language that is not equipped to operate on sets of data (see

DON'T BUY A SOUND BOARD UNTIL YOU'VE HEARD US TOOT OUR HORN.



SOUNDMAN® WAVE: GENUINELY BETTER SOUND, FULLY LOADED.

Maybe you've read* how *wavetable synthesis* uses actual recordings of instruments to create synthesized sounds. And how fantastic it sounds versus regular *FM synthesis*. Well it's true. SoundMan Wave lets gamers rock and roll with the real thing for an affordable price. *And* it comes loaded with great software like Recording Session® and MCS MusicRack™.

COMPLETE COMPATIBILITY GUARANTEE.

SoundMan Wave's Yamaha OPL4 chip is completely compatible with the AdLib/Sound Blaster standard so it is backed by a 100% money-back compatibility guarantee, *and* to back that up we'll give $500 to the first person that comes across a game with which SoundMan Wave isn't fully Sound Blaster compatible. Right now, hot games like X-wing, 7th Guest, Doom and Space Quest 5 already take full advantage of our wave technology. Dozens more are expected to hit the market each month.

DON'T BELIEVE US? CALL NOW FOR OUR FREE *SOUND ADVICE* AUDIO CD AND GET A $10 REBATE.

Listen to expert advice about adding sound to PCs, and hear for yourself the incredible difference between SoundMan Wave and run-of-the-mill 16-bit boards. Call for our *Sound Advice* Audio CD before supplies run out, and we'll enclose a $10 rebate coupon:

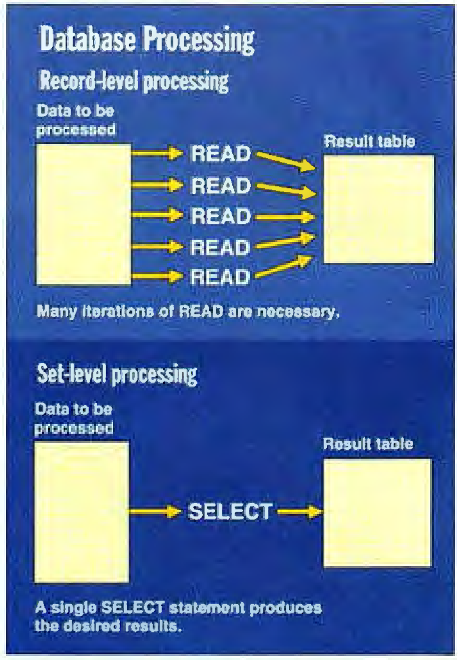
1-800-936-0012, OFFER #6K

*See PC Magazine, 12/21/93, p 95. ™/®—properties of registered owners.

LOGITECH

The Senseware™ Company

Circle 308 on Inquiry Card (RESELLERS: 309).



When you access a database one record at a time (top), it takes many READ operations to produce reports or result tables. If the DBMS operates at the set level, it can get the data it needs in one SELECT operation.

the figure "Database Processing").

2. The difference between the typing systems that the DBMS uses and the general-purpose programming language used to develop the rest of the application. For example, many RDBMS products support date types and date arithmetic, but most programming languages don't support them. Therefore, data returned from the DBMS must be transformed into a form that the programming language understands (e.g., by converting a date to a character string).

Typically, when accessing a relational database, you must embed a SQL query within a 3GL program. Because the two languages operate at different levels and some mechanism must resolve the differences (i.e., by copying data from the database language to the programming language and back again), the system incurs extra overhead. On the other hand, you normally access data in an ODBMS by using an OOPL, so no impedance mismatch is encountered. All operations are at the record level.

Why do you need to use two languages? For one thing, the DML (data manipulation language) of the DBMS generally lacks computational completeness and can't handle the nondata manipulation components of an application. On the other hand, most

programming languages lack the facility to handle persistent data other than in the form of files. They also typically lack abstract or high-level data types, constraints, and query capability. To enable the two languages to perform the tasks that each is ideally suited for, they must be able to communicate with each other. This, in a nutshell, is the impedance mismatch problem.

Resolving the Impedance Mismatch

Several different techniques have been tried, with more or less success, to overcome the impedance mismatch:

Query Download. Using this approach, queries are developed that retrieve all objects that the process can require to be executed. The data is translated to a format that the process can read before accessing the object. After execution, the objects are copied back into the ODBMS. This approach results in very efficient program execution at the expense of significant start-up and exit overhead, limited (or no) concurrent data access, and the inability to use the ODBMS during program execution.

BLOBs. Another solution is to store objects in the ODBMS as BLOBs. Instead of identifying each field (i.e., column) and its attributes to the ODBMS, you can store the entire object in a single large field. Once again, the major benefit of this approach is efficiency, but the drawbacks are usually unacceptable. Because the ODBMS is unaware of the object's internal structure, querying is impossible—access requirements can't be coded against individual components (i.e., fields) of the BLOB. Also, the ability to allow concurrent access is problematic.

DBMS/Program Affinity. Defining the program's level of interaction with the DBMS to be at a field-by-field (or object-by-object) level removes the set-level versus record-level processing mismatch. However, it also reduces the effectiveness of database access, because all access is one record at a time, thereby crippling the system's ad hoc query capability.

Procedural Database Language. One of the most elegant solutions to the impedance mismatch problem is to augment the database's query language with procedural flow-of-control operations (e.g., WHILE loops and IF...ELSE constructs). Using this approach, more of the application can be written in the query language. A number

Discover the basic principle of connectivity...

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

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

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

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

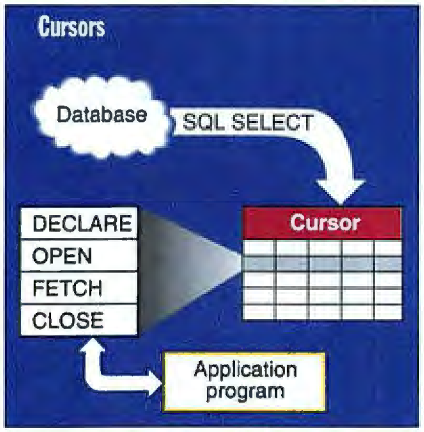
Discover SmarTerm.
It's the only emulation software that includes LAT and SmarTerm TCP/IP as a Windows Sockets DLL (a $199 value) FREE in every package. Discover the basic principle of connectivity today.

Call **1-800 EMULATE (1-800-368-5283).**

persoft®
CONNECTIVITY SOLUTIONS
DOS • Windows • Ethernet • Token Ring

Persoft U.S.A. 465 Science Dr. • Box 44953 Madison WI 53744-4953 • Phone (608) 273-6000 • FAX (608) 273-8227
Persoft Europe World Trade Center • Beursplein 37 • Box 30237 • 3001 DE Rotterdam, The Netherlands • Phone +31 10 405.3560 • FAX +31 10 405.5073

Circle 118 on Inquiry Card.



In a relational schema, a cursor is a data structure used to hold multiple rows of data returned by a SELECT statement. The application program can then read data from the cursor, accessing it a row at a time as if it were a sequential file, using the DECLARE, OPEN, FETCH, and CLOSE functions.

of RDBMS products, such as Oracle's PL/SQL and Sybase SQL Server's Transact-SQL, provide procedural extensions to SQL.

The coupling of program logic and data into a set-level procedural language is an attractive benefit of this approach. Likewise, performance is usually enhanced because network traffic is reduced. There are, however, some drawbacks; forcing a programmer to write the application using the database language instead of the general-purpose language limits the options and may pose difficulties. Finally, query languages often lack important computational powers and other important features, such as the ability to define and interact with the user interface.

Persistent Programming Languages. We call programming languages *persistent* when they can specify objects to "keep around" when the program is not executing. However, the ability to make program objects persistent still fails to address the interaction of the program with an ODBMS. Impedance mismatch will still occur because the DBMS's retrieval and data-typing scheme won't match those of the program.

Extended Data Types. Support for handling user-defined, extended data types is another approach. But unless both the DBMS and the programming language can define extended data types using the same methods, impedance mismatch is still inevitable.

Integration. In the end, the most workable solution is to simply remove the mismatch entirely. Integrating ODBMS products and programming languages so that they operate at the same level and use the same data model will eliminate the impedance mismatch problem. Implementing this approach, however, takes much effort. You must consider the following problems:

- the lack of a formal, standard object model
- an apparent compatibility conflict between encapsulation and database query languages
- the difficulty of providing standard interfaces and data models given the reality of different commercial implementations

RDBMSes and Impedance Mismatch

Many RDBMS products handle impedance mismatches through two primary mechanisms: cursors and type translation. You can think of a *cursor* as a kind of pointer (see the figure "Cursors"). The programmer declares a cursor and defines a SQL SELECT statement for that cursor. An application program accessing that RDBMS can navigate, one row at a time, through the set of rows returned by the SQL statement. In essence, the program uses the cursor much like a sequential file. It opens the cursor, fetches one row at a time from the cursor, and then closes the cursor. When processing with cursors, a SQL statement can return zero, one, or many rows. Four distinct operations are available for cursors:

DECLARE. Defines the cursor, gives it a name unique to the program in which it is embedded, and assigns a SQL statement to the cursor name.

OPEN. Readies the cursor for row retrieval. OPEN reads the SQL search fields, executes the SQL statement, and builds the result table. It does not assign values to host variables, however.

FETCH. Returns data from the result table one row at a time and assigns the values to specified variables. If the result table is not built at cursor OPEN time, it is built fetch by fetch.

CLOSE. Releases all resources that the cursor uses.

Type translation occurs when the program attempts to retrieve a column that has been defined as a data type that the

ARISTO

RELATIVE vs. ABSOLUTE

There's no sure winner. Both, relative pointing and absolute control have their moments. At times one outperforms the other by a mile. And vice versa, depending on the application. That's why we have invented the mouse that's both relative **and** absolute. So now you have the best of both worlds!

ARISTO
Technology with Prestige since 1862

FREE DEMO DISC
INTERACTIVE ANIMATION
UPON REQUEST

North America:
ARISTO Graphic Systems
A Division of KOH-I-NOOR Inc.
100 North Street, P.O. Box 68,
Bloomsbury, NJ 08804 - 0068
Tel: (800) 631 - 7646
Fax: (908) 479 - 1513

United Kingdom:
ARISTO UK LIMITED
TDS House
Terrace Road South, Binfield
Bracknell RG12 5BH
Tel: (0344) 306 936
Fax: (0344) 306 936

Head Office:
ARISTO Graphic Systeme GmbH & Co. KG
Schnackenburgallee 117
D - 22525 Hamburg, (Germany)
Tel: (040) 547 47-220
Fax: (040) 547 47-111

yes
It runs with NetWare

College Board\digital

THE ABSOLUTE AND RELATIVE MOUSE

*(SRP $ 369.00, includes integrated 5-button mouse, portable drawing and digitizing surface, software)

Circle 155 on Inquiry Card (RESELLERS: 156).

programming language doesn't support. Consider dates. For the program to access a date column, the data must be converted to a form that the programming language understands. For example, DB2 converts a date column to a `PIC X(10)` field in COBOL. Of course, some functionality is usually lost after this translation. The RDBMS can perform date arithmetic directly (e.g., calculating the number of days between two dates by simple subtraction), but the programming language cannot.

Object Databases Meet Their (Mis)match

ODBMS products manipulate data using the methods defined in object classes and via the programming language used to define the classes. This language is usually an extension of an OOPL and therefore will operate at a record-by-record level. The ODBMS's DML (data manipulation language) has no impedance mismatch problem because it can access entire objects and is tied to the type-checking mechanism of the ODBMS.

Having the DML and the general-purpose programming language so tightly intertwined avoids the data-typing mismatch. Even in this scenario, however, access to database records is still row-at-a-time. Is this really a solution to the set-level component of the impedance mismatch problem? By moving back in time (i.e., prerelational) to record-at-a-time processing, you lose the benefits of set-level database access, such as eliminating the need for looping constructs (WHILE, FOR, and DO) for selecting, updating, deleting, or modifying multiple rows. A set-level language like SQL also makes ad hoc querying and report writing much easier.

Also, OOPLs came into use before ODBMSes were developed and widely available. Many object-oriented development projects have used proprietary file structures or a SQL interface to a RDBMS. In this situation, the impedance mismatch problem looms as large as ever.

The Future

One thing you can expect to see in the future is that the rules that define and maintain the integrity of the database can be stored as methods in a reusable class library, along with the business rules that guide the way a company performs its day-to-day operations. Also, since the user interface, network interface, and procedural logic are increasingly being written in an OOPL, it will be necessary to couple the OOPL and the ODBMS more tightly together.

A DBMS can attempt to resolve the impedance mismatch by extending its DML so that more of the application can be written with the DML directly. Consider Sybase SQL Server and its extended SQL offering, Transact SQL. This is a product in which looping and IF...ELSE constructs can be used within SQL. Additionally, user-defined data types, rules, defaults, and triggers can be attached to tables and columns, and stored procedures can be housed in the DBMS. Of course, Sybase is not an ODBMS: It lacks complex object support, inheritance, and many other object-oriented features.

A computationally complete DML will not, by itself, enable an entire application to be written in the ODBMS's language. Without programming constructs that control external resources, such as the user

interface and hardware, the application cannot be successfully completed.

At present, ODBMS products are maturing and will inevitably eat into the huge market share enjoyed by RDBMS products. Nonetheless, RDBMSes will continue to prosper and thrive in the world of business data processing, where applications such as payroll and accounting do not generally require complex objects. Use of ODBMSes will continue to grow in those fields that require complex objects, such as CAD and manufacturing. There will always be true RDBMSes and true ODBMSes.

Successful RDBMS products will seek to incorporate the best components of object-oriented technology without compromising the relational model. Likewise, successful ODBMS products will seek to incorporate the best features of the relational model, without compromising the benefits derived from classes, inheritance, and encapsulation. This will likely lead to a marriage of the two technologies into a hybrid technology—object relational—that builds on the strengths of both relational and object-oriented concepts.

But—and this is no small matter—until the impedance mismatch problem is resolved, inconsistencies will continue to exist between the ways in which the DBMS and the programming language handle data items. ■

BIBLIOGRAPHY

Booch, Grady. *Object-Oriented Design with Applications.* Redwood City, CA: Benjamin-Cummings, 1991.

Braithwaite, Kenmore S. *Object-Oriented Database Design: Concepts and Application.* San Diego, CA: Academic Press, 1993.

Cattell, Roderick G. *Object Data Management.* Reading, MA: Addison-Wesley, 1991.

——, ed. *The Object Database Standard: ODMG-93.* San Mateo, CA: Morgan Kauffman, 1993.

Chorafas, Dimitris, and Heinrich Steinman. *Object-Oriented Databases.* Englewood Cliffs, NJ: Prentice-Hall, 1993.

Hertmo, Elisa, and Lorenzo Martino. *Object-Oriented Database Systems: Concepts and Architectures.* Wokingham, U.K.: Addison-Wesley, 1993.

Khoshafian, Setrag, and Razmik Abnous. *Object Orientation: Concepts, Languages, Databases, User Interfaces.* New York: John Wiley & Sons, 1990.

Kim, Won. *Introduction to Object-Oriented Databases.* Cambridge, MA: MIT Press, 1990.

Runbaugh, James, et al. *Object-Oriented Modeling and Design.* Englewood Cliffs, NJ: Prentice-Hall, 1991.

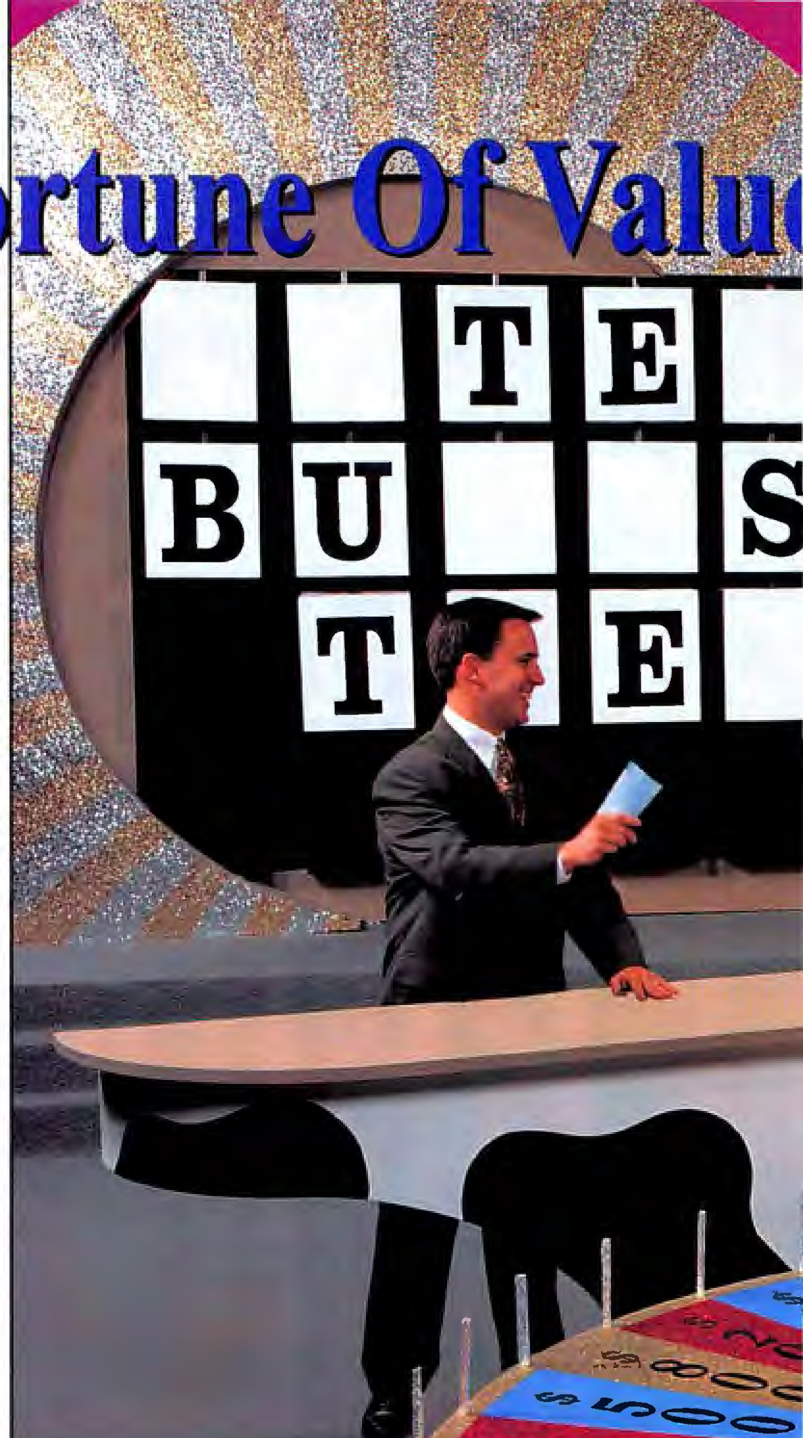
Taylor, David A. *Object-Oriented Technology: A Manager's Guide.* Reading, MA: Addison-Wesley, 1990.

Zdonik, Stanley B., and David Maier, eds. *Readings in Object-Oriented Database Systems.* San Mateo, CA: Morgan Kaufmann, 1989.

Craig S. Mullins is a technical researcher in database design, client/server technology, object orientation, and relational technology at Platinum Technology (Oakbrook Terrace, IL). He is also the author of DB2 Developer's Guide *(Sams, 1992). You can contact him on Prodigy at WHNX44A, on CompuServe at 70410,237, or on BIX c/o "editors."*

PC Buyer C'mon Down!

Get A Fortune Of Valu



PC buyers jump for joy! You're entering the exciting and competitive game of computer buying! We know you want to finish first with high-performance PCs and prize-winning service at the most affordable prices in the industry. It's no contest – with Gateway 2000™ you'll always be the big winner!

The Champ

And here are the stars of our show, Gateway's Pentium™-based systems! Starting from $2,495 you get stupendous features. New lightning-fast hard drive systems! Screaming new graphics controllers on our two high-end P5 systems! Along with the most powerful Intel® processors available today! And (*drum roll please*) – all this at 486 prices!

Now in all four Gateway 2000 P5 systems, a new PCI/IDE controller allows the hard drive to transfer data *up to twice as fast* as non-PCI-based systems. The PCI/IDE controller is a major enhancement to Gateway's Intel Pentium processor and PCI local bus. Now you can access data faster than ever before!

Our P5-66 and top-of-the-line P5-60 now include high-end graphics controllers. So you can really take advantage of the performance-boosting PCI bus for virtually unbeatable graphics performance! These graphics controllers are also available as an upgrade option for all Gateway's PCI-based systems.

The standard graphics system on other Gateway PCI-based machines is another sure winner. You get 2MB standard graphics memory giving you 64,000 colors at 1024 x 768 resolutions. This graphics system uses a high-performance interface to graphics memory that achieves 16 million colors, true 24-bit, in VGA.

Been spinning your wheels on how to get tomorrow's technology today and still pay 486 prices? The puzzle is solved. With a price tag between $2,495 and $3,995, you'll hit the jackpot when you buy a Pentium-based system from Gateway 2000!

We also offer a full line of 486 PCI local-bus and integrated desktops systems. All are upgradable to a Pentium OverDrive™ Processor for the power you'll need in the future.

The Home Version

pentium
PROCESSOR

Fun and games are only part of what you get with the Gateway 4DX2-50 Family PC™. This special system includes full multimedia capabilities and software choices for the whole family. The Family PC brings productivity, education *and* entertainment into your home.

GATEWAY2000
"You've got a friend in the business."®

800-846-2058

“X” Marks The Spo

Looking for the perfect portable PC? You'll get a celebrity performance when you choose Gateway 2000™ for the most value-packed portable PCs in the industry!

GATEWAY2000 COLORBOOK™

Gateway has all the right answers for incredible values with the ColorBook! Performance-enhancing features ... fast 486 processors and an incredibly big 10.3-inch screen on the DX4 model! ... make the ColorBook an undisputed champion.

Introducing the ColorBook DX4-75 with a faster-than-ever processor! This substantial power boost has made the DX4-75 the fastest 486 portable available today. And that's not all. For your extreme viewing pleasure, an extra-huge 10.3-inch dual-scan VGA color screen is now standard on the DX4. You won't find anyone else with a 10.3-inch screen at a better price.

All ColorBook models – 486SX-33, DX-33, DX2-50 and DX4-75 – have a host of great features. Weighing less than 5.7 pounds and measuring an ultra-thin 1.77 inches, the ColorBook supports simultaneous video; an easy-to-use, built-in trackball; two PCMCIA Type II slots; great battery life; and a suspend/resume feature so you can stop work anytime and resume later without losing data or restarting the system.

GATEWAY2000 HANDBOOK® 486

The revolutionary Gateway HandBook 486 is perfect for all your worldly travels. This powerful little performer will forever change the way you use a PC. And you won't have to think twice about taking it with you – no matter where you go. It's a no-brainer. The HandBook is so small (*about the size of a day planner*) and so lightweight *(it's less than three pounds)* that you'll never want to be without it!

Unless you mind all the extra attention, as described by a leading columnist: “I almost got mobbed the other day on the train. I was doing what I usually do on the commute: writing on a notebook computer. The only difference was that I was using a Gateway 2000 HandBook 486 ... I can't wait until everyone has one. Then they'll leave mine alone.”

The HandBook is a real PC with a powerful 486 processor; an IDE hard drive up to 130MB; standard 4MB or 8MB RAM, upgradable to 20MB; a 7.9-inch bright, backlit VGA display screen; 78-key keyboard; EZ Point™ integrated pointer; excellent battery life; and suspend/resume feature.

Looking for a square deal on the best portables around? The odds are stacked in your favor with Gateway's ColorBook and HandBook portable PCs.

GATEWAY2000

"You've got a friend in the business."®

8 0 0 - 8 4 6 - 2 0 5 8

Gateway 2000™ is the name of the game when it comes to the best service and support. The Gateway family is made up of hard-working Midwesterners who are dedicated to satisfying our customers. And although we're a Fortune 500 company, we haven't forgotten our simple philosophy of providing an honest value, a superior product and the best service possible. In return, Gateway's loyal customers are always there to cheer us on. But you don't have to just take our word for it. The surveys prove it!

Hands Down Winner in Service and Reliabilit

A big thank you to readers of *PC Magazine* who respondec to a Service and Reliability survey with impressive results: "In our latest survey, only Gateway 2000 gets our highest ratin in both the desktop and laptop categories." The survey covere reliability, satisfaction with repair experience, satisfaction with technical support, and the likelihood of buying new PCs from the same vendor again.

All the talented people appearing in this ad are Gateway 2000 employees.

PORTABLES

HANDBOOK® 486

- Weight: 2.94 Lbs.
- Dimensions: 9.75" x 5.9" x 1.6"
- SL Enhanced Intel® 486 Processor
- 4MB or 8MB RAM (expands to 20MB)
- 80 to 130MB IDE Hard Drive
- 7.9" Backlit VGA Display
- NiMH Battery & AC Pack
- Suspend/Resume Feature
- 1 PCMCIA Type II Slot
- EZ Point™ Integrated Pointer
- 78-Key Keyboard
- Parallel, Serial & PS/2 Ports
- MS Works for Windows™ 3.0
- MS-DOS 6.2, WFW 3.11 & Serial Transfer Cable

HANDBOOK 486SX-25

With 25MHz 486SX CPU, 4MB RAM and 80MB Hard Drive

$1495

(with 130MB Hard Drive)

$1595

HANDBOOK 486DX2-40

With 40MHz 486DX2 CPU, 8MB RAM, 130MB Hard Drive, Extra NiMH Battery, and Leather Carrying Case

$2295

HANDBOOK 486SX-25

With 25MHz 486SX CPU, 8MB RAM, 130MB Hard Drive, and Leather Carrying Case

$1895

PORTABLE OPTIONS

PCMCIA Cards:

- TelePath 14400/14400 fax/modem. **$249**
- 9600/2400 fax/modem. **$149**
- Ethernet adapter. **$149**
- Token Ring adapter. **$449**
- HandBook VGA adapter. **$229**

Batteries:

- 2.2Ah NiMH batteries. **$89**
- Alkaline battery pack. **$29**

Diskette Drive:

- HandBook external 1.44MB. **$99**

Cases:

- ColorBook **$49**, HandBook **$55**

Extended VIP Warranty:

- We'll ship a replacement within 24 hours during warranty. Point of sale only. **$100**

COLORBOOK™

- Weight: Under 5.7 Lbs.
- Dimensions: 11.7" x 8.5" x 1.77"
- SL Enhanced Intel 486, DX2 or DX4 Processors
- 4MB or 8MB RAM (expands to 8, 12 or 20MB)
- 3.5" 1.44MB Diskette Drive
- Removable 120 to 250MB IDE Drive
- 10.3" or 9.4" VGA Dual-Scan STN Color Display
- NiMH Battery & AC Pack
- Suspend/Resume Feature
- 2 PCMCIA Type II Slots
- Integrated Trackball (2 buttons)
- 85-Key Keyboard
- Parallel, Serial & PS/2® Ports
- External VGA Port
- MS Works for Windows 3.0
- MS-DOS 6.2 & WFW 3.11

COLORBOOK DX4-75

With 75MHz DX4 CPU, 8MB RAM, 250MB Hard Drive and 10.3" LCD

$3495

COLORBOOK 486SX-33

With 33MHz 486SX CPU, 4MB RAM, 120MB Hard Drive and 9.4" LCD

$1995

COLORBOOK DX2-50

With 50MHz DX2 CPU, 8MB RAM, 250MB Hard Drive and 9.4" LCD

$2995

COLORBOOK DX-33

With 33MHz DX CPU, 4MB RAM, 170MB Hard Drive and 9.4" LCD

$2495

COLORBOOK PACKS

Traveler's Packs:

- Case, extra battery & PCMCIA 9600/2400 fax/modem. **$279**
- Case, extra battery & PCMCIA TelePath fax/modem. **$369**

PC BUYER

SOFTWARE & EXTRAS

If a system comes with "choice of application software," choose one of the following packages:

- Microsoft Excel for Windows™
- Microsoft Word for Windows™
- Microsoft Word and Bookshelf,® CD-ROM Edition
- Microsoft PowerPoint for Windows™
- Microsoft Project for Windows™
- Microsoft Access™ for Windows
- Publisher's Pack (CD-ROM only; includes CorelDRAW 3,™ ArtShow, MS Publisher 2.0 & MS Design Pack)
- The Entrepreneur Pack (Works,™ Publisher,™ Money™ & games)
- Borland Paradox® database and Quattro® Pro for Windows spreadsheet
- Borland Paradox® and C++

With desktop and selected portables you also get the following software and extras at no additional charge:

- MS-DOS 6.2 & Windows for Workgroups 3.11
- CoSession™ Host Remote Diagnostics (with all modems)
- QAPlus Diagnostics
- Gateway Computer Glossary
- Gateway Mouse Pad

Systems with CDs also include:

- Gateway System CD
- Multimedia On-Line User's Guide
- Gateway Mall On-Line Catalog

SERVICE

Every Gateway system is backed by:

- 30-Day Money-Back Guarantee
- One-Year Limited Warranty
- Lifetime Toll-Free Technical Support
- On-Site Service Available To Most Locations
- Lifetime BBS Membership
- FaxBack Automated Fax Service

Our money-back guarantee does not include shipping. On-site service is provided at no charge during warranty if our technicians determine it is necessary. If you'd like to read our warranty and guarantee policies, please call for a free copy.

Printed on recycled paper with soy inks.

Gateway 2000 is a corporate sponsor of GLOBAL RELEAF

intel inside

Ready For Action

Gateway 2000's friendly employees will take care of you from your first phone call throughout the life of your system with lifetime technical support. We've also made it easy for you to buy one of our world-famous PCs.

Easy Payment Options

Gateway accepts most major credit cards and C.O.D. terms, with net 30-day terms and leasing options available to qualified commercial customers.

You can also apply for our new Gateway 2000 DuoLine MasterCard® Card, issued by Dial National Bank, which lets you make purchases from Gateway and anywhere else MasterCard is accepted by giving you two lines of credit — one for Gateway purchases and one for all other purchases. For Gateway purchases, the card has no annual fee and a low variable interest rate of just 12.9% APR. For other transactions, you get a variable interest rate of 13.9% APR and a low $18 annual fee.*

**Cash advance fee is $1 plus 2% of the amount of the cash advance, but not less than $5 nor more than $10. Financing is available on approved credit with the Gateway DuoLine MasterCard, issued by Dial National Bank, Des Moines, Iowa.*

Internationally Known

Gateway 2000 also makes it easy for our neighbors in Canada and Puerto Rico to buy Gateway systems. You get the same award-winning technical support, CSA approvals, and on-site service that is available in most Canadian and Puerto Rican locations. Our international shipping rates are some of the most competitive in the industry. Canadian and Puerto Rican customers can reach us toll free at 800-846-3609. All other international customers can call us at 605-232-2000.

Our Family PC comes with a 14-inch CrystalScan monitor, 101-key keyboard, double-speed CD-ROM, sound card, speakers, joystick, fax/modem and mulitmedia software. You choose one software option from five great Family PC multi-title packages.

intel inside

GATEWAY2000

"You've got a friend in the business."®

8 0 0 - 8 4 6 - 2 0 5 8

Vorld Class Winning

PC World's 1993 World Class Awards found readers honoring ateway 2000 with top honors in five categories including Best ervice and Support (for the second year in a row!) and Best Mail rder Company. Thank you, *PC World* readers!

Jesse Berst, editor of *Windows Watcher* vas quoted in *PC World*: "Gateway has iscovered an amazing secret, give people nore for less and they are going to like you." Ve knew our secret wouldn't be safe for long!

PC WORLD
WORLD CLASS
1 9 9 3

Good Answers!

Computer Shopper summarized its readers' responses best: "Gateway, dominator of Best Buy balloting for the past three years, is your choice as Best Overall Supplier of computer systems ... For state-of-the-art PCs at bargain prices, North Sioux City is where *Shopper* readers look first." And "...Gateway 2000 has inspired a high degree of confidence and brand loyalty among *Shopper's* readers, who continue to rank Gateway's service and support as the best of all direct-channel PC vendors." Thanks *Shopper* readers!

COMPUTER SHOPPER
Best Buy
OF 1993

Extra Winnings

You'll score bonus points with the peripherals listed below, sold only with the purchase of a system from Gateway 2000. Call our special component add-ons division for our complete line of extras for Gateway customers.

Multimedia

Multimedia Kit

Here's everything you need to add multimedia to your Gateway PC:

- Gateway 2000™ 16-bit CD-quality sound card, compatible with Sound Blaster™ cards, with MIDI/game port, mic in, stereo line in/out
- Double-speed CD-ROM drive, tray-loading, compatible with music CDs, multisession photo CDs and CD-ROM titles
- 2 Labtec® speakers that can attach to your PC monitor
- Microsoft® Encarta Multimedia Encyclopedia
- Corel Professional Photo CD Sampler

$299

Yamaha® YST-M10 Multimedia Speakers

The small speakers that sound big and come with a tiny price! This free-standing, self-powered speaker set is a great value! **$75**

Altec Lansing ACS-300 Multimedia Speakers

Get superior stereo sound with these top-rated Altec Lansing ACS-300 speakers with separate powered subwoofer. **$219**

Communications & Storage

TelePath™ II Fax/Modem

Internal fax/modem, 14,400bps modem, V.32bis, with 14,400bps fax capability. Package includes data and fax communication software, plus a CompuServe® trial membership. **$149**

Colorado Memory Systems® TBU

250MB internal automatic tape backup unit copies up to 9.5MB per minute. Comes with MS Windows™ and DOS® software, one tape and cable. **$159**

Networking

Intel EtherExpress™

A 16-bit Ethernet adapter from a world leader in networking. **$105** Twisted Pair or BNC

Ethernet Adapter from 3Com®

Manufactured by 3Com for Gateway. **$105** Twisted Pair **$125** BNC

Token Ring

IBM® 16-bit ISA Token Ring card. **$429**

Monitors

CrystalScan® 17-Inch Monitor

Non-interlaced color monitor with intelligent multiscanning analog color display capable of ultra-high resolution up to 1280 x 1024 in non-interlaced mode and .26mm dot pitch.
Upgrade from a 14-inch monitor **$430**
Upgrade from a 15-inch monitor **$350**
(Prices good only for upgrades at the time of system purchase.)

Printers

Epson® Stylus 800 Ink Jet Printer

Great laser quality at an ever greater value. Measuring only 17 inches by 10.5 inches, the Stylus 800 has seven different typefaces and prints an extra-quiet 150 characters per second at 360dpi. Parallel cable included. **$289**

Epson ActionLaser 1500 Laser Printer

The ActionLaser delivers professional-quality printouts. Fast six-page per minute speed, 14 resident fonts, 300 x 300dpi, and 1MB memory expandable to 5MB. Parallel cable included. **$669**

Home Office Pack

Add these peripherals to your new Gateway desktop, and you have everything you need for an efficient home office.

- Epson Stylus 800 Ink Jet Printer
- TelePath II Fax/Modem
- 1 Parallel Cable

$399

Phar Lap® FrontRunner®...

The Winning DOS Desktop for Windows

LAUNCH BAR

FrontRunner's Launch Bar offers one-button launching of your favorite applications. Customize it any way you like!

SIMPLIFIED RUN MENU

Run Menu offers Program Manager functionality without navigating through all those open windows!

HISTORY

Scroll to view the complete history of your DOS session.

COPY & PASTE

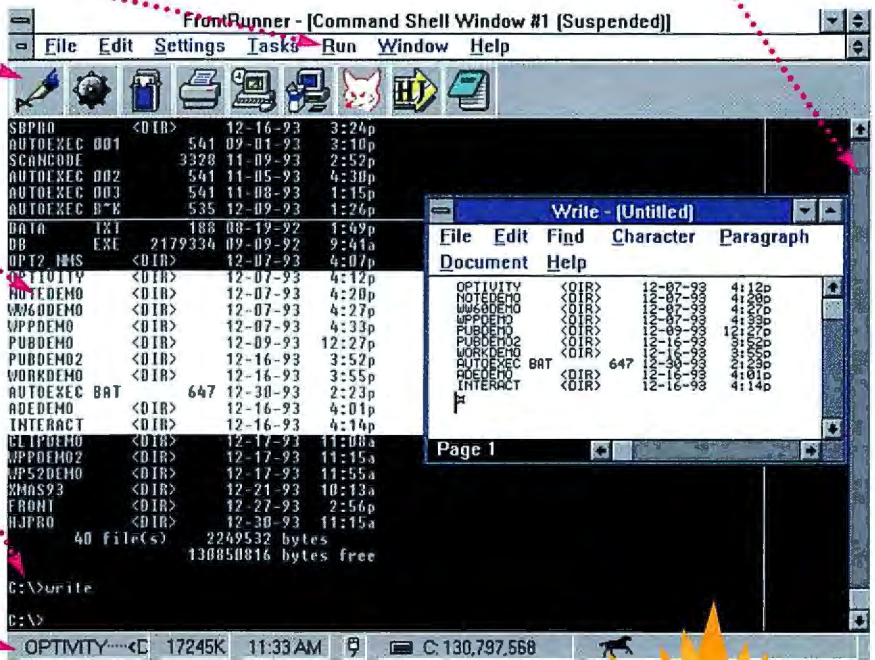
Just highlight and click to copy and paste any part of your DOS session into a Windows or DOS program.

COMMAND LINE POWER

Run DOS or Windows programs right from the DOS prompt!

POWERFUL REAL TIME STATUS BAR

FrontRunner's Status Bar displays real-time information including system resources... and lets you write modules to display your own up-to-date information!



Bringing the best of DOS to Windows... And the Power of Windows to DOS

Frustrated with switching between Windows and DOS applications? Now you can get the command-line power you need — integrated with the Windows graphical features you want. Phar Lap FrontRunner is a powerful DOS-based Windows desktop that brings intuitive GUI features to command-line DOS. FrontRunner lets you run Windows programs directly from the DOS prompt, provides an easy-to-use, menu-driven alternative to Program Manager, lets you launch applications with a click, keeps custom information at hand with Phar Lap's unique Status Bar, and much more!

FRONTRUNNER OFFERS YOU:

- ✔ A Better DOS Box — Scroll and view your entire DOS screen history and run Windows programs directly from the DOS prompt
- ✔ Quick and Easy Program Manager Replacement — no more searching through all those windows
- ✔ Customizable Launch Bar — instant access to your favorite programs
- ✔ Powerful Visual Batch Language Extensions for DOS — easily create visual front ends
- ✔ Programmable Status Bar — view the real-time information you need most
- ✔ Versatile Utilities — to enhance your productivity

Call Now To Order Or To Get Your Free Demo! 1-800-292-9622

Now you can test ride a winner with our free FrontRunner Lite and Guided Tour Demo disks. FrontRunner Lite is a trial-sized version of our DOS desktop for Windows that lets you try all of FrontRunner's powerful features... absolutely free! So call today and see how exciting a winning DOS desktop can be!

Phar Lap Software, Inc.

60 Aberdeen Avenue, Cambridge, MA 02138 617-661-1510 FAX: 617-876-2972

Circle 119 on Inquiry Card.

OBJECTS IN USE

Real-world applications of commercial ODBMSes show performance and development advantages

RUSSELL KAY

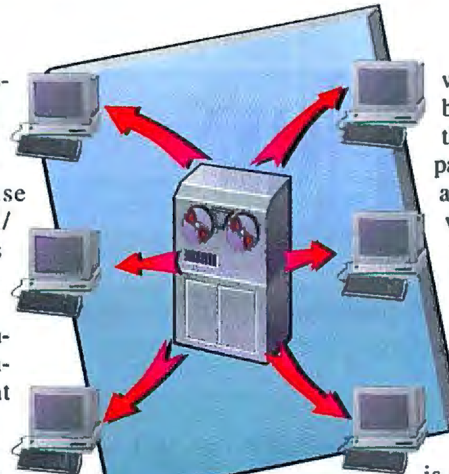
ILLUSTRATION: PAM BELDING © 1994

Not too long ago, DBMSes were complex pieces of mainframe software that only people with long experience could begin to comprehend or use. When microcomputers came along in the late 1970s, the first databases oriented toward end users were developed and marketed. Using these products, a whole new class of user-programmers began to create their own database applications. This was such a radical development that it marked a turning point in database computing.

Now, another shift is at hand. A whole new class of ODBMSes (object-oriented database management systems) has since been added to the wide variety of powerful and relatively inexpensive flat-file DBMS and RDBMS (relational DBMS) products on the market. To find out how these new products are being used in the real world, BYTE talked to a number of end users and systems developers about their experiences with object databases. We asked why they had chosen to go the object-oriented route, how they had evaluated and chosen the particular ODBMS product(s) they use, and what's still on their wish list—that is, what they would like to do but cannot at present. We found that most users began using object databases because, quite simply, they had complex data objects that needed to be stored. Here's a look at a few of these situations.

Betting on an ODBMS Is No Gamble

The Austin, Texas–based company Continuum is a vertical marketer of software to the insurance industry. The company's products help insurance companies—which until very recently were strictly large mainframe shops—move much of their processing onto workstation-based systems. Of course, the existing data and legacy systems are still important considerations. Continuum has two major products: Continuum Workstation Platform/Enterprise Solution, or CWP/ES, which helps



insurers manage distributed transaction systems; and Business Process Management/Enterprise Solution, or BPM/ES, which manages work flow and resource allocation.

According to Kenneth Schoff, a manager/consultant at Continuum, a typical insurance company can have as many as 15 different administrative systems, mostly mainframe-based, that might be up to 30 years old. But such a company wants to be able to present a single view of data to its internal users; for example, a user should be able to update an address change just one time and have it applied to all systems.

This type of system has to be transaction-oriented so that if a transaction fails for some reason, the data is current to the point before the failure. "We use Ontos ODBMS on OS/2 to maintain the persistence of all data that the user enters on-screen," says Schoff. Once the entry is completed on the PC, a local server submits the transaction to the mainframe, which handles validation, verifying that there is no conflict with another transaction. The local server resubmits the transaction later on if the system happens to be down.

This particular application didn't have to use an ODBMS, Schoff notes. "But everything else about the systems was object-oriented, so we tried to present an object view to the users. Then we translate that onto legacy systems," he adds.

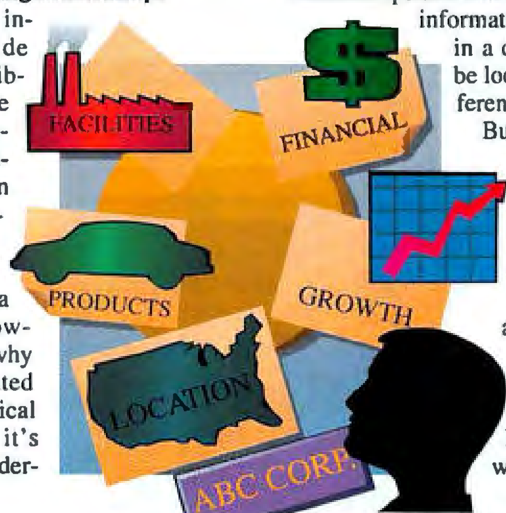
Continuum's work-flow management system is a true object-oriented system, where the objects are distributed. BPM/ES works by defining available resources—equipment, people, and so on—as one type of object. The system also defines work to be performed in terms of work-flow objects, which Continuum calls "case objects." These can be nested with subcases to any depth, down to the level of individual tasks, which is where the work gets done. The system also uses a bidding/assignment algorithm to assign the work to the resources. It uses a best-skills match and also balances work flow—so it doesn't overload one person while others are idle, for example.

An object-oriented database works so well for Continuum because it provides all the data that the company needs in one call, according to Schoff, who adds that "with a relational DBMS, we might have to do a series of joins to get all the information we need."

For both Continuum products, the processing engine is written in Smalltalk (Parc Place on OS/2, Digitalk on Unix). A database interface-process module acts as a layer between Continuum's object model and the operating system. The company developed the products on a SparcStation and is currently porting both BPM/ES and CWP/ES to Hewlett-Packard's HP-UX. A client interface layer, also written in Smalltalk, allows a customer to mix and match workstations and data-bases; for example, an OS/2 engine can talk to an AIX database or vice versa.

Continuum selected the Ontos ODBMS as the basis for its systems in 1991. "We had a requirement from our customers, who were underwriting the development," says Schoff, "that the systems had to run on OS/2. We knew ourselves that they also had to operate on Unix." Support for those two operating systems was the deciding factor in Continuum's picking Ontos. At that time, Schoff comments, "Ontos was the only vendor whose development schedule matched our needs." He adds that Continuum also evaluated GemStone, ObjectStore, and Versant before deciding on Ontos.

Objective: Exploring Relationships



Analyzing and integrating a wide variety of distributed data is the function of InfoPower, a product from Delfin Systems of Arlington, Virginia.

To get an idea of how InfoPower works, and why an object-oriented database is critical to its success, it's necessary to understand how the intelligence community works—how it gathers data and pulls information out of it. Traditionally, says Delfin marketing manager Kent Potter, "in the intelligence arena, you're confronted with [not only] huge quantities of complex data, full-text databases, and traditional structured databases, but also image databases and lots of other things—and you've got to bring all this together in a way that makes sense."

Most systems designed for intelligence analysts and for the command-and-control community began with existing databases; applications were built to access them. But pulling together very different kinds of data poses real problems. For instance, you may have one database of locations and another of relationships (e.g., subordinations, who reports to whom, who talks to whom, who controls what, and what facilities control what products). Yet another database may store other attribute information, such as what quantities of a product are produced, how many of what model tank the Italian government possesses (not just where they are located), and trends.

Particularly in the intelligence field, Potter comments, "you're never going to find all the information you need about an entity of interest in one database; [such a situation] doesn't exist, because some data collectors must collect information in specialized ways, and their needs can only be met by building a database that supports them directly."

The information analyst must break down the walls between different databases. He or she may begin with little glowing dots on a map and then want to see the facilities that, say, produce nuclear weapons or drugs and then uncover any relationships between these facilities. This information could be buried in a database, or it may be located in a set of different data sources.

But what if you think of a new question or acquire some new data? Say you want to click on one of those on-screen map nodes and look at a picture of it. How about recovering the full text? What about a time line? What if you want to include a group of facilities on a chart and add the amount of a particular chemical or the quantity of a piece of equipment each one produced in a given time frame?

One of InfoPower's modules is designed specifically to allow you to look at relationships. It has an auto-investigate function that starts at one node and goes out and looks at all the available relationships, explains Dan Stickel, Delfin's director of decision systems in Santa Clara, California. "Say it started with me; it could find out where I work, my religious preferences, and where I've traveled in the last few weeks."

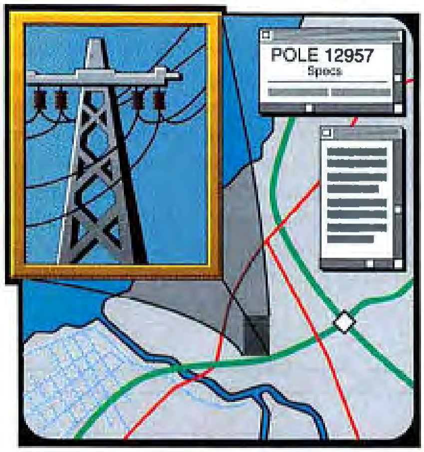
In its original government-sponsored work, Delfin used a relational database. Stickel comments that "we were trying to look at the relationships between real-world things; we're really strong on relationships. So, what we thought was that doing relationships in a relational database... the name sounds like it should work."

Experience proved otherwise, however, because exploring relationships with an RDBMS involves doing a lot of joins, and performance drops off steeply. Stickel found that using an object database really sped things up: "We were able to keep reference pointers instead of doing joins over and over again. Using the object database was definitely two orders of magnitude faster," he notes.

Expanding on the differences between the two approaches, Stickel notes that the RDBMS the company first used—Sybase—is a fine product. "If all you want to do is pull back lists of things, with filters, it's fast; there's no question about it. And going to an object database wouldn't make things faster. A lot of the time, the whole object-design methodology is more elegant and more extensible, but a little slower," he says.

Picking the right ODBMS product from the few that were available two years ago was no simple task. Stickel says that the company went through an extensive evaluation of several products, including Versant and Itasca, "to the point where we were actually using them." ObjectStore gave good performance, and at that time its technical support and documentation were deemed to be far superior to those of similar products that offered the features the company needed. "When we started [evaluating ODBMS products]," Stickel continues, "they were all really flaky—although reading about them in the press wouldn't have told you that. But trying to use them for real, we ran into one bug after another. Thankfully, that's no longer the case."

Delfin's Potter thinks that the advent of object databases has made a significant change in what's feasible. With more and more power becoming available on the desktop, and with vast amounts of data—of all types, not just rows and columns—proliferating, users need to access it in a fused, integrated way. You don't want to force people to learn multiple interfaces. "Now it is possible to put an object-oriented database in there as the hub; map those other, different databases to it; and then link out to whatever tools you need for visualization/analysis," says Potter. "In our view, that is a new category of product made possible by object databases. It's a brand new kind of product." *continued*



Power Play

Florida Power and Light provides electricity to millions of people in the Sunshine State. Part of this job includes the maintenance of existing facilities and the design of new power-distribution channels. A spokesperson for the utility, who asked not to be identified, told BYTE that in the late 1980s it had developed a pilot version of a generic AMFM (automated mapping/facility management) application using a FORTRAN toolkit and mainframe-based technology.

Called the Facilities Graphics Management System, the application allows Florida Power and Light distribution engineers, designers, and service planners to bring up on a computer screen a picture of the geography of a given area, including streets, canals, other waterways, and buildings. It even locates poles, transformers, and switches. And it's not just pretty graphics; the system presents an intelligent map where supporting information is tied to parts of the picture. Place the cursor on a utility pole, for instance, and you can bring up information about the pole's size, class, and ownership.

Although this pilot application started out on mainframes, by the early 1990s the developers knew it was a natural for implementation via an object-oriented system. There was also a desire to move it to desktop platforms. The developers looked at Unix workstations and also considered several object-oriented databases, looking for one that was flexible and still had the "usual" DBMS functions one would expect in a mature relational database (e.g., backup and recovery). And since the application was object-oriented, there were naturally many advantages to using an object database. Also, they were concerned that using a relational database might tie their hands and have an impact on the design of the object model itself. Finally, performance and cost were important factors to consider.

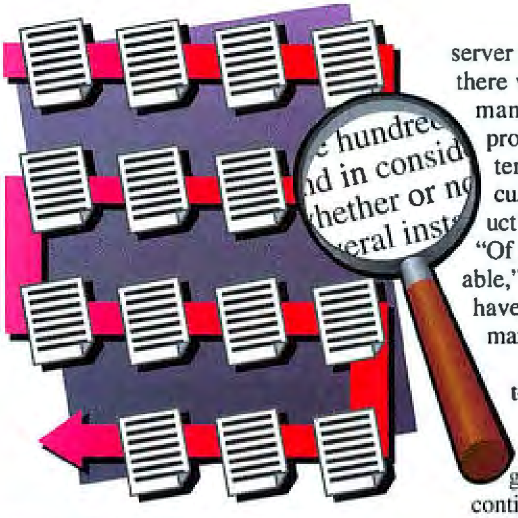
The developers decided to create the new system using a Smalltalk-based, object-oriented toolkit called Objective Facilities Management, which was developed at the University of Florida. Unfortunately, the toolkit provided no means of making objects persistent, so Florida Power and Light opted to use Servio's GemStone. The redone system, which was first implemented in Dade County, uses a master GemStone database on a central server, with local servers (which also run GemStone) at the various usage sites. Actual design work is done on IBM-compatible 486/33 PCs.

One interesting aspect of the system is that it typically encounters the "long transaction" problem. In other words, a single user can tie up a large area or block of data for a long period of time before it gets completed and returned to the server. However, there's not too much of a problem with different users trying to work on the same area at once.

Documenting the Advantages

PassagePro is a recently released document management and production system from Passage Systems. The object-oriented system runs on Silicon Graphics workstations and provides document check in/check out, configuration management, work-flow management, and workgroup notification, with automatic production of both on-line and hard-copy information.

According to Vance Nakamoto, president of the Mountain View, California–based firm, "the object-oriented paradigm fits our problem space very well." He adds that the company expects to ultimately be able to use relational databases as well, "but we figured the best way to start was with an object-oriented DBMS," he says. "We wanted to create an API from an object-oriented perspective rather than having relational technology affect our implementation." To do this, Passage Sys-



tems built its API with a database transaction layer beneath it. "Now we're doing a Sybase port," Nakamoto says, "and it will have a new binding layer to the relational database."

Passage Systems decided about two years ago to use Versant as its ODBMS. Reasons for the choice included the fact that Versant was more focused on client/server and multiserver solutions and that there was already a lot of configuration management built into the ODBMS product itself. Finally, Passage Systems was attracted to the proactive, customer-oriented attitude of the product's company and its nearby location. "Of the few object databases then available," says Nakamoto, "they seemed to have the best performance for the data management scenario we were facing."

He adds that using relatively new technology carries its own price and that the early versions of the ODBMS software were quite buggy. Things are much better now, he continues, adding that PassagePro stresses the Versant system more than most and that Versant has been quite responsive. At the time BYTE talked with Nakamoto, he was about to begin the process of porting the product to Versant 3.0 on a Sun workstation.

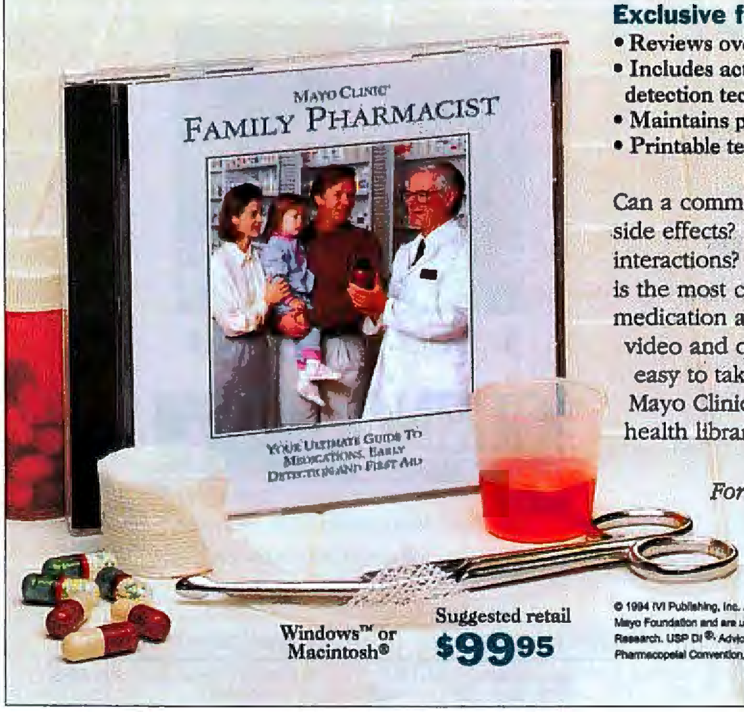
Nakamoto is not clear whether the capabilities and performance of object databases will scale up effectively for large installed databases that have gigabytes of data and thousands of objects. However, he might be encouraged by the positive experience at Florida Power and Light, whose database for Dade County alone is several gigabytes in size.

No Objections Here

Although this article takes a look at only a small sampling of how object database systems are being used in the real world, it seems clear that for a number of applications the promise of improved performance and added functionality has indeed been realized.

Clearly, ODBMS technology is not appropriate for many situations. However, where data is generated by object-oriented applications that are written with object-oriented programming languages, using an ODBMS to store persistent data is a win-win situation for systems developers and end users alike. ■

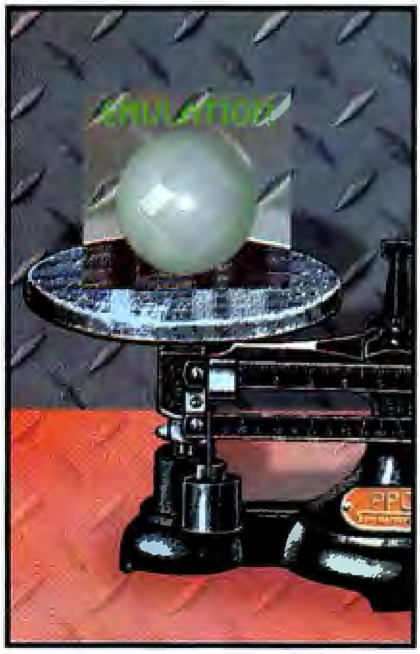
Russell Kay is a technical editor at BYTE. He can be reached on the Internet or BIX at russellk@bix.com.



CPU WARS:

The RISC Decision

RISC processors outperform the Intel 80x86 architecture. But do they have the operating-system, application, and development support to succeed on the desktop?



When a few engineers at Microsoft set out to write Windows NT,™ they sat down with many cups of coffee, and computers built around the MIPS R4400™ RISC microprocessor.

(No wonder: the NEC V_R4400™ MIPS processor is at the heart of some of the most powerful workstations in the world.)

During the next few years, they worked long and hard, missing quite a few dinners with their families and untold televised sporting events.

Today, Windows NT makes it possible for companies to run their enterprise software on a whole new class of dependable, affordable machines. Like the NEC Express RISCserver,™ direct descendant of the machines used to write NT itself. And it gives software developers, designers and engineers access to remarkable new tools like the NEC Image™ RISCstation.™

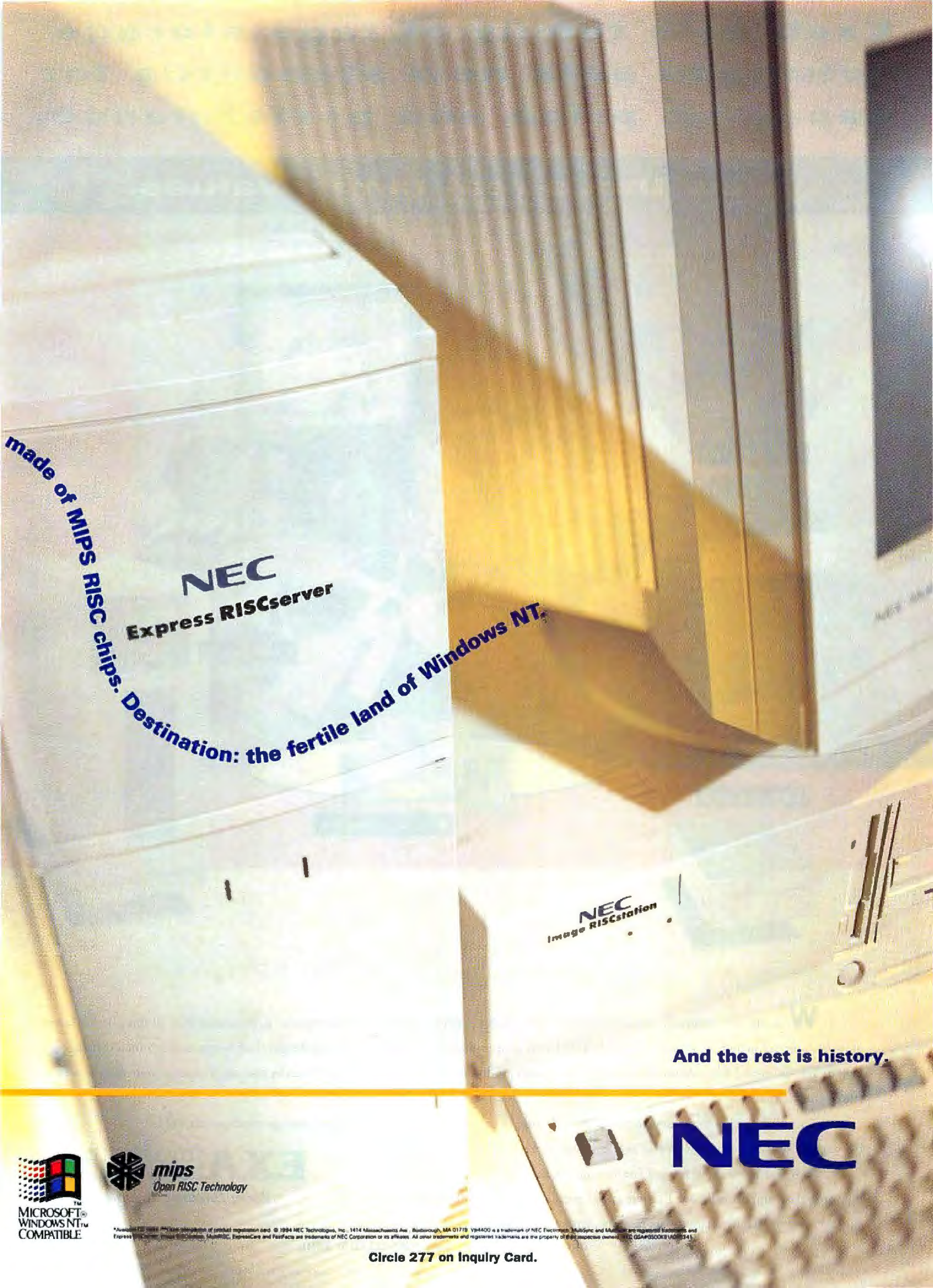
In short, a few engineers sat down. And the entire computing world leaped.

The only Windows NT-specific systems in the industry: NEC MIPS RISC Systems

- **Express RISCserver™** *for client/server and database applications*
- **Image™ RISCstation™** *for the new generation of 32-bit Windows applications*
- *NEC V_R4400™ MIPS RISC processors with MultiRISC™ architecture supporting dual processor SMP operation.*
- *MultiRISC system management for hardware problem detection and reporting (standard on RISCserver)*
- *Fully optimized multithreading among four hardware subsystems: I/O, processor, video and memory*
- *Up to 128MB RAM on the system board; additional memory expansion up to 512MB (ECC coding) using industry-standard SIMMs*
- *MultiSpin® 3X1 CD-ROM standard on all NEC RISC Systems**
- *Hard drive options up to 2.0GB*
- *Fault-tolerant "hot-swap" RAID option (RISCserver)*
- *3-year limited ExpressCare™ warranty,** ExpressCare upgrade options available*

A river of coffee. A raft

For more information, call 1-800-NEC-INFO or, for details via fax, call NEC FastFacts™ at 1-800-366-0476, #46474721 Image RISCstation; #97774721 Express RISCserver.



made of MIPS RISC chips. Destination: the fertile land of Windows NT.*
NEC
Express RISCserver
NEC
Image RISCstation
And the rest is history.
NEC
MICROSOFT® WINDOWS NT™ COMPATIBLE
mips
Open RISC Technology
Circle 277 on Inquiry Card.

Windows on RISC

STEVE APIKI

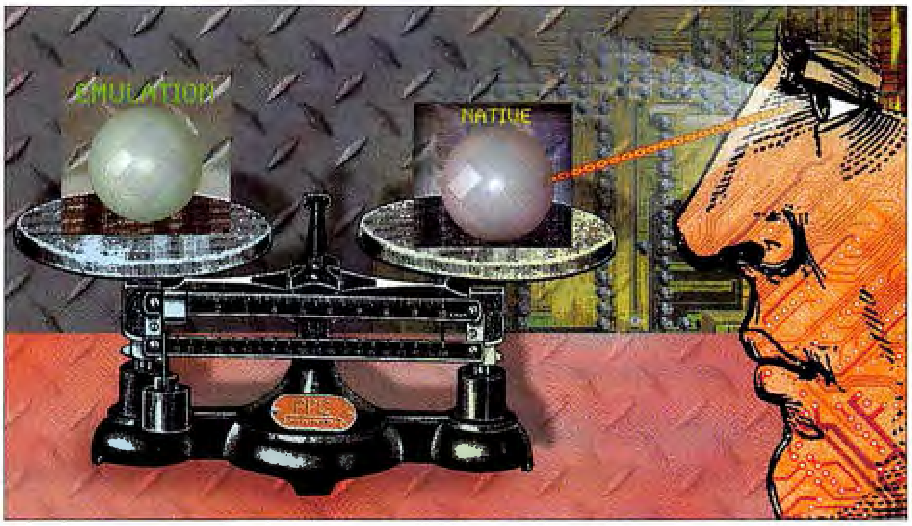


ILLUSTRATION: MARC YANKUS © 1994

Windows PCs are no RISC workstations, but then, RISC workstations are no Windows machines, either. Workstations may make the perfect platform for core business activities, such as hosting corporate databases or serving as development or engineering systems. But traditionally, RISC workstations have provided a poor environment for running the kinds of tools that most *individuals* in a business need daily—the humble word processors, spreadsheets, and small-scale databases for which Windows excels.

By making workstations capable of directly running 16-bit Windows applications, emulation technology promises to bring to the workstation desktop the rich selection of commercial and in-house applications that Windows users now enjoy. SunSelect's Wabi, Insignia Solutions' SoftWindows, and Microsoft's Windows NT emulation support are examples of this technology, supporting Windows binaries on Hewlett-Packard's PA-RISC, Sun Microsystems' SPARC, DEC's Alpha, the PowerPC, and Mips systems (see "Emulation: RISC's Secret Weapon" on page 119).

Pure instruction-by-instruction emulation exacts, of course, a severe performance penalty; so each of these technologies combines emulation with various native Windows components to provide speeds closer to those expected of the underlying machine (Insignia Solutions' SoftPC and sibling SunPC from SunSelect more closely match the pure emulation model). And performance can be a critical issue, especially since the Windows applications that users will likely run under emulation will be highly interactive.

BYTE tested the performance of Windows applications, running through emulation, on workstations built on each of the processors listed above. There is noticeable variance among machine and technology combinations, but on balance, RISC workstations will not deliver the Windows performance to which you are probably accustomed: Current workstations and emulation technology provide only about 20 percent the speed of a good native Windows platform (e.g., a 66-MHz 486DX2 with accelerated graphics). While this performance might be adequate for many common office applications, tasks that require moderate to heavy computation will suffer under emulation. This includes applications such as data analysis, imaging, and CAD.

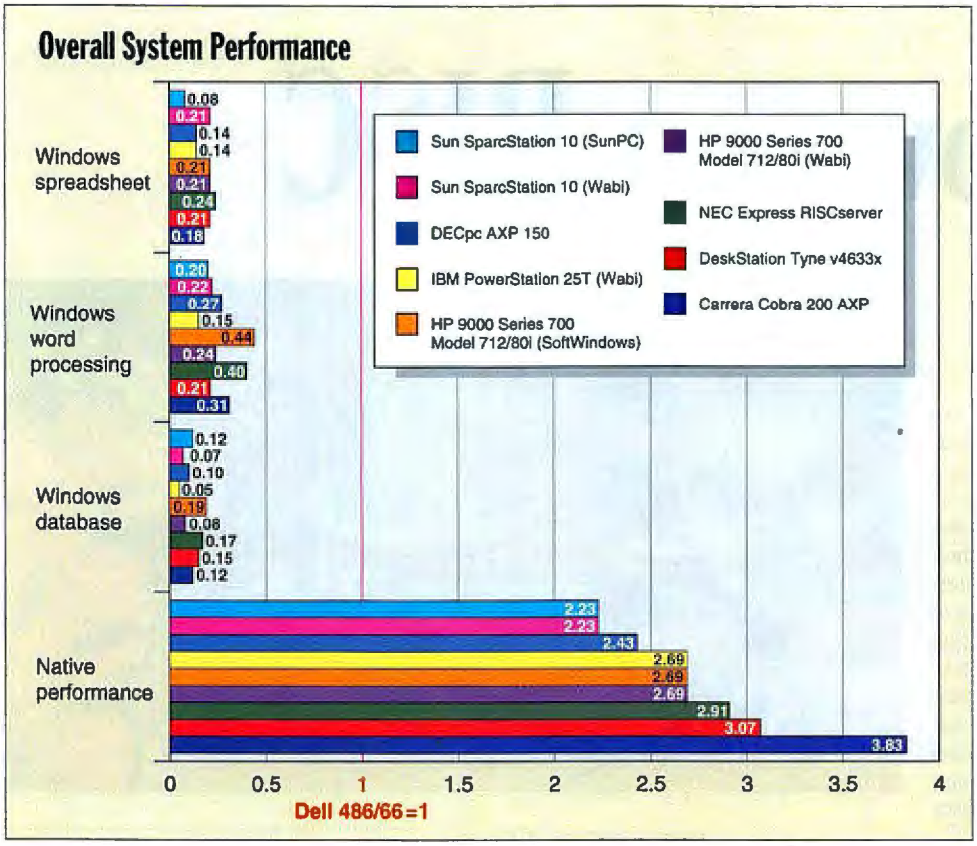
Wabi, Windows NT, or SoftWindows: Whichever way you run Windows on a RISC workstation, CISC is better

Testing Details

I tested seven systems: Carrera Computers' Cobra 200 AXP (Alpha), DeskStation Technology's Tyne Series v4633x (Mips), DEC's DECpc AXP 150 (Alpha), the IBM RS/6000 PowerStation 25T (PowerPC), the HP 9000 Series 700 Model 712/80i (PA-RISC), the NEC Express RISCserver (Mips), and the Sun SparcStation 10 Model 512 (SPARC). The PowerStation 25T, HP 712, and SparcStation 10 are Unix systems; the other machines run Windows NT. The configuration details for each system are given in the "System Features" table on page 114.

The Windows NT machines all run 16-bit Intel Windows binaries through Windows NT emulation, but the Unix systems exploit a few different technologies. I tested each running Wabi 1.0. I also tested the HP 712 with SoftWindows, and the SparcStation 10 using SunPC, Sun's emulation offering. Sun offers a hardware accelerator for SunPC (an actual 486 on an SBus card), but I didn't test that option because its software-emulation component accounts for only a small part of its performance.

For each of these combinations of system and emulation



Summary benchmark results for RISC workstations running 16-bit Windows applications. Systems are listed in order of native processing speed, as determined by BYTE's portable benchmarks. For each test, a score of 1 represents the performance of a typical Windows configuration, a 66-MHz 486DX2 PC with accelerated graphics. Although these systems average just under three times the speed of a 486DX2/66 running native code, the average speed for these RISC machines running Windows is only one-fifth that of a 486DX2/66.

technology, I ran four suites of tests. The first, BYTE's portable benchmark suite, is a collection of low-level synthetic benchmarks written in C. The portable benchmarks evaluate native processing performance for each of the systems, providing a yardstick against which to measure the performance of Windows applications running under emulation; they are a mixture of memory access, integer, and floating-point tests.

The other three suites are NSTL's Windows application performance tests. These test spreadsheet, word processing, and database performance using off-the-shelf applications. The suites test a mixture of operations appropriate for each application category, like charting for spreadsheets or updating a database. I used Microsoft Excel for spreadsheets, Microsoft Word for Windows for word processing tests, and either Borland's Paradox for Windows or Software Publishing's Superbase (depending on circumstances described below) for testing database management.

Testing Changes

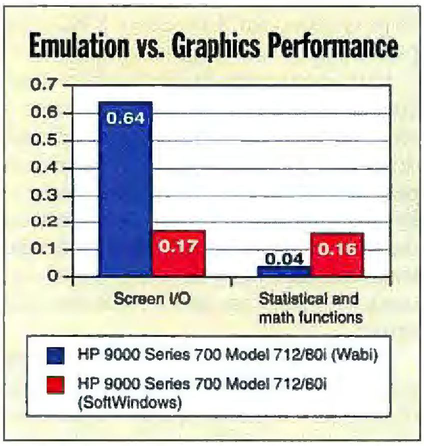
I had to make a few minor modifications to the standard test suites. First, these tests do not include printing performance, as these workstations' print emulation mechanisms are so different from one another that it would have made a fair comparison impossible. Second, some of the interactive tests for the database suite aren't counted, because they run too quickly on some of these systems to time accurately. Third, the word processing tests don't include some tests that are very dependent on screen size, since I couldn't normalize display modes across systems.

In addition to the systems under test, I also ran each suite on a Dell Dimension 486 to serve as a baseline for comparison. The Dimension includes a 66-MHz 486-DX2 processor, 24 MB of memory, and a Number Nine GXE graphics card, a PCI (Peripheral Component Interconnect) video accelerator. The Dimension is a fast machine, one that approximates the state of the art for Windows 3.1 desktop systems. All the test results are reported as indexed against this baseline; that is, a score of 1 on a test indicates performance equal to that of the Dimension.

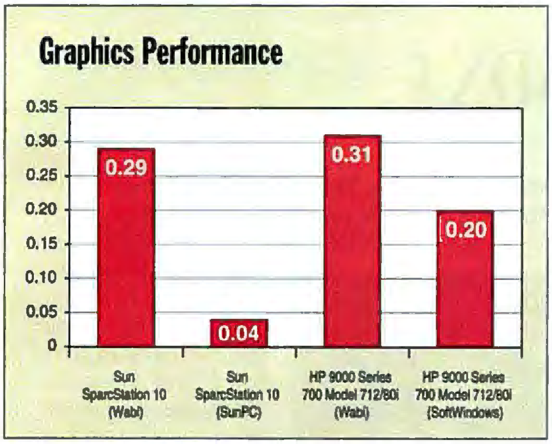
The only Wabi-certified Windows DBMS is Paradox for Windows. However, Paradox for Windows requires 386 support, so it can't be run on any of the other emulators, which supply only 286 emulation. Therefore, I ran Paradox for Windows on all the Wabi systems, and I ran Superbase on all non-Wabi systems. I ran both packages on the Dimension, and, again, all results are reported in comparison to that system.

Comparing Performance

The figure "Overall System Performance" shows the results for each tested system. Results are listed in order of native performance, according to the BYTE portable benchmarks. Native performance ranged from a high of 3.83 times the performance of a 486DX2/66 (for the Carrera Cobra's 200-MHz Alpha) to a low of 2.23 for the Sun SparcStation 10. Note that the BYTE portable benchmarks do not take advantage of the second processor in the SparcStation 10, so, for the purposes of this comparison, that system is effectively running on a single 50-MHz SPARC. On the average, these worksta-



Wabi is better when it comes to pure graphics tests, but it falls behind the superior emulation and native DOS support provided by SoftWindows on more floating-point- and processor-intensive tasks. These two tests, from the Windows spreadsheet benchmark, show a dramatic difference between graphics operations (screen I/O) and floating-point processing (statistical and math functions).



SunPC is a pure virtual PC environment; both Wabi and SoftWindows include components of Windows compiled natively. The difference is obvious when making heavy use of Windows graphics calls, as when drawing charts in Microsoft Excel.

tions are 2.75 times as fast as the Dimension running native code.

Emulated performance, however, is a significantly different story. For all three applications and all workstations, the mean workstation performance is only 0.19 times that of the Dimension.

Each application puts different demands on a system. All the applications consist of a variety of operations with different requirements, but they can be roughly broken down as follows. The database benchmarks are most affected by fast hard disk performance and processing speed; these are the least affected by the performance of Windows itself. The spreadsheet benchmarks are heavily influenced by Windows performance and vary primarily according to video display speed and floating-point performance. Word processing tests are about an even mix of display, processor, and disk performance and, again, are strongly dependent on Windows performance.

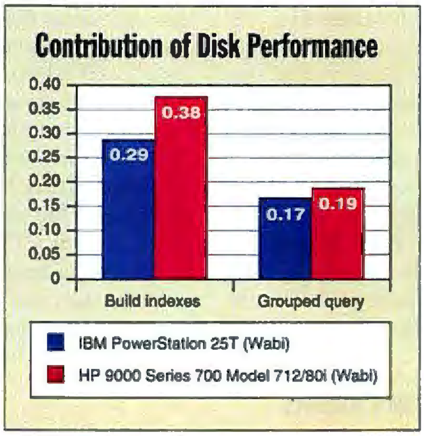
Separate Strengths

Similarly, each emulation technology has strengths of its own. Wabi, through its use of calls to the underlying X Window System manager, makes the best use of workstation graphics performance; however, when Wabi systems must emulate rather than make native calls, they are apparently weaker than SoftWindows or Windows NT systems. SoftWindows, with native versions of DOS and Windows, takes good advantage of underlying hardware and also offers very good emulation. Windows NT's emulation is similar to that of SoftWindows (as far as emulation on RISC goes) and presents the same strengths. SunPC, SunSelect's fully emulated PC environment, has excellent emulation but very poor display speed relative to the other technologies.

Test results suggest that the emulation provided by Wabi is not as good as that provided by SoftWindows. On the spreadsheet screen I/O tests, Wabi again takes better advantage of underlying graphics performance and outruns SoftWindows almost four to one on the same machine (the HP 712). However, the results are completely reversed for the floating-point- and processor-intensive statistical and math functions test, where SoftWindows' better floating-point support and processor emulation appear to make the difference.

Both SoftWindows and Wabi make use of the underlying X Window System, although Wabi's more complete exploitation of that system makes it the faster graphics platform. But any use of X makes an enormous difference over pure bit-map-oriented screen emulation. On the spreadsheet chart tests for SoftWindows, Wabi, and SunPC running on the HP 712 and the SparcStation 10, the Wabi systems performed better than the SoftWindows system.

The most obvious disparity, however, is between SunPC, which emulates the screen completely in software, and the other three systems, which make use of native graphics calls. On the SparcStation, Wabi is 6.5 times faster than SunPC on this test.



Emulation capability isn't the whole story when comparing Windows performance; sometimes it just boils down to faster components. The PowerStation 25T's PowerPC 601 runs exactly as well as the HP 712's PA 7100LC on BYTE's native processor benchmarks and is very close on the memory-intensive database query in Paradox for Windows. However, the HP 712 pulls ahead on the disk-intensive index test purely on the strength of better disk performance. Such component differences can mask the effects of emulation when comparing RISC systems.

Component Factors

Emulation performance isn't the only thing that affects the performance of Windows applications—sometimes it's just old-fashioned component speed. One test measures Windows database indexing and multiple-table queries under Paradox for the PowerStation and the HP 712. Although the PowerStation's PowerPC 601 and the HP 712's 80-MHz PA 7100LC are evenly matched on the portable benchmarks and both systems are running Wabi, the HP 712 easily outperforms the PowerStation while indexing, on the strength of a faster disk subsystem.

There's little correlation between operating system and emulation performance, as you might expect; the Windows NT systems performed primarily according to processor and component speed and were mixed with the Unix systems for overall results. Among the Windows NT systems, the Mips workstations and Alpha machines (the DECpc AXP 150 and the Carrera Cobra 200) present similar emulation performance despite a significant difference in raw CPU power.

Current Limitations

Emulation for Windows applications on RISC systems is still in its early stages, and I expect that performance results will change with pending releases of upgrades to these technologies. At the moment, working with these systems presents a challenge that goes beyond mere performance, as they are still unstable to some extent.

In general, the Windows NT systems proved to be more stable than the Unix workstations when running 16-bit Windows applications. SunPC had some problems unrelated to performance. Running the Word for Windows test, for example, twice generated an error message from SunPC for an unsupported instruction. But attempting to dismiss the error message box locked the console. The Excel spreadsheet tests also generated an exception (a plain old GPF, or general protection fault), but only on the first run; the second run worked fine.

I tested with beta versions of Wabi, so a

Intel, TI Show Off the 486DX4

MICHAEL NADEAU AND TOM R. HALFHILL

The PowerPC is poised to challenge Intel processors on the desktop. But what about portable systems? Here, it seems, Intel is at an even greater disadvantage. Its current fastest 486 and Pentium processors are slower and more power-hungry than the PowerPC 603. Building notebooks and subnotebooks with these Intel chips presents difficult engineering challenges, making the PowerPC all the more attractive to manufacturers of battery-powered systems.

But don't count out Intel in the portable arena yet. Its recently announced 486DX4 addresses both power management and performance issues.

The DX4's name is misleading. The trio of DX4 chips recently announced by Intel are actually clock-*tripled*, running their internal clocks at about three times the speed of their external buses. In fact, one of them runs only 2.5 times faster than its I/O bus. Still, at 100 MHz, 83 MHz, and 75 MHz, they are among the fastest 486-class microprocessors.

The DX4 chips also introduce other improvements, including 3.3-V operation; pin compatibility with existing 486 sockets and 5-V parts; lower power consumption and heat dissipation; 0.6-micron process technology; and a 16-KB instruction/data cache, twice as big as a normal Intel 486 cache. All have on-board FPUs and SL Enhanced power management.

The TI TravelMate 4000E.

The 486DX4-100 can operate its external bus at 33 or 50 MHz. It is available now and costs $649 in 1000-unit quantities; Intel says the price will drop to $580 in the second quarter.

Also available is the 486DX4-75, which has a 25-MHz bus. The 1000-unit pricing is $499 (expected to drop to $475 in the second quarter). Rounding out the line is the 486DX4-83, a not-quite-tripled processor with a 33-MHz bus. It won't ship until the second half of this year; prices are not yet available.

BYTE tested a beta version of the first DX4-powered notebook, the Texas Instruments TravelMate 4000E. Similar in design to the other TravelMate models, it features a 75-MHz version of the DX4 and an active-matrix color display.

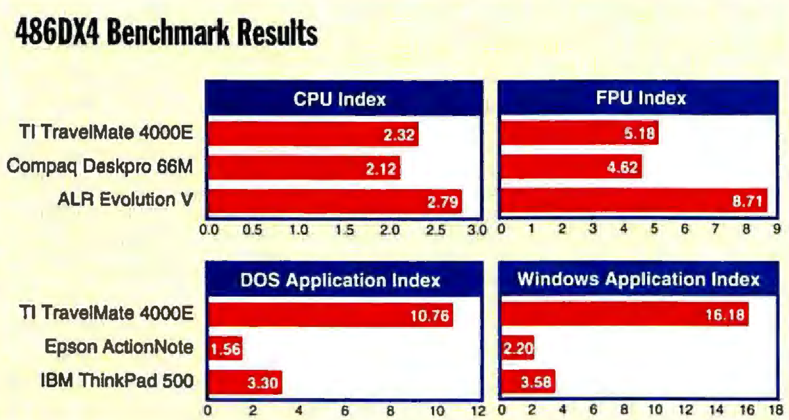
The system uses the same power management circuitry as TI's other 486 notebooks. TI takes pride in its ability to squeeze operating time out of a battery, and BYTE's battery tests have consistently rated its systems highly in this category. So TI is probably the best company to first show a DX4 notebook.

Under heavy use with a lot of hard disk accesses, we got about 2½ hours of battery time—a respectable showing, given the performance and color display. But TI doesn't deserve all the credit: Intel lowered power requirements on the DX4 to 2.5 to 3 W, from about 4 W on a DX2. The 3.3-V operation and SL Enhanced features help, too.

In raw performance, the 4000E scored a 2.32 on the CPU tests—about 10 percent faster than the 486DX-powered Compaq Deskpro 66M and 20 percent slower than the Pentium-based ALR Evolution V. (Note that the TI system uses the slowest DX4.) On the FPU side, the Pentium systems have a much bigger (about 70 percent) advantage.

Compared to other notebooks, the application-level results were much more impressive. The 4000E is 3.25 times faster than the IBM ThinkPad 500 (which uses a 50-MHz IBM 486SLC2) on DOS applications, and 4.5 times faster on Windows applications. Much of this advantage can be attributed to the fact that the DX4 has an FPU and the 486SLC2 does not.

The 4000E is a premium system with a premium price—$4499 for the tested model. However, you get a 6-pound color notebook with reasonable battery life that will run your applications faster than most DOS/Windows desktop PCs. That's a good reason to bet on Intel remaining at the top of the notebook processor heap for the foreseeable future.



The DX4's CPU performance falls between the 66-MHz 486DX's (Compaq) and the 60-MHz Pentium's (ALR). For CPU and FPU tests, a Compaq Deskpro 386/33 = 1. In the DOS application indexes, the big difference is the DX4's FPU; neither the Cyrix 486SLC (Epson ActionNote) nor the IBM 486SLC2 (ThinkPad 500) has one. This gave the DX4 a huge advantage on math-intensive tasks such as spreadsheet recalcs and database indexing. For the application indexes, a Toshiba T2200SX = 1.

Michael Nadeau is a BYTE senior editor, and Tom R. Halfhill is a BYTE senior news editor based in San Mateo, California. You can reach them on the Internet or BIX at miken@bix.com and thalfhill@bix.com, respectively.

HEARD THE ONE ABOUT THE GUY WHO DEVELOPED A HOST FRONT END USING QUICKAPP?

```
Sub Command1_Click ()
DcaNavigate1.HostNextScrn = "Inventory_Main_Menu"
End Sub
```

IT'S A ONE-LINER.

It's a one-liner, all right. But it's certainly no joke. And you should *really* hear the one about the guy who built a complete client/server application using DCA's QuickApp for Windows.

When you use QuickApp,™ a communications middleware development tool, in combination with Microsoft® Visual Basic,™ Powersoft® PowerBuilder™ or Microsoft Visual C++,™ you can create host front ends–or powerful new client/server applications that integrate information from 3270, AS/400 and Unisys® systems–faster than you ever believed possible. And you can do it without writing a single line of HLLAPI code. No competitive product (including those from Rumba® and Attachmate®) can do that.

Easily records host screens, keystrokes and action keys.

Used with the appropriate IRMA™ or INFOConnect™ software, QuickApp records keystrokes, action keys and screens while you work with the existing host application. Then you use your Windows™ application development tool, along with the QuickApp custom controls or user objects, to build your new GUI application.

Finally, a single command allows the development tool to navigate to the appropriate screens, associate host fields with those in the new application, and automatically update chosen fields. Other competitive tools can link fields, but you still have to write lines and lines of HLLAPI code. And the amount of time that takes is no laughing matter.


Why write HLLAPI code when you can navigate?

For more information and a free demonstration video, give us a call. And in no time, you'll be writing your own one-liners.

1-800-348-3221, ext. 59DD*

DCA®

The Freedom To Communicate.

Circle 262 on Inquiry Card (RESELLERS: 263).

SYSTEM FEATURES

System features that contribute to performance, and system pricing.

			
SYSTEM	**COBRA 200 AXP**	**TYNE SERIES V4633X**	**DECPC AXP 150**
Processor			
CPU	Alpha AXP 21064-200	IDT R4600	DECchip 21064
CPU speed (MHz)	200	133	150
Primary cache (KB, instruction/data)	8/8	16/16	8/8
Secondary cache (KB)	2048	512	512
RAM (as tested, MB)	64	64	64
Memory width (bits)	128	128	128
Graphics			
Graphics card	ATI	Appian Renegade 1280V	Compaq QVision SVGA
Graphics processor	ATI Mach 32	Appian AGC98032	Compaq
Resolution tested	1024 × 768	1024 × 768	1024 × 768
Graphics bus	PCI	VESA	EISA
Hard drive			
Hard drive tested	525-MB SCSI	540-MB IDE, 1080-MB IDE	1-GB SCSI (2)
System software			
Native operating system	Windows NT 3.1	Windows NT 3.1	Windows NT 3.1
Windows emulation	Windows NT 3.1	Windows NT 3.1	Windows NT 3.1
Other components in tested system	PCI SCSI, PCI Ethernet, PCI Video, 17-inch monitor, mouse, keyboard, serial/parallel ports, 1.44-MB floppy drive, CD-ROM	Ethernet, 17-inch monitor, mouse, keyboard, serial/parallel ports, 1.44-MB floppy drive, CD-ROM	17-inch monitor, Ethernet, mouse, keyboard, serial/parallel ports, 1.44-MB floppy drive, CD-ROM
System price			
As tested	$8995	$10,729	$13,012
Base configuration	$6995	$3995	$8495
Contact	Carrera Computers, Inc. 23181 Verdugo Dr., Suite 105A Laguna Hills, CA 92653 (800) 576-7472 or (714) 707-5051 fax: (714) 707-5053 carrera1@delphi.com **Circle 1078 on Inquiry Card.**	DeskStation Technology 13256 West 98th St. Lenexa, KS 66215 (800) 793-3375 or (913) 599-1900 fax: (913) 599-4024 **Circle 1079 on Inquiry Card.**	Digital Equipment Corp. 40 Old Bolton Rd. Stow, MA 01775 (800) 722-9332 **Circle 1080 on Inquiry Card.**

[1] Prices reflect two processors (price with one CPU: $22,495).

[2] Price with two CPUs is $15,000.

little instability is to be expected there. However, some of the difficulty in working with Wabi goes beyond its beta status. Getting Paradox for Windows to work, in particular, required a day of tweaking configuration files, even given that the file-locking limitations of Wabi were well-documented. Unfortunately, this is the only Windows DBMS that is currently certified to run on Wabi 1.0.

Trends

The benchmark results lead to a few conclusions: Wabi is the best technology for graphics applications, but it is somewhat lacking in emulation for code that doesn't run through supported Windows components. SoftWindows is surprisingly strong in all areas, although Wabi is still better on graphics. SunPC has excellent emulation and a good DOS platform but is not as fast a platform for Windows as the other two technologies available on SPARC (Wabi and SoftWindows). And Windows

			
RS/6000 POWERSTATION 25T	**HP 9000 SERIES 700 MODEL 712/80I**	**NEC EXPRESS RISCSERVER**	**SPARCSTATION 10 MODEL 512**
PowerPC 601	PA 7100LC	NEC VR4400SC	SuperSPARC (2)
66	80	150	50
32	256	16/16	20/16
None	None	1024	1024 per CPU
64	64	32	64
64	64	128	128
GXT150	Integrated	64-bit Jaguar VXL	Turbo GX Plus
IBM	Integrated	Jaguar	Turbo GX chip
1280 × 1024	1280 × 1024	1200 × 1600	1152 × 900
Local bus	Proprietary local bus	64-bit VXL	SBus
1-GB SCSI	1-GB SCSI	1.3-GB SCSI, 520-MB SCSI	1.5-GB SCSI-2, 1.05-GB
AIX 3.2.5/AIXwindows 11.r5	HP-UX 9.03	Windows NT 3.1	Solaris 2.3
Wabi	Wabi 1.1, SoftWindows	Windows NT 3.1	Wabi, SunPC
17-inch monitor, Ethernet, Token Ring, FDDI, mouse, keyboard, serial/parallel ports, 1.44-MB floppy drive, CD-ROM	19-inch monitor, Ethernet, mouse, keyboard, serial/parallel ports, 1.44-MB floppy drive, CD-ROM	Local-bus Ethernet, mouse, keyboard, 1.44-MB floppy drive, CD-ROM (no monitor)	20-inch monitor, integrated Ethernet, ISDN, audio, speakerbox, 1.44-MB floppy drive, CD-ROM
$14,775	$20,576	$12,000	$27,995[1]
$9395	$8820	$11,000[2]	$25,995[1]
IBM Corp. Old Orchard Rd. Armonk, NY 10504 (800) 426-2255 **Circle 1081 on Inquiry Card.**	Hewlett-Packard Co., Direct Mktg. P.O. Box 58059, M/S 511L-SJ Santa Clara, CA 95051 (800) 637-7740 fax: (800) 333-1917 **Circle 1082 on Inquiry Card.**	NEC Technologies, Inc. 1414 Massachusetts Ave. Boxborough, MA 01719 (800) 632-4636 or (508) 264-8000 fax: (800) 366-0476 BBS: (508) 635-4706 **Circle 1083 on Inquiry Card.**	Sun Microsystems Computer Corp. 2550 Garcia Ave. Mountain View, CA 94043 (415) 960-1300 fax: (415) 969-9131 **Circle 1084 on Inquiry Card.**

NT emulation runs about as well on Alpha systems as it does on Mips systems.

Despite these differences in the performance of each technology, the results taken as a whole suggest that RISC Windows performance on 16-bit Intel Windows binaries is still well below that of solid Intel-based Windows machines. The very best overall application score for any RISC workstation was earned by the HP 712 running Word for Windows under SoftWindows, at less than half the speed of the Dell Dimension. Overall, any application for which you require 33-MHz 486 or better performance isn't a very good candidate for emulation on RISC. ■

ACKNOWLEDGMENTS *BYTE Lab technical director Rick Grehan and BYTE Lab assistant Selinda Chiquoine also contributed to this story.*

Steve Apiki is a BYTE contributing editor and senior developer at Appropriate Solutions, Inc., a consulting firm based in Peterborough, New Hampshire, and specializing in cross-platform development. You can reach him on the Internet or BIX at apiki@bix.com.

What every

World-class performance is what the Olympic Games are all about. No wonder OS/2® is at the heart of the Olympic Games Results System that covers just about every event you can imagine.

Faster than you can spell Lillehammer—actually, faster than you can even *say* Lillehammer—an OS/2-based system helps track, record, process and then post results to venue scoreboards, TV and radio commentators, press agencies, newspapers, magazines and other information outlets. Industrial-strength OS/2 programs like DB2/2,™ Communications Manager/2, CICS/2™ and others work together to accomplish a task that would bring lesser operating systems to their knees. But instead of merely skating by, OS/2 rises above. That's why *anywhere* the competition is fierce, you'll find PCs riding on OS/2.

With OS/2, you can bring world-class performance, power and reliability to all your DOS, Windows™ and OS/2 programs. OS/2's preemptive multitasking not only lets you run more than one program at a time, it has an impact on

event is riding on.

multimedia that you can really see. And hear. And give the object-oriented Workplace Shell™ user interface high scores for making it easier than ever to use your PC.

At these Olympic Winter Games, and in PCs everywhere, OS/2 is certainly worth its weight in gold. Not to mention silver and bronze. To order or to find out more about OS/2, call 1 800 3-IBM-OS2.

From Norway to your way, when you want results, you want OS/2.

In Canada, call 1 800 465-7999.

Demand OS/2 preloaded on your next PC.

If you have Windows 3.1, ask about OS/2 for Windows. OS/2 2.1 and OS/2 for Windows are also available at local software dealers.

Operate at a higher level.™

© LOOC 1991

Lillehammer'94

Official Sponsor of the 1994 Olympic Winter Games

IBM®

What Makes A Desktop Projector™

A Desktop Projector?

Projecting the power of your computer in the meeting room.

It's not just the innovative, lightweight design. Or the remarkably easy-to-use controls. It's not even the brilliantly vivid computer and video images it so effortlessly projects—even in well-lit meeting rooms.

It's all of this and more.

In fact, one look at Proxima's Desktop Projector series of LCD projectors and you'll know that a new breed of computer peripheral has arrived. It's the ultimate way to present information and share data.

Look better, work smarter

Now you can use the same computing tools you already use at your desk to enhance the productivity of your meetings. With Proxima's Desktop Projectors, everyone can see, share, and shape information together. That's what we call Desktop Projection. It helps build consensus in meetings; lets workgroups create project schedules, budgets and other documents more quickly; and leads to faster, smarter decisions.

DESKTOP PROJECTION™

And that saves you time and money.

Of course, you can also project brilliant presentations that captivate your audience. Not only do Desktop Projectors let you incorporate sound, motion, and our amazing Cyclops cordless mouse, but they eliminate the need for slides, flip charts, and transparencies.

Any computer, any application

Proxima's Desktop Projectors connect just like a monitor to any PC or Mac and work with your favorite productivity-enhancing software. Starting as low as $4,995, and weighing as little as 18 pounds, there's a model for almost any budget or application—from high-performance color to multimedia projection.

Portable Desktop Projectors go where the action is.

So whether it's a sales presentation, management discussion, or training session, Proxima's Desktop Projector series lets you project the power of your computer in the meeting room.

For more information or the dealer nearest you, call us today.

1-800-447-7694

PROXIMA®

Desktop Projector 2800 shown above.

Proxima Corporation 6610 Nancy Ridge Drive, San Diego, CA 92121, (619) 457-5500. In Europe: Horsterweg 24, 6191 RX Beek, The Netherlands, +31-43-650 248. Proxima is a registered trademark and Desktop Projector and Desktop Projection are trademarks of Proxima Corporation. Other trademarks are the property of respective owners.

Circle 285 on Inquiry Card (RESELLERS: 286).

Emulation: RISC's Secret Weapon

TOM R. HALFHILL

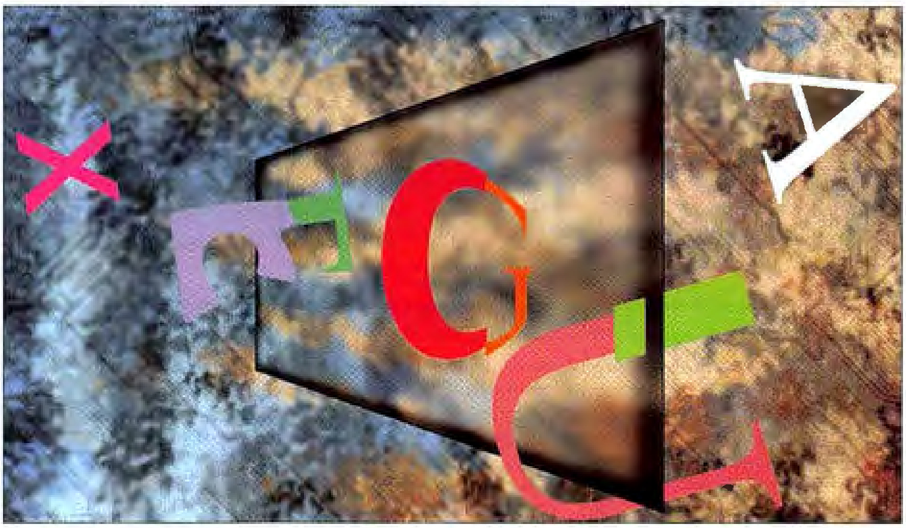


ILLUSTRATION: MARC YANKUS © 1994

Engineers at the forefront of today's software-based emulation technology shun the word that best describes their efforts. Not that their goal has changed—they're still working on software that transparently runs applications and sometimes operating systems on nonnative platforms. But over the years, *emulation* has acquired a reputation for poor performance and precarious compatibility. The next-best label is *translation*, which happens to be technically as well as politically correct, because it describes a new approach that is paying off with significant improvements in performance.

The allure of emulation is decades old, dating back to 1964, when IBM's then-new System/360 could run programs written for the IBM 1401, albeit slowly. Emulation was invented to bridge the gaps that inevitably appear when computer hardware evolves more rapidly than software. If you can run your old software on a new machine, or run nonnative software on the host machine you own, you can postpone obsolescence and win a degree of independence from cross-platform incompatibility. In short, emulation can free you to run the programs you want on the computer you want, with little concern for any technical differences in the underlying hardware and system software.

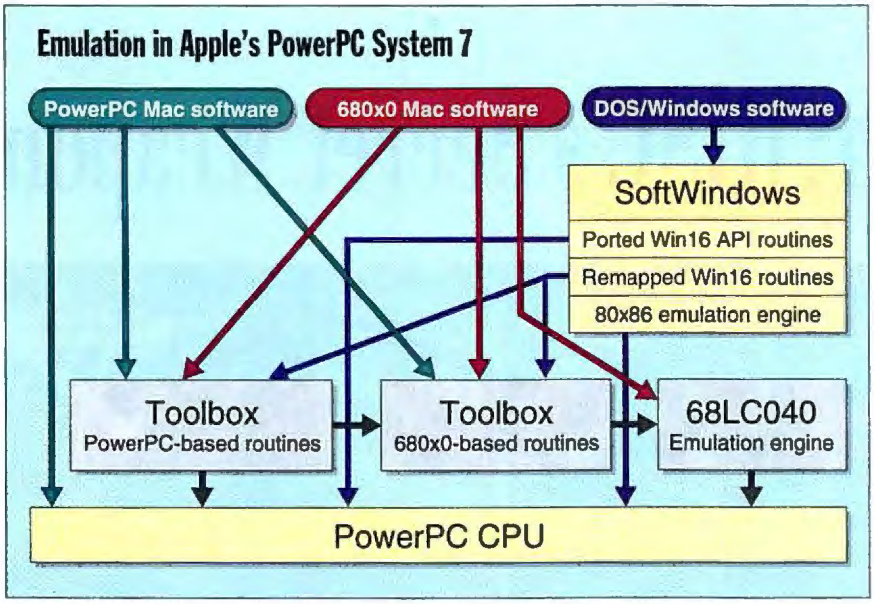
Emulation may sound like an impossible fantasy, but the technical challenge is not that great—if performance is not a factor. All an emulator has to do is convert the original binary instruction codes into equivalent instructions for the host CPU and simulate any other platform-specific dependencies that distinguish the two machines. It's stretching the point only a little to say that any computer can emulate any other computer. The real challenges that have dogged emulation for 30 years are to do all this while achieving near-native performance and to emulate the alien platform so thoroughly that even ill-behaved applications will run without crashing.

Emulation does not have to occur through software alone, of course. Add-in boards with their own processors have been available for many systems for years. The first IBM PCs, for instance, could run CP/M with one of several Z80-based boards. This article will focus on software solutions to emulation because although the hardware approach provides better performance, it is too costly.

The recent combination of superfast microprocessors and new approaches to emulation software design is yielding significant gains in speed and compatibility

Like nearly all programming problems, emulation can be tackled with clever software design and plain old-fashioned brute force. The latest-generation microprocessors put at least 100 MIPS on the desktop, and that kind of power goes a long way toward solving the performance problem, especially if the nonnative software is written to run acceptably on machines with significantly less speed. For example, if a program runs smoothly on a 33-MHz 386 that delivers 12 MIPS, it's a good candidate for emulation on a microprocessor that is cranking out 112 MIPS. The speedier CPU absorbs much of the overhead of emulation.

Still, even the brute force of today's fastest microprocessors isn't enough to make all emulation problems go away. Clever software design still has its place. Some designers are now adapting optimized compiler technology to their latest emulation engines, achieving impressive gains in speed. New to this field, but a key player, is IBM, whose Instruction-Set Translator goes far beyond the traditional model of emulating binary code in a serial fashion. The IST applies a level of analysis and optimization that is



System 7 for PowerPC *relies on built-in emulation not only for backward compatibility with 680x0-based Mac software, but also for its own Toolbox routines that aren't yet ported. Even native PowerPC programs call some Toolbox routines that must be handled by the 68LC040 emulation engine. Also, due to the effect of call chains, some native Toolbox routines call 680x0-based routines. If Insignia's SoftWindows is installed, some Windows code passes through two emulation layers: the SoftPC 80x86 engine and the 68LC040 engine.*

unheard of in real-time emulation.

Designers are getting enormous help from recent trends in the evolution of system software. The API layers originally designed to shield applications programmers from the complexity of the underlying operating system are a boon to emulators, which can take advantage of the API to further their agenda of hardware/software abstraction. API calls made by the nonnative program can be translated to similar API routines on the native platform, thus bypassing the tedious steps of instruction emulation.

Taken together, these three developments—faster CPUs, refined emulation engines, and API translators—amount to a breakthrough in emulation technology. The first clue that a watershed was reached came last year, when Microsoft included an 80x86 emulator in the RISC versions of Windows NT. This lets computers with Mips R4000 and DEC Alpha AXP microprocessors run Windows 3.1 binaries compiled for Intel microprocessors.

Also last year, SunSelect (Chelmsford, MA) announced Wabi, an API translator that runs several of the most popular Windows 3.1 binaries on Unix workstations. Microsoft countered by licensing one of its greatest corporate treasures—the Windows API source code—to Insignia Solutions (Mountain View, CA), a leading company in emulation technology. The result is Insignia's SoftWindows, which runs Windows 3.1 on major non-Intel platforms.

This March, Apple (Cupertino, CA) took emulation technology still further—taking perhaps the greatest risk in its history. The new Power Macs (see "Apple, IBM Bring PowerPC to the Desktop" on page 44) run a PowerPC version of System 7 that includes a hybrid 68LC040/68020 emulator. The emulator provides backward compatibility with 680x0-based Mac software on the new RISC platform, much as the 80x86 emulator in the RISC versions of Windows NT provides backward compatibility with Windows 3.1 software. But Apple is also using the emulator to run portions of System 7.

Thus, System 7 becomes the world's first recursively emulated operating system, relying on its built-in emulator to run parts of itself as well as existing 680x0 programs and native PowerPC applications. In a real sense, Apple is staking its future on the viability of emulation (see "The Power Mac's Run-Time Architecture" on page 131).

API Translation

Operating systems have long provided services to programmers for handling some low-level tasks that are specific to the underlying hardware. For instance, an operating system might provide routines for printing characters on the screen, reading incoming bytes through a communications port, or writing data on a disk. All the programmer has to do is pass the appropriate arguments to the routine, and the operating system does the rest. But the shift to graphics-oriented computing that occurred in the 1980s caused an explosion in both the number and sophistication of services provided by the operating system.

When Apple introduced the Mac in 1984, programmers complained it was difficult to program. Suddenly, programmers were responsible for constructing a graphics front end replete with pull-down menus, windows, dialog boxes, and icons, all managed by a complex event loop. Everything had to conform to a series of rigid "guidelines" laid down by Apple.

To make the job a little easier, Apple equipped the Mac with the Toolbox, a rich library of operating-system routines that saved programmers from hundreds of the most onerous chores. Common Toolbox routines like NewWindow (draw a new window on the screen), FillRect (fill a rectangular area with a pattern), and CopyBits (copy a block of pixels from one screen location to another) isolate Mac programmers from many of the lowest-level tasks and are often highly optimized. In effect, the Toolbox imposes a thick abstraction layer between the programmer and the hardware. Apple strongly discourages programmers from bypassing the Toolbox because the program might break on future releases of the operating system.

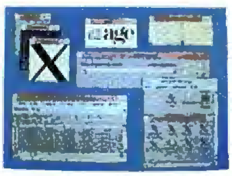
This model has been adopted by all modern GUI-based operating systems. The various Windows APIs, X Window System, Motif, Open Look, NextStep, GEOS, and PenPoint all have API layers that simplify the task of programming for a GUI while standardizing the look and feel of the application riding above it. If the API is ported to another CPU, programmers writing in high-level languages may not notice the difference. The API calls look exactly the same, accepting the same arguments and returning the same results.

This trend plays right into the hands of emulators, which seek to impose another abstraction layer that isolates nonnative binaries from the underlying differences in hardware and system software. All APIs share a number of common functions, and an emulator can take advantage of that by mapping—or "translating"—API calls from one library to another.

Alternatively, an API can be natively

John in MIS told me the data I needed was running on UNIX and I nearly panicked. Then he said I could access it right from my PC and I was happy again.

He calls it XoftWare.™ I call it 'UNIX for the rest of us.'™



With AGE's XoftWare™ PC X server products, you can work with networked UNIX applications right on your PC — pointing and clicking in a familiar Microsoft Windows environment. You can even share information between UNIX and PC systems by cutting and pasting text and graphics between windows, transferring files between systems, and printing UNIX files on local PC printers. Best of all, there's a XoftWare version available to meet your needs — whether you're running Microsoft Windows, Windows NT, OS/2 or DOS.

XoftWare PC X servers offer LAN managers an inexpensive software-based approach to connecting mixed platforms corporate-wide. That's open computing! Call (619) 455-8600 to receive our product preview diskette. Fax: (619) 597-6030 or email: sales@age.com

age

Circle 287 on Inquiry Card (RESELLERS: 288).

AGE Logic, Inc., 9985 Pacific Heights Boulevard, San Diego, CA 92121. All trademarks are the property of their respective owners.

ported to the target platform or completely rewritten. Whether the API is translated, ported, or cloned, as long as it accepts the same parameters and provides the same services, the differences are virtually invisible to programmers writing in high-level languages.

These approaches do not entirely eliminate the need to emulate binary instructions. There is always some code that doesn't call the API. Fortunately, the most time-consuming code (e.g., screen drawing) tends to rely heavily on API routines. Modern GUI applications spend enormous amounts of time redrawing the screen and performing other graphics chores, and almost all of that time is spent in the API.

Performance profiles reveal that a typical Windows program spends about 60 percent of its time executing API calls, while the average Mac program spends about 80 percent of its time in the Toolbox. Mac software tends to be more API-intensive since the Toolbox is significantly larger than the Win16 API: more than 4000 calls versus 800 to 1500, depending on which extensions are counted.

Look and Feel

When the routines of one API are substituted for the routines of another, a side effect is that the program may acquire the look and feel of the host API. For instance, if Apple's Toolbox call for displaying a pull-down menu is mapped to the corresponding routine in Motif, the result is a Motif-style menu, not a Mac-style menu. The Mac program adopts the appearance and behavior of a program that's written natively for Motif.

An example of this approach to emulation is the Equal Application Adapter from Quorum Software Systems (Menlo Park, CA). Equal allows you to run the Macintosh versions of Microsoft Word and Excel on a Unix workstation under Motif or Open Look. Quorum spent three years laboriously translating more than 4000 Toolbox routines into their Motif, Open Look, and X equivalents. A 680x0 emulation engine handles non-Toolbox code.

Equal makes no attempt to emulate the entire Mac OS. Instead, you launch the Mac applications directly from the Unix desktop. "People don't want to buy system software, middleware, because it doesn't do anything," says Nick Sturiale, Quorum's marketing director. "What they really want is an application that works." For this reason, Quorum has taken an application-based approach.

Depending on your point of view, this approach is either an advantage or a disadvantage. The emulated program looks and feels like a native port, integrating more smoothly with the host environment. Sometimes the emulated program runs even *faster* on the host than it does on its own platform, if the routines in the host API are more efficient than those in the original API. But some users don't want to lose the original look and feel of their applications, and they may also prefer to run the complete nonnative environment—operating system, GUI, and all. *continued*

COMPARISON OF SOFTWARE-BASED EMULATORS

	EMULATION SOURCE/TARGET	EMULATION ENGINE	LOOK AND FEEL	API TRANSLATION	SUPPORTED PLATFORMS
Equal Application Adapter (Quorum)	Mac on Unix	680x0	Unix Motif, Open Look (applications only)	Extensive mapping to Motif, Open Look, X	Sun SPARC, SGI Mips, HP PA-RISC
Liken (Andataco)	Mac on Unix	680x0	Mac System 6 (monochrome screen only)	Mac ROMs rewritten or mapped to Unix, X	Sun SPARC, HP PA-RISC, IBM RS/6000, DEC Alpha
Macintosh Application Environment (Apple)	Mac on Unix	68LC040	Mac System 7	Mac Toolbox natively ported and emulated	Sun SPARC, HP PA-RISC
Macintosh Application Services (Apple)	Mac on Unix	68LC040	Mac System 7	Mac Toolbox natively ported and emulated	IBM RS/6000 (PowerOpen Unix)
SoftPC (Insignia Solutions)	MS-DOS/Windows on Mac, Unix, NextStep[1]	286	MS-DOS, Windows 3.1	Minimal API translation	Mac, Sun SPARC, SGI Mips, HP PA-RISC, IBM RS/6000, NextStep Motorola, NextStep Intel
SoftWindows (Insignia Solutions)	MS-DOS/Windows on Mac, Unix, NextStep[1]	286	MS-DOS, Windows 3.1[2]	Win16 API natively ported, mapped to Unix or Mac OS, and emulated	Mac, Sun SPARC, SGI Mips, HP PA-RISC, IBM RS/6000, NextStep Intel
Wabi (SunSelect)	Windows on Unix	386/486	Windows 3.1 (applications only)	Win16 API rewritten or mapped to Unix, X	Sun SPARC, HP PA-RISC, IBM RS/6000, Novell UnixWare

[1]No CPU emulation necessary on 80x86 platform. [2] Future versions of SoftWindows for Unix platforms will allow users to select between the Motif and Windows GUIs.

For those users, there's Liken, a Mac-on-Unix emulator from Andataco (San Diego, CA). Liken strives to preserve the Mac's distinctive look and feel. It runs the Finder within an X window on the Unix desktop, and the Mac session works like a Mac in almost every respect. You can even launch multiple Mac sessions in their own independent X windows.

Liken takes a broad approach to API translation. First, it takes advantage of the fact that before System 7, Apple freely distributed copies of its system software through users groups, BBSes, Internet FTP sites, and other sources. Thus, Liken requires a copy of System 6.

However, large chunks of the Mac OS are also located in ROM, and you can't just plug Mac ROMs into a Unix workstation. So about 1500 ROM-based Toolbox routines were rewritten with more than 90,000 lines of code, mostly in C. Those routines include all or parts of the Mac's HFS, boot-up procedures, Resource Manager, and Font Manager.

Toolbox calls that aren't critical to look and feel are mapped to underlying routines in Unix's CLib and X's XLib. There is also a 68000 emulation engine that handles applications and parts of the Mac OS that Andataco didn't rewrite. As a result, Andataco says Liken runs as fast as a low-end Mac Quadra on a Sun SparcStation 10 and as fast as a high-end Mac Quadra on Hewlett-Packard's best PA-RISC box.

Preserving original look and feel was also a key goal of SunSelect's Wabi, a Windows-on-Unix emulator. Wabi has a 386/486 emulation engine to execute non-API code, plus a library of work-alike Win16 routines that bypass Motif. Thus, a Windows application retains its normal attributes under Wabi. Hundreds of those work-alike calls that don't affect look and feel are mapped to corresponding routines in CLib and XLib, letting some Windows operations run faster under Wabi than they do on native PCs.

To demonstrate this, SunSelect ran the Texas Instruments WinTach 1.2 benchmark program on two identical 50-MHz 486 PCs, one with Wabi and the other with Windows 3.1. Wabi scored an RPM (relative performance measurement) of 19 versus 12 for Windows, a difference of more than 63 percent. (One RPM equals the performance of a 20-MHz 386.) WinTach is highly API-intensive, so it's a good measure of relative API performance, although not necessarily a good benchmark of overall performance.

One drawback of Wabi is that it does not duplicate the entire Win16 API. Instead, it implements a core API—including some calls undocumented by Microsoft—required by thirteen "certified" Windows applications. Those programs include popular packages from Lotus, Microsoft, Borland, WordPerfect, Corel, Aldus, Software Publishing, and Datastorm. Wabi will run additional programs that aren't certified, but the results are unpredictable.

Wabi also doesn't include the Windows desktop (i.e., Program Manager and File Manager), although it can run PROGMAN.EXE and FILEMAN.EXE if you have a copy of Windows. SunSelect expects most Wabi users to manage files from their Unix desktops. Also missing from Wabi 1.0 are multimedia extensions, sound (except for simple beeps), and PC networking.

"Official" Emulators

Third-party products like Wabi, Equal, and Liken are prodding the operating-system vendors into action. Microsoft and Apple want to ensure that their competing operating systems will spread to non-native platforms on officially sanctioned emulators. Microsoft is largely delegating the job to Insignia Solutions, while Apple is readying its own emulation technology.

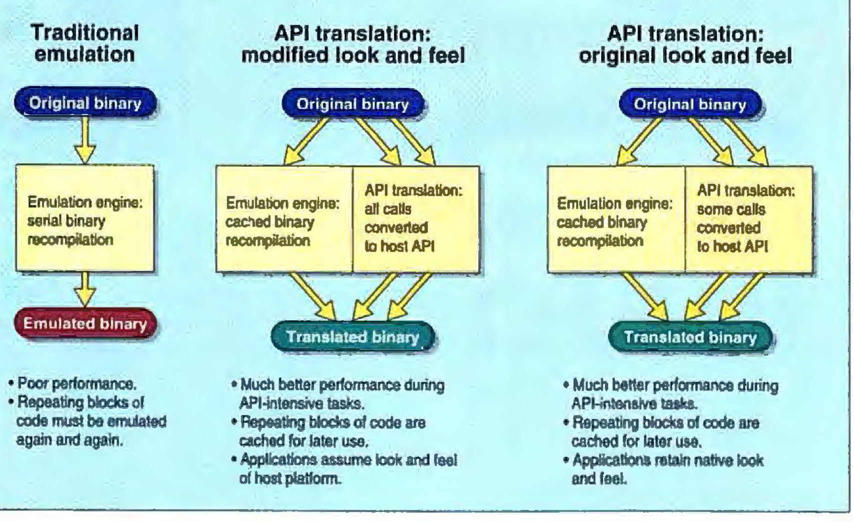
All this neatly dovetails with the cross-platform strategies of Microsoft and Apple. Windows NT is already spreading the Windows GUI to different CPU platforms—including DEC Alpha, Mips R4000, and PowerPC—with integral 80x86 emulation. Apple is working on Mac emulation for Unix and has decided, for the first time, to openly license the Mac operating system to PowerPC clone makers (see "Apple Opens the Mac OS" on page 24).

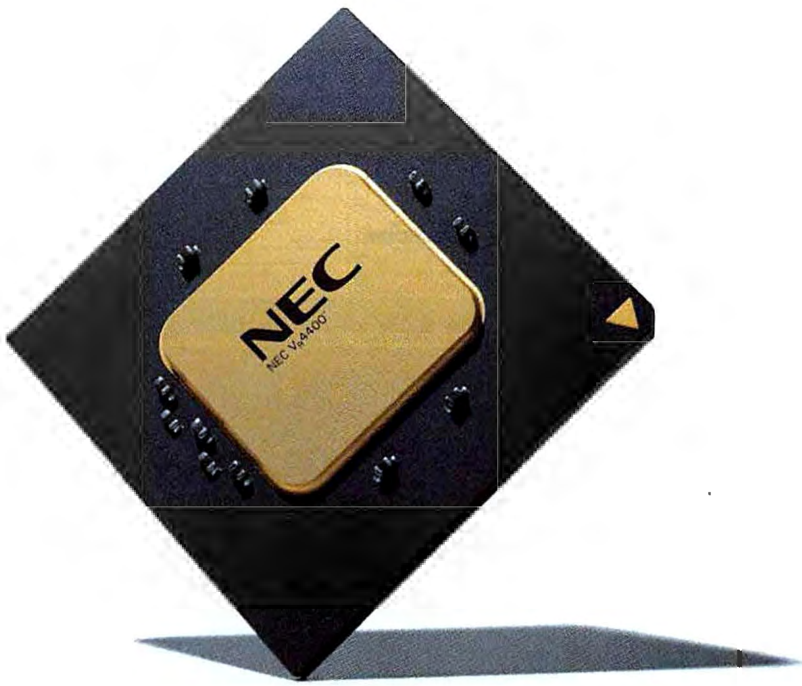
Microsoft wasted no time making its intentions clear. No sooner had SunSelect announced Wabi than Microsoft stole some of the thunder by revealing it had licensed the Windows API source code to Insignia. Insignia was already a major force in the emulation market, thanks to its SoftPC series of DOS and Windows emulators for Unix and the Mac. But SoftPC relies heavily on instruction-level emulation, and its performance is snail-like on all but the fastest machines. With access to Windows source code, Insignia can port or translate the API to run at native speeds on any RISC platform. Another bonus is that Insignia can ship its product with the latest versions of MS-DOS and Windows.

The result is Insignia's SoftWindows, the successor to SoftPC. SoftWindows began shipping late last year for some Unix workstations and debuted in March on the new Power Macs. Its performance approximates the feel of a fast 386 or a low-end 486, depending on the speed of the host CPU (see "Windows on RISC" on page 109). Naturally, SoftWindows does much better on API-intensive tasks, because those calls can either run natively or be mapped to host API routines that don't alter the look and feel of Windows. Non-API code is pumped through the same 80x86 emulation engine that's found in SoftPC.

Access to the Windows API source code isn't a magic bullet, however. Insignia

Three Approaches to Emulation





The brains behind Windows NT.™

When Microsoft* went searching for a processor to develop Windows NT,* where did they turn? To the best brains in the business.

The mighty MIPS R4400 RISC microprocessors.

Which isn't surprising, really. The NEC V_R4400* 150MHz MIPS processor is already at the heart of the most powerful workstations in the world.

And now, thanks to Windows NT, the same 64-bit brain that powers these machines can be right on your desk. Manipulating spreadsheets. Processing data. And, perhaps, even changing the course of history.

The reason Microsoft chose the MIPS RISC architecture is simple—raw, unadulterated speed. In fact, NEC's V_R4400 runs Windows NT almost twice as fast as Pentium,* and nearly four times as fast as the 486* DX2/66.*

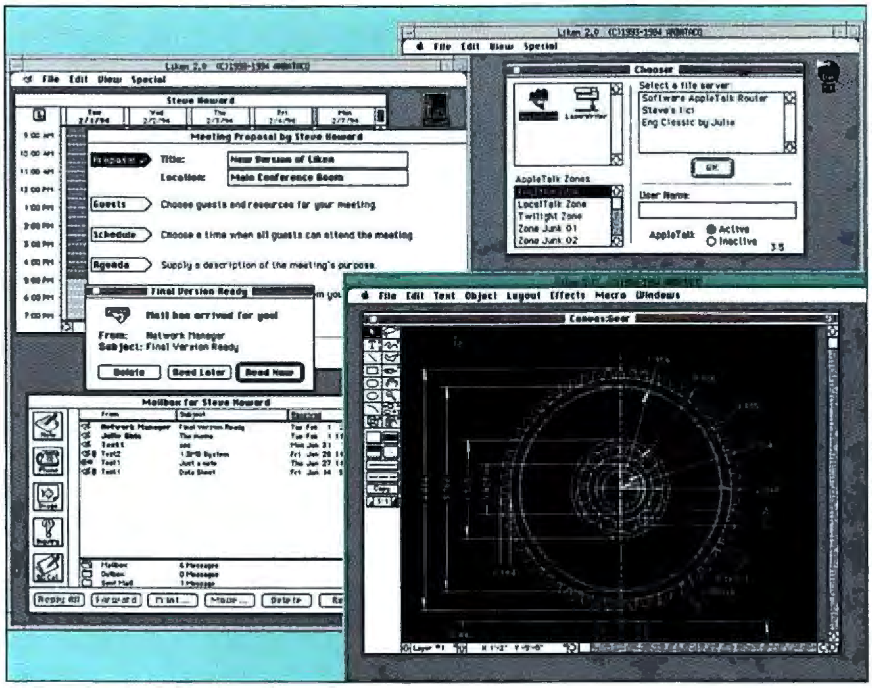
So before you buy a computer to run Windows NT, think about what's inside. After all, it only makes sense to choose the quickest processor that processed the program.

If you're responsible for evaluating new PCs running Windows NT, look for the new V_R4400-based systems. They run faster, save you money and even let you use your existing DOS and Windows 3.1 applications.

If you want to discover more about our V_R-Series* microprocessors, and to receive a list of systems vendors shipping V_R-Series based PCs, please call NEC Electronics Inc. at 1-800-366-9782. Or fax us at 1-800-729-9288 and ask for Info Pack #167. For information on NEC MIPS-based PCs, call NEC Technologies, Inc. at 1-800-NEC-INFO.

NEC

Circle 278 on Inquiry Card.



Andataco's Liken runs the *Mac Finder within an X window under Unix.*

faces a challenge similar to Apple's port of the Toolbox to the PowerPC—and for many of the same reasons. Both the Win16 libraries and the Toolbox trace their lineage back a decade or more, which means there's lots of old code written in mixed languages by long-gone programmers. The most recent parts of both are written in C, but older chunks were written in Pascal, and the most critical routines were hand-coded in assembly language. The assembly routines tend to be highly optimized, resorting to every trick in the book, including self-modifying code. And, of course, the documentation for this old code ranges from adequate to hopeless.

As with Apple's port of the Toolbox, therefore, Insignia's port of the Win16 API is not entirely native in the first release. In fact, much of Win16 in SoftWindows is emulated in the usual way. Porting this code (or remapping it to the host API) is an ongoing effort that over time promises to reap even greater gains in speed.

Insignia is also revamping its core emulation engine, which currently simulates an Intel 286/287. SoftWindows can't run some programs that require 386 instructions (e.g., Borland's Paradox for Windows) or Windows 3.1 in enhanced mode. Without enhanced mode, you can't have a virtual memory swap file, so you must allocate more RAM to run major Windows applications. For Power Macs, Insignia recommends allocating a total of 12 MB to SoftWindows: 5 MB for the emulator itself, 4 MB of simulated extended or expanded PC memory, and 3 MB for a special cache. Insignia hopes to have a 486 emulation engine ready this summer.

Meanwhile, Apple is pursuing Mac emulation on Unix. Because the Toolbox is about three times larger than Win16, it's much more difficult to port. The longtime absence of Mac clones has as much to do with the scale of this project as with the aggressiveness of Apple's lawyers. The closest attempt to date is a hybrid operating system from NuTek U.S.A. (Cupertino, CA) that duplicates most of the function, but not the look and feel, of the Mac OS. NuTek remaps the Toolbox to a 680x0 version of Motif.

Apple wants to preserve the Mac's look and feel while running a Mac session in an X window—much as Andataco's Liken does, but with full support for System 7 and its latest extensions. Now that System 7 is up and running on the PowerPC chip, Apple is retooling it for Unix under the name Macintosh Application Services.

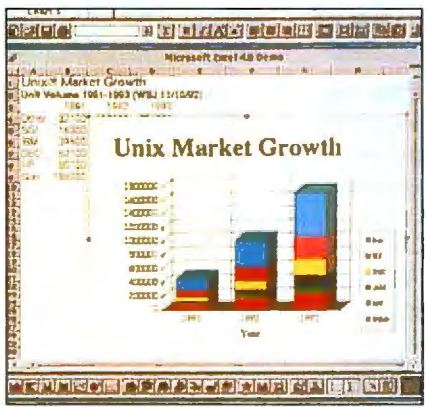
MAS is an optional layer that will ride atop future Unix operating systems certified by the PowerOpen Association (Burlington, MA). It supports a fully functional System 7 session in an X window and runs both 680x0-based and PowerPC-based Mac software.

In addition, on March 14, Apple introduced a new Mac-on-Unix emulator called the Macintosh Application Environment. MAE brings a full implementation of System 7 to Sun SparcStations running Solaris 2.3 and HP Series 700 workstations running HP/UX 9.0. As with MAS, MAE floats in an X window on the Motif or Open Look desktop. Some Toolbox calls are mapped to XLib and CLib for near-native performance, without sacrificing the Mac's look and feel. Unlike MAS, however, MAE 1.0 runs only 680x0-based Mac software, not the latest PowerPC-based applications.

Emulation Engines

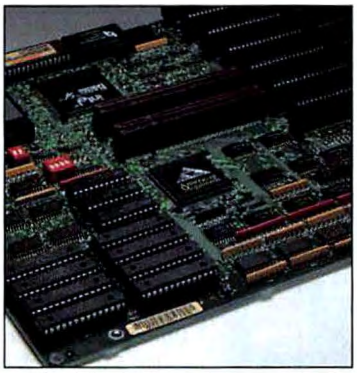
API translation yields a quantum leap in performance but still isn't enough. Even the most API-intensive program spends time executing binary code that can't be mapped to high-level libraries. Handling that code requires an emulation engine to translate the program's native binary instructions into corresponding instructions on the host CPU. The emulation engine also has to simulate all the other functions of the original processor—registers, interrupts, status flags, privileged modes, and so on—plus other differences between the two platforms (e.g., absolute memory addresses referenced by programs).

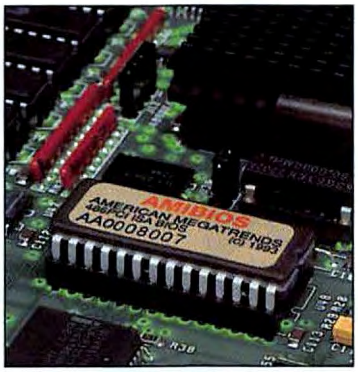
This is where emulators have historically bogged down in performance. One problem is that different microprocessors have different instruction sets, so translation isn't straightforward. Sometimes it takes dozens of instructions to duplicate the function of a single original instruction. Microprocessors also have widely varying arrangements of registers, status flags, and interrupt mechanisms. All these

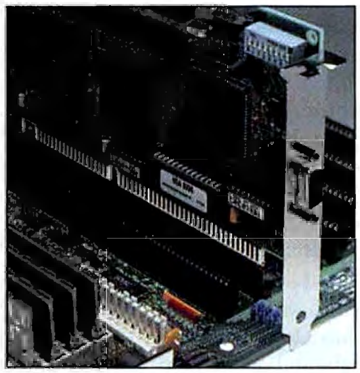


The Equal Application Adapter *from Quorum runs Mac applications under Motif or Open Look, losing the Mac look and feel.*

Experience the Difference



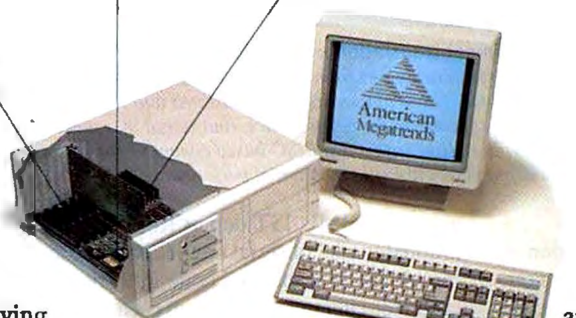




MOTHERBOARDS
PCI, VESA, EISA, ISA
486 and Pentium™ CPUs

BIOS PRODUCTS
Green PC, System BIOS,
Keyboard, PCMCIA, PCI

ADD-IN PRODUCTS
SCSI, Sound, SVGA
Communications, PCMCIA



Whether you are building or buying a PC, the only components to consider are those from American Megatrends, the BIOS people known for their world famous AMIBIOS. Now, with hardware, you can get the same compatibility and performance that has made the AMIBIOS world famous. With high quality motherboards and add-in products from American Megatrends, you can make the difference between an ordinary PC and an outstanding personal computer. So experience the dramatic difference our expertise can make and demand only quality American Megatrends components in your personal computer.

American Megatrends

THE DIFFERENCE WITHIN

American Megatrends

American Megatrends, Inc.: 6145-F Northbelt Parkway, Norcross GA 30071
Sales: 1-800-892-6843, Fax: (404) 263-9381, Fax-Back: (404) 246-8787
UK Office: Crawley, West Sussex - (44) 293-536-365
France Office: Noisy Le Grand - (33)-1-43042220
Singapore Office: Singapore - (65) 339-0992

Circle 258 on Inquiry Card (RESELLERS: 259).

differences can be resolved by writing more emulation code, but the overhead soon becomes prohibitive.

Another problem is that straight emulation works much like an interpreted programming language. Incoming binary instructions are translated serially, and repeating sequences of code have to be translated again and again. For example, consider how the QuickBasic interpreter that comes with MS-DOS would handle the following simple loop:

```
For Loop = 1 To 100
Print "Hello"
Next Loop
```

This code fragment prints `Hello` on the screen 100 times, and for each pass through the loop, QuickBasic must interpret the `Print` instruction all over again. A traditional emulator has the same limitation when it's translating repeated sequences of binary code.

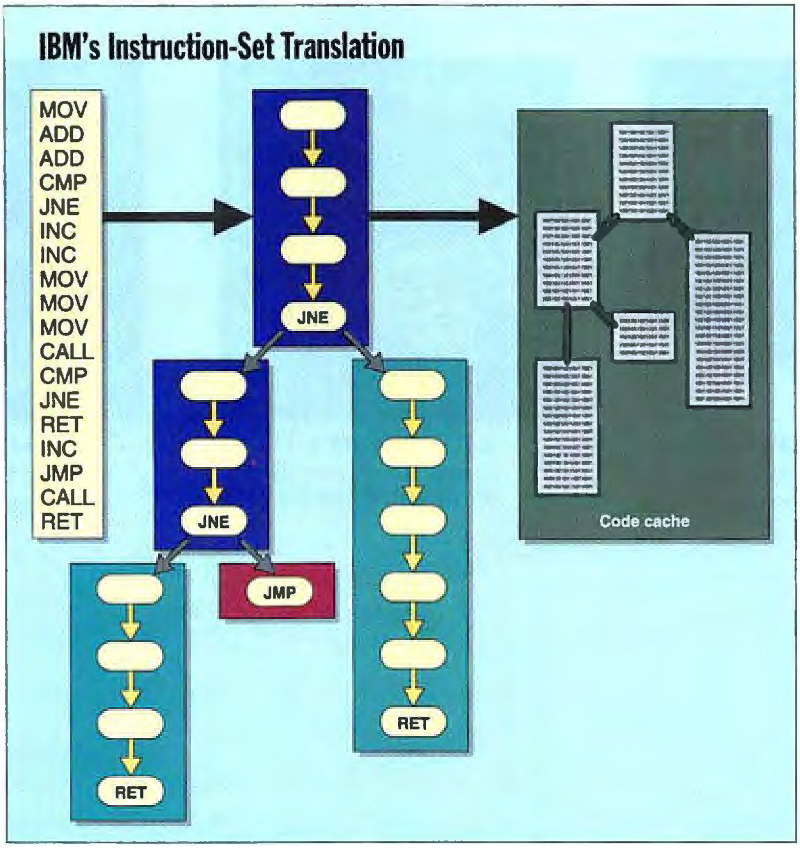
To attack these problems, emulation architects are increasingly turning to compiler technology. An emulation engine, after all, is essentially a code generator, like the back end of a high-level language compiler. The main differences are that a compiler has the advantage of working from source code instead of binary code, and it doesn't have to build its binary while simultaneously executing the code. Compilers are free to make multiple passes through the source code, carefully resolving branches and address offsets. An emulator has to translate and execute a stream of binary code on the fly.

Again, the unprecedented speed of today's advanced microprocessors is coming to the rescue. On-the-fly compilation techniques that were unthinkable a few years ago are now being adapted to emulation engines. Insignia Solutions and IBM are at the forefront of this technology.

Both companies are taking similar approaches. Insignia's SoftPC emulation engine and IBM's IST depart from the traditional model of serial emulation by storing blocks of translated code in a special cache for later execution. Both caches have mechanisms for discarding blocks of code that aren't needed anymore, making room for new blocks.

Consider the QuickBasic example above. Instead of laboriously translating `Print "Hello"` 100 times, Insignia's emulator would notice that the code fragment is within a loop. After translating the fragment the first time, it would store the recompiled binary in the cache. On subsequent passes through the loop, the emulator would hit the cache, thus eliminating the overhead of retranslating that piece of code. This technique yields big gains in performance.

Insignia refers to its cache as the delta cache. When running SoftWindows with the recommended 12 MB of RAM, the delta cache is 3 MB. Allocating more than 3 MB yields diminishing returns, although it's difficult to measure, because it partly depends on the instruction mix of the emulated program.



IBM's instruction-set translation *technology works like on-the-fly compilation. The stream of Intel 80x86 instructions from the application is first analyzed and divided into logical blocks of code. Those blocks are then translated into RISC code for the host platform, "wired" together in proper sequence, and stored in a special memory cache for subsequent execution. IBM says a fast RISC-based computer can carry out all these operations without perceptible degradation of performance.*

IBM appears to be pushing the caching technique even further. The IST caches blocks of code whether they are frequently repeated or not and then "wires" the blocks together for execution. It's remarkably like a multiple-pass, optimizing compiler.

In a process that's called *discovery*, the IST analyzes the original binary to construct a *directed graph* representing the program's flow of execution. In concept, the directed graph is like a flowchart, with each series of related instructions divided into *basic blocks*. Typically, the basic blocks are delineated by branches, jumps, calls, returns, and other instructions that redirect program flow. However, if a jump or call references a target address within 256 bytes, it falls within a basic block and discovery continues.

In any case, the build of the directed graph stops when the number of instructions hits an arbitrary limit that balances the benefit of deeper analysis against additional overhead. Larger blocks might be desirable for optimization, but they would take too long to create.

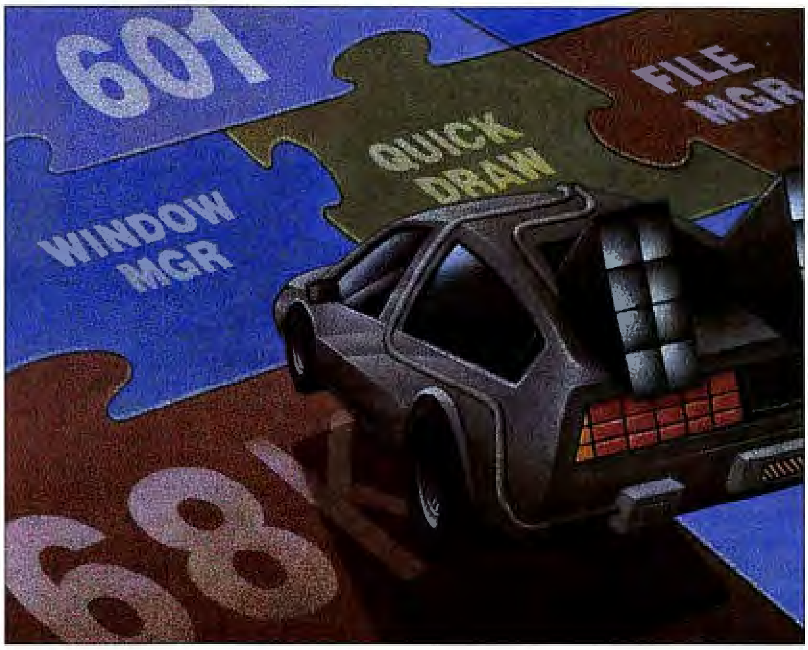
In the next step, *analysis*, the IST optimizes the code while translating it. In some cases, it might fold two or more 80x86 instructions into a single instruction on the target CPU. In other cases, the IST is intelligent enough to recognize frequently repeated pairs or triplets of 80x86 instructions, such as CMP (compare) followed by JNE (jump if not equal). These common sequences—or *idioms*—are quickly translated into their RISC equivalents.

Another optimization eliminates redundant CPU condition states. For example, if a series of ADD instructions that repeatedly set the 80x86 carry flag are followed by a CMP instruction that generates all new condition codes, there is no need to simulate and track the condition-code

UNDER THE HOOD

The Power Mac's Run-Time Architecture

RANDY THELEN



JOHN PATRICK © 1994

If you put a 680x0-based Mac Quadra 800 next to a new PowerPC-based Power Macintosh 8100/80, you might think they were identical except for the nameplates. Glancing at the screens wouldn't help, since the menus, icons, and windows are exactly the same. The applications also look the same; in fact, you could install the same ones on both machines. But if you used both computers for a few minutes, one difference would jump out at you: The Power Macintosh is distinctly faster.

This is just what Apple's software engineers planned. Power Macintoshes maintain 100 percent compatibility with existing Macintosh software. This was accomplished through PowerPC implementations of the Macintosh API, a 68LC040 emulator, a new Mixed Mode Manager, and modifications to the Process Manager. (A *Manager* is a set of related functions that work with a given series of data structures. The Process Manager has routines that manage processes. A *process* is a running application.)

However, backward compatibility wasn't the only goal of the Power Macintosh's operating-system design. While support for existing applications is crucial, the system software was also engineered to support future developments, where powerful new applications will take full advantage of the PowerPC's speed.

In this discussion, I'll take a look at how Apple achieved these two contradictory goals. I will concentrate on the new portions of the design where appropriate, since much of the compatibility issues are covered elsewhere in this issue (see "Emulation: RISC's Secret Weapon" on page 119).

Application Structures

I'll start by examining the structure of an existing 680x0 application. (From this point on, I'll use the term *68K* to denote any of the 680x0 processors.) Macintosh files are composed of two structures called *forks*. Each file has a data fork and a resource fork.

Physically, there's no difference between these two types of forks. They're just streams of bytes located somewhere on disk. However, the Mac OS treats them differently. A file's data fork contains data—typically the output from an application, such as text from a word processor or numbers from a spreadsheet. A file's resource fork contains information on the file's creator (this is how the Mac OS knows what application to launch when you double-click on a document), the icon that is displayed on the Desktop, and other information.

An integration of PowerPC code and 680x0 code yields compatibility and speed while providing new capabilities

For 68K applications, the resource fork also contains program code. When you double-click on a file icon, the Finder summons the Process Manager to start—or *launch*, in Macintosh parlance—the application. The Process Manager then uses a part of the Mac OS called the Segment Loader to read the code resources from this fork into memory.

The 68K Macintosh application code resources are divided up into *code segments* that the Segment Loader loads into and out of memory. Code segments are typically 32 KB in size, because Mac applications use PC-relative (program counter) instructions. Such instructions are used so that code is address independent and capable of being placed anywhere within scarce physical memory. These segments might be used briefly, purged from memory to make room for other code segments, and then reloaded as necessary into another portion of memory.

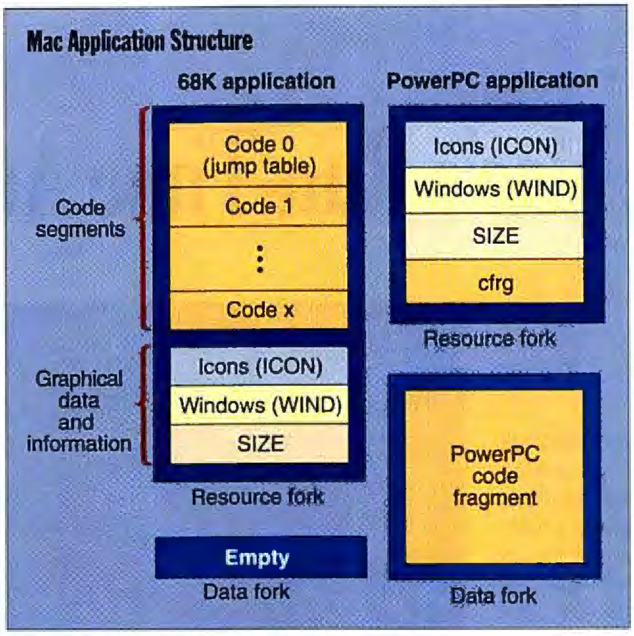
Because the 128-KB Macintosh used a 68000 processor, the offset values of these instructions were limited to 15 bits in size. The sixteenth bit was a sign bit to indicate the direction of the offset (either forward or backward in memory). This limits references to within ±32 KB of the instruction. Subsequent 68K processors had larger offset values, but PC-relative instructions and segments are still being used to implement address-independent code.

The Segment Loader loads code segments on demand as functions within them are called. Essentially, any function call outside of the current code segment is made through a nonpurgeable code block called the *jump table*. If the code block with the called function isn't in memory, its entry in the jump table is actually a call to the Segment Loader. The Segment Loader loads the missing code block into memory and then modifies the corresponding jump-table entry, along with all the jump-table entries associated with that code block.

Instead of acting as calls to the Segment Loader, these jump-table entries have jump instructions to the functions themselves. When the code block is purged from memory (an operation that only the program has control over), the jump-table entries are reset so that they are again calls to the Segment Loader.

The Power Macintoshes use a significantly different design (see the figure "Mac Application Structure"). Applications are a single code fragment (except for imported library functions, which reside in other code fragments). *Code fragments* are the atomic units for libraries and applications in a Power Mac application, and they can be any size.

An entire PowerPC application's code is stored as one continuous unit in a file's data fork. Code fragments can export internal entry points (e.g., a Mac OS function library) and can import entry points of other code fragments (e.g., an application that requires a Mac OS function). The system software is responsible for dynamically linking the entry points of code fragments at run time. As you might expect, the part of the operating system called the CFM (Code Fragment Manager) deals with loading and managing code fragments.



The structure of a 68K Mac *application and a PowerPC Mac application. The program code for the PowerPC Mac (i.e., the code fragments) is located in the data fork of the file, while resources for windows, icons, and controls still reside in the resource fork.*

The process of launching a PowerPC Mac application is similar to that for a 68K Mac application. The Finder hands the job to a slightly modified Process Manager, which calls the CFM to load in a code fragment. From there, the CFM handles the details of dynamic entry-point resolution, which I will cover later.

But on a Power Mac, the Process Manager faces a dilemma when you double-click on a file. How does it know whether to use the Segment Loader or the CFM? The answer is a special cfrg resource that has flags that inform the Process Manager whether the application is a PowerPC application or a "fat binary" (i.e., a combination of PowerPC and 68K code that can run on any Mac). The Process Manager uses this resource to determine whether to use the CFM or the Segment Loader to launch the application. If the Process Manager fails to find this resource, it assumes the application has only 68K code and uses the Segment Loader.

Code Fragments Revealed

While Power Mac applications are single code fragments, they often depend on functions in other code fragments, such as libraries or system software. In fact, portions of the Power Mac ROMs are packaged as code fragments. One of the CFM's jobs is to resolve all dependencies of a given code fragment after it loads the fragment into memory.

Code fragments exist in two executable formats, XCOFFs and PEFs. XCOFF is IBM's Extended Common Object File Format, while PEF is Apple's Preferred Excecutable Format. Here I will focus on the PEF file structure. A PEF is a container of code, data, and loader information. The PEF container is the code fragment itself, and the loader information spells out imported functions and data, exported functions and data, and version information.

To see how this all fits together, consider the example of when the CFM launches a Power Macintosh application. It first loads and locks the given code fragment into memory. The CFM then searches through the import portion of the PEF container to obtain a list of all the libraries that the application depends on. Iterating through the list of dependencies, the CFM builds a list of all entry points into each code fragment that the application needs. The CFM loads each fragment required by the application. This process is recursive.

Once a fragment that has no other dependencies is loaded, its globals and statics are built within the application heap. Then the recursive function of loading fragments is unraveled via a two-step process. First, each dependent fragment receives the addresses of the entry points into the fragments that they use. Then the dependent fragment's globals are created.

A concrete example of this is where application code fragment A depends on code fragment M, which in turn depends on fragment X. The Process Manager first allocates a heap space for application A. Next, code fragment A is loaded by the CFM. (Note that the code fragment might not be loaded into the application heap space, as is the case with 68K applications.) Then fragment M is loaded, followed by fragment X.

The CFM, knowing that X doesn't rely on other libraries, creates X's globals within A's heap space. Then the CFM preinitializes M's jump table with the addresses of all entry points within X that M is dependent on (i.e., addresses of functions, procedures, gobal data structures,

A STAR IS BORN.

Samtron SC-428UXL 14" High Resolution (75Hz) Color Monitor

- *Multi-Scan*
- *1,024 x 768 (75 Hz) High Resolution*
- *Super Fine 0.28 Dot Pitch*
- *Digital Controls*
- *Power Saving*
- *VGA, SVGA, XGA VESA Compatible*
- *Flicker-Free*
- *Low Emission, MPR II*
- *Non-Interlaced*
- *3-year Limited Warranty*

Starpower. It is a quality that makes some shine brighter than others. It is a word reserved for describing those who lead their peers. It is what symbolizes Samtron's commitment to building monitors that incorporate leading-edge technology with the reliability necessary to meet the demands of day-to-day use. ★ Samtron now introduces the new SC-428UXL 14" Color Monitor, the first of the new StarPower™ line. Designed for users of Windows™ and other leading business applications, it features 1,024 x 768 (75 Hz) High Resolution, Digital Controls, Power Saving, and Low Emission Protection. Like other Samtron Color Monitors, it is VGA, SVGA and VESA compatible, as well as complying to the United States EPA Energy Star™ standards. ★ Thousands of users depend upon Samtron monitors because of their accuracy, reliability, and value. Samtron's new SC-428UXL will make you a star. Call your Reseller today.

SAMTRON.
MONITORS WITH STARPOWER™

SAMTRON DISPLAY, INC. 14251 E. FIRESTONE BLVD. #101 LA MIRADA, CA 90638 TEL: 310 802-8425 FAX: 310 802-8820 CUSTOMER SERVICE: TEL: (800) SAMTRON. DISTRIBUTORS: CANADA, TEL: (416) 858-3000 MEXICO, TEL: 011-525-325-0993

The EPA Energy Star™ emblem does not represent EPA endorsement of any product or service. Specifications subject to change without notice. VGA is a trademark of International Business Machines Co., Ltd. Windows is a trademark of Microsoft Corp. Screen is simulated. 3-year Limited Warranty: 3 years parts, 2 years labor.

Circle 280 on Inquiry Card.

and other global variables). Then, M's global variables are created. Finally, A is preinitialized with the entry points and addresses of M. Then A's own global variables are built by the CFM. Finally, A's `main()` function is called, which begins program execution.

Statics and Globals

A critical part of the Power Macintosh's application setup is the creation and initialization of a fragment's global variables and data. The CFM gives the code fragments access to global variables, static data, and a jump table through a data structure called the Table of Contents, or TOC. The TOC contains a list of pointers to the various data elements and entry points within the global data space and to other shared libraries to which the code fragment needs access.

After the CFM loads and resolves all of a fragment's dependencies, it prepares and initializes the fragment's globals and statics. First it allocates memory for the globals' data space—which also contains the TOC—within the application's heap space. Shared libraries that are required by an application fragment build their data structures within the application's heap space as well. Then the CFM initializes the pointers within the TOC.

The TOC has three kinds of pointers. They can reference the code fragment's own globals and statics, the globals and statics of another code fragment, or entry points within other code fragments (which is essentially a jump table). See the figure "The Structure of Dynamic Links for Code and Data."

References to globals require two assembly language references to memory. The first retrieves the address of the global, while the second actually gets and sets the global's value. The question that's often asked is, "Why two references?" There are two benefits that code fragments get from using double indirection. First, TOC entries are referenced using a fixed 16-bit offset from a base register. This means that code can have only 32 KB of global data (64 KB if negative offsets could be used). In the double indirection model, code can have 32 KB (or 64 KB) of pointers to data, yielding up to 8192 (or 16,384) individual items, each of which can be any size. A second benefit is that one fragment might wish to access a variable used in another fragment. Double indirection allows this type of memory sharing, since both fragments can have pointers to the same shared location.

Consider in detail how the mechanism for calling another code fragment works. The PowerPC physically has 32 general-purpose registers. One of those registers, which is a pointer to the globals, is known as GPR2 (General Purpose Register 2). It's commonly called the TOC register because it points to the TOC for the currently executing code fragment.

If code fragment A calls a function in code fragment M, what's going to set the TOC register to point to M's globals? The Power Macintosh run-time architecture assigns this responsibility to the caller. In other words, whenever a code fragment executes, it can rely on the TOC to be a valid pointer to its globals (except, perhaps, for some native interrupt handlers).

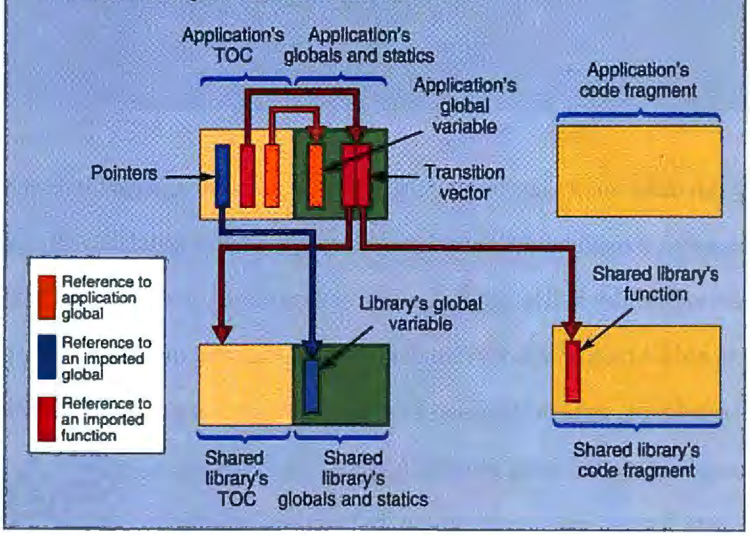
Therefore, the application needs to have not only the address of an entry point into a code fragment, but also the address of that code fragment's globals. This information is stored within the globals' space in a structure called a *transition vector*. This structure contains two elements: the pointer for the target code fragment's TOC, and the entry point of the function being called.

The process of calling another code fragment is called "making a cross-TOC call." The code to perform this must do four things. First, the caller saves the current TOC GPR within the linkage area of the stack. Second, it sets the TOC GPR to point to the called fragment's globals. Then the caller makes the function call. Finally, when execution returns to the original code fragment, the TOC gets reset to point back to the caller's globals, which completes the cross-TOC call.

This dynamic linking strategy works to minimize the copies of various libraries in RAM during concurrent execution of applications that rely on the same libraries. Each application that relies on a library invokes an "instance" of the library. Each instance has its own global variables, unless the library implements a shared global-memory strategy.

One major benefit of this design is that access to global information is significantly easier than was possible with the 68K run-time architecture. Previously, extensions, plug-in modules, and various periodic tasks had to resort to assembly language code to access globals within the operating system or in an application. Now global data access is a characteristic of the Power Macintosh run-time architecture itself; no special programming is required to use information inside another code fragment.

The Structure of Dynamic Links for Code and Data



A PowerPC application *uses a TOC to point to various structures required by the application. The TOC points to the application's own global and static variables, other fragments' globals, and transition vectors that point to the TOC and function-entry points of shared libraries that the application uses.*

Compatibility Components

As mentioned earlier, the Power Macintoshes support existing 68K applications using the Macintosh API, a 68LC040 emulator, and a new Mixed Mode Manager. Macintosh applications rely on the services of system software through published entry points, which are collectively called the Macintosh API.

This API is made up of numerous Managers, including QuickDraw (which handles screen drawing), the Window Manager (which uses QuickDraw to draw windows), and the Font Manager (which handles the display of text in a variety of typefaces and

The boundaries of speed have truly changed. You want the very latest technology to satisfy your ever growing need for more speed. You need ALR's EVOLUTION V family of 60- and 66-MHz Pentium technology-based systems.

ALR bests three other 60MHz Pentium systems

Winstone 94 Version 1.0	
Advanced Logic Research Inc. Evolution V™	82.2
AST®Research Inc. Premmia™ LX P/60	72.6
Compaq® Computer Corp. Deskpro™ 60M	69.2
IBM® ValuePoint™ P60/D	75.9

Longer bar indicates better performance.

Product of intense research and development, the EVOLUTION V family achieves record-breaking performance by expanding the latest advances in microcomputer technology. Unlike other manufacturers, *who rely on retro-fitted 32-bit designs*, we've engineered these systems from the ground up to fully support and enhance this data hungry 64-bit Pentium processor. In fact, with ALR's proprietary QUADFLEX™ architecture, the path between the 512-KB (dual 256-KB) of high-speed cache and main memory is 128-bits wide (dual 64-bits), delivering up to 50% more power than less optimized designs. Even main memory expands to an unheard of 1-gigabyte right on the system board.

ALR is a proud sponsor of the USSS

United States Speed Skiing

Taking system performance and expandability even higher, we've surrounded the optimal processor and memory design with the latest advances in I/O technology. Equipped with up to eight high-speed ISA or ten EISA 32-bit, VESA VL or PCI local bus slots, the ALR EVOLUTION V Series gives you compatibility with the fastest graphic cards, disk controllers, and SCSI adapters available. We've evenintegrated onto the system board, on selected models, local bus IDE with ALR's advanced MULTUS™ controller, PCI SCSI II, as well as high-speed ethernet connectivity.

Limited Time Offer!
FREE LOCAL BUS GRAPHICS*
WITH THE PURCHASE OF ANY ALR EVOLUTION V SERIES SYSTEM CONFIGURED FROM ALR WITH A HARD DRIVE

With security minded chassis that can hold from six to thirteen drives and up to 900 Watts (dual 450 Watts) of fault tolerant power, the ALR EVOLUTION V Series has unmatched expansion capabilities.

And because we engineer and manufacture these systems ourselves, we provide the most comprehensive, 5 year/15 month Warranty along with the first year of on-site service for free*.

Whether you need a high-speed super server, graphics crunching desktop, or powerful mini tower, ALR's EVOLUTION V Series of Pentium processing systems are designed to fit a wide range of applications and budgets.

For the location of an Authorized ALR Power Partner Reseller or for more information, call our toll-free number today;

800-444-4ALR

ALR can be reached on Compuserve -- GOALRINC

ALR

Advanced Logic Research, Inc.
9401 Jeronimo Irvine, CA 92718 (714) 581-6770 FAX: (714) 581-9240

"Speed that's bound to inspire a case of Pentium envy in any user who tries out an Evolution V"

PC World - January 1994

intel inside pentium PROCESSOR

What's next?

January 25, 1994

PC MAGAZINE EDITORS' CHOICE

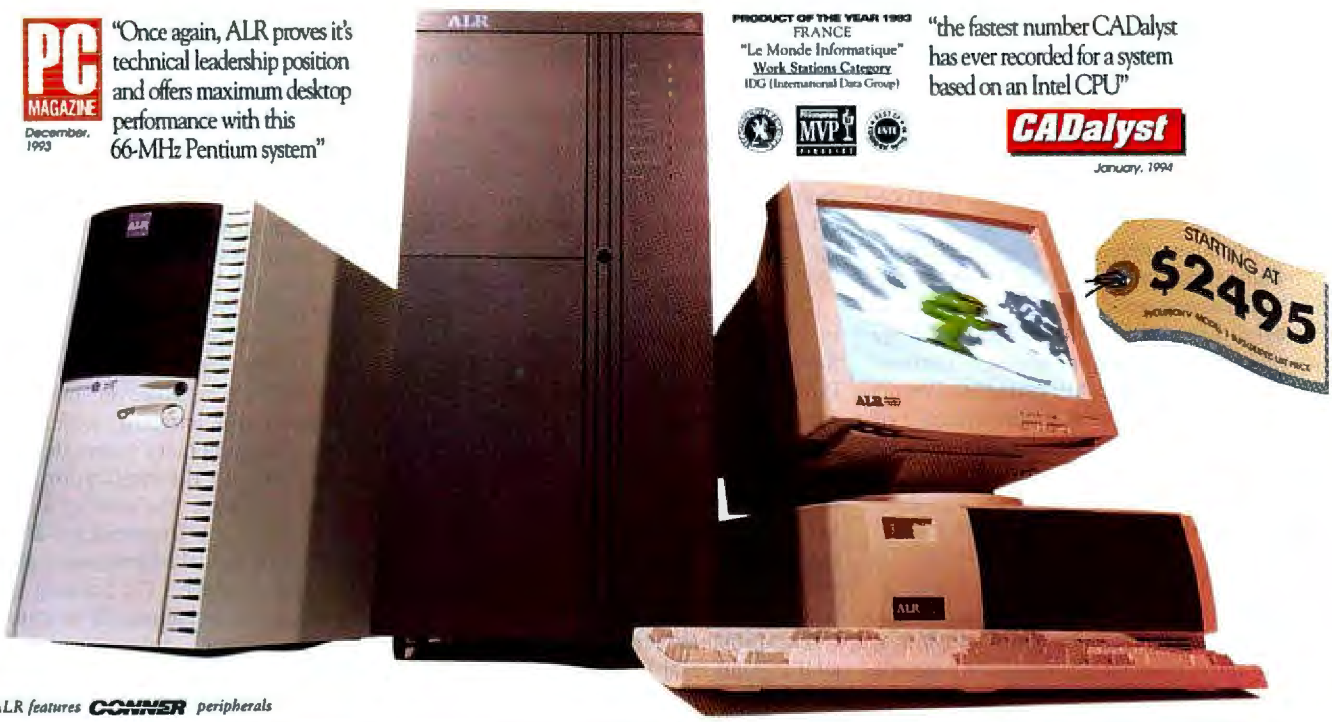
PC MAGAZINE December, 1993

"Once again, ALR proves it's technical leadership position and offers maximum desktop performance with this 66-MHz Pentium system"

PRODUCT OF THE YEAR 1993
FRANCE
"Le Monde Informatique"
Work Stations Category
IDG (International Data Group)

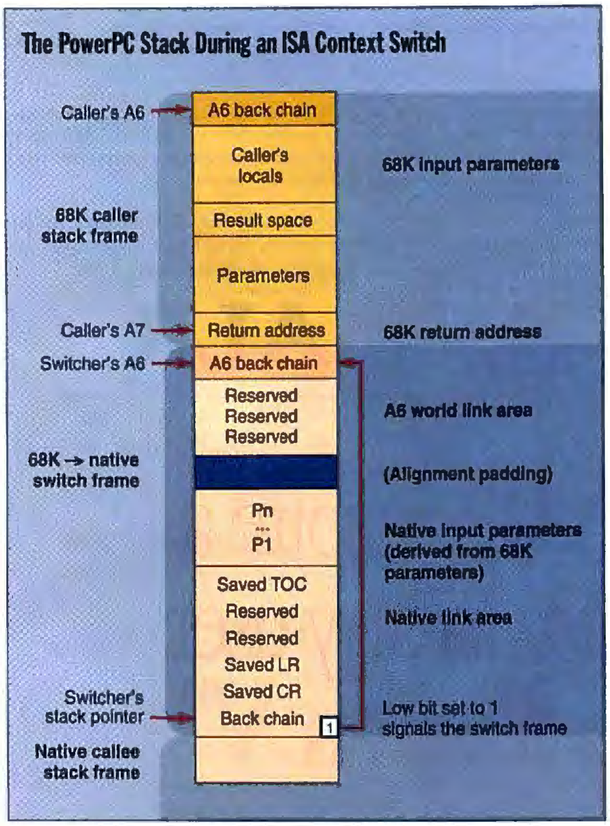
"the fastest number CADalyst has ever recorded for a system based on an Intel CPU"

CADalyst
January, 1994



ALR features CONNER *peripherals*

Circle 257 on Inquiry Card.



The PowerPC stack *during a mode switch. A 68K application calls a PowerPC function, which invokes the Mixed Mode Manager, which in turn uses information in a routine descriptor to build a switch frame. The switch frame contains information about the function to be called, the state of various registers, and the parameters passed to the function. Register A7 is the 68K stack, and A6 is the 68K link register. The 601's Link Register (LR) points to code that cleans up the stack and restarts the emulator.*

styles). The Macintosh API also provides high-level, hardware-independent access to low-level functions, such as sound generation (via the Sound Manager), expansion boards (via the Slot Manager), and serial I/O (via the Communications Toolbox).

Because applications use only these well-defined published entry points, Apple software engineers could replace the code behind the API without requiring huge changes to existing applications. Furthermore, replacing the API code with PowerPC code improves the performance of these applications dramatically because they rely so heavily on API calls.

The 68LC040 emulator deals with those portions of the application code that do not make calls to the Macintosh API. It maintains the stack frames, user and supervisor mode, interrupt handling, and other processor characteristics on which programmers depend. The emulator supports all 68LC040 user-mode instructions. However, it does not emulate either the FPU or the MMU (memory management unit).

The applications that query the system software for the processor type discover that a 68020 is operating. The 68020 is used because this processor marked the greatest expansion of the feature set of the 68K processor line. The 68020 introduced many new user instructions, several addressing modes, and support for a coprocessor. Subsequent processors have become faster, not more complicated.

The Mixed Mode Manager

At any given moment, a Mac application might be running emulated 68K code or executing native PowerPC code when it makes a call to the Macintosh API. This is further complicated by the fact that, in the interest of getting the Power Macintoshes on the market rapidly with a minimum of compatibility problems, the designers did not write all the Macintosh API calls in the PowerPC code.

The new Mixed Mode Manager is at the heart of making disparate PowerPC code and 68K code work together, while providing the benefit of both ISAs (instruction set architectures). It allows functions in the PowerPC ISA to call functions in the 68K ISA and vice versa.

Essentially, the Mixed Mode Manager is a stack-frame transformation engine. Switching between 68K emulation and PowerPC execution is fairly straightforward, while converting a 68K stack into a PowerPC stack can be quite involved. The calling conventions used by the Macintosh 68K model are dependent on the language (Pascal, C, and 68K assembly language each use a different calling convention), while the PowerPC has a unified strategy for all languages.

This problem is resolved by supplying a UPP (Universal Procedure Pointer) for all exported functions. The UPP points directly to 68K code (on a 68K Mac) or to a *routine descriptor* (on a Power Mac). A routine descriptor is a data structure that gives the Mixed Mode Manager the necessary pointers to the actual implementation(s) of the function, either in 68K or PowerPC code. The routine descriptor also provides information on the function's language-calling convention (Pascal, C, or assembly language), the number of arguments used, and their size. This way, the Mixed Mode Manager can determine what ISA to use when jumping to a called function, as well as how to massage the stack parameters if an ISA context switch is involved (see the figure "The PowerPC Stack During an ISA Context Switch").

For calls made to the parts of the Mac API that are written in PowerPC code, the thread of execution proceeds as follows. First, a routine descriptor is encountered, which invokes the Mixed Mode Manager. The Mixed Mode Manager uses the routine descriptor information to place any passed parameters into a switch frame for use by the PowerPC function. The routine descriptor also points to the transition vector, which in turn points to the code fragment's globals and code. The Mixed Mode Manager uses the transition vector to pass control to the target code fragment.

Apple has supplied headers that define UPPs for every Macintosh API function, so porting existing code to a Power Macintosh should be transparent to the programmer. You have to write a UPP only if you are writing a plug-in module, an extension, or a custom procedure. This UPP lets the Mixed Mode Manager know what to expect when functions in your code are called.

Memory Management

By and large, system-level memory management on the Power Macintoshes has not changed from that of 68K Macs. The design decision for this was strongly influenced by the desire to maintain compatibility. There is, however, one major enhancement: *file mapping*, which is essentially virtual memory where the backing-store data for the application is the code fragment itself. Put another way, an application's code fragment on disk is mapped into a logical address space above the backing-store file. (The backing-store file is where virtual memory is written out to disk.)

As other applications run, a background application's variables might be swapped

out to the backing-store file. The only time that code fragments are loaded into memory is when they execute. When the section of memory in which a code fragment resides must be reused, that fragment simply gets purged, because fragments are read-only code: No changes need to be swapped out to the backing store. When necessary, the fragment is read back into memory. This minimizes disk I/O, because the only data actually written to the backing-store file is an application's variables, not the invariant code in the fragment.

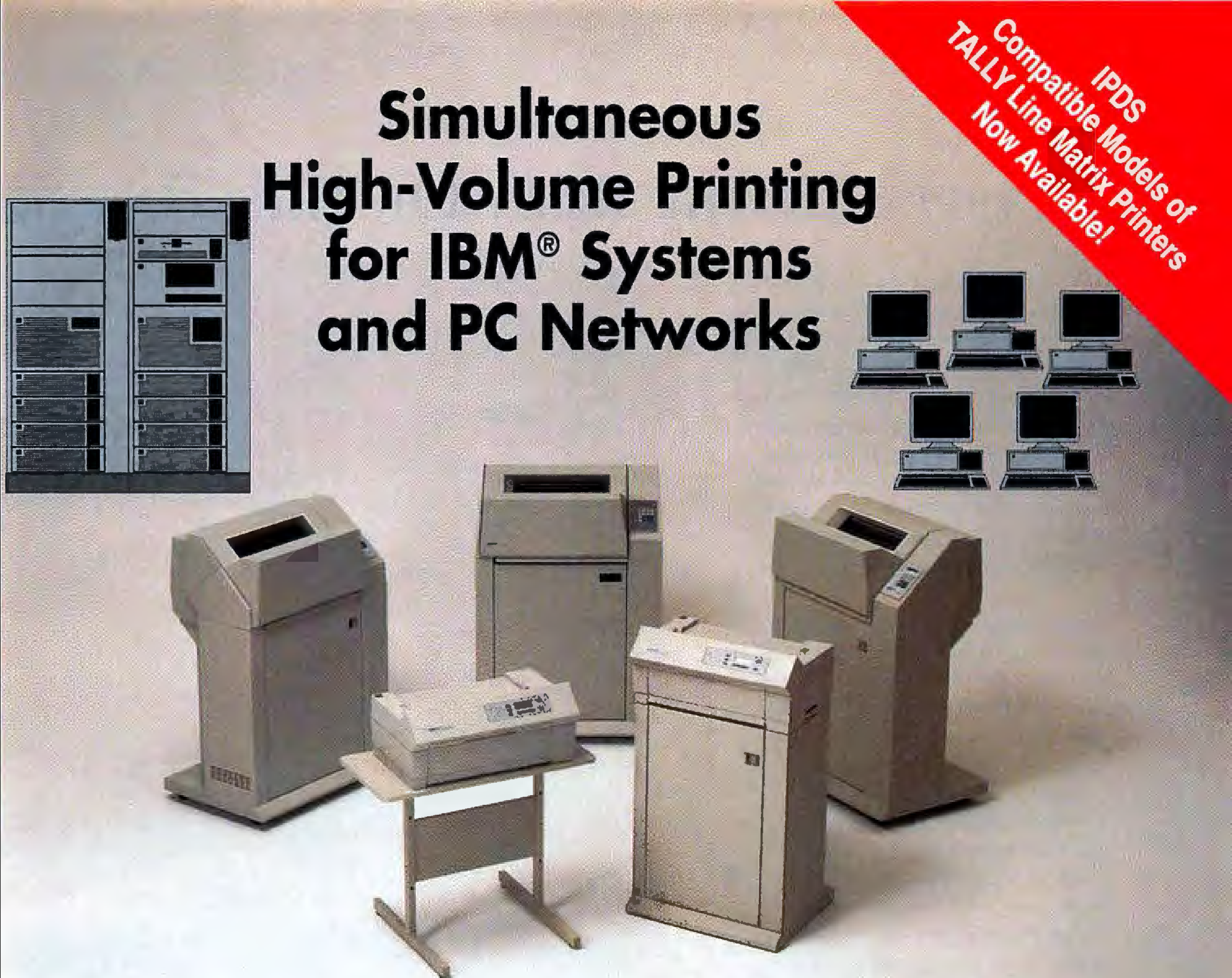
The major benefits of file mapping, besides virtual memory, are that PowerPC-based applications do not consume valuable virtual memory space in the swap file; and application heaps do not need to be so large, because the application code itself is not within the heap. Therefore, a user can run more applications within the same-size virtual memory footprint. The Macintosh 68K segmented application strategy, on the other hand, is not a flat memory model, it supports self-modifying code (e.g., the jump table), and in general it does not lend itself well to file mapping.

Back to the Future

The speed and power of the PowerPC processor has enabled Apple to accomplish what many thought couldn't be done: incorporate a RISC chip into a mainstream consumer product. The 68LC040 emulator allows the existing base of 68K applications to operate with good performance. The Macintosh API provides public entry points that enable existing 68K applications to access system resources. It also taps into the speed offered by the operating-system functions that are written in PowerPC code. The new Mixed Mode Manager seamlessly integrates the two incompatible processor ISAs into one smoothly operating whole.

Nevertheless, this major design improvement is not just for backward compatibility. The new Power Macintosh application run-time architecture is also ready for the time when applications can more easily communicate with one another and share resources. It lays a solid foundation on which a microkernel-based operating system with memory protection, preemptive multitasking, and multiple threads will evolve. ■

Randy Thelen is a system software engineer for Apple Computer (Cupertino, CA). You can reach him on AppleLink as "RANDOM," on the Internet at random@applelink.apple.com, or on BIX c/o "editors."



The ENTERPRISE PRINTERS From Mannesmann Tally

Auto-Switching Support for IBM® Systems and PC Networks (or DEC® Systems): Auto-switching serial & parallel I/O on all models supports local and remote hosts at the same time (Optional: IBM Twinax/Coax & parallel).

Auto-Switching Emulations: The host-selected PC and System printer emulations switch with the interfaces.

	High-Speed Text	Monthly Workload
MT350	112 - 225 lpm* (540 cps)	18,000 pages
MT360	150 - 300 lpm* (720 cps)	22,400 pages
MT645	450 lpm**	80,000 pages
MT661	800 lpm	145,000 pages
MT691	1,400 lpm	250,000 pages

*varies w/column width **lines per minute

Full Speed & Functionality for All Platforms: All of the speed and functionality of Mannesmann Tally printers is maintained in a variety of line printer and dot matrix printer emulations.

POSTNET & Industrial Bar codes: All Enterprise Printers from Mannesmann Tally offer built-in industrial bar code capability and all models print POSTNET bar codes at text speeds. All line matrix models now provide built-in QMS® CODE V™ Version 2 compatibility at no additional cost.

Heavy Forms Printers: Straight paper paths and easy front loading make these printers ideal for high-volume printing of heavy multi-part forms and labels.

To find out more about Mannesmann Tally Enterprise Printers, just call:

1-800-843-1347 Ext.19

MANNESMANN
Tally

Mannesmann Tally Corporation
Kent, Washington

IBM is a registered trademark of International Business Machines Corporation.
QMS is a registered trademark and CODE V is a trademark of QMS, Inc.
DEC is a registered trademark of Digital Equipment Corporation.

Circle 319 on Inquiry Card (RESELLERS: 320).

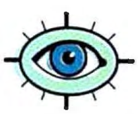
TRAPPED IN THE BODY OF THIS TINY SE

This is a story about a small computer engineered to be so dependable, you wouldn't think twice about trusting it with your mission-critical applications. And to be this without filling a closet, much less a room. If you haven't thought of Compaq as a business-critical platform before, kindly grab your bifocals and begin. (We'll be cramming lots of information into this ad, which only makes sense, given how much we fit into our ProLiant servers.)

If there's one thing we've learned working with our customers, it's that you're running more and more mission-critical applications on your network. And if your network goes down, your business goes down. All of which should give you a better sense of why we built the Compaq ProLiant servers.

ProLiant is our family of affordable, high-performance and easy-to-manage servers engineered specifically to provide the high availability you need for mission-critical networks. We've designed ProLiant in three different models, ranging from a single-processor configuration to a four-Pentium processor model.

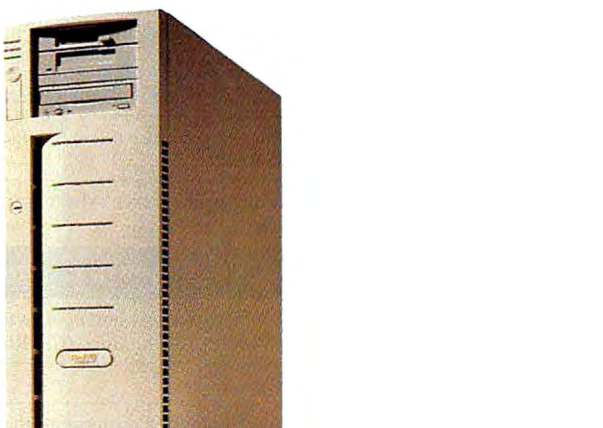
Now, how can you be sure our server is truly a miracle and not a mirage? To begin with, there's Full Spectrum Fault Management, provided by Compaq Insight Manager technology and software that continually monitors over 800 aspects of the server's operating status. (For example, Drive Parameter Tracking checks 15 hard-drive parameters.) All of this information is constantly gathered, analyzed and then used to prevent, tolerate or recover from system problems.



If the performance of a monitored component drops below a specified level, our unique Pre-Failure Warranty kicks in. We'll actually replace a Compaq warranted drive or memory system free. Before it stops working. No downtime. Ringing cash registers. Happy boss.*

Still, no network's perfect. In the unlikely event a problem occurs, our servers exhibit remarkable tolerance. Every ProLiant includes Compaq-designed hot-pluggable drives. ProLiant Models 2000 and 4000 come standard with advanced error-correcting memory and off-line backup processor features (whereby the server reboots automatically to a second processor). And, most notably, the Compaq Smart SCSI Array Controller together with the ProLiant Storage System ensures mission-critical data integrity. Should a network problem bring the server down, the Rapid Recovery Systems of the ProLiant are designed to bring it back up.

ER IS A MAINFRAME WITH AN ATTITUDE.



For example, Automatic Server Recovery 2 uses a historical record of server status and performance to perform an astonishing array of tasks. Like intelligently restarting the server, automatically correcting a variety of problems, and accessing a telephone pager to contact network administrators.

By now you'd expect us to have rethought server setup, configuration and OS installation, but you might be surprised by the results. SmartStart is a CD-ROM system that takes the headache out of getting your server up and running. ProLiant includes a CD-ROM drive and bundled CDs of optimized Netware and other major operating systems. To get hooked up to your network operating system, simply call your dealer for an access code, enter it, answer a few questions, and leave. Minutes later—say, after you've enjoyed a cup of coffee and a jelly donut—you'll return to find an integrated OS fully installed and optimized for increased performance and improved management. And we'll keep you updated via CD when new operating system versions appear.

*And finally, to accompany our new line of mission-critical servers, we're introducing mission-critical support. With ProLiant, we now offer extensive analysis, installation and service through our CompaqCare System Partners, a select group of highly trained systems experts backed by Compaq engineers. You can now choose 4-hour on-site warranty response upgrade** direct from Compaq. Again, there's our unique Pre-Failure Warranty. And, of course, all Compaq servers come with a 3-year on-site† warranty, and 7-day-a-week, 24-hour-a-day technical support.*

All in a surprisingly small box for not a whole lot of money. In fact, a DX2/66 Compaq ProLiant 1000 starts at about $6000‡.

Which may help to explain the look your boss gives you when he hears how much money you've saved: stunned admiration. But you'll get used to that. It goes with the territory. If you'd like to receive model, feature and specification information for the ProLiant servers quickly via fax, that's easily arranged. Just call us at 1-800-345-1518, select our convenient PaqFax option and request document #4003. Or, if you'd like a brief technical overview, we can get that to you even faster. Just turn the page.

COMPAQ

Circle 318 on Inquiry Card.

THE COMPAQ PROLIANT MISSION-CRITICAL SERVERS

	ProLiant 1000	ProLiant 2000	ProLiant 4000
HIGH PERFORMANCE NETWORK SERVERS			
Processor	Intel DX2/66 or Pentium 60MHz	Intel DX2/66 or Pentium 66MHz	Intel DX2/66 or Pentium 66MHz
Architecture	Flex or TriFlex/PC One Processor	TriFlex with up to two symmetric processors	TriFlex with up to four symmetric processors
Network Interface	Up to 12 High-Speed Channels; NetFlex 2 with Packet Blaster Technology Standard		
Standard Disk Controller	Integrated Fast SCSI-2 and Smart SCSI Array Controller (selected models)		
Storage Capacity	550MB–112GB Internal/external	1050MB–140GB Internal/external	1050MB–140GB Internal/external
Typical Usage	Departmental network services—primarily NetWare	Departmental network application services—NetWare, NT and Unix	Application services for preemptive downsizing—NT and Unix
Transaction Rating	50–150 TPS	200–300 TPS	300–400 TPS
Estimated Starting Street Price‡	$6,000	$8,900	$13,900
SERVER DEPENDABILITY AND AVAILABILITY			
Management	Second-generation Compaq Insight Manager (standard) combines with innovative hardware design to constantly monitor, assess and report server health and performance		
Fault Prevention	Insight Manager alerts you to server status changes in over 800 component parameters, allowing proactive server management backed by 3-Year Pre-Failure Warranty		
Fault Tolerance	Standard support for RAID levels 1,4,5; hot-pluggable drives; on-line spare drive; off-line backup processor§; advanced ECC RAM§		
Fault Recovery	Standard rapid recovery services automatically return server to full operational status even in the event of a critical subsystem failure		
SIMPLICITY, EASE OF OWNERSHIP AND SUPPORT			
SmartStart	Standard CD-based intelligent hardware configuration and system software installation, providing simplified server configuration for NetWare, NT or Unix. (CD-ROM drive standard)		
System Warranty	Free Three-Year, On-Site Limited Warranty		
Pre-Failure Warranty	Three-Year, On-Site Warranty replacement of designated components that fall below preestablished thresholds		
4-Hour Warranty Response Upgrade	Optional Three-Year On-Site Warranty upgrade to 4-hour response		
Technical Support	Toll-free, 7 x 24 technical phone support from Compaq engineers		
CompaqCare System Partners	Highly trained, dedicated, third-party professionals who provide systems maintenance and comprehensive technical support		
QuickFind/PaqFax	Proactive notification and delivery of new technical information/7 x 24 fax response for updated specification, configuration and settings data		

COMPAQ

 *Applicable only to advanced ECC memory and disk drives running under Compaq IDA, IDA-2 or SMART SCSI Array controllers. **Fee-based option supported under CompaqCare and not part of the Three-Year On-Site Warranty. † This service provided by Contracted Service Providers and may not be available in certain geographic locations. Certain restrictions and exclusions apply. Monitors, battery packs and certain options are covered by a one-year warranty. For further details on our limited warranty, contact the Compaq Computer Support Center. ‡ Estimated U.S. reseller selling price, actual reseller pricing will vary. § Models 2000 and 4000 only.

Developing for RISC

ALEX LANE

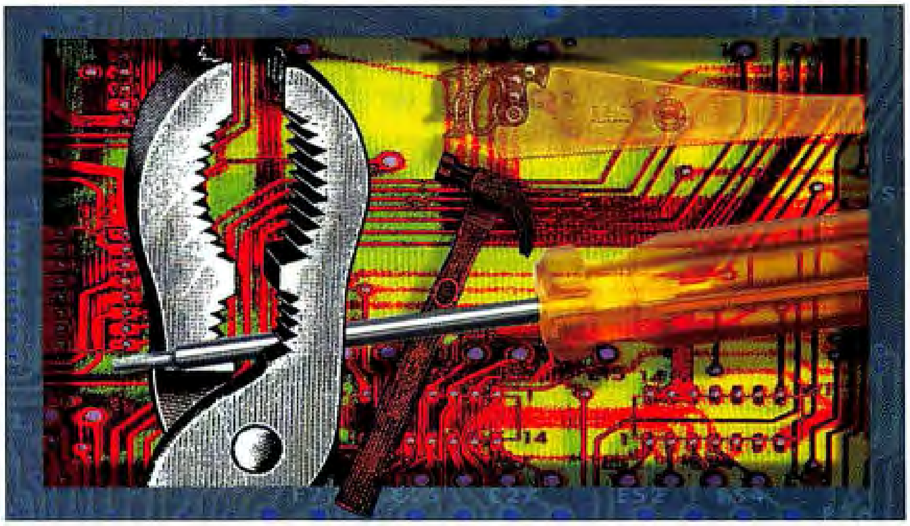


ILLUSTRATION: MARC YANKUS © 1994

RISC processor makers are looking to take on the dominance of Intel and its CISC architecture at the desktop level. To do that, RISC system vendors will have to capture the hearts and minds of the software developers who will create the applications. Several processors—primarily IBM/Apple/Motorola's PowerPC, Mips Technologies' R4x00, Sun Microsystems' SPARC, Hewlett-Packard's PA-RISC, and DEC's Alpha—are competing to become the RISC standard. Consequently, those software developers must choose not only between RISC and CISC, but also which RISC processor.

The key to the success of this effort is the ability to deliver software that solves user problems and takes full advantage of RISC architectures. To create this software, developers need tools. For some RISC platforms such as PA-RISC and SPARC, those tools are readily available. Newer processors such as the PowerPC and the Alpha are not so well endowed at this time.

The various RISC chips are being used in conjunction with several operating systems and environments. Conversely, operating systems have become "multidenominational" platforms that run on a variety of hardware systems. These operating systems include Microsoft's Windows NT, Apple's System 7, and variations of Unix. In addition to AIX, IBM is working to move OS/2 to the PowerPC, with the eventual goal of having every current operating system running on PowerPC-based systems.

The Key to RISC Performance

RISC chips are generally faster than popular CISC processors, such as the Pentium. For software developers, however, clock speed isn't the only quality by which they judge a computer system.

The performance of any given RISC processor is closely tied to compiler and, more precisely, to optimization technology. CISC-oriented compilers from companies such as Microsoft, Borland International, Symantec, and others compete largely on the basis of ease of use and slick development environments—the "front end" of the development task. In the code-generating "back end," processor-independent optimizations are the rule, owing to the complex nature of the instruction set and (prior to the Pentium) the absence of superscalar, pipelined architectures.

Tools for Intel-class processors are easier to use and more plentiful, but RISC tools are beginning to close the gap

In contrast, RISC compilers typically have so-so front ends and rely heavily on processor-dependent optimizations in the back end to squeeze maximum performance from the hardware. Issues such as instruction scheduling, cache management, and register tracking are vital in light of the memory-intensive and pipelined nature of RISC chips and become even more important for superscalar architectures. Proper optimization can improve RISC benchmark results by as much as 50 percent over nonoptimized code, according to Gary Guardia, president of Kuck & Associates (Champaign, IL), a publisher specializing in C and FORTRAN optimizing tools for RISC platforms.

What Kinds of Tools?

Tools for RISC development mirror those used for CISC development. Compilers, interpreters, database development systems, 4GLs (fourth-generation languages), and so on are used to build applications. Applications can't be built without such tools, and applications are the key to the success of a platform such as RISC on the desktop. Of these, compilers are the "core" tool, because all other tools are built using a compiler.

continued

Because RISC performance is dependent on compiler technology, compiler writers often work together with hardware architects on chip design. As a result, it's difficult for outsiders to achieve the depth of knowledge required to write a suitable compiler. That's why companies who sell chips also build RISC compilers specifically for those chips.

Preprocessors (e.g., those from Kuck & Associates), which analyze source code files and rewrite portions of the code before it is passed on to a compiler for compilation, are an important development-tool niche for RISC systems. Kuck & Associates markets C and FORTRAN preprocessors for IBM's POWER (Performance Optimized With Enhanced RISC) architecture, encompassing IBM RS/6000 and PowerPC systems. The preprocessors restructure code and rewrite it so that it takes advantage of the processor's architecture, performing such tasks as loop unrolling, strip mining, and function-code inlining (see "Optimizing for Today's CPUs," February BYTE). Other Kuck preprocessors for C or FORTRAN are available for the DEC Alpha AXP chip in systems running OpenVMS or OSF/1, as well as for the Mips, PA-RISC, and SPARC processors.

Other development tools lever off the core compilers. For example, Harlequin (Cambridge, MA) sells a Common Lisp development environment called LispWorks that is used for writing applications. Although the tool was built by iteratively more sophisticated versions of Lisp (analogous to building a C compiler in C), the original compilation of the bootstrap loader that produced the starting Lisp image was done using vendor-supplied C compilers. LispWorks is available on a variety of RISC platforms, including Alpha (OSF/1), SPARC (Solaris and SunOS), RS/6000 (AIX), Mips (Irix and Ultrix), and PA-RISC (HP-UX), with possible future appearances on NT and PowerPC systems, according to Randy Zeitvogel, a technical consultant at Harlequin.

Another example of a tool that leverages off the core compiler is Cognos's PowerHouse 4GL, an applications development environment with integrated CASE features. Built using DEC compilers, the product is available for Alpha systems running OpenVMS. Cognos is porting the application to OSF/1 owing to a perceived increased interest in DEC's Unix operating system. While low-level effort is needed to do the port, Cognos notes that the overall effort is simpler since the tool does not directly generate executable code. Cognos expects to ship the Unix product in the second half of this year.

> **"We have not bothered to recompile our product for any RISC platform," said Phillip Jain, a manager at WinSoft (Menlo Park, CA), "because the market is too small and too fragmented."**

Windows NT: A Common Thread

One of the factors that is setting the stage for a new generation of RISC-based PCs is the NT operating system. It is available for Mips R4x00–, Alpha AXP–, and 80x86-based systems. It is being ported to the PowerPC and SPARC platforms. Applications that use the Win32 API will be able to run on any of these systems after recompilation with the appropriate tools. This strategy allows developers to preserve their investments in tools and in the time spent learning the API.

Currently, developers can create NT applications for Intel platforms using Microsoft Visual C++ and then recompile them for the RISC platforms using command-line tools found in Microsoft's Win32 SDK (Software Development Kit), including RISC versions of the Microsoft Foundation Classes (MFC 2.0). See the text box "Porting to RISC: Not Just a Recompile" on page 142. Microsoft is committed to delivering its visual tools to the Alpha, Mips, and PowerPC platforms, with delivery of the Mips tool set slated for the first half of this year. Microsoft's MS Test product will also be ported to the RISC NT platforms, although no ship date has yet been announced.

Microsoft's approach appears to work. Doug Hamilton, president of Hamilton Laboratories (Wayland, MA), says that porting the Intel version of the Hamilton C shell product to the Mips version of NT took about a week; most of that time was spent working around compiler differences. Once that port was done, the effort to create an Alpha version of the product took one day—and it ran without debugging.

What's significant here is what Microsoft's competitors in the Intel arena—Borland, Symantec, Watcom, and others—are not doing. Even though they are offering NT compilers for Intel machines, they are not following Microsoft's lead in providing cross-platform tools for RISC-based NT.

The likely reason for this is that the market for RISC is minuscule when compared to Intel processors (see "Intel Pushes the 80x86 Envelope" on page 22). So, while NT offers a fine opportunity to make applications available on multiple platforms, some developers believe that providing tools for RISC systems is not worth the investment. "We have not bothered to recompile our product for any RISC platform," said Phillip Jain, a manager at WinSoft (Menlo Park, CA), "because the market is too small and too fragmented."

For other companies, it's a matter of setting priorities. "Symantec will be focusing first on the high-volume platforms," said Gene Wang, executive vice president for development tools and applications, talking about NT.

Indeed, some RISC architectures may not survive, as was the case with Intergraph's Clipper RISC processor. While working on a port of NT (including a set of tools) for a PC-bus version of a Clipper, Intergraph decided it no longer wanted to be in the microprocessor business. Its chip designers went to Sun to work on the next-generation SPARC processor, and Intergraph is now working on a port of NT for that chip, with a tentative ship date in mid-1995.

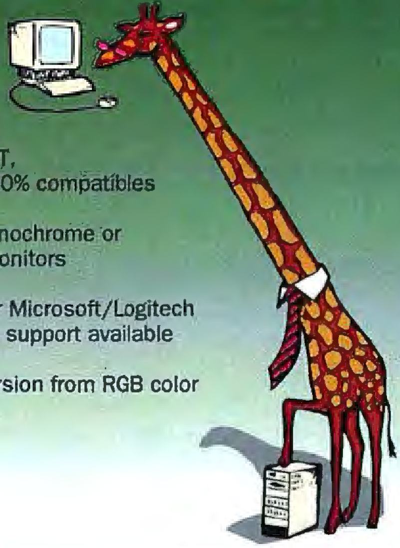
Unix: RISC's Traditional Partner

A strong traditional interrelation exists between Unix and RISC-based systems, due primarily to Unix's portability, which allows it to be implemented relatively easily on any hardware platform. However, this portability is offset by a lack of binary compatibility across systems, as well as by the variation in hardware available to different systems.

A problem developers face with Unix is standards—there are too many of them. Among these are the SVID (System V Interface Definition), Posix, and XPG (X/Open Portability Guide) source-level standards; the COFF and iABI binary standards; the OpenWindows and OSF/Motif graphics standards; and the BSD and Unix System V release 4.0 implementation standards. Further, a number of standards are

PC-EXTENDER *Plus*™

Extend the distance between your PC and a keyboard, VGA monitor, and mouse up to 250 feet!



- Supports PC, PC/XT, PC/AT, PS/2 and 100% compatibles
- Supports monochrome or color VGA monitors
- PS/2 style or Microsoft/Logitech serial mouse support available
- Offers conversion from RGB color to gray-scale

PC-COMPANION *Plus*™

Add a second keyboard, monitor and mouse to your PC up to 250 feet away!

- Supports PC/AT, PS/2 and 100% compatibles
- Combine monochrome and color VGA monitors
- Mouse support available at both local and remote workstations
- Switch selectable privacy mode

Announcing Macintosh Support!

Open up a new world of applications for your Macintosh! The new Mediator™ for Macintosh allows you to connect any of these PS/2 compatible Cybex products or PS/2 peripherals to your Macintosh computer.

PC-EXPANDER *Plus*™

Add up to 7 keyboards, monitors and mice to your PC up to 250 feet away!

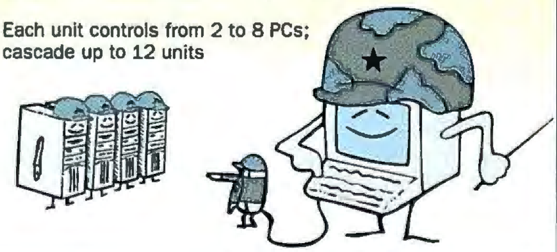
- Supports PC/AT, PS/2 and 100% compatibles
- Microsoft and Logitech serial mouse support available at all workstations

- Selectable privacy modes
- Automatic keyboard and mouse switching

AutoBoot Commander™

Control up to 96 file servers with just 1 keyboard, monitor and mouse!

- Supports all 100% IBM compatible computers
- AutoBoot™ feature boots computers without user intervention
- New KeyScan™ feature for keyboard-controlled scanning
- Jumperless support for analog (VGA) and TTL video
- Add a second control center up to 150 feet away
- Each unit controls from 2 to 8 PCs; cascade up to 12 units



Cybex Corporation
4912 Research Drive Huntsville, AL 35805 USA
(205) 430-4000 (205) 430-4030 fax

CYBEX™

Circle 260 on Inquiry Card (RESELLERS: 261).

enhanced with proprietary extensions by different vendors.

There is no dearth of tools for Unix developers, but no software giants such as Microsoft are selling (cross-platform) Unix tools, either. Consequently, many developers use the compilers that come bundled with the hardware. Other developers use the GNU suite of tools, simply because the source code is available and the tools are free and available via the Internet for virtually every processor. GNU is a project of the Free Software Foundation. Still others purchase tools from third parties such as MetaWare (Santa Cruz, CA). Overall, there are over 300 compiler and language products and programming tools and utilities available for the Unix platform.

Unix initiatives such as PowerOpen—an idea initially backed by Apple, IBM, and Motorola and now a consortium with more

Porting to RISC: Not Just a Recompile

ED PERRATORE

The list of developers porting desktop applications from Intel and Mac systems to RISC-based platforms is growing at a rapid clip. Microsoft's Windows NT is the main driving force, owing to the clear field left by its competitors. Desktop flavors of Unix have yet to earn widespread confidence. IBM's Workplace OS remains in development. And while a number of ISVs (independent software vendors) intend to formally announce ported Mac applications the day Apple announces its PowerPC Mac, a native development environment has been slow in coming.

NT also has in its favor the single Win32 API, which leaves the door open for vendors who develop first for Chicago. But despite Microsoft's success at promoting NT as the platform of choice across systems such as Mips Technologies' Mips R4400, DEC's Alpha AXP and, soon, the IBM/Apple/Motorola PowerPC, for some ISVs the road to RISC is not without its potholes.

When Mips helped Cadkey (Windsor, CT) port Cadkey to NT on Mips in only 10 days on the heels of Spring Comdex 1993, it was a revelation for the vendor, which previously sweated to release Unix versions of its 3-D CAD software 30 to 60 days after the DOS version shipped. After exhibiting at the Microsoft OEM booth, relates senior vice president George Krucik, "We said to ourselves, 'Why are we doing Unix ports? Why are we spending two to four months suffering the pains of not being able to release our product on multiple platforms over a reasonable period of time? This is nuts!'" The end result: "In the future, we're just not going to do it."

Krucik, however, called Microsoft to task on the absence of a front end matching that of Microsoft's Intel offering. "The Microsoft [Win32] Software Development Kit has a Mips compiler, but it's not the same as the Visual C++ version," he says. "Unless your compilers are in sync, you never quite know whether any bugs generated are compiler-based or whether they're yours." This uncertainty, he added, has precluded Cadkey from moving ahead more quickly with production-based software for the Mips platform. Microsoft plans to introduce Visual C++ for Mips in the first half of this year. Alpha and PowerPC versions are slated for the fourth quarter. Once those versions become available, developers will have a consistent user interface and code base across platforms.

For Bentley Systems (Exton, PA), the development brains behind Intergraph's MicroStation software, early success at porting the CAD package to NT on an Intel 80x86 did not deter the company from waiting out the first versions of DEC's Alpha AXP compiler. "They evidently went through quite a bit of shakeout in their tools, and we let somebody else be the leading edge on that," said executive vice president Barry Bentley. Aside from the task of facing two sets of compilers, Bentley complained of some "pretty significant bugs" they found when they did begin the Alpha port. The compiler would crash, and early on, a program that did compile wouldn't run.

Once DEC worked out the problems, MicroStation became an easy port—actually a recompile—from NT on Intel to NT on Alpha. The 1.5 million lines of C in the program (plus components written in assembly language and in MicroStation Development Language, a pseudo-interpreted C language) required two weeks to produce a version that not only ran but could be shown to customers.

A third developer, Fractal Design (Aptos, CA), ran into difficulty merely in porting Painter 2.0 to the PowerPC to run under the ported Apple System 7. The biggest problems with early versions of the Macintosh on the RISC SDK, says chairman of the board Tom Hedges, showed up in both the compiler and the linker. "The first release of the compiler was very slow; it barely worked," he said. "And the first release of the linker didn't work. It was not capable of linking any application." Hedges noted that Fractal Design's experience would have been far more difficult had the company not already ported its product to Windows using Altura Software's Mac2Win technology, which implements the Macintosh API on Windows.

While Apple has since gotten both the compiler and linker working to some degree, Fractal Design found another problem in the linker that, although Apple claims it should be corrected by the time you read this, would otherwise affect any product ported to run natively under System 7 on the PowerPC. Namely, that the generic PowerPC 601 optimizations in the compiler introduced as many as two dozen bugs that rendered the program unusable.

"What compounds this problem," says Hedges, "is that whenever you turn the optimizer on, it disables all symbols and all debugging information. So where you might say, 'Gee, there's a bug in the compiler. I'll just get into the debugger and figure out what it is.' But than 170 members—for the PowerPC offer a tantalizing vision of a system running Unix with the capability of running Windows and Macintosh applications in emulation; however, all this must wait for the delivery of PowerOpen-compliant Unix implementations, which will begin to appear in June.

The idea behind PowerOpen is for all applications to share a common ABI (Application Binary Interface) and API across different PowerPC platforms, allowing developers to write to a single set of functions. Porting, say, AIX applications to PowerOpen will require a set of appropriate libraries, as well as taking account of a handful of implementation details such as long double variables being 128 bits in length.

Several vendors have signed on to develop tools for PowerOpen. Tools that pass

no, you can't do that. You can only use very difficult, low-level assembly debuggers, and an assembly debugger with no symbols, which makes it almost impossible to use if you turn on any compiler optimization."

The fix was expected sometime in February, but until then, Fractal Design has resorted to turning off all compiler optimization whatsoever for the sake of a program that runs. "That means we're giving up a fair percentage—I'm not exactly sure how much—of the potential performance," he says of what they hope to make available when Apple releases a Mac PowerPC. "I'm not happy about that."

Of course, in every game there are a number of players who sit it out at least until the market requires their presence. "We don't see a real desktop opportunity," said Peter Cohen, a spokesman for Lotus Development's desktop applications group. In general, desktop productivity will naturally carry DOS and lower-end Windows applications first to Chicago and then, if the market demands it, to NT. Vendors in this group include Intuit and Central Point Software, although the latter intends to provide a native Mac PowerPC version of Central Point Anti-Virus.

"We will not build it and wait for users to come," said Traveling Software chairman and CEO Mark Eppley of his company's plans to eventually bring its flagship LapLink to NT on the PowerPC and hold off on Mips, Alpha, or Workplace OS on any processor. ■

Ed Perratore is a BYTE news editor. You can contact him on the Internet or BIX at eperratore@bix.com.

Developers Committed to RISC

Mips R4400 (Windows NT)

Adobe Systems: PostScript, Photoshop
Arbor Software: eSSbase, eSSbase Application Server
Attachmate: Extra
Autodesk: AutoCAD
Cadkey: Cadkey
Calera Recognition Systems: WordScan-OCR
Computer Associates: CA-Realizer
Corel Systems: CorelDraw
DEC: PrintServer for Windows NT
FutureSoft Engineering: DynaComm/Elite
Image-In: Image-In-Color Professional
Intergraph: MicroStation
Interleaf: Interleaf
Lenel Systems International: Media Viewer, MultiMedia Works
MathSoft: Mathcad
Micrografx: Windows Draw, Designer
Microsoft: FoxPro, Office (and core applications), SQL Server, SNA Server, Visual C++, C/C++ for Win32, Hermes, Project, Macro Assembler, Object Basic, Visual Basic, Works
Novell: NetWare Client
Oracle: Oracle7 Server
Quark: QuarkXPress
Software Publishing: Harvard Graphics
Wall Data: Rumba
Wolfram Research: Mathematica
WordPerfect: WordPerfect

Alpha AXP (Windows NT)

Arbor Software: eSSbase
AutoDesk: AutoCAD
DEC: Print Server for Windows NT, Pathworks for Windows NT (client/server versions), C/C++, DCE (client/server versions)
Design CAD: Design CAD 2D, 3D
FutureSoft Engineering: DynaComm/Elite
Intergraph: MicroStation
MathSoft: Mathcad
MetaWare: C/C++ multiplatform tool
Microsoft: Office (and core applications), SNA Server, SQL Server, Visual C/C++
Micrografx: Picture Publisher
Novell: NetWare Client
Quark: QuarkXPress
Wall Data: Rumba
Wolfram Research: Mathematica

PowerPC (Workplace OS)

Quantum Development: Quantum Leap for Workplace OS
Microformatic: Fax PM
ChipChat-Cawthon Software: ChipChat Communications Objects
Hilgraeve: HyperAccess
Media Cybernetics: Halo Imaging Library, Halo Advanced Imaging Library
The Software Lifeline: Software Lifeline (product line)
SAS Institute: SAS System
Ask Group: Ask Windows 4GL

PowerPC (System 7)

Acl US: 4th Dimension, 4D Server
Adobe Systems: Photoshop
Aladdin Systems: StuffIt Deluxe, StuffIt SpaceSaver, StuffIt Lite, StuffIt InstallerMaker 2.0
Aldus: PageMaker, Persuasion, FreeHand, Digital Darkroom, Fetch
Canto Software: Cumulus Image Database
Claris: ClarisWorks
Deneba: Canvas
Fractal Design: Fractal Design Painter, Fractal Design PainterX2
Frame Technology: FrameMaker for Macintosh
Graphisoft Software Development: ArchiCAD
Great Plains: Dynamics 2.0, Dynamics C/S+
HSC Software: Kai's Power Tools
Insignia Solutions: SoftWindows for the Mac with PowerPC
Itedo Software: IsoDraw 2.0
Metrowerks: CodeWarrior
Ray Dream: Ray Dream Designer
Specular International: Infini-D, BackBurner
Wolfram Research: Mathematica
WordPerfect: WordPerfect, WordPerfect Works

an application compliance test suite will offer developers the option of mixing and matching different tools (e.g., compilers, debuggers, and profilers) from different vendors. Third-party tools are expected to ship approximately one year after PowerOpen ships.

PowerPC: An Attractive Platform

Strong commitments from IBM and Apple to the PowerPC series of processors have given it instant credibility among both potential customers and software developers (see "Apple, IBM Bring PowerPC to the Desktop" on page 44). Apple sells its Macintosh on RISC SDK in a prerelease version and promises to have the final product ready by mid-May. This SDK has Apple's MPW Development System, a PowerPC assembler, a two-machine debugger, a C/C++ compiler, and a MacApp framework for PowerPC systems.

One promising third-party Mac PowerPC tool is CodeWarrior from Metrowerks (St. Laurent, Quebec, Canada), a cross-compiling development environment containing a single-pass C and C++ compiler, along with project management tools and an object library. A PowerPC version will ship in concert with the PowerPC Macs. Elsewhere, a joint effort is also under way at Apple and Symantec to provide native PowerPC tools for the Mac for delivery later this year.

IBM's Programming Systems Laboratory in Toronto, Ontario, Canada, has available C and C++, FORTRAN, Ada, and Pascal compilers for the RS/6000 and PowerPC, as well as class libraries, debuggers, class browsers, and an IDE (Integrated Development Environment).

Chip architectures—particularly RISC—are becoming increasingly superpipelined and superscalar as more features (e.g., on-chip cache and branch-prediction logic that already are featured in existing chips) are introduced. New optimization techniques will be developed to take advantage of new architectures. These new techniques will be more complex and require a finer understanding of how the chip operates, making the overall job of tool development more difficult.

Operating-Systems Support

PowerPC
System 7, AIX, B.O.S./X (Bull), Workplace OS, OS/2 (IBM), Solaris, Unix

PA-RISC
HP-UX, MPE/iX (HP)

SPARC
Solaris, SunOS

Mips R4x00
Windows NT, Unix

DEC Alpha
Windows NT, OpenVMS, OSF/1

Alpha AXP

The DEC Alpha AXP is the highest-performing RISC processor, with a superscalar, superpipelined, 64-bit architecture running at 150 MHz and better. The Alpha features 16 KB of cache memory, divided into instruction and data caches, that funnels into a seven-stage integer pipeline and a 10-stage floating-point pipeline. The faster and more extensively pipelined architecture of the Alpha requires a high-quality compiler to restructure the source to avoid stalling the pipelines with incorrectly ordered instructions.

NT, OpenVMS, and DEC's OSF/1 are the operating systems available for Alpha-based machines, and it is basically DEC tools that are available for creating applications on these platforms (the Alpha compiler in the Win32 SDK is licensed from DEC).

Other RISC

Two other popular RISC platforms are Sun Microsystems' SPARC processor and HP's PA-RISC. As mentioned earlier, next-generation versions of these processors are likely candidates for NT.

Several tools exist for the SPARC architecture, including an Ada Software Development Environment from Alsys (Burlington, MA), embedded C/C++ tools from Cygnus Support (Mountain View, CA), and various language compilers from Edinburgh Portable Compilers (Edinburgh, Scotland), as well as from SunPro (Mountain View, CA), a spin-off of Sun.

Although PA-RISC is little known in PC circles, sales of PA-RISC systems achieved a more than 34 percent share by revenues of the RISC-system market in 1993, according to Andrew Allison, editor of the newsletter *Inside the New Computer Industry*. HP has several software development models for its system, the primary one being the host-based model, where a customer buys a workstation and uses the tools that come with the workstation to compile applications. A second model involves systems partners who want to compile to a different operating environment, as in the case of Convex Computer, which uses PA-RISC for supercomputing applications. In this model, the partner licenses compiler technology from HP and creates development tools for their systems. A third model involves the possible porting of third-party compilers or licensing of HP technology for embedded applications. Both SPARC and PA-RISC systems generally run Unix-based operating systems.

Outlook for New Tools

There is no reason to expect the development of new kinds of tools to accommodate RISC architectures. Even compilers designed to generate code for multiprocessor systems will likely have a front end that's similar to today's tools. Nevertheless, some interesting variations on existing tools are possible.

For example, the fact that RISC compilers tend to perform aggressive optimizations makes source-level debugging ever more challenging. This is because as source code is increasingly optimized, the resulting code that executes bears less correspondence to the original code. Recently developed debug formats may help partially by identifying enregistered variables that reside in different registers in different instruction-code sequences. This is a very active area of research, with no easy solution in sight.

Optimizations will continue to become increasingly aggressive, according to Kuck & Associates' Guardia, particularly as chip architectures become more complex. One new technique may involve the use of a profiler to help determine the best way to arrange for branches in code, in effect augmenting the branch-prediction logic embedded in many RISC processors.

Ironically, one missing tool is a quick-and-dirty, high-speed compiler that could be used to create applications quickly. Such a tool would be useful in situations where performance of the application is not an issue or where you simply want to prove a point. It would also likely compile three to five times faster than existing tools and appeal primarily to end users.

The availability of tools used to create applications for any given platform is a requirement for a platform to prosper. Those tools for RISC-based systems exist today and will enhance the chances for the successful deployment of RISC-based systems on the desktop that Intel dominates. ■

Alex Lane is a Colorado-based writer, speaker, and consultant. He can be reached on the Internet or BIX at a.lane@bix.com.

PROTECT YOUR SOFTWARE

NO BUTTON, NO ACCESS.

Dallas Semiconductor is re-shaping the world of software protection and distribution control with a new family of microchips called Authorization Buttons™.

Put a Lid on It

We put the lid on software piracy by packaging microchips in button-shaped, stainless steel cans. The chips contain missing but critical information to make the software run. Execution rights are determined by possession of the Authorization Button. And thanks to the high-volume, low-cost nature of canning, Buttons are the lowest cost way to protect software.

Pick Your Button, Name Your Price

We offer a variety of Authorization Buttons and features so you can select the level of protection and price point that are right for you.

Current offerings include a laser-engraved serial number, a memory with an expiration date, and a multi-level, password-protected memory.

Security Continuum

Button Type	Unique Serial #	Read/Write Memory	Password Protection	Expiration Timer	Decoy Responses
DS1420 ID Button	X				
DS1427 Time Button	X	4K bits		X	
DS1425 Multi Button	X	2K bits	X		X

Encourage the Trial

With the DS1427 Time Button, you can actually encourage software trials (and still sleep at night). Trial or lease plans can be based on calendar time, elapsed time, or the number of times an application has been accessed. When the trial period that you specify is up, the software no longer functions.

Snap-In, Snap-Out

Buttons interface to the PC's parallel port via the DS1410 Button Holder. They simply snap in and out. So an inexpensive Button can be sent out for a new release, a security update, or a lease extension. Each Button Holder accepts two Buttons, so your customers don't have to piggy-back dongles to protect multiple packages.

The future will be a dongleless world. New computers that accept Buttons directly, including palm and notebooks, are being designed at OEM's today. Buttons are not parallel port-dependent.

Software Protection with Complete Compatibility

Dallas Semiconductor Buttons are compatible across all ISA, EISA, and MCA machines — on underpowered notebooks as well as the anti-compatible Brand X's. We achieve this total compatibility through microchips that are self-powered, unlike other protection devices that must draw power from the host machine.

Made in the U.S.A.

At Dallas Semiconductor, we design *and* manufacture our own microchips. And we're the only ones in the software protection business who do. Sixty intricate process steps and a 64-bit unique serial number lasered into each chip prevent duplication.

To learn how to button down your software, give us a call.

DALLAS SEMICONDUCTOR

FREE!
Authorization Button.
Call 800-258-5061

Circle 153 on Inquiry Card.

4401 South Beltwood Parkway Dallas, Texas 75244-3292 Telephone: 214-450-0448 FAX: 214-450-3715

Justifying NT

NT Advanced Server and SQL Server for NT let you deploy file and database servers over a range of RISC and CISC platforms

JON UDELL

If Windows NT could run everywhere, from laptops and desktops to applications servers and file servers, Chicago would still be just a city in Illinois. No one at Microsoft pretends that cramming Win32 into a 4-MB procrustean bed—the Chicago design goal—yields optimal results. Sadly, most PCs today ship with just 4 MB of RAM—too little, really, for Windows 3.1. Even when new systems default to NT's required 16 MB (perhaps by 1995), most of the tens of millions of previously installed desktop systems will remain unable to run NT. That inescapable reality will shape NT's role in the enterprise for the next few years.

Some companies will ante up and deploy NT to the desktop anyway, just as some have done with OS/2 and desktop Unix. Why? Everyone's mission is critical; downtime is unacceptable; multitasking matters; and real operating systems pay back the investment required to run them in ways that are hard to quantify on the comptroller's spreadsheet. When Win32 versions of BYTE's line-of-business applications arrive, I'll be the first to argue that we should run them on NT, not Chicago. Then, when I lose that argument to the finance people, I'll make a more modest proposal that defines which systems should run NT and why.

Today, you have two important options. First, Windows NT Advanced Server 3.1, the latest in a long line of SMB-/NetBIOS-based LAN operating systems from Microsoft, offers a capable, attractively priced alternative to NetWare. Second, Windows NT 3.1, without the full LAN operating-system capability of Advanced Server, is a fine platform for server applications such as Oracle and SQL Server. In these scenarios, NT delivers robustness, connectivity, ease of installation and use, RISC and multiprocessing support, threaded multitasking, manageability, and a 32-bit Windows-compatible API. On paper, none of the competitors—OS/2, Unix, and NetWare—can match NT feature for feature. In reality, each is supported by the type of sophisticated infrastructure that comes from years of deployment in various niches.

In evaluating NT for production use, I wanted to answer two questions. First, is it the right database-server platform? Second, is it the right LAN operating system? The short answers are yes and no, respectively. The long answers are, naturally, more complex. Before diving in, I'll explain how the evaluation worked.

NSTL supplied two kinds of benchmarks—SQL database tests and file-server tests. The file-server tests, conducted at NSTL, pit NT Advanced Server against NetWare and LAN Server on a uniprocessor Intel machine. The SQL tests, performed jointly at NSTL and BYTE, compare the OS/2, NLM (NetWare loadable module), and NT versions of SQL Server on uniprocessor Intel hardware. They also assess SQL Server for NT on uniprocessor Mips and Alpha machines and on a multiprocessor Intel box (see the text boxes "How We Tested SQL Server on NetWare, OS/2, and NT" on page 150; "SQL Server for NT on CISC and RISC" on page 158; and "LAN Operating-System Testing" on page 164 for discussions of the benchmark results).

In addition to quantitative testing, I worked extensively with NT Advanced Server and SQL Server in a production environment—BYTE's own editorial LAN. Our mix of

One of NT's strengths is its ability to run on RISC-based hardware such as the Alpha-based DEC AXP 150 and the R4400-based SGI/Mips Magnum.

How We Tested SQL Server on NetWare, OS/2, and NT

CHARLES VOGT

NSTL's database-server tests measure the speed of transactions and queries against a database of books, authors, orders, payments, and shipments. In the tests, the three SQL Server/operating-system combinations were tested on the same hardware—an IBM PS/2 Model 95 configured with 32 MB of RAM and a pair of IBM 400-MB SCSI drives—one for the database, and one for the transaction log. The tests were both transaction- and query-oriented.

Each transaction test stresses the database server in a different way. For example, the multitable selects make the order-entry tests fairly processor-intensive. The payments tests, which feature simple record-selection criteria and in-place updates of existing records, are by contrast more disk-intensive. The transaction tests consist of the following:

ISBN Order. The test program generates a random ISBN number, selects the book, and identifies the author using a three-table join.

Author Order. The program generates a list of authors using the LIKE operation. After the user selects an author, the program generates a list of titles by that author.

Title Order. The test program selects book titles using a partial title key and the SQL LIKE operator. It selects a title from those returned and retrieves additional information from that book's record.

Payment. The test program generates a random order number and then selects an order record and its corresponding entries and updates the order record.

Shipment. The program finds the lowest order number for an unshipped order. It selects the order record for that number and all corresponding entries, and the order record and the entry records for book records with ISBN numbers that correspond to the selected entry record.

The query tests quantify a server's ability to handle the types of information requests you see in a corporate environment. The tests consist of the following:

Query 1. This is a single-table query with range search. The test program retrieves order number, customer name, payment status, and shipment status for a range of ZIP codes. The query returns approximately 2000 rows. During the six- and 12-user

SQL SERVER ON NETWARE, OS/2, AND NT: TRANSACTIONS

	16 MB OF RAM		13 MB OF RAM	
	SYBASE SQL SERVER NLM	MICROSOFT SQL SERVER 4.2 FOR NT	MICROSOFT SQL SERVER 4.2B FOR OS/2	MICROSOFT SQL SERVER 4.2 FOR NT
One station				
ISBN order	2.2	1.5	1.8	1.5
Author order	3.7	2.0	2.4	2.0
Title order	3.0	1.7	2.0	1.8
Payment	0.3	0.2	0.2	0.2
Shipment	0.5	0.4	0.5	0.4
Six stations				
ISBN order	2.8	2.4	2.3	2.7
Author order	4.5	3.8	3.6	4.0
Title order	3.9	3.6	3.9	3.9
Payment	0.4	0.3	0.2	0.3
Shipment	1.1	1.0	1.0	1.1
12 stations				
ISBN order	4.5	4.5	5.3	5.3
Author order	6.8	6.9	7.1	7.0
Title order	5.9	6.4	8.0	6.9
Payment	0.5	0.6	0.4	0.6
Shipment	2.0	1.6	1.9	2.1
24 stations				
ISBN order	8.9	8.8	11.6	10.9
Author order	13.7	13.2	15.3	15.9
Title order	11.4	12.6	15.8	15.5
Payment	0.8	1.1	0.7	1.1
Shipment	3.8	2.9	3.9	4.2

System: IBM PS/2 Model 95 (a 33-MHz 486DX with 32 MB of RAM, two IBM 400-MB SCSI hard drives, and an IBM SCSI drive controller).
Numbers represent average response time in seconds.
Red = best.

tests, one-third of the users execute this query while the others execute payment transactions.

Query 2. This single-table query is based on a list of values. The test program retrieves an order number, customer name, payment status, and shipment status for a list of 100 order numbers generated at random. During the six- and 12-user tests, one-third of the users execute this query while the others execute payment transactions. Note: NT would not process this query. The list of 100 order numbers creates a long SQL statement; NT truncated that statement, and the query failed. Thus, we didn't report results for this test.

Query 3. This test uses a three-table join. For a range of ISBN numbers, the query lists the book title, the quantity in stock, the number shipped, and customers who have ordered each book. The ISBN numbers, generated at random, span 500 values. During the six- and 12-user tests, one-third of the users execute this query while the others execute order transactions.

Query 4. This test uses a five-table join. For a range of order number values, the program lists the customer name, all books ordered, and each book's authors. The highest order number, generated at random, falls within 200 values of the lowest order number. Because no values are selected that are updated by transactions, background transactions are not run with this query.

Query 5. The final query is a grouped query with an outer join. For a range of ISBN numbers, the program lists the total number of orders placed for that book, the total number of books ordered, and the total cost of the books ordered for all books with two or fewer orders. To include those books with no orders placed, the program executes an outer join between the book table and entry tables. During the six- and 12-user tests, one-third of the users execute this query while the others run order transactions.

About the Results

For transactions, the NT version was a clear winner. For queries, the NLM (NetWare loadable module) version and the NT version both exhibited very good performance. The OS/2 version did relatively poorly, even when compared to a cache-constrained NT.

Why did we use OS/2 1.3? SQL Server for OS/2 remains a 16-bit application, and Microsoft recommends OS/2 1.3, rather than OS/2 2.1, as the best operating system on which to run it. Since OS/2 1.3 could use only half the RAM on the Model 95, that left at most 13 MB of RAM for SQL Server. So we ran the NT tests twice—once with the standard 16 MB of RAM and once with 13 MB.

SQL Server for NT obtains a high cache-hit ratio on our test (approximately 98 percent), even with 24 active-client sessions. When the amount of memory allocated to SQL Server is set the same on NT and OS/2 1.3, the two versions perform similarly on the transaction-processing tests. The NT version performs better on queries, however. One explanation may be its more sophisticated use of threads. Another reason may be that it incorporates some query optimization that appears in Sybase System 10 but is not present in the OS/2 (or NetWare) versions of SQL Server. ■

Charles Vogt is manager of performance testing at NSTL. You can reach him on the Internet or BIX at editors@bix.com.

SQL SERVER ON NETWARE, OS/2, AND NT: QUERIES

	16 MB OF RAM		13 MB OF RAM	
	SYBASE SQL SERVER NLM	MICROSOFT SQL SERVER 4.2 FOR NT	MICROSOFT SQL SERVER 4.2B FOR OS/2	MICROSOFT SQL SERVER 4.2 FOR NT
One user				
Query 1	6.80	10.43	11.48	10.20
Query 3	24.00	15.46	17.57	16.40
Query 4	51.10	28.22	46.49	31.10
Query 5	7.60	5.30	5.45	5.20
Six users				
Query 1	8.00	21.16	27.22	26.30
Payment with query	0.70	0.48	0.52	0.40
Query 3	36.10	39.86	129.46	76.50
ISBN order with query	3.20	2.91	7.38	3.40
Query 4	56.40	40.16	74.87	50.40
Query 5	9.40	10.39	10.12	9.90
ISBN order with query	5.50	12.93	38.23	15.20
12 users				
Query 1	13.20	44.22	54.63	55.70
Payment with query	1.30	0.86	0.88	0.70
Query 3	60.20	112.11	328.62	157.00
ISBN order with query	5.40	6.36	41.66	10.40
Query 4	76.00	74.47	179.24	86.80
Query 5	12.30	17.33	19.45	16.70
ISBN order with query	43.60	74.99	115.71	69.50

System: IBM PS/2 Model 95 (a 486DX/33 with 32 MB of RAM, two IBM 400-MB SCSI hard drives, and an IBM SCSI controller).
Numbers represent average response time in seconds.
Red = best. Blue = worst.


eXceed
"The clear winner as far as performance is concerned is HCL's eXceed/W 3.3.3."
– Originally published November 22,
Digital News & Review. © 1993 Cahners Publishing Company with permission.

DOS, Windows, Mac, and NetWare systems typifies what you'll find in many corporations today. My work in converting a homegrown FoxPro contact manager into client/server form and fielding it on our LAN convinced me that NT is ready for prime time as an applications server and that SQL Server leverages NT's strengths. When I evaluated Advanced Server as an alternative to NetWare, considering its pros and cons for DOS, Windows, and Mac users and for network administrators, the picture that emerged was cloudier.

NT as Database Server

For the qualitative evaluation, I ran SQL Server 4.2 for NT on four machines. The version that ran on RISC hardware—an SGI/Mips Magnum and a DEC AXP 150—was beta code, scheduled to ship in final form in late January, just after completion of this review. For that reason, take the benchmark results for the Mips and Alpha systems with a grain of salt. The version that ran on the Intel platforms—a Compaq Proliant and an Everex Step 486/50—was the shipping version.

The reliable sameness of NT and SQL Server across this range of processors and system architectures represents a stunning accomplishment. That portability, along with SQL Server's 32-bit addressing and NT's 64-bit file pointers and disk-spanning capability, means you can bring nearly unlimited resources to bear on data management.

Matching Up

NT and SQL Server are a natural match in many ways. Under 16-bit OS/2, SQL Server can't make optimal use of threads, according to Microsoft. The limit of 53 threads per process made it impractical to assign one thread to each user connection. Instead, a single OS/2 thread services all connections, and SQL Server schedules simulated threads within the context of that worker thread. Under NT, however, SQL Server uses a pool of worker threads. This approach leverages native NT scheduling services and ensures even distribution of work across multiple processors in SMP (symmetric multiprocessing) systems. OS/2 2.x's per-process (and systemwide) limit of 4096 threads will support the same approach, but neither the 32-bit OS/2 version of SQL Server nor the SMP version of OS/2 2.x is yet available.

NT simplifies the management of SQL Server in many ways. With respect to SCSI peripherals, for example, NT users today enjoy many of the benefits that Chicago users with Plug and Play hardware will enjoy tomorrow (and that Mac users have taken for granted for years). NT's boot-time procedure for enumerating devices on a SCSI bus and recording information about them in the system registry was in fact the model for Chicago's similar mechanism. The payoff, for me, came when I ran the NSTL tests, which require that the test database and its transaction log reside on separate disks. Adding a second disk to the Alpha machine and then moving it to the Mips machine was a trivial exercise. Because NT's Disk Administrator can shuffle drive letters around—a terrific convenience—I was able to make the disk show up as drive F on both machines, and thereby avoid changing drive letters encoded in SQL scripts and batch files.

The ability of NT to stripe data across physical disks (and of Advanced Server to stripe with parity) means that you no longer have to juggle SQL Server disk devices and segments to spread out the I/O load. Managing SQL Server storage at the segment level is complex and scary. Creating stripe sets with Disk Administrator is child's play.

The instrumentation built in to NT—hundreds of counters that continuously measure the vital signs of processes, disks, memory, cache, network transports, and other system objects—reports a wealth of data that you can use to analyze the performance of an NT system using the NT Performance Monitor utility. The mechanism is open to applications, and SQL Server uses it to report its own statistics to Performance Monitor in the same way that system objects do. This integration of system and application performance data can yield crucial insights.

You can use Performance Monitor to know, not merely guess, what SQL Server's optimal memory allocation should be for a given NT configuration. You can even use Performance Monitor to set alerts (i.e., thresholds on system or application counters) and specify commands that run in response to the triggering of those alerts. NT's sophisticated and unified approach to monitoring, though not widely recognized, contributes mightily to its mission-critical capability.

SQL Server for NT

PROS
- **Employs multiple clients and protocols**
- **Supports ODBC**
- **Automates data administration with Object Manager**

CONS
- **Poor backup capabilities**
- **Ill-matched security with operating system**

Getting Connected

NT comes out of the box ready to run three network protocols: NetBEUI, IPX/SPX, and TCP/IP. (Advanced Server adds a fourth—AppleTalk.) SQL Server puts that flexibility to good use. The ability to communicate using multiple IPC (interprocess communications) mechanisms over multiple transports was formerly available in the form of SQL Server "integration kits" for NetWare and Vines. Those capabilities are now bundled with NT.

Of the most interest to me was the ability to support some DOS, Windows, NT, or OS/2 clients using named pipes over NetBEUI and other protocols—simultaneously—using SPX sockets. The target audience for my test application included Windows for Workgroups nodes running NetBEUI and plain Windows 3.1 nodes running IPX/SPX. SQL Server made deployment a snap. The client software's installer let me pick the Net-Library I needed in each case. It was not always this easy to field a SQL Server application in a predominantly NetWare environment like ours.

My only gripe is that Microsoft doesn't bundle the Mac client components. Mac (and Unix and VMS) clients can talk to SQL Server using TCP/IP sockets, but to make this happen you need versions of DB-Library (the SQL Server API) and Net-Library available only from Sybase.

SQL Server also now comes out of the box ready to support ODBC (Open Database Connectivity) clients. This is irrelevant to the SQL Server version of the NSTL benchmark, which is written to DB-Library and makes extensive use of stored procedures, but it isn't irrelevant to me. Unlike the benchmarks, the application I built is purely generic; the tool I used to construct it, Coromandel Industries' Integra Visual Database Builder, talks only to ODBC. In choosing that tool, I traded advanced back-end features for flexibility; thus, I can point the application not only at other servers (e.g., Oracle and Informix) but also at dBase or FoxPro files—an option that creates interesting possibilities. Any client application for NT SQL Server can

WINNER

"BEST OVERALL" & "HIGH QUALITY"

JANUARY 1994
BYTE
BEST
GENERAL BUSINESS
COLOR MONITOR

"The 15-inch (SCEPTRE) CC-615GL distinguished itself with top-flight screen quality, below average cost, and the best scores for its monitor class in both the power conservation and distortion tests."
BYTE/NSTL Lab Report, January 1994

Of more than 30 brands tested such as NEC, IBM, Mitsubishi, Zenith & Epson, **SCEPTRE CC-615GL** scored the highest as the **BYTE BEST** choice in both Best Overall and High Quality categories for general business applications.

SCEPTRE 15-inch Line Up

CC-615	MPU
CC-615G	MPU, EPA Green
CC-615L	MPU, MPR-II
CC-615GL	MPU, MPR-II, EPA Green

Available from SCEPTRE are a full-line of quality displays ranging from 14-inch monochrome TTL to 21-inch ultra-resolution color monitors, with Low Radiation (MPR-II) and EPA Energy Saving options. Contact your local SCEPTRE dealer today for more information.

In an effort to protect the Monitor Lizard such as Brutus, pictured right, SCEPTRE donates a portion of its proceeds to the Center for Reproduction of Endangered Species (CRES), a division of the Zoological Society of San Diego.

energy EPA POLLUTION PREVENTER

DISTRIBUTED BY

SCEPTRE®

ISO 9002 Certificated Manufacturer ISO 9000

Tech Data CORPORATION

SCEPTRE TECHNOLOGIES, INC. 714-993-9193 FAX 714-993-2997

1-800-237-8931

Circle 289 on Inquiry Card (RESELLERS: 290).

run locally on LAN-attached nodes, or remotely on a node that dials in to NT's Remote Access Service. With ODBC, there's also the possibility of stand-alone use. If you export SQL Server data into, say, dBase or FoxPro files, an unconnected client can simply switch ODBC drivers and use the same application to access the snapshot data for read-only purposes.

Managing the Data

To make SQL Server's high-performance engine hum, administrators traditionally had to climb under the hood and monkey around using rather primitive tools. That began to change when version 4.2 provided SQL Administrator, a graphical tool for OS/2 and Windows that you use to create, mirror, and modify storage devices; assign databases and transaction logs to storage devices; manage users and groups; configure SQL Server options; and issue queries. The NT version of SQL Administrator adds a few enhancements. For example, the query tool can now graph query statistics (e.g., scans and logical and physical reads) and display a graphical summary of the query plan.

The big news, though, is the new SQL Object Manager, a real Swiss Army knife for managing data. (Incidentally, it is also available with the 4.2b upgrade of OS/2 SQL Server.) You use Object Manager to create and manage tables, indexes, keys, views, triggers, and stored procedures and to assign permissions to these objects.

One powerful feature that I put to use in my application is the ability to generate *triggers*: special stored procedures that fire on update, insert, and delete events. This let me enforce referential integrity between tables in a nearly automatic way. Object Manager makes setting up primary key/foreign key relationships a point-and-click affair, but it relies on triggers to cause changes to ripple from one table to another.

My simple contact manager, for example, uses company and contact tables related by a company-name key. When I asked Object Manager to create a new update trigger for the company table, it found the related contacts table and wrote the half-dozen lines of Transact-SQL necessary to synchronize the two tables. As a result, when I rename a company, all the related contact records snap instantly into place in the master-detail view that my application presents. If you've solved this kind of problem in a navigational database like FoxPro, you'll appreciate the economy with which SQL Server's triggers express the same logic. And if you've written triggers yourself, you'll love the fact that Object Manager automates the task.

Is the lack of true declarative referential integrity a serious flaw? In that religious debate, I side with the Microsoft/Sybase camp. Users tell me they want changes logged and business rules enforced when transactions occur. With triggers, you can write the code to do these things in a server-based, application-independent way.

Object Manager also tracks object dependencies, so you can select a table and list the triggers and stored procedures that refer to it or, conversely, select a stored procedure and list the tables it refers to. In addition, Object Manager can write out the SQL scripts that define all the objects in a database. It even wraps a graphical shell around the venerable BCP (bulk copy program)—which imports and exports BCP-formatted and comma- or tab-delimited ASCII data. An early beta version dangled the promise of support for other formats, such as dBase, FoxPro, and Access, but unfortunately, these didn't make the cut.

Hands On

With SQL Server installed on NT, it took just a couple of days to build my test application, dividing my time about equally between server-side and client-side chores. I've been using the application ever since, because it's faster and more convenient than its FoxPro predecessor. SQL Server's newfound ease of use, and Coromandel's first-class application builder, made the development task vastly more approachable than it was even just a year ago. The barriers to client/server development are crumbling; it's fast becoming a game the average corporate programmer can play and win. I'm excited by the new vistas NT SQL Server opens up, but there are still a few items on my wish list.

For starters, backup and recovery procedures remain rather primitive and do not integrate with the (also rather primitive) backup facility of NT. NT needs something like Novell's Storage Management Services architecture.

While I'm wishing, how about an agent that can digest SQL Server's diagnostic data and form useful recommendations? Interpreting Performance Monitor screens usefully requires a lot of expertise. The same holds true for the output of ShowPlan, a utility that lets you view the deliberations of SQL Server's cost-based query optimizer. Moving some of that expertise into software would be a tremendous boon.

SQL Server and Advanced Server work together on security matters, but not as well as I'd like. The rules governing user names differ between the two systems, and smoothing out those differences proved tricky. Synchronizing the database and network directories requires manual intervention; new users added to an NT group don't automatically show up in the corresponding SQL Server group, and there's no link to the NetWare bindery.

There's also a quirk in the Sybase/Microsoft client software that needs fixing: Only one database cursor can be active per client connection. The problem showed up when I implemented a two-table, master-detail view. When a query against the master table returned hundreds of records, the dependent query against the detail table was slow to respond. According to Coromandel, that's because the client software can't keep both cursors simultaneously active. By constraining the master result set—which was the right thing to do anyway for my application—I solved the performance problem. But the underlying limitation shouldn't exist.

Despite these details, NT SQL Server gets an emphatic thumbs-up from me. Client/server computing, RISC, and multiprocessor systems have been dry seminar topics for too long. With a platform like NT and an application like SQL Server, they come alive as practical technologies that you can apply today in the enterprise.

NT as File Server

With the advent of Windows NT 3.1 and Windows for Workgroups 3.11, Microsoft has standardized on a rich workgroup foundation. Peers in a Windows workgroup can share files, printers, and clipboards over NetBEUI, IPX/SPX, or TCP/IP and exchange mail using simple MAPI. (For more on the use of routable protocols with NT, see "Wide-Area Windows Networking," January BYTE.) NT and Windows nodes are equal partners in workgroups and communicate effortlessly across the 16-bit/32-bit divide. Other network services available to 16- and 32-bit applications include named pipes, NetDDE, Windows sockets, mail slots, and the WNet APIs used to browse for, connect to, and share resources. This common substrate contains much of the capability that LAN Manager formerly provided. *continued*

states for the ADDs. IBM says this optimization really pays off in reduced overhead, because almost every 80x86 instruction affects some kind of flag.

Finally, the IST stores the translated and optimized blocks of code in its special memory cache for execution. Soon the cache holds the referenced sections of the original program, reducing the need for further discovery and optimization. Amazingly, all this analysis, optimization, and code generation happens on the fly, while the program is running.

IBM says the IST currently delivers the SPECint performance of a 486DX/33 CPU when running on a PowerPC 601 processor, approximately one-ninth the performance of native code on the PowerPC. With further refinements, the goal is one-third the performance. Future versions of the IST might spawn a separate thread that continues to optimize the cached code, even while the discovery and translation steps are executing on another thread.

One-third to one-ninth of the original CPU performance may not sound impressive, but remember, it's worst-case emulation: pure 80x86 code that doesn't call high-level API routines. Ironically, Windows programs may run faster than DOS programs under this kind of emulation.

The IST is new technology that will probably show up later this year in IBM's version of Wabi. The IST may also appear in future RISC versions of IBM's Workplace operating system.

Although Insignia and IBM are making great strides with code caching, the idea may not work as well when it's applied to other platforms. Dave McMillen, who is manager of software technology for Andataco, says code caching isn't nearly as effective when emulating the Mac. As a legacy from the days when the Mac had only 128 KB of RAM, Mac programs use a great deal of indirection to shuffle blocks of code and other resources around in memory. If an emulator translates, caches, and attempts to use this code later, it may find that references to memory addresses are no longer valid. The cache would have to be flushed and the code retranslated. These cache misses happen so often, says McMillen, that little or nothing is gained.

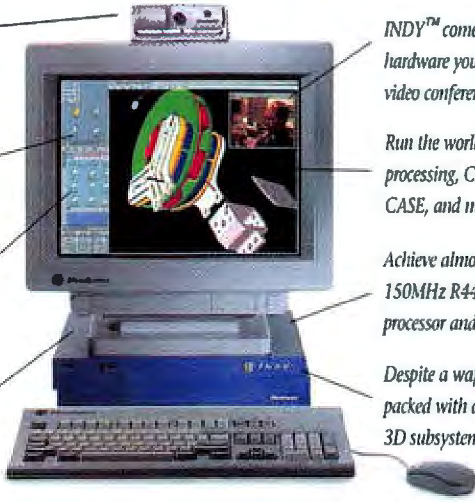
Nevertheless, Liken does take advantage of other on-the-fly techniques to boost performance. The approach is becoming more and more commonplace, and programmers who are experienced in writing compiler back ends are becoming a frequent sight in the labs of emulation developers.

Optimized compiler technology holds even more promise for the future. As microprocessors keep getting faster, emulators will benefit not only from linear gains in brute force, but also from the additional on-the-fly optimizations that become possible. And as APIs mature and encompass more of the same high-level functions, translations from one library to another will become more straightforward.

Someday soon, you may be able to walk into a computer store blindfolded, pick a software package off the shelf, and be sure it will run on your computer—no matter what kind of computer you prefer to use. ■

Tom R. Halfhill is a BYTE senior news editor based in San Mateo, California. You can reach him on the Internet or BIX at thalfhill@bix.com.

THERE'S NOTHING LIKE IT.



The IndyCam™ color digital camera is standard equipment; the most sensible input device for the visual world.

Work in the first true multimedia interface — the Indigo Magic™ User Environment — and merge 3D, blistering 2D graphics, audio, video, and text.

It runs applications for every major platform: Windows/DOS, Mac, and UNIX — all simultaneously.

Built-in ports accommodate every device imaginable: even VCRs, all your CDs (image, music, and data), and MIDI.

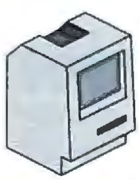
INDY™ comes complete with all the hardware you need for media-mail and video conferencing.

Run the world's best software for image processing, CAD/CAM, chemistry, GIS, CASE, and more.

Achieve almost reckless speed with a 150MHz R4400™ or 100MHz R4000® processor and a true 64-bit architecture.

Despite a wafer-thin profile, INDY is packed with audio, video, and 2D and 3D subsystems, yet still has plenty of room for option cards.

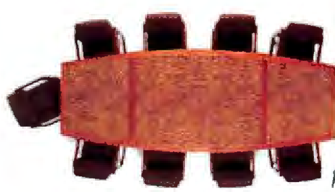
IT'S LIKE EVERYTHING ELSE.



Read, write and import PC, Mac, and UNIX files with just a click of the mouse. Sit comfortably on Novell® and Appletalk™ networks.

If you've ever used a Mac® or Windows,® you'll feel right at home with the intuitive Indigo Magic user interface.

Standard com ports for Ethernet 10Base-T or AUI, and ISDN make INDY an easy-to-reach address in any virtual neighborhood.



The video capabilities are like having conferences in your cubicle, design reviews on your desktop, and chats from your favorite chair.

With its volume buttons, headphone jack, and digital and analog audio I/Os, it's like a sound system built into a computer.

INDY™ Here's the machine that finally unites communications and computing; the machine that lets you design, simulate, and demonstrate in three dimensions; the machine for everyone who uses multimedia as a tool, not a toy. It also happens to be a nitro-fueled computer with afterburners. **Call 1-800-431-4331, Dept. B26** for both sides of the story.

SiliconGraphics Computer Systems

INDY includes all the features above, plus: 32MB of RAM (expandable to 256MB); IndyCam™ color digital camera; microphone; 8-bit graphics w/ Virtual-24 support; 3 juggling balls; 14", 16" or 19" non-interlaced monitor; external volume controls; 2 GIO32 high-performance expansion slots; space for 2 hard disk drives (accepts 21MB 3.5" floptical drive that reads/writes Macintosh® DOS and UNIX diskettes); Display PostScript®; Indigo Magic™ User Environment; Hot Mix Application Trial CD (trial copies of Insignia SoftPC 3.1 DOS/Windows emulator and Quorum software application adaptor for Macintosh MSWord® and MSExcel®); ability to read Kodak Photo CD; and, IRIX™ 5.1 & Motif™ 1.2.

SQL Server for NT on CISC and RISC

This test examines various hardware platforms for SQL Server for NT. The test machines were a SGI/ Mips Magnum (a 75- to 150-MHz R4400SC with 1 MB of cache memory and 32 MB of RAM), a DEC AXP 150 (a 150-MHz DECchip 21064 with 512 KB of cache memory and 32 MB of RAM), a Compaq Proliant (a dual 66-MHz Pentium with 256 KB of cache memory, and 32 MB of RAM), an Everex Step 486/50 (a 486DX2/50 with 256 KB of cache memory and 16 MB of RAM), and an IBM PS/2 Model 95 (a 486DX/33 with 256 KB of cache memory and 32 MB of RAM). The SGI/ Mips Magnum is a favorite of mine. It's the fastest, smoothest NT workstation I've used regularly—a real thoroughbred. It's quickly becoming a collector's item, however, because SGI has passed the baton to NEC for the manufacturing of Mips-based NT workstations.

Waiting in the wings was a Carrera Pantera II (a 200-MHz Alpha with 2 MB of cache memory) and an NEC Express RISCserver (a dual 75- to 150-MHz R4400), neither of which arrived in time for testing. On the horizon, DEC is working on Alpha-based multiprocessing systems.

The tests used are the query tests from NSTL. The transaction test results are not reported because of anomalies in the hard disk used for the transaction log.

About the Results

Best scores on individual queries were distributed rather evenly among the Compaq Deskpro 66/M, the Proliant, and the Magnum. The Proliant's multiprocessor technology, clearly capable of great results, can also falter. The Magnum's RISC engine similarly shows flashes of brilliance. But neither multiprocessing nor RISC clearly dominates these tests. RISC versus CISC? It's all just horsepower to NT, and if you can yoke the horses into teams, so much the better.

WINDOWS NT SQL SERVER QUERY PERFORMANCE ACROSS SYSTEMS

	IBM PS/2 MODEL 95	COMPAQ DESKPRO 66/M	COMPAQ PROLIANT (TWO CPUS)	SGI/MIPS MAGNUM	DEC ALPHA AXP 150
Processor	486DX/33	486DX2/66	Pentium 66	R4400SC	DECchip 21064
Processor clock rate (MHz)	33	66	66	150	150
Processor secondary cache	256 KB	256 KB	256 KB	1 MB	512 KB
RAM (MB)	32	32	32	32	32
One user					
Query 1	10.43	7.82	4.24	4.65	13.50
Query 3	15.46	12.87	35.37	6.31	14.07
Query 4	28.22	17.32	5.31	13.68	16.41
Query 5	5.30	2.89	13.22	1.87	4.38
Six users					
Query 1	21.16	16.38	8.89	13.12	37.66
Payment with query	0.48	0.30	0.17	0.22	0.34
Query 3	39.86	31.51	257.73	62.29	174.47
ISBN order with query	2.91	1.49	1.69	1.98	3.18
Query 4	40.16	31.79	6.72	18.61	25.37
Query 5	10.39	6.07	4.33	3.69	9.08
ISBN order with query	12.93	6.80	9.52	9.15	19.37
12 users					
Query 1	44.22	34.97	20.08	30.37	82.82
Payment with query	0.86	0.57	0.29	0.38	0.60
Query 3	112.11	76.15	319.96	87.20	273.75
ISBN order with query	6.36	3.12	5.37	5.84	9.99
Query 4	74.47	62.82	11.65	34.25	46.53
Query 5	17.33	12.19	26.44	6.16	16.58
ISBN order with query	74.99	21.16	70.11	33.78	70.72

Numbers represent average response time in seconds.
Red = best. Blue = worst.

CADVANCE, Claris CAD, VersaCAD, MacBravo! users ...

TRADE UP to MicroStation

Trade requires proof of purchase. $1,500 until June 30, 1994. Price good in U.S. only.

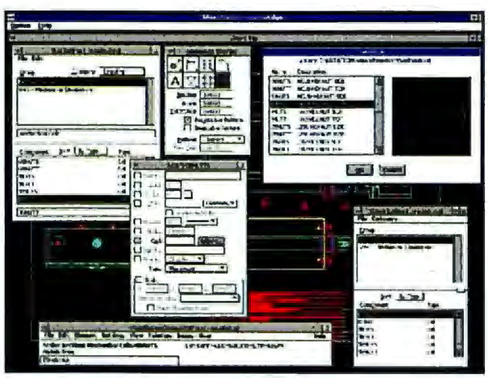
Rendering. *Visualization and flythroughs – at your fingertips! MicroStation offers photo-realistic rendering to every designer, right in the software. It's easy to make your image reflect your imagination.*

Windows. *It walks and talks Windows. Behind MicroStation lies the user-responsive programming you look for in good Windo[ws] software. Version 5 gives you the ultimate in integration of CAD, engineering, and business applications.*

MORE POWER TO YOU.

Modeling. *Model any surface you can imagine in MicroStation. NURBS surface modeling combined with 3D Boolean operations gives you astounding flexibility in creating and modifying freeform models.*

Read & write AutoCAD .dwg



Workspaces. *Choose the design environment that matches your profession or your CAD expertise – even AutoCAD. Complete with custom interfaces, drafting styles, and design environment management. CAD has never been so streamlined!*

Drafting. *MicroStation gives you first-rate drafting pow[er] – without the limitations of old technology. Enjoy the advantag[es] of contemporary features like a[sso]ciative patterning/hatching, plo[t] preview, standard text editing a[nd] fonts, and context-sensitive Hypertext help.*

C

ma

Mo

point

for fut

As a result, LAN Manager's heir, Advanced Server, focuses exclusively on the issues that separate enterprise networking from workgroup networking: central administration, fault tolerance, heterogeneous client support, and remote access. To that end, Advanced Server inherits and extends LAN Manager's domain-based security model, offers disk mirroring/duplexing (RAID 1) and striping with parity (RAID 5), delivers Macintosh file and print services, and bumps NT's limit of one remote user to 64.

All this costs a lot less than NetWare. A 100-user NetWare setup lists for $6995 (for version 3.12) or $8795 (for version 4.01)—and that doesn't include Mac support. And while NetWare's licensing cost climbs as you add more users, Advanced Server's stays flat at $2995 ($1495 until June 1). Of course, there are a host of other considerations, not the least being that Advanced Server needs a bigger, faster machine to run acceptably. But when you toss in features not included (e.g., remote access and RAID 5) or not possible (e.g., RISC and multiprocessing support and local GUI application capability) with NetWare, Microsoft's latest LAN operating-system offering merits a close look.

Out of the Box

I ran Advanced Server on two machines: the SGI/Mips Magnum and an IBM PS/2 Model 90 486 XP. Each machine was a primary domain controller, accessible to Windows, OS/2, NT, and Mac clients on BYTE's Ethernet LAN. While it's faster and easier to install from CD-ROM, the Advanced Server package also includes a stack of 23 floppy disks if—as was the case with my PS/2 machine—your server lacks a CD-ROM drive.

With Advanced Server, as with NetWare, it's a breeze to set up disk partitions and configure network protocols. When you want to reconfigure these things, however, NT sometimes lacks NetWare's flexibility. For example, exploring the use of IPX/SPX and TCP/IP as alternate substrates for the basic Windows networking features (file-, printer-, and clipboard-sharing), NT forced me to reboot every time I added or even just tweaked a protocol. With NetWare, I can load or unload TCP/IP and AppleTalk stacks without downing the server or disrupting logged-in IPX/SPX clients, and I've been grateful to be able to do that. While NT's transport drivers are, in principle, unloadable, the mechanism that binds transports is rooted deep in NT's boot process. Continuous availability is a vital issue for me. With NetWare, I can change an IP address or an AppleTalk zone name on the fly; Advanced Server needs to be equally adaptable.

The Knowledge Gap

My protocol experiments also brought to light another glitch that underscores the immaturity of NT and Advanced Server. Installation and binding of drivers, protocols, and services are highly automated in NT. Graphical utilities kick off routines that create and destroy keys in the system registry, where all configuration information lives in binary form.

This is a great feature when the installation tools work properly, and in my experience, they almost always do. But in one case, I got stuck. NT has the notion of service dependencies—for example, NWNBLink, Microsoft's NetWare-compatible NetBIOS, depends on NWLink, Microsoft's IPX/SPX transport. When I installed NWLink, NWNBLink came along for the ride. I could have removed both by uninstalling NWLink, but instead, I mistakenly uninstalled NWNBLink and, per instructions, rebooted. That left things in a state of limbo. I couldn't remove NWLink, nor could I add NWNBLink.

NT Advanced Server
PROS
• Low per-user costs
• Easy to install and configure
• Works great with NT clients
CONS
• Must reboot after changing protocols
• Limited remote administration
• Limited flexibility in changing domain configurations

To compound the trouble, I next removed the network card driver, planning to reinstall all the networking pieces from scratch. But the NWLink transport remained in limbo. In retrospect, I realized that I should have reverted to the "Last Known Good" configuration at the first sign of trouble; that's how you recover from catastrophic configuration errors. But my error wasn't catastrophic. And because the undo stack is just one level deep, when I took out the network card driver and rebooted, NT marked the prior—and problematic—configuration as "Last Known Good." I tried booting from the NT panic disk and restoring the configuration stored there, but for some reason, that didn't expunge the rogue NWLink. Finally, I took a stab at deleting its registry keys, but NWLink, Lazarus-like, kept returning to haunt me. In the end, I fired up the installation CD and took a coffee break.

Don't get me wrong. On the whole, I find NT a little easier to configure than NetWare and a lot easier than OS/2 or Unix. But it has its own unique approach. Experts who fully understand that approach, books that document it, and third-party tools that complement it are, today, in scarce supply. (The invaluable three-volume Windows NT Resource Kit is the outstanding exception to this rule.) Some would-be implementors will cite this knowledge gap as reason to adopt a wait-and-see stance with respect to Advanced Server. Others will view it as a career opportunity.

Working with Advanced Server

Advanced Server does what every LAN operating system must do—share files and printers—with minimal fuss and maximal point-and-click ease of use. You share directories using File Manager; the procedure will be familiar to users of NT or Windows for Workgroups. You can share FAT (file allocation table), HPFS (High Performance File System), or CDFS (CD-ROM file system) volumes, but only with directory-level security. (Unlike NetWare, Advanced Server makes CD-ROM sharing a trivial exercise.) For full file-level security, you need to use NT's journalizing file system, NTFS.

Advanced Server's Mac file services use NTFS for two reasons: file-level security, and because the ability of an NTFS file to contain multiple-named data streams of unlimited size maps neatly to the data-fork and resource-fork components of a Mac file. Because NT's back up utility is NTFS-aware, you can backup and restore Mac files without damage to long filenames or creator/type resources (I checked; it works.) Unlike NetWare's Mac name space, which you install once to make an entire volume visible to Mac clients, Advanced Server's Mac volume maps to an individual NTFS directory. The advantage of this scheme is that you don't litter your whole volume with Mac directory entries when, as is true on our network, Mac and PC users tend to exchange files using a few directories designated as drop boxes. The disadvantage

LAN Operating-System Testing

CHARLES VOGT

The relative performance of network products can vary substantially because of differences in how applications access files, so the NSTL file-server tests use a mix of popular applications. Programs such as Lotus 1-2-3, cc:Mail, and XCopy read and write files in relatively large chunks. On the other hand, Microsoft's FoxPro makes many small read and write requests when accessing shared database files and can generate many lock and unlock requests.

About the Results

Lacking support for a high-end token-ring adapter, NT fared poorly. Ironically, Microsoft's own LAN Manager 2.2 was the best performer. The effect of using a slower 16-bit adapter with Microsoft NT Advanced Server is particularly noticeable on the XCopy tests, which move the greatest amount of data between the servers.

In addition, NT Advanced Server is particularly slow relative to both versions of NetWare and LAN Manager 2.2 on the FoxPro transaction-processing test. Microsoft says that the small size of the requests that FoxPro generates when reading and writing data, along with the processing of lock requests, substantially lowers the performance of NT Advanced Server. This test result shows that NT Advanced Server is not a good choice for a high-volume transaction-processing application written in a file-oriented database such as FoxPro.

NSTL FILE-SERVER PERFORMANCE TESTS

	BANYAN VINES 5.5	IBM LAN SERVER 3.0	MICROSOFT LAN MANAGER 2.2	MICROSOFT NT ADVANCED SERVER 3.1	NOVELL NETWARE 3.11	NOVELL NETWARE 4.0 (VLM)	NOVELL NETWARE 4.0 (NETX)
Four workstations							
cc:Mail	0.31	0.34	0.27	0.22	0.32	0.31	0.32
Lotus 1-2-3	0.33	0.41	0.40	0.41	0.33	0.28	0.30
WordPerfect	0.42	0.48	0.55	0.31	0.43	0.38	0.34
FoxPro	10.67	10.69	11.37	7.81	14.07	7.47	10.96
XCopy-1 (26 files, 40 KB)	0.04	0.21	0.24	0.08	0.12	0.24	0.21
XCopy-2 (104 files, 10 KB)	0.02	0.12	0.13	0.02	0.08	0.10	0.08
Eight workstations							
cc:Mail	0.51	0.62	0.70	0.42	0.56	0.50	0.45
Lotus 1-2-3	0.60	0.79	0.79	0.77	0.61	0.51	0.46
WordPerfect	0.55	0.75	0.83	0.40	0.66	0.52	0.40
FoxPro	15.38	18.39	19.81	10.86	23.75	12.08	13.98
XCopy-1 (26 files, 40 KB)	0.03	0.19	0.24	0.08	0.08	0.24	0.24
XCopy-2 (104 files, 10 KB)	0.02	0.10	0.11	0.02	0.05	0.11	0.07
16 workstations							
cc:Mail	0.66	0.94	1.11	0.58	0.81	0.78	0.65
Lotus 1-2-3	0.97	1.51	1.55	1.40	1.01	0.74	0.66
WordPerfect	0.50	0.99	0.99	0.40	0.85	0.63	0.57
FoxPro	15.58	20.50	22.05	10.74	25.93	13.72	14.65
XCopy-1 (26 files, 40 KB)	0.03	0.17	0.25	0.08	0.06	0.25	0.21
XCopy-2 (104 files, 10 KB)	0.02	0.08	0.11	0.02	0.04	0.10	0.06
24 workstations							
cc:Mail	0.57	1.05	1.25	0.56	0.84	0.85	0.75
Lotus 1-2-3	0.93	2.14	2.24	1.72	1.23	0.78	0.78
WordPerfect	0.41	1.05	0.96	0.37	0.90	0.61	0.66
FoxPro	12.49	19.20	21.07	11.49	25.88	12.81	13.25
XCopy-1 (26 files, 40 KB)	0.00	0.14	0.15	0.08	0.05	0.15	0.14
XCopy-2 (104 files, 10 KB)	0.00	0.11	0.08	0.02	0.04	0.07	0.05

All results are in transactions per second. Red = best. Blue = worst.

When you invested in SCSI bus performance, this probably wasn't what you had in mind.

Give your bus a boost with FPT.

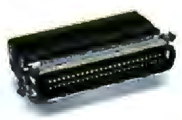
Data transmission problems on your peripheral bus can decrease your system's performance. Now, you can buy the same breakthrough technology that the top OEMs are specifying for their top-of-the-line systems.

Every peripheral on your bus is probably connected by a connector from a different company, and tied to the end of cable by who-knows-who. Any difference in impedance can cause signalling errors, resulting in bottlenecks and inefficient data transmission.

Forced Perfect Termination was developed cooperatively by Aeronics and IBM to solve the problems of reflections in data transmission, when high-performance computers are installed with peripherals from multiple vendors.

First with Forced Perfect Termination, our active terminators purposely mismatch impedance higher and lower than the impedance of the transmission line, convincing the system that it is seeing a perfect impedance match. Because our terminators provide higher noise immunity resulting in improved data integrity, you can transfer data faster and farther while improving overall SCSI system reliability. Depending on your application, we offer a full line of FPT products — the FPT-3™ Silver Series, the FPT-18™ Gold Series for 50-pin fast SCSI performance, and the new FPT-27™ Platinum Series, a 68-pin wide-SCSI terminator.

And the best news is that, because the SCSI bus only needs terminators at the beginning and end, you can solve this problem for surprisingly little cost. Customers like Chase Manhattan spent days and thousands of dollars trying to pinpoint the problem; only to discover that the solution was to replace the no-name passive terminators that came with their external drives and printers, with the original American-made FPT terminators from Aeronics.



Cheap passive terminators can't touch the performance of Aeronics' active FPT terminators. And copycat products are generations behind in terminator technology. With a full line of FPT products, Aeronics is the undisputed leader in terminator engineering and manufacturing — our business is terminators, not connectors. That's why when companies like IBM, Unisys, Sun and Chase Manhattan need a solution to troublesome SCSI bus performance, they specify Aeronics' FPT terminators.

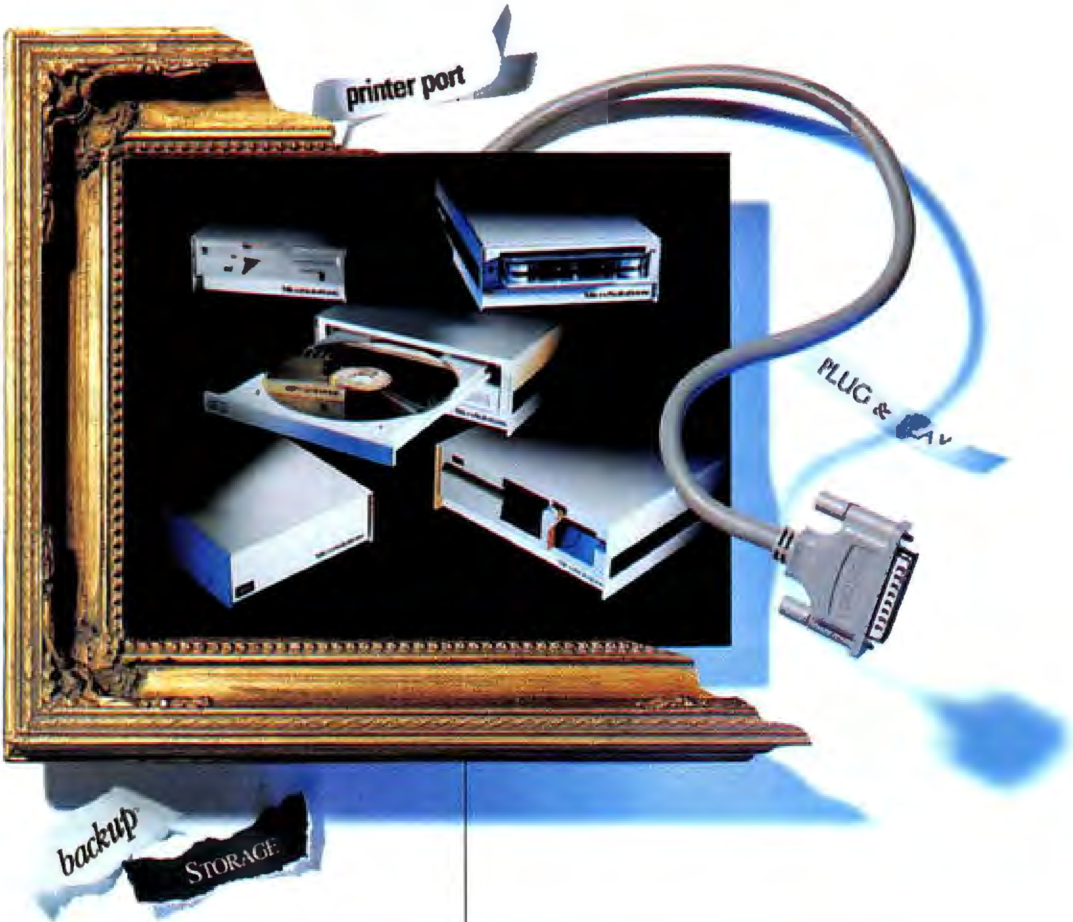
Fax us your system configuration along with the problems you're experiencing and we will fax back a solution. All Aeronics products are 100% electrically tested, burned in, and backed by our full two-year warranty.

AERONICS INC. ™

Turning concepts into reality.

FAX (512) 258-8441 • TEL. (512) 258-8040 • 12741 Research Blvd., Suite 500 • Austin, TX 78759

Circle 298 on Inquiry Card.



With Backpack's unique printer port connection, family support has never been easier.

Adding additional storage to your IBM compatible, laptop or notebook has never been easier. The *backpack*® family of no-slot drives plugs directly into your parallel printer port to provide you with additional storage instantly. Using them one at a time, or daisy chaining up to four together, there are no interface cards to install so you don't have to open the cabinet of your computer. And because your printer attaches directly to the *backpack* drive, you don't have to disrupt your print operations. With the *backpack* family of diskette, hard, tape or CD-ROM drives, you can easily transport your information wherever you go—just plug *backpack* into the parallel printer port of any IBM compatible or portable. And, of course, all *backpack* drives work with Windows.™ With *backpack*, there's no hassle. Just sit back and enjoy the new member of the family.

**Just plug and play.
It's the no-hassle approach to additional storage.**

MicroSolutions

132 W. Lincoln Hwy. DeKalb, Illinois 60115 Telephone 815.756.3411 FAX 815.756.2928
Call Toll Free 800.295.1214

Circle 295 on Inquiry Card (RESELLERS: 296).

is that you have to maintain PC shares and Mac shares separately. On our NetWare server, a single directory called Temp is available to everyone. With Advanced Server, I had to create Temp twice and deal with two sets of permissions.

Advanced Server lets you set up the systemwide auditing policy so that it records the success (or failure) of file access requests in its security event log. It also lets you fine-tune your auditing policies using File Manager. For selected files or directories, you can adjust the list of users and groups whose actions Advanced Server will audit and the list of actions that it will audit. Advanced Server dumps the audit trail into the security event log, which you can read using the same Event Viewer that you use to explore the system and application event logs.

The Win32 APIs that write and read event logs invite third-party drivers and applications to cooperate with current and future system management tools. Like the standard monitoring techniques exposed through Performance Monitor, the standard logging techniques exposed through Event Viewer bode well for Advanced Server's long-term manageability.

Management: The Dark Side

It's important to keep the manageability of an Advanced Server network in perspective. Widespread adoption of performance monitoring and event logging can vastly improve software maintenance and support. Because both Performance Monitor and Event Viewer are enabled by RPCs (remote procedure calls), I can point them at any NT system on my network, not just my local NT machine. Put on an administrator's hat and imagine how effective you'd be if your users' applications routinely reported trouble—low memory, file not found, unable to print—into standard logs that you could visit remotely.

Unfortunately, this rosy scenario requires NT on both sides of the RPC pipe. Event logging is a part of the Win32 API. Sadly, both Win32s and Win32c, the variant that Microsoft hopes to bring to the masses with Chicago, don't provide it. Thus, event logging isn't going to show up en masse on the client side anytime soon—a real pity because the heaviest support costs pile up on the client side. So while NT and Advanced Server offer tantalizing glimpses of holistic network management, only NT clients can enjoy the full benefits.

Another administrative benefit enjoyed only by NT clients on Advanced Server networks is the RPC-enabled Print Manager. It obviates the need to install printer drivers on clients. A driver installed once on an Advanced Server machine is available, in client/server fashion, to all NT workstations. Advanced Server's user profiles, which enable desktop settings, file and printer connections, and log-in scripts to follow users from workstation to workstation, are also NT-specific. In these cases, Windows 3.x clients are again left out in the cold, although Chicago clients, which can use the Win32 RPC and registry APIs, should fare better.

Even in the NT realm, even just considering server management, there are some key restrictions. A NetWare administrator can dial up a server from anywhere using a DOS laptop and manage that server with RConsole. But while an Advanced Server administrator can dial in from either Windows 3.x or NT clients, that person won't often be able to tuck an NT machine into a briefcase.

If you're one of the lucky few who can tote NT, you're still not home free. While many administrative tasks can be performed in client/server mode, others—including the control of services and the installation and configuration of drivers—require local access to the server. Lacking an X Windows System–like solution, Microsoft will not have an answer to this problem until the debut of Hermes, the suite of NT-based network management technologies due later this year. One Hermes feature is a remote screen/keyboard/mouse capability.

About the Products

SQL Server for NT
Desktop, $995; 10 users, $2995; 64 users, $7995; unlimited users, $14,995 (Intel) or $19,995 (RISC)

NT Advanced Server
Unlimited users/all platforms, $2995

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-8661
(206) 936-8661
fax: (206) 936-7329
Circle 993 on Inquiry Card.

A Matter of Trust

A domain unites a group of servers into a single administrative unit. The idea is that you can log in and supply a password just once and then access any secure shared resource on any server. The reality falls a bit short because the MS-Mail address book doesn't yet integrate with Advanced Server's account database. Of course, Novell users have the same problem. Even in NetWare 4.0, the MHS address book isn't an integral part of the NDS (NetWare Directory Service).

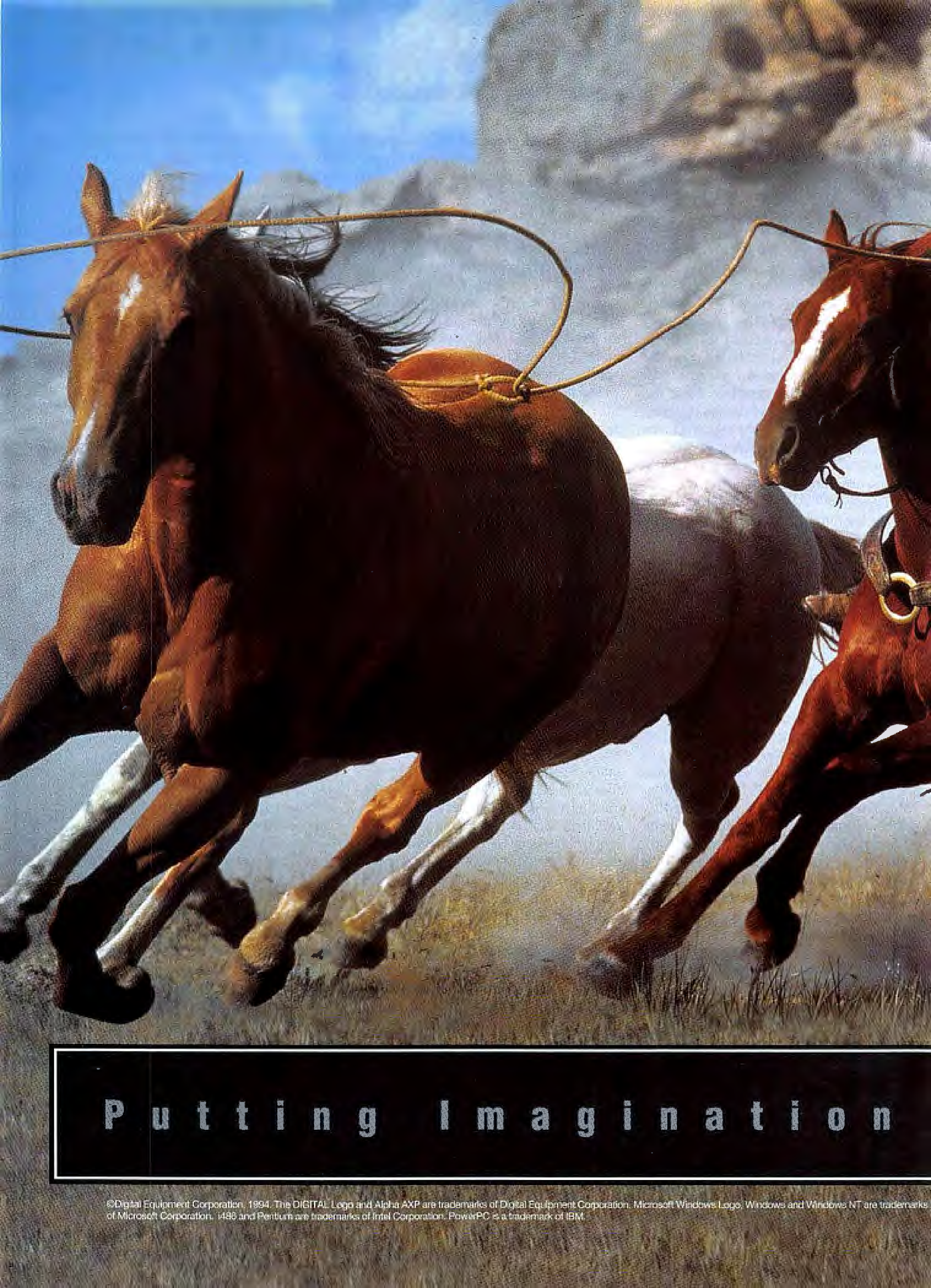
In other respects, though, Advanced Server's domain-based security works as advertised and benefits greatly from the new ability to set up trust relationships between domains. If the administrator of Domain A agrees to trust Domain B (and B's administrator permits A to trust B), then B's users and groups can be granted explicit rights and permissions in A. This is actually easier to do than to explain. Basic trust relationships are a lot less confusing than global groups (which can contain users from just the current domain but can be referenced in foreign domains) and local groups (which can contain users from foreign domains but can be referenced just in the current domain).

Trusted domains can enable a bottom-up approach to the construction of large networks that's very different from the top-down approach required by NetWare 4.0. Advanced Server domains can evolve independently and then join in trust relationships if necessary, so you can delay enterprise-wide decisions about network structure. Novell's all-encompassing NDS forces you to design the enterprise-wide structure up front.

There's a key inhibitor to the organic growth of Advanced Server networks, however. I originally set up my two Advanced Servers as controllers of separate domains so I could explore trust relationships between the domains. My plan then was to convert one server to be a backup domain controller in the other's domain. No such luck. You can easily move an NT workstation from one domain to another, but to move an Advanced Server, you have to reinstall. With that discovery, multidomain networking suddenly looked a lot less flexible.

The bottom line? NetWare 3.11's in place, and it does the job. When it's time to upgrade our two 8-MB 386-/486-class servers, I'll likely recommend NetWare 4.0. For a population of NT workstations, Advanced Server makes a lot of sense. But for DOS, Windows, and Mac users, there's no compelling advantage. ■

Jon Udell is a BYTE senior technical editor at large. You can reach him on the Internet at judell@bix.com.



Putting Imagination
©Digital Equipment Corporation, 1994. The DIGITAL Logo and Alpha AXP are trademarks of Digital Equipment Corporation. Microsoft Windows Logo, Windows and Windows NT are trademarks of Microsoft Corporation. i486 and Pentium are trademarks of Intel Corporation. PowerPC is a trademark of IBM.

Almost as Good as Being There

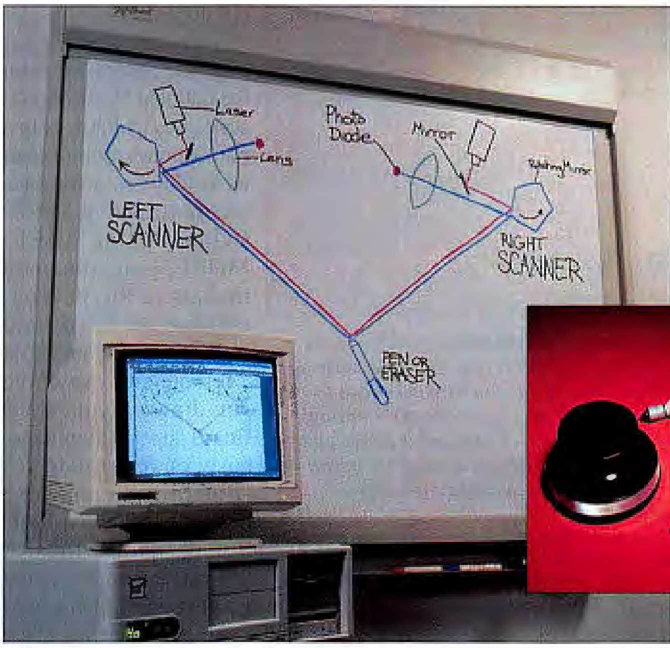
New technologies improve long-distance conferencing

HOWARD EGLOWSTEIN

Teleconferencing isn't exactly a new idea. If you've got the camera equipment, satellites make it possible to bounce live video across the country or around the world. New PC-based videoconferencing hardware promises to provide similar benefits at less cost, letting you get your point across long distance over high-speed phone lines. The real low-cost solution, however, is so-called document conferencing or whiteboarding software (see the text box "Whiteboarding with Software"). Although they don't yet support video images, packages like Fujitsu's DeskTop Conferencing or Modus Software's Synconference let you collaborate on computer-generated images and documents over standard telephone lines using modems, through a LAN connection, or both.

This review looks at two unique hardware products designed to augment conferencing software. Microfield Graphics' SoftBoard ($2995) gives you both a real whiteboard and the remote benefits of whiteboarding software. The SoftBoard is a high-quality porcelain whiteboard with an infrared laser scanning system that tracks every stroke, and even the color, of your pen. With the included software, you can record your drawing sessions stroke by stroke. There's also optional software available that lets you send the session live over a modem connection.

AT&T Paradyne's $535 DataPort 2001 modem simplifies your teleconferencing setup by merging voice and computer data over a single phone line—transparently to most software. By eliminating one phone connection, it also lets you share and discuss data with people who don't have the luxury of separate voice and data lines.



Microfield Graphics' SoftBoard, *a porcelain/steel whiteboard, uses lasers to scan the surface and report any pen activity to an attached computer. Included Windows or Macintosh software converts your drawings into viewable images.*

Each of the SoftBoard's pens *has a specially encoded reflective collar so the laser can identify the pen and determine its color. The larger eraser uses a similar reflective surface.*

Microfield's SoftBoard

It's hard to find a conference room anywhere that doesn't have a whiteboard, and people often have one in their private offices to stimulate their creative juices. There's something magical about having a huge surface that you can walk up to and draw on with a nice fat pen.

The biggest problem with whiteboards (besides figuring out how to clean the erasers) is that there's no easy way to record what you've drawn. Some people videotape their whiteboard presentations and play them back through video boards on their computers. Some whiteboards have scanners that can read in a finished drawing and print out a copy on thermal paper.

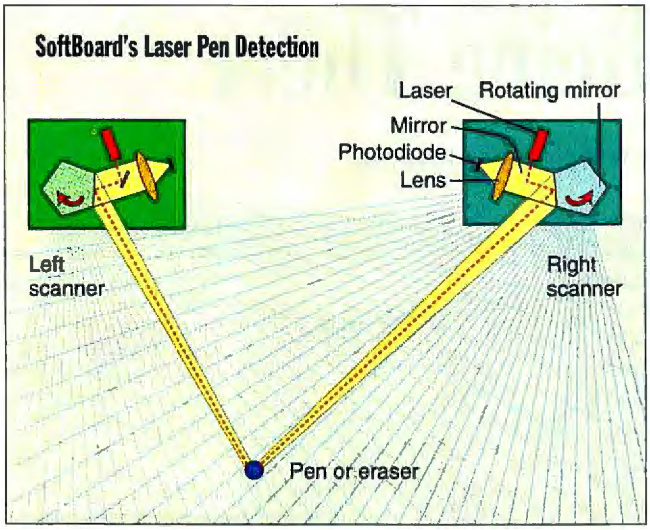
Microfield's solution, called SoftBoard, uses a pair of lasers and sensors to scan the surface of an otherwise ordinary whiteboard. When you connect the SoftBoard to a computer running Microfield software, you can record a presentation, print the resulting drawings, or send a blow-by-blow representation of your whiteboard session to a remote site.

The pens have special reflective collars near their tips, and the eraser has one, too. When the sensors see the laser reflect from a pen's collar, software running on a 40-MHz Texas Instruments DSP (digital signal processor) uses triangulation to determine the position of the pen on the surface. The DSP can figure out not only the position but also the color of the pen you're using, because each pen has a different collar pattern.

The lasers scan the board 416 times each second and can discern 80 data points per second. Pen position is reported more accurately in the center of the board, although I found the results to be more than acceptable right up to the edges. The system can track only one pen or eraser at a time, and you must not block the coded collar with your finger while you're writing. The board measures 60 inches wide by 54 inches tall and has an active writing area of 54 inches by 40.5 inches.

Pen-stroke and color information is encoded into a 4800- or 9600-bps data stream and fed through a standard RS-232 connection. The data stream encapsulates your strokes as vectors, including all pen-up and pen-down motions. The scanning lasers are active up to about a quarter of an inch above the surface, so you must lift your pen deliberately between strokes.

Windows software (SBRECORD) interprets the data stream and re-creates the whiteboard drawing in real time on-screen. SBRECORD can save your drawing, along with the real-time information used to create it, in a file for later playback. The vector representations used to save the information are quite efficient—a drawing that



Infrared lasers in the two upper corners of the SoftBoard *each emit a beam onto a five-faceted mirror spinning at 5000 rpm. The reflected beams effectively scan the entire surface of the board 416 times each second. Any beam hitting a special reflective surface on one of the erasable marking pens or on the felt eraser bounces back and is picked up by a photodiode. A 40-MHz DSP notes the rotation angle of the mirror and uses that information to determine the beam deflection angle. Comparing the angles from both laser/mirror/diode systems, the DSP triangulates the object's position. Bar-coded patterns on the pen tips let the DSP figure out the pen color.*

took 5 or 10 minutes to draw and used about a hundred pen strokes took only 30 KB on disk.

A set of controls, similar to VCR controls, at the top of the playback window allows you to play the image forward or backward, at real time or high speed. If you give a sales presentation to a group and capture it via SBRECORD, you can send it along with a companion play-only package (SBVIEW) to anyone who wasn't able to attend your meeting. SBVIEW plays back the captured file exactly the way you presented it. SBVIEW is also freely distributable, so you can use your SoftBoard to create a presentation and distribute it along with a copy of SBVIEW. (SBVIEW and a sample SoftBoard file can be downloaded from BIX or BYTE's BBS. See page 5 for details.)

SBRECORD can also export a drawing as a Windows metafile (WMF format) or as a bit map. A number of Windows applications support these formats. Using CorelDraw and Illustrator, I moved a drawing off the whiteboard into EPS format without difficulty.

If all you need is a hard copy of your artistry, attach any Windows-compatible (or, for the Mac version, Macintosh-compatible) printer. I found a Hewlett-Packard 1200C/PS color ink-jet printer to be a perfect match for the SoftBoard. I set the printer to run in PCL 5c (color PCL) mode using HP's drivers. Attached to a 33-MHz 486 PC, it typically took less than 15 seconds after selecting SBRECORD's print function before the printer started churning out copies.

Teleconferencing capability comes through the optional SBREMOTE software, which was in a beta version when I tested it. This is a remote-access version of SBRECORD. Using SBREMOTE, you connect a modem to the PC controlling the SoftBoard and dial up another PC at a remote site. Anything you draw on your SoftBoard appears simultaneously on the remote PC. If that remote machine happens to have a SoftBoard, too, the folks at that end can draw on their board, and their drawing appears in a window on your PC.

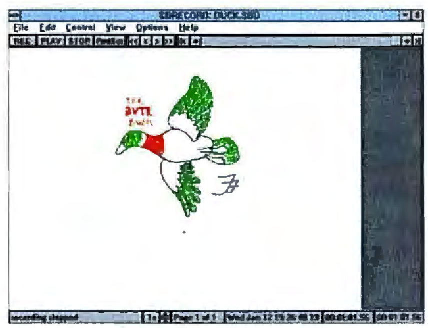
The remote software requires a high-speed modem. The beta version was set up for a limited selection of modems, but it worked amazingly well with a Practical Peripherals PM14400FXMT 14.4-Kbps modem. To connect the modem and serial SoftBoard at the same time, however, you'll need a PS/2 or bus mouse; three serial devices is one too many. Since a large number of clones ship with serial mice, check your machine configuration if you plan on running the remote software.

I also looked at a pre-beta copy of SBRECORD for the Mac. It works the same way as SBRECORD does under Windows. The interface has many of the same control elements as the Windows version and should be able to interchange files with its Windows cousin. The beta version I used didn't have the file interchange working yet. Microfield wasn't ready to announce any plans for other platforms or other Macintosh support.

Although the product is shipping, Microfield is still tuning a few details. Mounting the board requires a delicate touch. The drawing surface has to be held nearly flat and against a good, steady surface. A standard gypsum-board wall will do fine, and that's what the company expects you to have. My review unit came with four carefully machined mounting studs, one for each corner. Two simply attach to the wall with supplied wall mounts (molly bolts for hollow wallboard), and the other two have adjustable screws that let the mount move in and out. You use a template supplied with the board, drill holes for the molly bolts, attach the mounts, and slip the board's four keyhole slots over the mounts. Once you get the board mounted, a simple alignment procedure helps you adjust the two lower mounts in and out until the board is as flat as possible.

I had two significant problems trying to get the board mounted. First, the wall I needed to use was solid concrete, and there was no way to get Microfield's molly bolts into it. I ended up using masonry slugs and lag bolts to attach the board. The lag bolts were fatter than the recommended bolts, and the precision board mounts wouldn't fit over them. It took some trial and error, but two of us managed to maneuver the 60-pound (27 kg) board onto the four bolts. Without the fancy mounts, however, it took some doing to adjust the corners so that the surface was flat. I made those adjustments by turning the lag bolts to move the heads farther from or closer to the wall.

Microfield's alignment software bounces the laser beams off special reflectors at the corners of the board, measures the error, and suggests how to turn the adjustable



Microfield supplies software *(Windows version shown) that captures the data from the SoftBoard, displays it on-screen, and saves it for future playback. The software controls simulate a VCR and allow the drawing to be played back at any speed, forward or backward, and let you print the image to any Windows-compatible printer. With SBREMOTE, an optional program, you can transmit an image as it's drawn to a remote site over any high-speed asynchronous modem.*

mounts. The numbers change radically with even small adjustments, and the software makes the tiniest error look like you've just killed your best friend. (Microfield is planning to change the software to be more forgiving.) The board had to go on

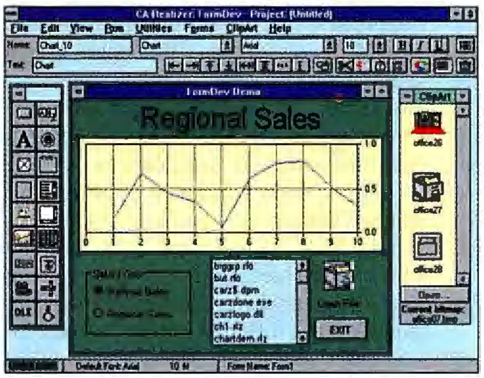
A Better Basic.

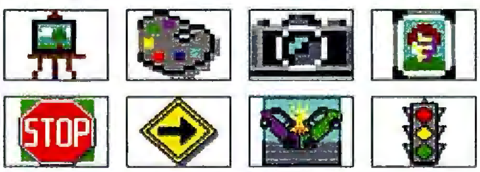
New CA-REALIZER® 2.0 Beats Visual Basic 3.0.

Compared to Visual Basic 3.0, CA-REALIZER® 2.0 is half the cost and twice the product.

CA-REALIZER is already the easiest, most powerful BASIC for Windows and OS/2, and with version 2.0 it's even better. No one can match our combination of features, ease of use, and price. No one can make it easier to port your applications from QuickBASIC, and no one can make it more fun to develop for Windows and OS/2.

CA-REALIZER also comes with a huge array of powerful, plug-and-play tools like spreadsheets, charts, text editors, animation, graphics tablets and database forms, along with many features other BASICs don't offer. Arrays are re-dimensioned and processed automatically. Algorithms can be written as formulae instead of complex looped expressions. Once an application is complete, compile it into a stand-alone OS/2 or Windows application and distribute it royalty-free with the run-time module that's included. And you can generate an installation disk with the push of a button.





PC Computing said, "No other Windows BASIC can match it for power and breadth of features."

1992 W 100 WINDOWS MAGAZINE ANNUAL WIN AWARD

BEST SPRING 1991

1991 BYTE AWARD OF MERIT

At $99, no one can match our price either, and it includes our award-winning Windows report writer absolutely FREE.

Only CA-REALIZER Gives You All Of This:

- Develop for Windows and OS/2
- Create and save libraries of pre-coded and formatted controls dynamically from within REALIZER
- Use any standard Windows and OS/2 custom control in FormDev
- Integrated Programmable Application Tools such as Charts, Spreadsheets, Text Editors, Graphics, Animation, and a Scheduler
- Easy migration of QuickBASIC applications to Windows and OS/2
- Import/Export Of 1-2-3, Excel, CA-Supercalc, CA-Compete! & Xbase Files
- Interactive WYSIWYG application design
- Generation of user accessible & modifiable BASIC code
- Full support for DDE and DLLs
- Instant database forms from DBF files
- Dynamically expandable multi-dimensional arrays with a full range of array and matrix operators and functions

MICROSOFT WINDOWS. COMPATIBLE

Call 1-800-225-5224, Dept. 25500
Today Or See Your Local Dealer.

This offer is good for a limited time only. Call today and find out how much better BASIC can be.

COMPUTER ASSOCIATES®
Software superior by design.

New CA-REALIZER 2.0

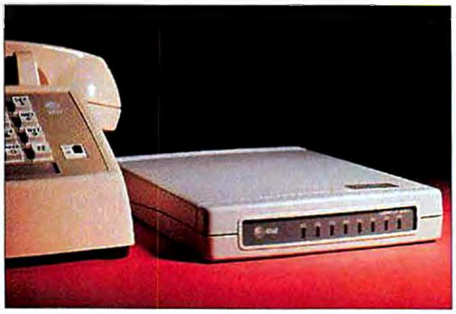
Circle 75 on Inquiry Card.

and off the wall several times before I got the bolt heads at exactly the right height. Microfield is working on a new mounting design that should make the entire process easier and more flexible.

If your conference-room wall is made of anything other than standard wall board, plan on using a bit of creativity to get the SoftBoard mounted, or check with Microfield for suggestions. But even with the mounting difficulty, I had the board out of the box, mounted, and connected to a computer in less than an hour.

The SoftBoard sells for $2995 with a mounting kit, eight coded pens (two each of red, green, blue, and black), an eraser, a cable, and SBRECORD/SBVIEW software either for the PC under Windows or for the Mac. That price is high only when compared to a standard mute whiteboard or a software whiteboarding package—it compares favorably to whiteboards with built-in copiers and is far more versatile.

The Windows SBREMOTE software will sell for an additional $290. If you want the standard software for both PC and Mac platforms, the second platform will cost you $190. Supply costs are reasonable. A box of four pens goes for $7.95, and 12 boxes for $90. Erasers are either $9.95 or $4.95, depending on whether you replace the whole eraser or just the felt pad.



AT&T Paradyne's DataPort 2001 *is a 14.4-Kbps fax/data modem that can combine voice and data into one simultaneous connection. It allows you to send someone a file or a remote presentation and talk with him or her at the same time.*

AT&T Paradyne's DataPort 2001

The DataPort 2001 Multimedia Communicator isn't the first 14.4-Kbps data/fax modem in AT&T's family of DataPort modems. But it is the first to use AT&T's VoiceSpan technology, which lets you simultaneously talk and transfer data over the same phone line. VoiceSpan employs a single DSP to encode both voice and data signals.

Putting both signals on one line has benefits for almost any type of person-to-person communications session. Say, for example, that you're talking with a sales manager across the country and she requests a current copy of your product price list. If you both have a computer and modem attached to second phone lines, you can continue your conversation while the computers move the data. If a second line is not available, you have to hang up the phone and then set up the data connection, and if one of you isn't familiar with your communications package, the other can't help.

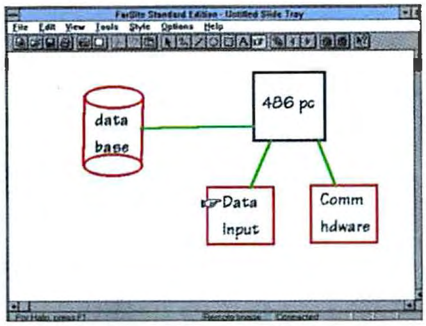
With phones connected through two DataPort 2001 modems, it's another story. Anytime during a voice call, you can set up communications software to dial out on one computer and answer calls on the other. At the calling end, the DataPort modem pretends to dial out, returning the signals necessary to keep the communications program satisfied. At the answering end, the other DataPort modem pretends to answer the call, also providing any necessary signals to the software. Even though you have been talking on the line the whole time, the two software packages think they have established a connection on an idle line.

In cases where you have established the data call first, you simply pick up a phone at one end to talk. This causes the DataPort 2001 modem on the other end to make ringing sounds, prompting the other person to pick up the phone. The modems maintain the data connection while you talk. The DataPort 2001's ability to make both voice and data connections will work transparently with most software and on any computing platform. I tried it with PCs, Macs, and a dedicated Canon word processor, with no problems.

The only catch is that you can't send data at 14.4 Kbps and talk at the same time. Data transfers at 14.4 Kbps require most of the available bandwidth on a standard telephone line. Adding a simultaneous voice channel eats into that bandwidth, so when a full-duplex voice channel is active, the maximum data rate drops to 4800 bps.

In some situations, you don't need a full-duplex phone connection. If, for example, you're using the DataPort to transmit a sales presentation to a remote site, the presenter will need to talk, but the person on the other end of the line will only be listening. If you want full 14.4-Kbps speed for a data transfer, you can disable voice transmission from your end with a hook flash (i.e., a quick press of your phone's hook switch). The other person can continue both to talk and to transmit data at full speed. You can reestablish your ability to talk with another hook flash.

The only problems you may encounter with combined voice and data communications are a little bit of echo in the voice



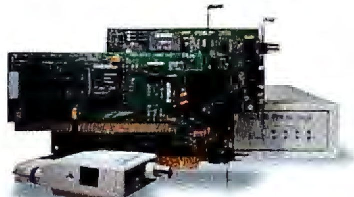
A version of DataBeam's FarSite, *a whiteboard application, comes bundled with AT&T's DataPort 2001 and complements the DataPort's voice/data capability. FarSite allows two computers to share a simulated whiteboard, transferring drawn graphics and pre-made slides over a modem connection.*

channel and configuring your application to talk to the modem. Like other high-speed modems, the DataPort 2001 can generate some unusual status messages that communications software may not understand without configuration.

AT&T bundles the DataPort 2001 with a version of DataBeam's FarSite for Windows, a typical electronic whiteboard program. In a nutshell, an electronic whiteboard connects two machines by modem, or two or more machines over a LAN. (The bundled FarSite doesn't provide LAN support.) Using the simple drawing tools provided, you can pen a flowchart, sketch a design on-screen, or annotate a preexisting image. The other participant in the "meeting" can see the drawing happen in real time and make additions, too.

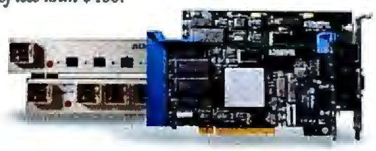
FarSite tools consist of predrawn bit maps (called *slides*) and line, circle, rectangle, and text tools that work in many colors and sizes. Slides can come from just about anywhere, and the program supports a dozen different import formats, including PCX, TIFF, Windows or OS/2 BMP, EPS, and GIF. Either end of the connection can load a slide, grab an annotation tool, and point out salient features.

You can, for example, create a graph in Excel, grab the screen, paste it into a slide, and then save it as part of a FarSite slide tray. Later, when you establish the connection to another FarSite machine, a click or two on the mouse transmits the slide across the connection. You can then draw a circle around an important data point, or



Token Ring.

TokenRx. A line of Token Ring network adapters and multi-station access units that feature on-site support by IBM's own Customer Engineers. The adapter cards feature 100% IBM driver compatibility, the IBM designed TROPIC chip and a retail price of less than $400.



Ethernet.

Our EtheRx family of ISA and EISA Ethernet network interface cards, dual interface pocket adapters, concentrators and transceivers provide solutions for a wide range of Ethernet connectivity needs. With uncompromised reliability and compatibility plus value pricing, EtheRx is the ideal Ethernet choice.

PCMCIA Ethernet Cards.

Combining industry leading performance with a retail price of less than $200, EtheRx PCMCIA cards are setting new standards for portable connectivity. They are available in both 10Base-T and 10Base2 versions, support the widest range of Type II compliant notebook, laptop and desktop systems and are compatible with all popular network operating systems.

OUR LARGE STRIDES IN MEMORY HAVE LED US INTO NETWORKING.

Certified Compatibility.

Kingston networking products are certified compatible with Novell Netware, Microsoft Windows for Workgroups and LANManager, Artisoft LANtastic and support every other popular network operating system including IBM OS/2 Extended Edition and Banyan VINES.

yes It runs with NetWare

MICROSOFT WINDOWS COMPATIBLE

LANtastic Compatible Artisoft Labs

Kingston Reliability.

Network users enjoy the same reliability customers have come to expect from Kingston memory and processor upgrades. Every product is individually tested prior to shipping, supported by free comprehensive technical assistance and is backed by a five-year warranty.

More Information.

For more information on the Kingston line of networking products, contact your nearby Kingston dealer or call (800) 435-2620, (714) 435-2600 or fax (714) 435-2699. In Canada: Dynatech, Ltd. (416) 636-3000 or in Mexico: MPS Mayorista 325-09-93 or Ingram Dicom 328-11-11.

[800]

Kingston TECHNOLOGY CORPORATION

THE INSIDE NAME IN UPGRADES

Whiteboarding with Software

One point that confuses many people is the difference between whiteboard software (e.g., DataBeam's FarSite) and remote-control software. The difference is that, while remote-control software literally lets one machine act like a local mouse, keyboard, and screen for a remote computer, most whiteboard software simply transmits images to the remote site. (Fujitsu's DeskTop Conferencing is an exception; it can do both.)

With remote-control software, you can not only see the Excel chart at the remote site, for example, but also enter new data into cells or generate a new chart on the remote PC. If that same chart is displayed in a whiteboard package, someone had to capture the Excel screen and paste it into a predefined slide. You can see what the Excel chart looks like, but it's simply a static image that you can annotate with text or simple graphics symbols. The advantages whiteboarding software has over remote control are that you can prepare a presentation of slides or screen shots beforehand, and showing images is faster than actually going through a program to illustrate a point.

Whiteboard software usually incorporates special tools for annotating images that remote-control software doesn't. You may find tools like lines, circles, rectangles, paintbrushes, and text that you can use freely on the image. Crosswise's Face to Face, which works in both Mac and Windows environments, provides document layers that act as transparent overlays so that annotations from different people can be kept separate.

Most whiteboard software connects one site to one other through a pair of modems; many also support more than two participants through a LAN configuration. I didn't look at it here, but WorldLinx's VIS-A-VIS whiteboard package can support more than two participants if you have a multiport serial card, giving you the benefits of a LAN connection without the LAN.

indicate it with the pointer tool. Coupled with the simultaneous voice capability of the DataPort 2001, FarSite is a very effective application.

Drawing to a Close

Microfield's SoftBoard is a sophisticated input device that lets you make presentations to large groups or brainstorm ideas and then print them out, play them back, or send them electronically to colleagues who can't physically attend a meeting. I find a whiteboard pen to be an incredibly empowering drawing device, letting me think much better than I can when trying to sketch with a mouse.

Using whiteboard software is an effective way to teleconference without wasting the bandwidth (and expense) of a video connection. Two sites can effectively develop ideas cooperatively on an inexpensive voice-grade phone line. AT&T's DataPort 2001 allows you to establish this connection between any two asynchronous computers, regardless of platform, without sacrificing voice communication or using two phone connections.

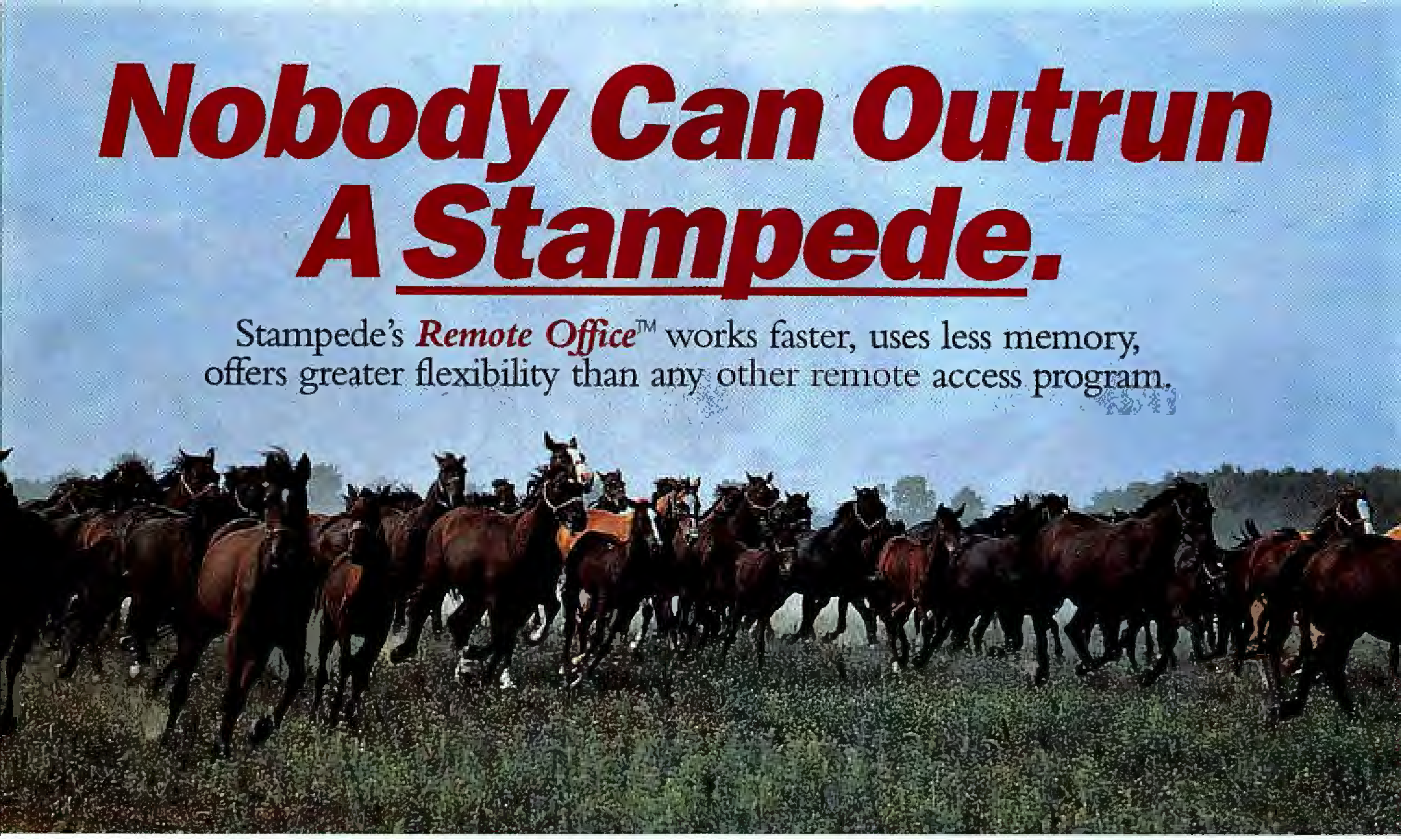
With the combination of the SoftBoard and a voice/data modem like AT&T's DataPort 2001, you can connect your remote offices to in-house meetings with no more trouble than simply calling from a speakerphone. ■

About the Products

DataPort 2001 ....$535
(includes DataBeam's FarSite software)
AT&T Paradyne
8545 126th Ave. N
Largo, FL 34643
(813) 530-2000
fax: (813) 530-2875
Circle 1075 on Inquiry Card.

SoftBoard $2995
(includes SBRECORD and SBVIEW software; SBREMOTE remote-access software for Windows is a $290 option)
Microfield Graphics, Inc.
9825 Southwest Sunshine Court
Beaverton, OR 97005
(800) 334-4922
(503) 626-9393
fax: (503) 641-9333
Circle 1076 on Inquiry Card.

Howard Eglowstein is a BYTE testing editor. You can reach him through the Internet or on BIX at heglowstein@bix.com.



Your remote PC becomes a true node on the network – with the fastest system in the field.

Consider the advantages:

FLEXIBILITY. Access any server, printer, gateway or desktop PC on your network from anywhere in the world!

Remote Office is the only product that runs on a non-dedicated DOS-based PC host. It can support virtually any networking environment. And, it's upgradable – to 32 ports – to protect your investment.

PERFORMANCE. Stampede's *Remote Office* runs right over the competition. Compared to Novell's NetWare Connect, it's 19% faster on average, 20% faster on E-mail.

Greater speed means less time on the line – cutting your costs.

Need proof? Check the Labs Review in the 12/27/93 issue of **PCWeek**, comparing *Remote Office* to *NetWare Connect*. Their findings: *Remote Office* "faster, easier to install... better protocol support... user-friendly... provided more useful management information."

SMALL MEMORY FOOTPRINT.

Ours is just 24K on the remote PC – smallest in the business, roughly a third that of competitive systems. ***More room for memory-hungry programs, less need for static RAM.***

Free DigiBoard!

SAVE $100, AND GET A DIGIBOARD ACCELERATOR CARD, FREE!

Just $295

Order now, and we'll not only knock $100 off the price of our *Remote Office* 2-port version software (Reg. $395), we'll also throw in a 2-port DigiBoard, free! You pay just $295! Limited time only.

Call 1-800-R-Office (763-3423).

Offer available in the U.S. and Canada only.

DigiBoard® Multisession Accelerator. *2-Port DigiBoard Serial Communications Board • 64K of dual memory to interface with the Remote Office™ host • 8 MHz 80186 onboard processor • 8 Kb memory window • Uses standard DB-9 connectors • Requires one 3/4 length 16-bit slot, one unused I/O port address, one unused IRQ interrupt request line.*

Operating Systems and Environments:
MS DOS 3.1 or higher
LAN Operating Systems: Novell® NetWare® 2.15 or higher • NetWare Lite 1.0 or higher • LANtastic™ 4.0 or higher • Windows™ for Workgroups 3.1 or higher • Banyan 4.01 or higher.

STAMPEDE

STAMPEDE TECHNOLOGIES, INC.
78 Marco Lane, Dayton, Ohio 45458 USA
Telephone 513-291-5035 Fax 513-291-5040

MICROSOFT. WINDOWS. COMPATIBLE

yes It runs with NetWare

yes NetWare Tested and Approved

Circle 171 on Inquiry Card.

Multiprotocol Print Server

Axis Communications' NPS 550 Ethernet print server adds multiprotocol smarts to any printer

BEN SMITH

Today's multicultural networks make sharing peripherals complicated. With various PCs, Macs, and Unix boxes linked through the same cable, a shared printer must understand several LAN protocols in addition to juggling print jobs. Many modem printers understand multiple protocols, though at some extra cost, through their built-in standard or optional network connections.

A more effective and flexible way to make printers available to all systems on a network can be an external multiprotocol print server. These small boxes attach several printers directly to a network, interpreting various LAN protocols and managing job flow. A good one like the Axis NPS 550 Ethernet print server ($695) can also simplify administration.

While a print server can turn older printers into network printers, it can also be a better buy than a new network printer. That's because printers become technologically obsolete long before print servers do. If you pay more for a multiprotocol network printer, you throw away that extra investment when you replace the printer.

You can move plug-in print-server cards from one printer to another, but only as long as you stick to one printer family. A card designed for a Hewlett-Packard LaserJet II, for example, will not work in a QMS printer. An external print server works with almost any printer and can attach more than one printer to a network.

There are more than just financial advantages to going with an external print server. You get a dedicated processor that can manage print jobs coming from multiple sources and provide higher throughput. With the NPS 550, you also get Axis Communications' *virtual printer* technology, which vastly simplifies the problems of providing different printer configurations for different users.

The NPS 550 provides eight virtual printers, each of which is a custom printer configuration that you can select by name. You can, for example, set one virtual printer to use the letterhead tray and another to use the plain-paper tray. To the network user, the virtual printers appear as separate printers, whereas they may actually be the same physical device but with different print-control values.

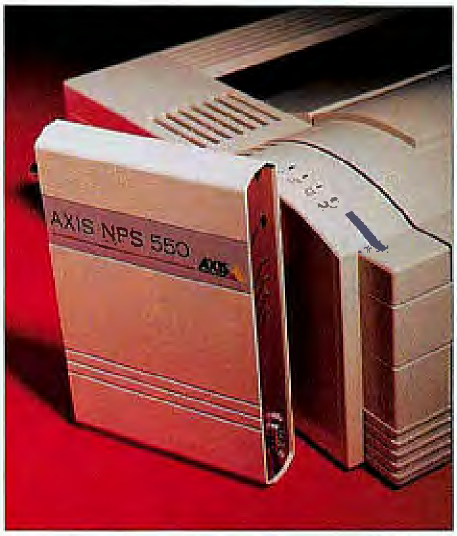
Axis's automatic ASCII-to-PostScript conversion lets you print ASCII files on PostScript printers. The NPS 550 will detect ASCII files sent to any virtual printer set for this feature and wrap them with PostScript code.

You can connect the NPS 550 Ethernet print server to either thin Ethernet (10Base-2) or twisted-pair Ethernet (10Base-T). The NPS 550 automatically and simultaneously handles TCP/IP, Novell NetWare, Apple EtherTalk, and NetBEUI, and it interfaces with Unix (BSD, System V, and AIX), IBM MCS, MS-DOS, Microsoft Windows, Novell Portable NetWare, and Apple Mac OS. (The unit I tested did not support NetBEUI; the current product does.) Axis also sells the NPS 530, a pocket print server that supports Novell NetWare and NetBEUI for $399, and these plus TCP/IP and Apple EtherTalk for $599. The NPS 650 is a multiprotocol Token Ring print server that supports Novell NetWare and NetBEUI for $795, and also TCP/IP for $995.

With the NPS 550's two Centronics parallel ports and one nine-pin RS-232 serial port, you can simultaneously drive three printers. I tested the NPS 550 with a Dataproducts LZR 965 PostScript printer attached to one parallel port; the capability to wrap PostScript around plain text was invaluable. I hooked an HP LaserJet 4L, a PCL-controlled printer, to the second port.

The parallel ports are rated at above 100 KBps (with burst rates as high as 250 KBps)—more than fast enough to handle two HP LaserJet 4Si MX 600-dpi printers. You can set serial-port transmission as high as 38.4 Kbps and select either XON/XOFF (software) or RTS/CTS (hardware) handshaking. As serial printers are almost an extinct species, you'd typically use the serial port to connect to a plotter or specialized display that uses only serial communications. The serial port is on the front of the 8- by 5- by 2-inch NPS 550.

The front panel has four status LEDs to indicate power, network activity, printer activity, and print-server status. Also on the front is a test button. In addition to printing out a simple test page with some basic statistics and operating instructions, you can use the button to print out the entire set of more than 150 parameter settings, plus the 17-page set of installation and integration instructions that reside in ROM—a truly nice feature. Those little network peripherals manuals always seem to be somewhere else when you need them.



With one serial port *on the front and two parallel ports on the back, the Axis NPS 550 can connect three printers to a 10Base-2 or 10Base-T Ethernet LAN.*

Evaluating the NPS 550

I found the NPS 550 easy to install and use in the NetWare, Apple EtherTalk, and most Unix TCP/IP environments. With NetWare 3.11, I only had to run PCONSOLE to add a print server (the name must include the Axis serial number) and then assign the print server to a NetWare print queue. I had some difficulty making the second port available through NetWare. (The relationships between NetWare print servers, print queues, print jobs, and the utilities to configure them weren't very clear to this Unix-minded reviewer.)

The Mac installation was easy. When I powered up the NPS 550, it advertised its existence to Apple EtherTalk clients. Mac users on the network just needed to select one of the Axis virtual printers from their Chooser menus.

continued

Reviews Multiprotocol Print Server

The only complex installation was for the Unix systems. Some of the complexity arose from the fact that Axis provides several different Unix print-spooler interfaces for both System V spoolers and BSD spoolers. Once you use ARP (address resolution protocol) to assign an IP address and name to the print server, you must then decide which program the Unix print spooler will use to communicate with the printer: FTP (a simple copy without any error logging), a named-pipe daemon, or an Axis-written interface to the printer that sends error messages to the user as E-mail. Systems with BSD's `printcap`-based print spooler also have the last option.

The source code and installation instructions for all these methods exist in the print server's ROM. You copy the instructions to each of your print-spooler hosts using `ftp`. The named-pipe daemon, however, requires a compiler for installation on your system. (Even without a Unix print spooler, you can still print by copying your file to the printer with `ftp`. This is also a way of testing the basic setup.)

You can manage the Axis server from any system that has an `ftp` utility—even a Macintosh, if you have FTP for your Mac. You can also use menu-based DOS and Windows interfaces provided by Axis, or you can go with an SNMP interface program. The FTP method consists of downloading a configuration file, editing it, and then uploading it to the print server—a method very much in the Unix tradition. Axis has cleverly written the print server's FTP daemon to give you informative error messages when you send improper configuration settings to the print server.

I found the on-line instructions and the 50-page user's manual clear and comprehensive. For an extra $30, you can get an optional technical-reference manual, an excellent work of documentation that not only tells you what to do but provides some of the theory of why you do it and how the system works. This manual is necessary to fully appreciate the value of the print server, and I think Axis should package it free with the hardware.

Operating Parameters

Sitting on a shelf with a few cables plugged in and its LEDs flashing, the NPS 550 seems an unpretentious little box. When, as a network user, you access a printer attached to the NPS 550, you won't even know the print server exists; its operation is so transparent as to be invisible. When you access the NPS 550's configuration information as a network administrator, however, you will be duly impressed.

From top to bottom of each protocol stack, the NPS 550 is an example of fine engineering and attention to detail. The more than 150 operating parameters that you can modify are a clear symbol of its design quality. For example, you can set the Centronics parallel-port interface timing to three settings: slow (25 KBps), for older printers that don't support standard Centronics timing; standard (the default), up to 90 KBps; and fast (up to 125 KBps), for printers like the HP LaserJet 4Si MX.

You can also specify an action when a job arrives for a printer that's already busy; for example, have a secondary printer handle the job. There are parameters that hold the logical printer names that will be advertised on Macintosh printer Chooser lists. Also, there are parameters that you can use to optionally map NetWare print queues to logical printers within the NPS 550 rather than on the NetWare server.

The largest collection of parameters is dedicated to defining each virtual printer. They define the physical printer that a virtual printer represents, the control strings sent to the printer before and after a print job, string and byte substitutions for the incoming data string, whether to enable text-to-PostScript conversion, actions taken when a virtual printer gets a Printer Busy signal from the physical device, and even a flag for a hex dump mode.

Other parameters describe the PostScript that is wrapped around text when that feature is enabled: character font and size, page size and orientation, margins, and line spacing. A virtual printer can even map one of seven 7-bit ASCII character sets (ISO 8859-2, UK English, German, French, Norwegian/Danish, Swedish, and DEC) to the 8-bit IBM PC Set 2.

Not only is the NPS 550 an efficient way to connect printers to Ethernet, it is also a versatile "black box" that you can put between your applications and your printer. As such, the NPS 550 print server is a valuable addition to any Ethernet LAN that needs shared printers. ■

Ben Smith is a testing editor for the BYTE Lab. You can reach him on the Internet at ben@bytepb.byte.com or on BIX as "bensmith."

About the Product

NPS 550 Ethernet print server........$695
Axis Communications, Inc.
99 Rosewood Dr., Suite 170
Danvers, MA 01923
(800) 444-2947
(508) 777-7957
fax: (508) 777-9905
Circle 1085 on Inquiry Card.

"What to do when Windows™ won't work."

INCREASE SPEED

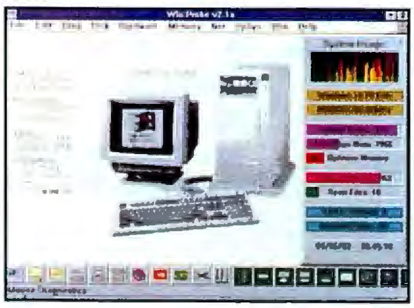
WINProbe uncovers the secrets to faster Windows operation. Simply click your mouse on "Tune Up" and **WINProbe** analyzes your system, then gives you up to 35 suggestions on how to speed up your system...

- Analyzes SmartDrive settings to improve hard drive performance
- Identifies and explains how to set up a permanent swap file
- Identifies which mode is best, Standard or Enhanced
- Pinpoints the optimum driver for your VGA card
- Optimizes and frees fragmented memory
- Analyzes and suggests the best Windows setup for your system

TROUBLESHOOT YOUR OWN PC

Few things are more aggravating than computer downtime and lockups. You waste time waiting for help and usually pay a dear price to get it when you finally do. Your time is valuable, so let **WINProbe** troubleshoot the problem for you. You'll be able to quickly identify the source of the problem; hardware, software, or configuration. Telephone support time is slashed. Repair bills drop like a rock (50% and more of your repair bills are for diagnosing the problem, **WINProbe** does it for you at NO COST!). Tests include...

- CPU and system board in 16 and 32 bit operation
- Math coprocessor
- Memory; conventional, extended, expanded, and XMS
- COM ports and MODEM control lines
- Floppy drive speed and surface analysis
- Hard drive surface analysis
- Keyboard and scan codes
- Video adapter and screen
- Mouse initialization and interrupts
- Printer operation, output, and cable



Windows SOURCES EXPERTS' PICK

"This $99 toolkit deserves high praise for ease of use, completeness, and accuracy."
Windows Sources

"A bargain worth writing home about."
PC Computing

"WINProbe's most impressive offering is its memory-reclamation capability. This feature alone is worth the price of admission."
PC Computing

RESOLVE SETUP PROBLEMS

Say 'goodbye' to software and hardware configuration and setup problems. **WINProbe** provides helpful information on...

- Installing a new hard drive
- CMOS display and edit
- IRQ, DMA, and UMB usage
- What to do when installing an add-in card
- Cleaning up *.INI and *.GRP files
- Memory allocation and management
- Locating and removing duplicated system files

OPTIMIZE MEMORY

WINProbe includes a memory optimization feature which lets you reclaim memory that Windows applications use but don't properly make available when you're in another program. Now you can avoid system crashes and other problems caused by reduced available memory.

COMPATIBILITY

WINProbe requires an IBM AT, 386, 486, PS/2 or compatible with at least 1MB of RAM, DOS 3.1 or higher, Windows 3.0 or higher, and either a Hercules mono, EGA, VGA, or SVGA video. A mouse is recommended but not required.

BUY WINPROBE OR BUY THE BUNDLE

WINProbe is available by itself or in a special bundle with **PC Certify**, Landmark's DOS troubleshooting software and **Landmark DOS for Windows**, the remarkable DOS-like operating shell for Windows.

2 GREAT DEALS! YOUR CHOICE:

WINPROBE...

ONLY $49

WINPROBE BUNDLE...

WINProbe • PC Certify
Landmark DOS for Windows

ALL 3 PROGRAMS

ONLY $99

TOLL-FREE "We're Here to Help You." SUPPORT

90 Day Money-back Guarantee!

TO ORDER, OR FOR THE DEALER NEAREST YOU, CALL

(800) 683-6696

FAX: (813) 443-6603 • Int'l (813) 443-1331
Mon-Thur:8AM-9PM, Fri:8AM-6PM, Sat:10AM-3PM

LANDMARK
RESEARCH INTERNATIONAL CORPORATION
703 Grand Central Street • Clearwater, FL 34616

EGGHEAD SOFTWARE North America's Software Eggsperts • COMPUSA THE COMPUTER SUPERSTORE • COMPUTER City SUPERCENTER • EB • SOFTWARE ETC

Circle 133 on Inquiry Card (RESELLERS: 134).

Easier Ethernet

Tut Systems' Silver Streak adapter delivers 10 Mbps on plain telephone wire and makes it easier to build small Ethernet LANs

BARRY NANCE

When you are designing a small LAN, ease of installation can be as important as reliability and affordability. Tut Systems' new Silver Streak Ethernet connector promises all three traits by making plain telephone wire (also called *silver satin*) an Ethernet cabling possibility. Where you might once have installed thin Ethernet (or *thinnet*) cable, you can now string silver satin instead and get full 10-Mbps packet transmission.

Typically, you choose a LAN type based on the topology that fits the size and layout of your business and then balance reliability characteristics and cost to further choose cable type (see the text box "Ethernet Cabling Methods"). For small LANs (20 nodes or fewer), a daisy-chain or bus topology is often the best solution, and that has meant using thinnet cable—a high-quality, moderately expensive cable that is difficult to install in tight spaces.

Tut Systems' Silver Streak is a $99 Ethernet connector that borrows technology from the analog world of telephone lines to make digital LAN communications possible over plain, inexpensive, easy-to-install telephone wire. Plain telephone wire lacks the minimum number of noise-reducing twists per foot that is a characteristic of data-grade UTP (unshielded twisted pair) cable. No LAN installer would ever recommend using silver satin to create a LAN—until now.

A network that uses Silver Streak units has size and distance limitations that are similar to those of a thinnet-based LAN. The Silver Streak LAN can have up to 30 Ethernet connections per segment, a minimum distance between nodes of 7 feet, and a maximum cable length of 600 feet per segment (see the table on page 186). A Silver Streak network also uses the same topology as a thinnet LAN: a simple bus or daisy chain.

Silver Streak's Secret

Silver Streak is a small (approximately 2 by 3 by ½ inches) box containing a printed circuit board. The box has a 15-pin connector at one end to connect to the AUI (attachment unit interface) connector found on many Ethernet cards, and two RJ-11 jacks at the other end that attach the silver satin. The box's electronics filter noise from the data signals and match the impedance of the phone cabling to the AUI connector. (An AAUI, or Apple AUI, version for Macs also costs $99.)

Plug Tut Systems' $99 Silver Streak adapter onto your Ethernet card, and you can string inexpensive, easy-to-install silver-satin phone cord instead of thin Ethernet. Silver Streak allows full 10-Mbps Ethernet speed over the UTP phone cord.

With each Silver Streak unit you get good documentation, 20 feet of silver-satin cable with RJ-11 connectors at either end, a terminator, and an in-line phone-cord coupler for extending the network. You use telephone-wire terminators on Silver Streak LANs in the same way that you would use coaxial-cable terminators at the opposite ends of a thinnet LAN. Silver Streak has LEDs that flash to indicate when the unit is working and when collisions take place on the network.

Silver Streak incorporates a specially designed, patented balun. A *balun* is an impedance-matching transformer, most often used to connect coaxial cable to twisted-pair wiring. It converts the impedance of one type of wire to that of another type of wire to prevent unwanted signal reflections. (The characteristic impedance of a cable is the total opposition to AC current flow that a wire would have if it were infinitely long.) Baluns are commonly used with IBM 3270 terminals, for example, to connect to a host computer through twisted-pair cable instead of the usual coaxial cable.

Tut Systems' balun also provides extremely effective signal filtering, which is what allows Silver Streak to get 10-Mbps throughput over silver satin. The manufacturer claims that Silver Streak reduces interference by over 80 dB (decibels), for a ratio of 10,000 to 1, without attenuating the differential mode signal of the data transmission itself.

Performance and Price

I took a multiplatform approach to testing Tut Systems' new cabling technology. I installed four Silver Streak units on four workstations and ran a variety of network software products. In each case, I attached a Silver Streak to the AUI port of the workstation's Ethernet network adapter. I used adapters from Intel (the EtherExpress), Standard Microsystems (the EtherCard Plus Elite 16), and Asante Technologies (the EN/SC Ethernet connector for Macintosh PowerBooks).

In separate tests, I used Novell NetWare, Microsoft Windows for Workgroups, Artisoft LANtastic, and IBM LAN Server to provide the network file- and printer-sharing services. I bought the telephone wire used in the tests from a local hardware store.

In all cases, the Silver Streak units allowed LAN packets to flow normally over ordinary silver-satin phone cord. The Silver Streak technology created network connectivity through a type of wire that for an ordinary Ethernet setup might as well be rope or string.

In researching cable pricing, however, I was surprised to discover that there really isn't a big price advantage in buying silver-satin telephone cord over thinnet cable. A few phone calls to local suppliers of

Ethernet Cabling Methods

Most Ethernet cabling systems use unshielded twisted pair (UTP) or coaxial cable (thin or thick) to carry LAN packets. Twisted pair is just what its name implies—four wires twisted in two pairs. Twisted pair is used in a star topology for 10Base-T Ethernet networks. UTP runs from each node on a network segment to a hub, which may then connect with other parts of the network through a backbone or stacking hub arrangement.

Twisting the wires reduces electrical interference. *Shielding* refers to the amount of insulation around the wire and, thus, its noise immunity. Underwriters Laboratories certifies UTP cable as category 1 (voice grade; also called silver satin), category 3 (data grade), or category 5 (high-speed data grade). A 10Base-T network requires category 3, while category 5 is being used with new 100-Mbps Ethernet systems.

The STP (shielded twisted pair) used in some Token Ring networks looks somewhat like the wire used to carry house current (110 V) throughout your home. STP actually carries a relatively low voltage signal, however, and the heavy insulation is for noise reduction, not safety.

Though more expensive than twisted pair, coaxial cable has more advantages. Thick coaxial cable lets you run greater distances and attach more nodes, because it's less prone to signal interference and attenuation. (For these reasons, coaxial cable is also used for cable TV hookups.) Thin coaxial cable lets you daisy chain. Sections of Ethernet networks using coaxial cable employ a linear bus topology.

Standard Ethernet coaxial, or *thicknet*, cable has a greater degree of noise immunity and is more difficult to damage, but it requires a combination of vampire tap (a piercing connector) and a drop cable to connect to a LAN. The newer thinnet cable is somewhat thinner than thicknet. Although thinnet doesn't carry signals over as long a distance as thick cable, thin Ethernet cable uses a simple BNC connector (a bayonet-locking connector for thin coaxial cables), costs less, and has become a standard for small- to medium-size Ethernet LANs.

In an Ethernet network, the number of connections (or *taps*) and their intervening distances can be limiting factors for a particular cable type. For thicknet, you can use repeaters to regenerate the signal every 500 meters or so. Without repeaters in a long network, standing waves (i.e., additive signal reflections) distort the signal and cause errors. Detection of collisions (i.e., two network adapters trying to transmit at the same time) depends partly on timing; only five 500-meter segments and four repeaters can be placed in series before the signal propagation delay becomes longer than the maximum time period allowed for detection of a collision. Without this limit, the workstations farthest from the sender would be unable to determine whether a collision had occurred.

cable and wire revealed that silver satin costs approximately $35 to $45 per thousand feet, while thinnet goes for $110 to $120 per thousand feet. Once you add in the cost of a $99 Silver Streak at each node, what you save on less expensive cable disappears. LAN cables just aren't that expensive.

If saving on cable price isn't one of Silver Streak's attractions, what is? According to Jeff Ellerbruch of Tut Systems, the company feels that people who are creating or upgrading a small network will like the convenience of being able to buy LAN cable from a hardware store rather than from a supplier of specialized cable and wire. Ellerbruch also said that Silver Streak allows people to take advantage of some existing telephone wiring systems and avoids the need to install a completely new cabling system. Note, however, that you cannot use Silver Streak units to piggyback Ethernet signals on top of an active telephone system. You also can't use data-grade UTP wire with Silver Streak. Only silver satin (category 1 UTP) will do.

One disadvantage of using Silver Streak units and phone cable for your LAN is that you won't be able to upgrade to one of the fast new 100-Mbps Ethernet standards, which require category 5 UTP. And you can't use cable testers from companies such as WaveTek, Fluke, and Microtest to troubleshoot your LAN (see the text box "Verifying Your LAN Cables"). These testing units expect to find themselves attached to data-grade wire and will flunk silver-satin wire.

continued

NETWORK DISTANCE LIMITATIONS

Strung between Silver Streak adapters, silver-satin phone cord behaves most like thin Ethernet. Note the 7-foot minimum distance, however. (N/A = not applicable.)

NETWORK ADAPTER TYPE	CABLE TYPE	MAXIMUM (FEET)	MINIMUM (FEET)
Silver Streak	UTP (silver satin)	600	7
Ethernet	Thin	607	1.67
	Thick (drop cable)	164	8
	Thick (backbone)	1640	8
	UTP (10Base-T)	328	8
Token Ring	STP	328	8
	UTP	148	8
ARCnet (passive hub)	N/A	393	Depends on cable
ARCnet (active hub)	N/A	1988	Depends on cable

In addition to the limitations shown here, keep in mind that you can't connect more than 30 computers on a thin Ethernet segment, more than 100 computers on a thick Ethernet segment, more than 72 computers on UTP Token Ring, or more than 260 computers with STP Token Ring cable. (N/A = not applicable.)

It's a Jungle Out There!
And MAG InnoVision wants to keep it that way. It's why we're introducing Green Energy.
Green Energy was developed to have minimal impact on the environment. Green Energy means EPA Energy Star compliancy. Green Energy means VESA Display Power Management Signaling compatibility. Green Energy means conformance with SWEDAC MPR II low-emission standards. And Green Energy means no ozone depleting substances were used in manufacturing or packaging.
Best of all, monitors with the Green Energy logo from MAG InnoVision will have the legendary performance and quality of a MAG that earned us PC Magazine's Editors' Choice for 4 consecutive years, and Readers' Choice in Service and Reliability this year. The kind of performance and quality you'd expect from top systems and future green systems.
GREEN ENERGY
Call us at 1-800-827-3998 (1-714-751-2008 in California) and we'll send you information about MAG InnoVision's new Green Energy monitors, how they help save the environment and where you can get one.
It's a jungle out there! Let's keep it that way.
MAG
©1994, MAG InnoVision, Inc. All rights reserved. MAG InnoVision and its logo are trademarks of MAG InnoVision, Inc. All brand and product names are trademarks or registered trademarks of their respective owners.
Circle 147 on Inquiry Card (RESELLERS: 148).
DX17F
Green Energy
Monitor
DX15F
Green Energy
Monitor

Verifying Your LAN Cables

For reliability and speed, the LAN cables in your network must form an unbroken, noise-free link between workstations and file servers. Electrical noise or other line transmission problems can cause your LAN to fail or, more often, mysteriously and insidiously slow down. When you're wiring a new LAN, modifying an existing system, or troubleshooting poor performance, a cable tester is an indispensable tool.

A cable tester contains a TDR (Time Domain Reflectometer) and perhaps additional test circuits. A TDR works by sending radar-like pulses through the LAN cable. It detects pulse reflections, analyzes them, and displays its findings. A cable tester typically can tell you the length of a cable, whether the cable is correctly wired internally (i.e., pin-to-pin wire mapping), whether it contains a short circuit (i.e., wires touching each other through damaged or missing insulation), whether it contains a broken wire (or an *open*), and whether it suffers from electrical cross talk (i.e., interference between wires).

When noise blocks the data signal flowing through LAN cables, the network responds by retransmitting the data signal. If the noise happens infrequently, the network's retry mechanism will hide the problem and you won't even know it exists. If the noise happens with slight to moderate frequency, you'll scratch your head wondering why the network has slowed down; the retries keep the network from running at normal speed.

Two important criteria by which cable-testing hardware can judge the cable quality are *signal attenuation* and *impedance*. Attenuation is the decrease in a signal's strength over the length of a cable. A cable tester measures attenuation in decibels, with 0 dB signifying no signal loss. As an example of a typical value, the maximum attenuation allowed for 10Base-T UTP cabling is 11.5 dB.

Measurement of characteristic impedance, measured in ohms, is more important for coaxial cables than for twisted pair. The thickness (i.e., gauge) of the copper conductors, the distance between the conductors, and the properties of the insulation (i.e., the dialectric material) in the cable all influence impedance. The characteristic impedance of both thick and thin Ethernet cable is 50 ohms; ARCnet cable has a characteristic impedance of 93 ohms.

The method that a cable tester uses to detect discontinuities within a cable relies indirectly on cable impedance. A change in the characteristic impedance of a wire somewhere along its length causes reflections inside the cable. Broken wires, short circuits, and mixed wire types cause such unwanted signal reflections because they create impedance boundaries. By measuring signal reflections, a TDR locates discontinuities.

Cross talk is electrical interference between wire pairs in twisted-pair cable. *Near-end* cross talk (abbreviated NEXT) is the interference that occurs in the cable adjacent to a connector at either end. The tester measures NEXT by transmitting a signal through one wire pair and detecting the resulting spillover of current into the other wire pair.

Short circuits and open connections can occur months or years after installation, especially if cheap insulation dries out, becomes brittle, and cracks. Similarly, a water-soaked cable won't carry LAN traffic very well. Sometimes during installation a person will pull a wire around a corner and part of the insulation will scrape off (this is a *shiner*). The cable problem may not manifest itself until months later when it causes a network outage.

Some wiring problems happen during cable manufacture or during connection. Once in a great while, the factory or the installer will put connectors on the cable with the wrong wire leading to the wrong pin, and the new cable won't work at all. Or the person may mix up the wire pairs by attaching connectors in a way that causes one of the wires to carry a signal that the other wire pair should carry (a condition known as *reversed pairs*).

Even with perfectly manufactured, carefully connected wire, you can still cause cable-related problems if you overlook the published limitations of the wiring specification in your planning of a network installation or enhancement. The result can be a LAN segment with cables that are too long or that have too many nodes in a segment. It's easy to overlook distance and number-of-nodes limitations when you're concentrating on giving people access to the network.

You should use a cable tester to check the installation of new LAN cables. When you build a new LAN or add a new cable segment to an existing LAN, you'll want to know that the new wires can carry noise-free LAN signals before you try to log on to a file server. If you have a contractor install and maintain your LAN wiring, insist that the contractor perform cable tests during the installation. If you install your own wiring, use a cable tester to check your work.

For Convenience's Sake

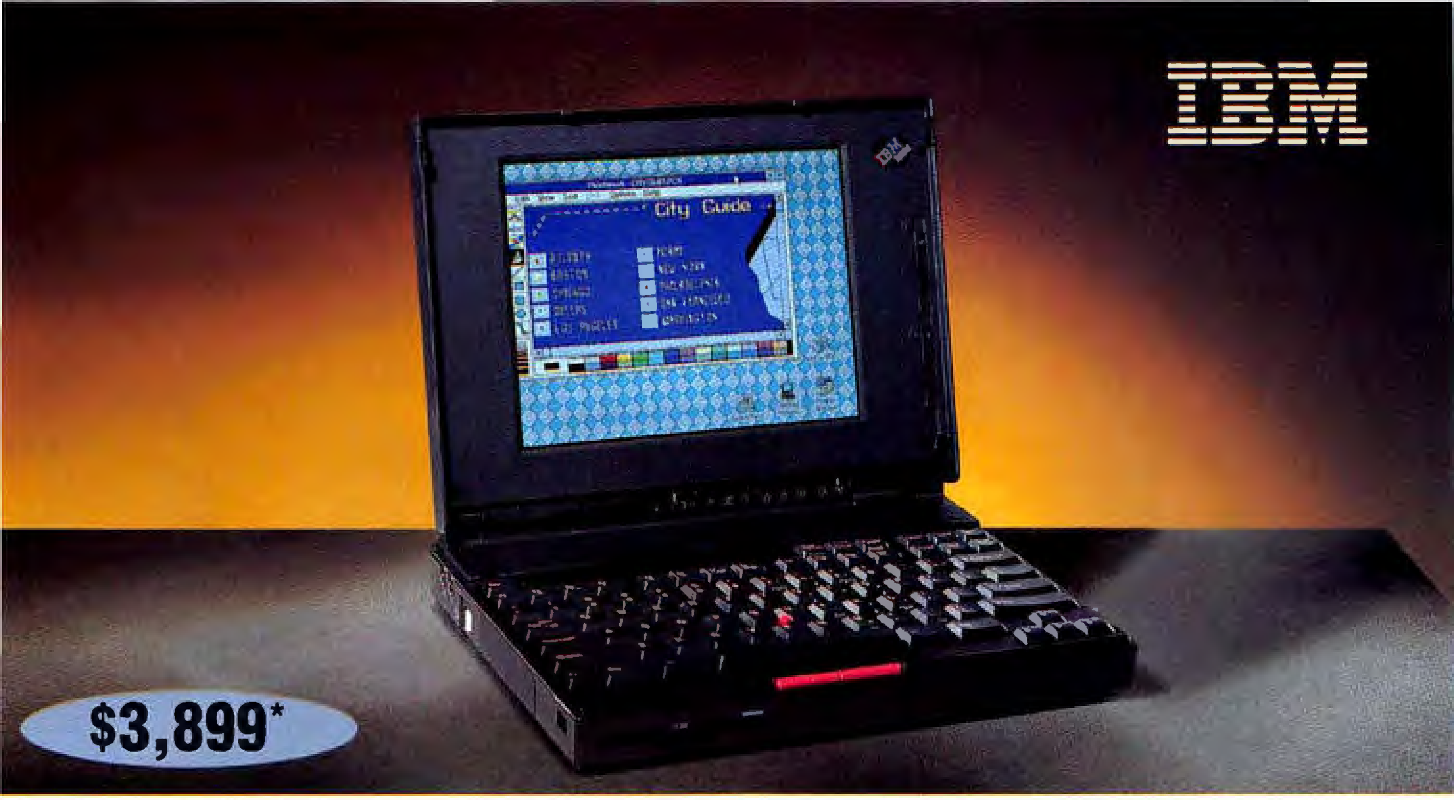
Silver Streak units provide convenience, allowing you to use existing telephone wire that you're currently not using. Or, if you are building a small Ethernet LAN, you get the simplicity of buying plain telephone wire from a local hardware store, phone store, or retail electronics outlet. Thin and flexible, silver satin is also easy to string.

Because of its daisy-chain topology, Silver Streak is suitable for small LANs only; as with thinnet, cable breaks can bring down the network. More important, you can't troubleshoot a Silver Streak setup with standard cable testers, nor can you upgrade to faster Ethernet. ■

About the Product

Silver Streak Ethernet connector $99
Tut Systems
2446 Estand Way
Pleasant Hill, CA 94523
(510) 682-6510
fax: (510) 682-4125
Circle 1077 on Inquiry Card.

Barry Nance is a BYTE contributing editor and has been a programmer for the last 20 years. He is the author of Using OS/2 2.1 *(Que, 1993),* Introduction to Networking *(Que, 1992), and* Network Programming in C *(Que, 1990). Barry is also the Exchange Editor for the IBM Exchange on BIX. You can reach him on the Internet or on BIX at barryn@bix.com.*



Think faster.

John Craig
PC Consultant

At IBM PC Direct™, we'll help you configure an IBM ThinkPad that's just your speed. You'll be surprised how many options are available. Ask about them.

Hey, you there – the one running at warp speed – this is for you. Slow down and catch a glimpse of one of the fastest notebook PCs around. The IBM ThinkPad® 750Cs.

It has an i486™SL/33MHz processor with an 8KB internal cache to get those high-powered applications really cranking. There's a crystal-clear 9.5" diagonal measurement dual scan color display so you can do less squinting and more doing. And there's a standard full-size keyboard and integrated TrackPoint II™ pointing device for convenience (and control) that's second to none.

The ThinkPad 750Cs even reconfigures faster. Just lift the hood (a hinged keyboard!) to pop in available quick-change hard drives and floppy drives. Special power management features mean you don't have to exit your application to change batteries on the fly. And the weight of the ThinkPad 750Cs won't slow you down, either. It's a sleek 6.2 pounds, batteries and all.

Go ahead and find the time – call IBM PC Direct to order. And while you're on the line, ask us about an array of options to help you think even faster still.

The IBM ThinkPad 750Cs.
To order yours from IBM PC Direct, get to the phone pronto!

- i486SL/33MHz processor with 8KB internal cache
- 4MB RAM
- 170MB Removable Hard Drive
- 3.5" 2.88MB Removable Floppy Drive .
- PCMCIA slots
- 9.5" dual scan color display
- Full-size keyboard with integrated TrackPoint II
- Audio input/output jacks
- 11.7" x 8.3" x 2.0"
- 6.2 lbs with battery pack
- IBM DOS, Introductory Demo and Prodigy® preinstalled
- 3-year international traveler's warranty°

To order:
call 1 800 426-8533

8am-10pm M-F, EST
9am-5pm Sat., EST
Purchase order available for qualifying customers.

IBM PC Direct

We're putting the personal in personal computing.

We'll configure any of our newest ValuePoint™ PCs the way you like. See the next page now!

Instant Gratification. We mak

priced right an

What's new? The "V" series borderless, energy-saving monitors.[1] And Soft Select preinstalled software.

You want it all. right now. (That's O.K. people expect more from IBM.) For instance, you want the latest dazzling monitors.

So we created the new "V" series monitors with a sharp. borderless image. And they're so energy-efficient they've qualified for an EPA Energy Star rating.[2]

You said, "Installing software takes up too much time." So now we can do it for you at the factory with Soft Select™. We test and optimize each application to work on your particular PC. And we give you customized configurations. plus the quality and support you expect from the world's largest computer company.

So go ahead, be demanding. We're ready for anything. Call us now.

ValuePoint Si.
Conserve space and money.

- 3 expansion slots, 3 bays
- VESA Local Bus Video
- Pentium[3]-upgradable (except 425SX/Si)
- IBM Basic 101-Key Keyboard and IBM Mouse
- DOS and Windows preinstalled
- 512KB Video Memory
- Choose your IBM Color Monitor: 14L8. 14V (add $100 to base model price), 15V (add $250), 17V (add $670)

425SX/Si
i486SX/25MHz, 120MB HD, 4MB RAM
14L8 (IBM Credit Lease: $45/mo.**) $1,259*

433DX/Si
486DX/33MHz,† 120MB HD, 4MB RAM
14L8 (IBM Credit Lease: $59/mo.) $1,639*

433DX/Si
486DX/33MHz,† 212MB HD, 4MB RAM
14L8 (IBM Credit Lease: $63/mo.) $1,749*

466DX2/Si
i486DX2/66MHz. 212MB HD, 4MB RAM
14L8 (IBM Credit Lease: $77/mo.) $2,149*

ValuePoint DeskTop.
The modern-day workhorse.

- 5 expansion slots, 5 bays
- VESA Local Bus Video
- Pentium[3]-upgradable
- IBM Enhanced 101-Key Keyboard and IBM Mouse
- DOS and Windows preinstalled
- 1MB Video Memory
- Choose your IBM Color Monitor: 14L8, 14V (add $100 to base model price), 15V (add $250), 17V (add $670)

425SX/D
i486SX/25MHz, 212MB HD, 4MB RAM
14L8 (IBM Credit Lease: $57/mo.**) $1,589*

433DX/D
486DX/33MHz,† 212MB HD, 4MB RAM
14L8 (IBM Credit Lease: $70/mo.) $1,939*

450DX2/D
i486DX2/50MHz, 340MB HD, 4MB RAM
14L8 (IBM Credit Lease: $81/mo.) $2,259*

466DX2/D
i486DX2/66MHz, 340MB HD, 8MB RAM
14L8 (IBM Credit Lease: $100/mo.) $2,769*

IBM PC Direct

We're putting the personal in personal computing.

t easy to get the PC you want, eady to go to work.

ValuePoint Mini-Tower®.
With room to grow.

- 8 expansion slots. 6 bays
- VESA Local Bus Video
- Pentium[3]-upgradable
- IBM Enhanced 101-Key Keyboard and IBM Mouse
- DOS and Windows preinstalled
- 1MB Video Memory
- Choose your IBM Color Monitor: 14L8, 14V (add $100 to base model price), 15V (add $250), 17V (add $670)

433DX/T
486DX/33MHz,† 340MB HD, 4MB RAM
14L8 (IBM Credit Lease: $80/mo.**) $2,219*

450DX2/T
i486DX2/50MHz, 340MB HD, 8MB RAM
14L8 (IBM Credit Lease: $93/mo.) $2,569*

466DX2/T
i486DX2/66MHz, 424MB HD, 8MB RAM
14L8 (IBM Credit Lease: $108/mo.) $2,989*

466DX2/T
i486DX2/66MHz, 527MB HD, 8MB RAM
14L8 (IBM Credit Lease: $113/mo.) $3,129*

Soft Select preinstalled software lets you hit the ground running.
We can preinstall many of your favorite applications, then thoroughly test and optimize them – all for only a $10 flat fee. When your new ValuePoint arrives, just plug it in and go. Of course, we also give you the diskettes, manuals and documentation. Installing software doesn't get any easier – or faster.

Here's just a sampling of IBM Soft Select applications.
Call for our latest additions

Microsoft® Office (WIN)
Intuit Quicken™ (WIN)
Borland Quattro Pro® (WIN)
Microsoft PowerPoint® (WIN)
WinFax™ Pro (WIN)
WordPerfect® (DOS)
IBM VoiceType™ Control (WIN)

Salil Muma, HelpCenter® Specialist

With HelpWare®, you're covered by the best support people in the business.
IBM HelpWare goes beyond ValuePoint's one-year warranty and our 30-day, hassle-free moneyback guarantee.[4] HelpWare is tech support people who are always there when you need them, 24 hours a day, 7 days a week. And it's one year of free onsite service, provided by thousands of dedicated IBM service reps who make house calls anywhere in the U.S., no matter how remote.[5]

To order: call 1 800 426-8533

8am-10pm M-F, EST
9am-5pm Sat., EST
Purchase order available for qualifying customers.

Multimedia Presentations

Time-line-based presentation software spices up a traditional electronic slide show

SHELLEY CRYAN

Multimedia. It's the buzzword of the nineties. With cheaper, faster computers widely available, people who give presentations are often looking to incorporate the latest flashy elements into their shows: movies, sounds, and animations.

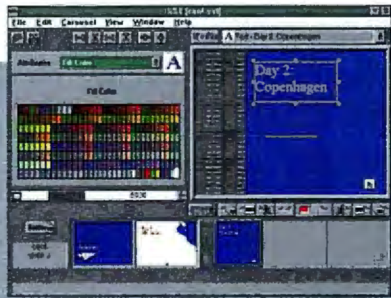
These elements can, of course, be used in top traditional slide-presentation programs. Programs such as Aldus Persuasion and Microsoft PowerPoint let you show slide presentations on your computer screen, complete with fancy slide transitions and some or all of these multimedia elements. There is a glitzier alternative, however.

I look here at programs that offer the added element of time. That is, they allow you not only to select a wide range of media formats to incorporate into your presentation, but also to define exactly when all this activity will occur. Picture this: The introductory scene of a presentation shows a title sliding into place; then colorful ellipses bounce around and reshape until they land behind the title. A sound track plays in the background throughout the scene, muted when an electronic narrator reads the title just as it appears on-screen. The final action shows a corporate logo rolling into place in the bottom left corner, and then the presentation date fades into the lower right corner. The scene ends by dissolving, bit by bit, into the next scene.

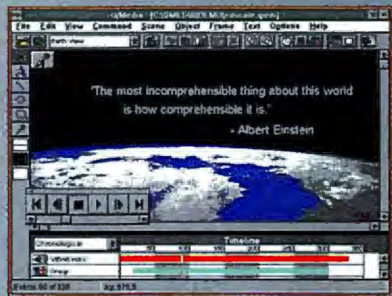
That's multimedia presentation, as executed by the programs in this roundup: Super Show and Tell from Ask Me Multimedia Center (Windows), Q/Media for Windows from Q/Media Software, Vividus's Cinemation (Mac), Macromedia's Action (Windows and Mac), and Gold Disk's Astound (Windows and Mac). I've limited the selection to programs aimed at the general business presenter rather than the multimedia jockey, so I've left out analyses of the more complex and pricier programs, such as Macromedia Director and Passport Producer Pro.

Breaking with Tradition

With the added factor of time, multimedia presentation programs give you more to

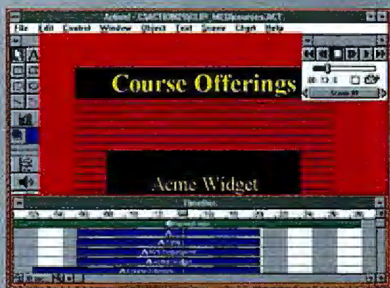


Super Show and Tell is anchored by a unique, streamlined interface. SST packs everything into a single window: scene preview (which shows the scene you're working on), navigation controls, media editors, and thumbnail sketches of other scenes in the presentation. If you're looking for a capable, basic multimedia presentation tool with a short learning curve, you'll be happy with SST.



Like most of the programs in this category, Q/Media for Windows is based on the familiar slide metaphor. Each slide is a scene that can be filled with sound, movies, graphics, and text. At $99, Q/Media is the least expensive program of the bunch. It lacks animation tools and interactivity, but it's rich in transition effects, import formats, time management, and fine control over presentation elements.

Vividus's Cinemation takes an entirely different approach to multimedia presentations. Instead of working with slides or scenes, you work with frames in a filmstrip. The biggest drawback: It's harder to set action durations, since you're dealing with frame quantities rather than the more familiar time quantities. The benefit: easier, better animation. In all, Cinemation is a powerful tool with an unconventional yet effective approach.



Macromedia's Action offers a slew of conveniences to streamline production. Templates, a content list, and a scene sorter all help you create your presentation painlessly. With a bar-style time line, standard interactivity controls, and a collection of animation options, Action packs all the major features of a multimedia presentation program into a solid performer.

Gold Disk's Astound not only offers the requisite multimedia presentation features but also includes features found only in top traditional presentation packages. This makes learning the program a snap for anyone who's familiar with traditional presentation programs. Astound pulls all this together into a slick, well-designed program.

juggle than you would have in a traditional slide-making program. But the payoff for some extra complexity can be substantial: With multimedia presentation programs, you've got more control over your show, so you can create stunning, memorable presentations.

Most multimedia programs also let you create simple animations, so you can show graphical elements flying around your screen along a path you define. All but one in this group (Q/Media) let you incorporate a bit of interactivity into your presentations, too. This is handy when you want to branch off into different topics at will during a presentation, where you press a button and the presentation jumps to a predefined slide. Other types of interactive controls let you play back movies and pause the presentation.

All this time-based activity, animation, and interactivity requires a computer's processing power during playback. This sharply diverges from the traditional slidemaking programs, which, besides running on a computer, can output to 35mm slides and overheads. You'll also give up the superior text-handling capabilities of the traditional slidemakers if you opt for a multimedia presentation program. Traditional slidemakers offer an outliner, which makes it easy to create lots of text-based slides and perform such functions as spelling checking and find-and-replace.

Of course, every rule has an exception, and Astound fills that role among multimedia presenters. It hedges its bets by providing features of both traditional and multimedia presenters.

With its all-in-one-window approach, *SST is a snap to learn. The scene preview is your main work area. You modify elements with SST's media editor. By selecting objects and clicking on the action button, you can add effects such as motion or dynamic changes to size, color, or font.*

But to get this combination, you're not limited to Astound. Many of the multimedia presenters let you import static slide presentations, so you can use the features of both types of program. It's often not as convenient as Astound's all-in-one approach, but it can be a valuable option. If you've already created several traditional slide presentations that you now want to jazz up, or if you depend on particular features of a favorite program, you won't have to give those up.

The Feature Mix

Which features are most important? Ease of use is a key issue. To maximize the creative and persuasive impact of your work, you must be able to focus on content rather than production. Conveniences like templates and master pages, which streamline formatting by acting as overall design guides, are vital.

Also critical are support for a variety of import formats, interactive controls, animation capabilities, and a decent scheme for managing time-based events. For polished presentations, look for a good selection of transition effects. You'll also want at least basic tools for creating and editing various types of media, such as drawing tools, rudimentary sound editors, and graph generators. Don't expect full-blown features in this area; for a full set of such tools, you can turn to a dedicated third-party program like Adobe Illustrator or DeltaPoint's DeltaGraph Pro. But it saves time and memory to have a few basics in your presentation program.

All the programs discussed here include a free run-time player that lets others view your presentation if they don't have the source application. But because you can't be sure that everyone has the proper hardware and software drivers to run a multimedia program accurately, wide distribution is still tricky. It's critical to have the option, however, and each of these programs passed this test.

SST Features

By the time you read this, version 1.1 of Super Show and Tell will be available. According to Ask Me Multimedia Center, new functionality will include the following:

- **Enhanced branching: Jump to a specific slide position within another slide set.**
- **Bring Forward/Push Behind: Reposition media elements to appear behind or on top of other media elements.**
- **Show multiple AVI files on the same screen and control playing time.**
- **Additional file formats: WMF, CGM, Kodak Photo CD.**
- **25 new transitional effects.**
- **Print handouts.**

The write-ups that follow focus on the criteria I've discussed, with special emphasis on each program's approach. For a quick comparison of capabilities, check out the features table on page 194.

Super Show and Tell

Super Show and Tell, by Ask Me Multimedia Center, targets the true computer neophyte and defines one end of the ease-of-use spectrum. To achieve this distinction, SST has cut out a lot of the features and flexibility that you can find in other programs. You may outgrow it or be disappointed if you plan to create presentations frequently. Yet fewer features means less to learn, so if you're looking for a capable, basic multimedia presentation tool and a short learning curve, you'll be happy with SST.

SST is anchored by a unique, streamlined interface. Unlike the other programs, SST packs everything into a single window: scene preview (which shows the scene you're working on), navigation controls, media editors, and thumbnail sketches of other scenes in the presentation. This all-in-one approach makes it easy to find what you're looking for, and it's instantly obvious if a feature isn't available.

For real out-of-the-box productivity, templates would quickly give scenes a consistent look. Unfortunately, however, SST doesn't support templates or master slides. You'll need to create each scene from scratch.

To create a scene, you select the background in the preview scene area and turn to the media editor to apply a few overall attributes. Gradient or patterned backgrounds aren't an option; you're limited to a single-color background, or you can place an image in the center. You can "tile" the background image to create a wallpaper effect.

To add a background sound track, you use the media editor again. SST supports WAV and MIDI files, but the package doesn't include much clip media (e.g., sound, graphics, and movies). The alternative is to use third-party sources.

Adding objects that come and go over

60 FIELDS PER SECOND
10:1 JPEG
EVERY FIELD

MICROPOLIS® AV Series Disk Drives are specifically designed for enhanced digital video and audio performance in applications such as multimedia, desktop publishing, digital video editing, and video servers.

Data Stream Gaps occur when ordinary drives are engaged in internal housekeeping tasks that can take 500 ms or more. Video frames will be lost when the drive's response goes above the video requirement line.

Minimum Sustained Data Rate of 3.0 MB/s and a maximum uninterrupted data rate of 2.9 MB/s ensures a smooth and continuous data delivery for audio/video reproduction.

Superior Worst Case Data Access: 30 ms No more frozen frames or audio drop outs because AV drives provide a higher maximum uninterrupted data rate than standard data processing disk drives.

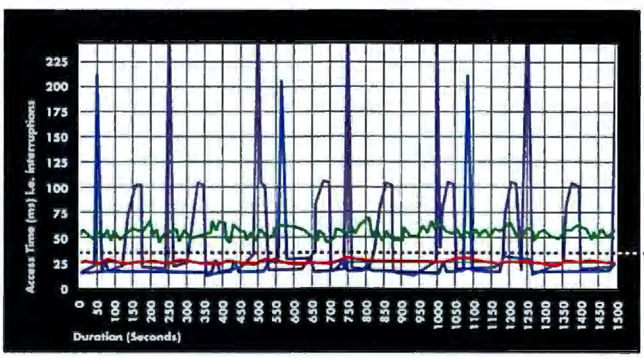
ATC™ Advanced Thermal Calibration technology ensures that the drive's self calibration procedures do not interrupt the data stream.

Advanced Cache Management Multi-segmented, Read-Ahead Caching improves read performance dramatically, improving noninterlaced audio/video by eliminating extra seeks.

Super-Capacity™ Micropolis AV Series Disk Drives provide the capacity needed for audio/video applications.

THE AV SERIES

MICRODISK LT *modules are removable for easy transport.*



	AV LT	AV LS
3.0 GB	5.25-in.	Model 1936*
1.7 GB	3.5-in.	Model 2217*
1.0 GB	3.5-in.	Model 2210*

**Also available for external installation in MICRODISK AV LS and LT enclosures.*

Five Year Warranty Micropolis disk drives carry a five year warranty when purchased from an authorized reseller.

For the name of the reseller nearest you, call toll free 1-800-395-3748.

MICROPOLIS®

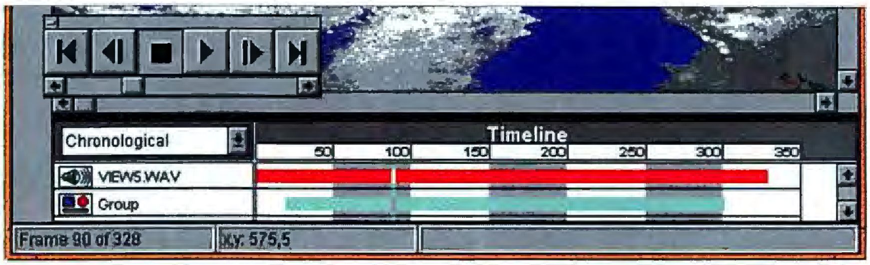
All logos and names are the property of their respective owners.

Circle 106 on Inquiry Card.

time is straightforward. You click on the media button to add text, imported images, sound, and movies. You select the draw option under the media button to create your own objects with SST's rudimentary drawing capabilities (you are limited to lines, rectangles, and ellipses). Again, you use the media editor to apply attributes like text formatting and colors. Any object can become an interactive button, jumping the presentation to a specified slide or calling up and running another SST presentation.

With your objects set, it's time to add action, such as motion, or dynamic changes to size, color, or font. This, too, is simple. Select the object, click on the action button, and make the appropriate modifications. To show text moving in from off-screen, for example, you first drag the text block beyond the bottom left corner of the preview screen. With the block still selected, you click on the action button and select move. Finally, you drag the text block to where you want it to end up, and SST fills in the in-between motion.

You can specify how long it takes to complete the move or any other action, and you can specify when such activities will occur. Yet the way SST manages and synchronizes time-based events is probably the one area where the attempt at simplification doesn't make things easier. There's no bar-style time line. Instead, there's a playlist, which lists actions in a scene in the order in which they occur, along with the amount of time the activity will take. Under this structure, it takes more than a glance to see exactly what is supposed to happen, and it's difficult to figure out how to change the timing of events.



Despite its low price, *Q/Media offers excellent control for managing time-based events. Although Q/Media's bar-style time line is not as flexible as Action's time line, it still provides a convenient way to stage the coming and going of disparate media elements. VCR-like controls help you navigate through a presentation.*

Q/Media for Windows

At $99, Q/Media is the least expensive program of the bunch. But instead of offering limited capabilities like SST, Q/Media focuses on a few areas and fully implements these targeted functions.

Q/Media lacks animation tools and interactivity. Without interactive capabilities, you can't branch to different topics in a presentation. However, Q/Media is rich in transition effects, import formats, time management, and fine control over presentation elements. It rivals its higher-priced competition in many of these areas.

Like most of the programs in this category, Q/Media is based on the familiar slide metaphor. Each slide is a scene that can be filled with sound, movies, graphics, and text. You start by defining the slide/scene size, background, and so forth. To do this, you click on the scene info button on the handy toolbar. Unfortunately, it can take a long time for the dialog box to appear; with my 33-MHz 386 PC, sluggishness cropped up fairly often.

Q/Media offers an impressive array of scene-format options. You can set a custom stage size for each scene, as well as fix its position on the computer screen. Scene background options include patterns, wallpaper, full-screen graphic, and gradient. Q/Media even allows you to customize how the rest of the screen will look if a presentation doesn't fill it entirely. There are 19 different slide transition effects to choose among.

This plethora of choices extends to adding transitional elements—sound, images, text, or movies—to the scene as well. You can set any color in bit maps to be transparent, and you can set up third-party editors to launch automatically from within Q/Media when you double-click on an object.

With no animation tools, you need to rely on Q/Media's object transition effects to add the feeling of movement. These object transition effects are the same as the slide transition effects. So, for example, text could appear on-screen from behind thin venetian blinds.

Time-based events are managed with Q/Media's bar-style time line. Although it is not as flexible as Action's time line, it still provides a convenient way to stage the coming and going of disparate media elements.

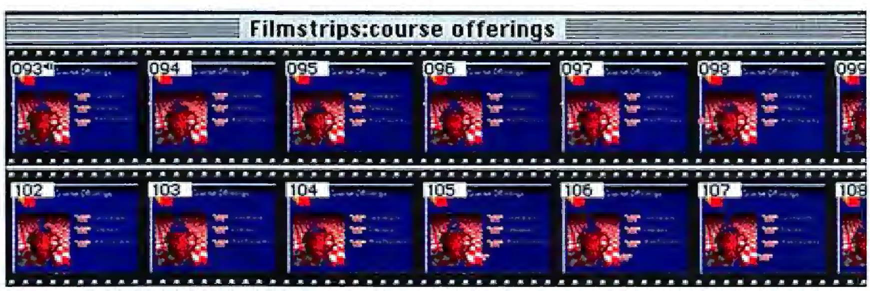
Q/Media has announced a CD-ROM version. For $149, you get Q/Media 1.2 for Windows along with a 500-MB clip-media library.

Cinemation

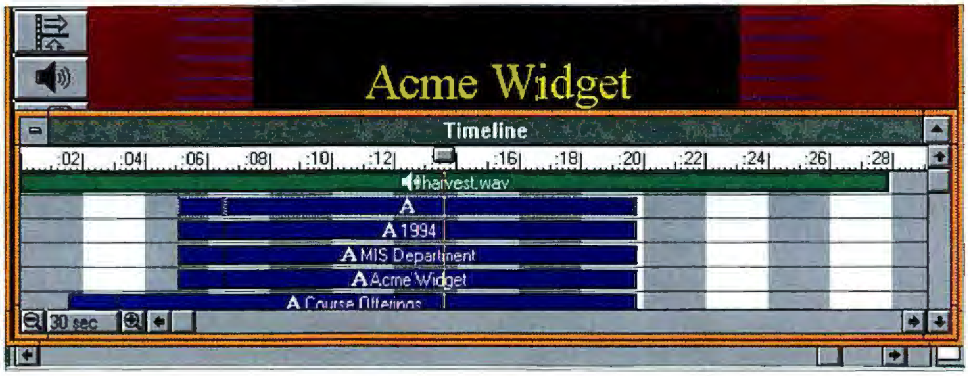
Cinemation, by Vividus, takes an entirely different approach to multimedia presentations. Instead of working with slides or scenes, you work with frames in a filmstrip. This distinction is striking. With a filmstrip, you see every step of every movement. If a graphic bounces across the screen, pauses, and bounces back the other way, it may span 100 frames, each one successively showing the graphic a little further along its path.

This filmstrip approach is certainly different, but it's fairly easy to work with. The biggest drawback is that it's harder to set action durations, since you're dealing with frame quantities rather than the more familiar time quantities. The benefit is that you get easier, better animation.

Imagine a presentation scene that shows a movie, followed by four text boxes slid-



Cinemation treats presentations *as a series of frames in a filmstrip, so you see every step of every movement. You can navigate through your presentation by clicking on frames in the filmstrip window.*



scene is represented by a bar. The longer the bar, the longer an object remains in the scene. As in other programs, you can move or resize the bars to alter an object's entry/exit time and duration.

ing into view accompanied by sound effects. When a viewer clicks on any one of the text boxes, the presentation branches to the corresponding topic. Cinemation lets you create a relatively complex slide like this.

First, you open a design template, complete with background gradient and text and graphics placeholders. Then you add text and graphics where the placeholders are and adjust their placement. Next, you import the movie and place it next to the bullet points. Cinemation automatically adds frames to the presentation filmstrip to accommodate the movie's animation. Testing playback is simple using the VCR-like controls.

Cinemation really shines when defining motion. It offers four alternatives: You can apply an AutoMotion template, which attaches predefined movements to objects in your frame; you can define a beginning and an end position and ask Cinemation to fill in the motion between them; you can draw animations frame by frame; or you can drag objects around and record the activity.

If you choose to drag-and-record, Cinemation automatically adds frames to accommodate each object's movements and automatically loops the QuickTime movie so it will continue to play while the bullets, markers, and text are moving into place. It also automatically copies all the graphical objects to any new frames that it creates.

Adding sound is easy, too. You select the frame during which a sound should play, click on the sound tool, and then select a sound file from the dialog box that pops up. Cinemation supplies an ample collection of sample sounds.

Cinemation's interactive controls include the basics: You can define buttons that, when pressed, jump the presentation to a specified frame in the filmstrip or jump to a different movie altogether. You can define a transition effect to occur when the scene changes. And you can set up pauses.

One of Cinemation's greatest capabilities is that it can import entire Aldus Persuasion and Microsoft PowerPoint files with a single command. Each slide in the presentation becomes a separate frame, to which you can add motion or interactive buttons.

In all, Cinemation is a powerful tool with an unconventional yet effective approach.

Action

With a bar-style time line, standard interactivity controls, and a collection of animation options, Macromedia's Action packs all the major features of a multimedia presentation program into a solid performer. Action offers a slew of conveniences to streamline production. Templates, a content list, and a scene sorter all help you create your presentation rather painlessly. Action features excellent intuitive tools for manipulating and animating objects. One of the first multimedia presentation packages is still a sound choice.

Action's presentations are collections of scenes that structurally resemble slides. A collection of templates is provided, or you can create and save your own. And you can choose among gradients, patterns, and images for a custom background.

Action's media creators aren't as extensive as Astound's; in particular, Action lacks sound and movie editors. But its charting capabilities will save you from constant reliance on a third-party grapher. The charting features are available only in the Windows version, which is ahead of the Mac verson on several features.

The drawing tools are standard, as are the controls over interactivity. You set buttons to jump to a specified scene, replay the current scene, and pause.

As you'd expect given the program's name, Action's strong suit is its options for adding actions to objects such as text, graphics, and movies. You can apply transitions and motions to an object for when it enters or exits a scene and set custom durations for those actions. The large selection of transition effects includes ones that will reveal an object in a checkerboard pattern or from the outside in.

Action offers several options for object entry and exit motion. You can make the object swoop in from any side or corner of the scene, or you can define start and end placement and Action will fill in the movement. Action's Path Editor also lets you customize movement. You combine dragging and mouse-clicking to define straight path segments along which the object will move.

You can apply a third type of action—a light effect—to occur when an object isn't moving or in transition. A light effect such as a sparkle or shimmer can add interest to an object and, for example, help to highlight particular bulleted text.

Action's time management controls are centered around its bar-style time line, where each object in a scene is represented by a bar. The longer the bar, the longer an object remains in the scene. As in other programs, you can move or resize these bars to alter an object's entry/exit time and duration. VCR-like controls help you navigate through a presentation while editing. A particularly handy feature is the compressed-view option, which shows all the elements that will appear over time in

ACTION FEATURES

As this review went to press, Macromedia announced Action 3.0 for Windows. According to the company, some of the new features will include the following:

- **a new outliner**
- **text-formatting controls (e.g., ruler, tabs, and text alignment)**
- **a spelling checker**
- **OLE 2 support**
- **a larger selection of templates with motion and effects built in**
- **expanded format support, including QuickTime for Windows, Photo CD, and direct import of GIF, TIF, and PCX**

KEY FEATURES OF TIME-LINE-BASED PRESENTATION SOFTWARE

Multimedia presentation software should support a wide variety of media formats, including Video for Windows (AVI) and QuickTime on the Macintosh. Embedded media editors allow you to work on media elements without relying on other software. Templates and bundled clip media make it easier to assemble a multimedia presentation. N/A = Not available. (● = yes; ○ = no)

	ACTION 1.01.4/ MAC	ACTION 2.5.1/ WINDOWS	ASTOUND 1.01/ MAC	ASTOUND 1.5/ WINDOWS	CINEMATION 1.1	Q/MEDIA 1.2	SUPER SHOW AND TELL 1.0
Company	Macromedia	Macromedia	Gold Disk	Gold Disk	Vividus	Q/Media Software	Ask Me Multimedia Center
Retail price	$299	$299	$399	$399	$495	$99	$149.95
Platform(s)	Mac	Windows	Mac	Windows	Mac	Windows	Windows
Short take	Solid multimedia presentation program	More functionality than Mac product	Combines features of traditional and multimedia programs	Same functionality as Mac version, with enhancements (e.g., improved charting and interactivity)	Frame-based presentations; super animation tools	Good for linear presentations	Easy to use; limited
Requirements	Mac Classic II, System 6.x, 2 MB RAM (more with 7.x)	Windows 3.0, 386, 2 MB RAM	Mac Plus or better, System 6.0.8+, 2 MB RAM (more with 7.x)	Windows 3.1, 386, 4 MB RAM	Any Mac, System 6.07+, 2 MB RAM (more with 7.x)	Windows 3.1, 386, 4 MB RAM	Windows 3.1, 386SX, 2 MB RAM
Import formats							
Sound	AIFF, SoundEdit	WAV, MID, CD Audio	snd, SoundEdit, AIFF, SoundEdit Pro, AIFFc, Amiga IFF, WAV	WAV, MID, CD Audio	snd, SoundEdit	WAV, MID, CD Audio	WAV, MID
Images	PICT	BMP, DIB, WMF, convert utility for EPS, GIF, PCX, TIF	PICT, GIF, EPSF, TIFF, Photo CD	BMP, DIB, PCX, GIF, TIF, CGM, Photo CD, TGA, WMF, RLE, PCT	PICT	BMP, PCX, WPG, DIB, TIF, GIF, WMF, TGA, JPEG, PICT, EPS, CGM	BMP, PCX, DIB, TIF, GIF, TGA
Video	QuickTime	AVI, MOV	QuickTime	MOV, AVI	QuickTime	AVI, AVS	AVI
Animation	PICS	MMM, FLI, FLC	PICS, Animation Works	AWM, AWA, SCM, AIM (Gold Disk)	PICS, Scrapbook, Cinemation	FLC, FLI, MMM, AWI	FLC, FLI
Data	N/A	WKS, TXT, CSV, XLS, DBF, CHT	Excel, Lotus	Excel, Lotus, tab/return delimited	N/A	N/A	N/A
Import entire slide shows with one command	●	●	●	●	●	○	○
Interactive controls	●	●	●	●	●	○	●
Run-time player	●	●	●	●	●	●	●
Media editors/creators							
Sound	○	○	●	●	●	○	○
Draw	●	●	●	●	●	●	●
Graphs, charts	○	●	●	●	○	○	○
Number of scene transitions	30	46	22+	22	21	19	7
Animation	●	●	●	●	●	○	●
Design templates	●	●	●	●	●	○	○
Bundled clip media	Ample	Ample	Largest selection of category	Largest selection of category	Ample sounds and animation	Modest; 500 MB in CD-ROM version ($149)	Sparse

the scene. This view is useful for aligning objects relative to one another.

Although Action is available in both Mac and Windows versions, the two aren't compatible, so presentations created in one version can't be opened in the other.

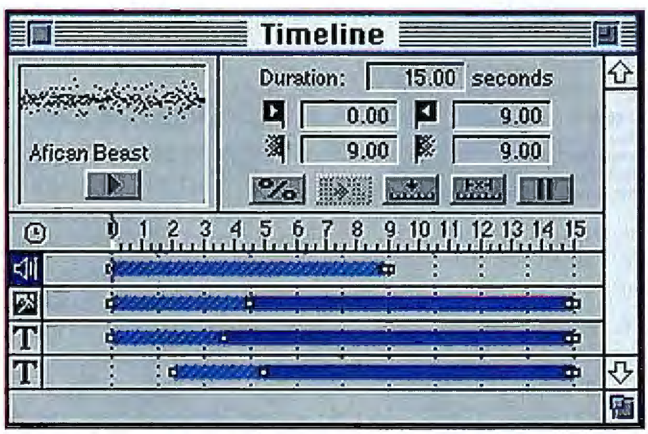
Astound

Not only does Gold Disk's Astound offer the requisite multimedia presentation features—time-based events, animation, and interactivity—but, unique to this category, it also includes features found only in top traditional presentation packages: an outliner, complete with some text-handling features, as well as the ability to output to 35mm slides. Astound's interface incorporates the traditional slide, outline, and slide sorter views, in addition to a timeline view. This makes learning the program a snap for anyone familiar with traditional presentation programs. Astound pulls all this together into a slick, well-designed program.

But don't trash your traditional slidemaker yet. Astound's outliner isn't as full-featured as PowerPoint's or Persuasion's. You can't import text or see text formats in outline view. It also lacks the seamless navigational aids of top slidemakers.

Yet Astound's outliner is still a welcome feature. It helps you organize your thoughts as you prepare a presentation, and it gives you a good overview of all your slides as you edit your work. And never turn down a spelling checker.

Like other packages, Astound lets you apply templates to quickly standardize a design. A healthy supply of templates is included for 35mm slides, 13- and 9-inch screens, overheads, and PowerBooks.



Astound does double duty *as a slide-making program as well as a multimedia presentation program. Its time line helps you synchronize the media elements that make up your presentation.*

Astound offers a wide assortment of media creators and editors. Its drawing tools are better than average for the group, and its graphing capabilities are fairly sophisticated. Astound's sound and movie editors are particularly full-featured and, for many users, will virtually eliminate the need for third-party editors.

Another strong area is the selection of transition effects. Astound offers 22 scene transitions, with nine customizing effects for most, leaving no shortage of creative permutations. But what's truly notable are the choices for object transitions. You can set entrance and exit text transitions that make text drop letter by letter, for example, or you can customize how an object rotates into or out of a scene.

Astound offers the standard interactive controls, and its bar-style time line is quite capable. You animate objects by defining paths along which they travel.

The package comes bundled with a CD-ROM filled with over 1300 pieces of clip media. The library includes graphics, backgrounds, sound effects, music, digital video clips, and animated actors. It's the largest set of bundled clip media in the category.

Be forewarned that, with all these features, Astound is not for the faint of hardware. Despite the manufacturer's listed minimum recommendations, you'll really need 4 MB of application RAM and at least a Mac IIcx to take advantage of Astound's feature set and to better your chances for smooth playback. And make some room on your hard drive for the generous assortment of clip media supplied with this package.

I looked at the Macintosh version in depth for this roundup; the final Windows version came too late to be included. However, the beta of the Windows version seems to perform much like the Macintosh version, and Gold Disk claims cross-platform compatibility—something unique to this category. Either way, Astound is a winner.

The Wrap

With the varying approaches of multimedia presentation software, the question is not "which is the best program?" but "which is the best program for me?" Consider your needs carefully before plunging ahead, and then match your needs with the appropriate offering.

Each program takes a different slant on how best to create stunning presentations, and each of the packages reviewed here does an admirable job of meeting its goals. For quick, basic presentations, Super Show and Tell is a good choice. Q/Media is the budget choice, limited to linear presentations without animation. For the best in animation, Cinemation is your program. Astound and Action are the top all-around, full-featured alternatives, with Astound offering a broader base of features than its chief rival. ■

Shelley Cryan runs a consulting business in Tarrytown, New York, that helps companies incorporate computer-based technologies. She holds an M.B.A. in finance and marketing from the University of Chicago. You can contact her on CompuServe at 71232.3673, on the Internet at 71232.3673 @compuserve.com, or on BIX c/o "editors."

About the Companies

Ask Me Multimedia Center
(Super Show and Tell 1.0)
7100 Northland Cir., Suite 401
Minneapolis, MN 55428
(612) 531-0603
fax: (612) 531-0645
Circle 1086 on Inquiry Card.

Gold Disk, Inc.
(Astound 1.01 for the Mac,
Astound 1.5 for Windows)
3350 Scott Blvd., Building 14
Santa Clara, CA 95054
(800) 982-9888
(408) 982-0200
fax: (408) 982-0298
Circle 1087 on Inquiry Card.

Macromedia
(Action 1.01.4 for the Mac,
Action 2.5.1 for Windows)
600 Townsend St.
San Francisco, CA 94103
(800) 288-4797
(415) 252-2000
fax: (415) 626-0554
Circle 1088 on Inquiry Card.

Q/Media Software Corp.
(Q/Media for Windows 1.2)
312 East Fifth Ave.
Vancouver, B.C., Canada V5T 1H4
(604) 879-1190
fax: (604) 879-0214
Circle 1089 on Inquiry Card.

Vividus Corp.
(Cinemation 1.1)
378 Cambridge Ave., Suite I
Palo Alto, CA 94306
(415) 321-2221
fax: (415) 321-2282
Circle 1090 on Inquiry Card.

Matrox MGA:

The World's Fastest Graphics Accelerator

The proven 64-bit graphics series

Accelerate your Windows, CAD and Multimedia applications to their graphical limits as they take advantage of MGA's 64-bit technology. Not only does MGA provide the world's fastest performance, but MGA also gives you the productivity features you need most. And MGA has received over a dozen awards to prove it!

MGA Ultima

MGA's newest PCI and VL additions to the Ultima family provide the ultimate low-cost graphics solution for the PC Power User. The MGA Ultima starts at $599 for 2 MB of VRAM and the MGA Ultima Plus, at $699, is fully upgradeable to 4 MB.

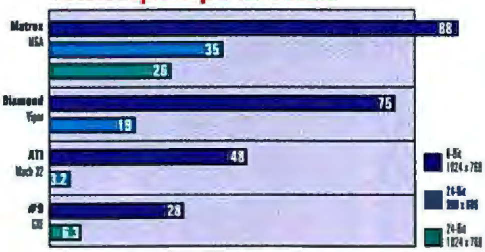
MGA Ultima Specifications

- Up to 90 million WinMarks[1] of blazing speed
- Up to 35 million WinMarks[1] in 24-bit color
- Up to 1600 x 1200 in 8 and 15-bit color
- Up to 1152 x 882 in 24-bit color
- Refresh rates up to 120 Hz
- Accelerated 24-bit Video-for-Windows playback
- Real-time CAD acceleration with our powerful DynaView™ drivers.

MGA Impression and Impression Pro

And for professional true color and 3D CAD users, Matrox offers the MGA Impression series of graphics boards which provide 24-bit color acceleration at resolutions up to 1280 x 1024 and real time manipulation of 3D wireframe and Gouraud shaded drawings.

VL-Bus speed performance



MGA's feature-filled Control Panel

Access MGA's advanced Windows features using a practical control panel:

- **Instant Modeswitch™** on-the-fly resolution and color depth switching without exiting Windows
- **Pixel Touch** hardware pan and zoom (2x,4x)
- **QCDP™** true color simulation in 8 and 15-bit at resolutions up to 1600 x 1200
- **Virtual Desktop** sizes up to 1600 x 1200
- **VideoView** full screen VfW playback at 30 frames per second

Matrox - proven performance

Matrox's reputation for reliable hardware and solid drivers is a result of nearly two decades of proven performance in developing graphics solutions for companies like Sun, Hewlett Packard and IBM. Matrox is now bringing its technological innovations and workstation-level products to the PC market but for thousands of dollars less.

MGA offers support for PCI, VL, ISA and MCA, and driver support for Windows 3.1, NT, OS/2, X-Windows, AutoCAD and MicroStation. For more information, call:

1-800-361-1408

MatFax: (514) 685-0174

(1) Based on in-house testing of a 2 MB MGA Ultima PCI version using Ziff-Davis WinBench 3.11, Pentium 66MHz, 512K cache, 72 Hz
(2) Based on in-house testing of 2 MB VL boards using Ziff-Davis WinBench 3.11, Pentium 66MHz, 512K cache, 72 Hz. MGA and Number Nine's 1024 x 768 x 24-bit scores are based on 4 MB VL boards.

MATROX MGA POWER GRAPHICS

See us at Windows World '94

matrox

Matrox Electronic Systems, Ltd.
1055 St-Regis, Dorval, Quebec, Canada H9P 2T4 Tel: (514) 685-2630 Fax:(514) 685-2853
Matrox (UK) Ltd. 6 Cherry Orchard West Kembrey Park, Swindon, England Tel: 0793-614-002

PC · PC · MVP · BYTE · PC Direkt · win · Personal Computer · l'Ordinateur Individuel

Circle 104 on Inquiry Card.

Mac Programming Power Tools

Mainstay's VIP-C and VIP-BASIC can speed applications development for novice and experienced programmers alike

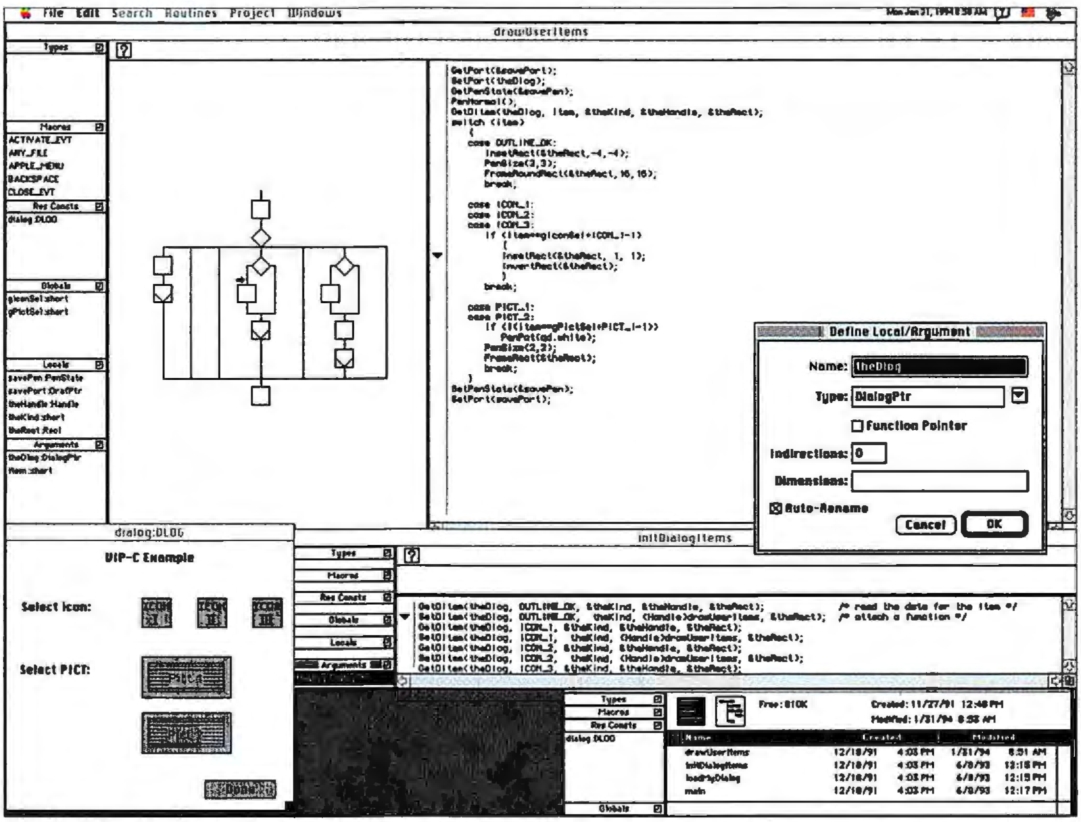
RAYMOND GA CÔTÉ

VIP-C and VIP-BASIC are a pair of Macintosh development tools that fit no single product category. Priced at $495 and $295, respectively, the two products provide complete structured-development environments for the C and BASIC languages. Because the VIP packages supply so many features not found in competing products, I found myself constantly redefining the programs as each new feature or capability popped up.

On first use, the VIP packages struck me chiefly as being structured editors. You create an application as a project, with each function a separate entry in the project window and all variables, type definitions, and macros in separate subwindows for easy tracking and definition. However, VIP-C and VIP-BASIC also include resource editors, an optimizing language interpreter, and a debugger. What's more, both packages can interface to external compilers (e.g., Symantec C and Microsoft QuickBasic) and also import ASCII text files into a project for reverse engineering.

VIP stands for *visual interactive programming.* This name, and a casual reading of Mainstay's marketing literature, might lead you to believe this is some form of CASE tool. Although both VIP products produce excellent flowcharts that help you decipher how your code behaves, they are really not CASE tools, because you can't edit the diagrams themselves.

I spent most of my review time with VIP-C. When I did switch over to VIP-BASIC, I found it to be an almost exact duplicate of the VIP-C application except for the actual language supported: BASIC rather than C. Everything else, including the ability to design interfaces, debug applications, and build stand-alone applications, is identical. I will use just plain VIP when I mean both applications, and though most of my examples will refer to VIP-C, you can assume they also apply to the VIP-BASIC environment.



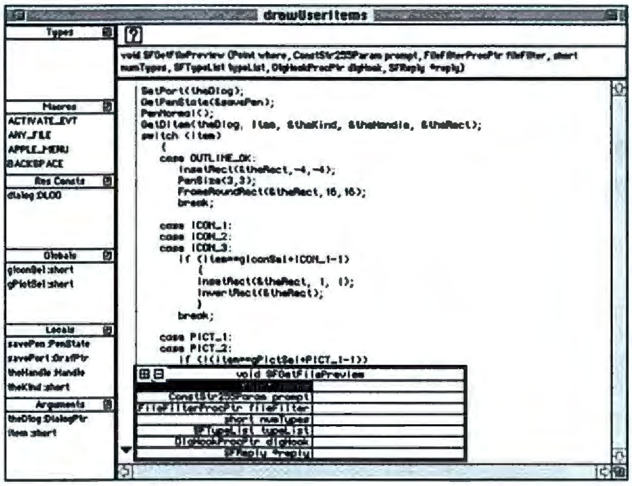
A typical VIP screen layout with an application in development. Shown are the VIP-C project window (lower right); a dialog window being designed (lower left); two routines, one in the form of a flowchart; and a local-variable definition.

Structured Editing

More than anything else, VIP is a structured editor, which can be both good and bad. On the positive side, a structured editor can guide you through program development by automatically inserting program constructs (e.g., `if`, `while`, `switch`, and `do`) and checking your syntax on the fly. While these features are useful for the novice, or at least for a programmer new to a particular environment, they can annoy an experienced programmer who is also a good typist. Development tools should make programming easier, not get in the way.

VIP walks that thin line between guidance and annoyance. Every time you enter a new line of code, it checks your syntax and updates the accompanying flowchart. If you find syntax error messages derailing your train of thought while you're entering large amounts of code, you can temporarily disable these features. However, you may not need to. On a Mac IIci, I found that syntax checking and flowchart updating were sufficiently quick as to be unnoticeable.

VIP conveniently lets you access all your routines from a single project window. You can switch the display from an alphabetical list of routines to a diagrammatic function-call display that shows how the routines relate to each other. For easy



VIP-C templates *provide easy reference to the parameters for infrequently used functions. The window at the top holds a routine prototype, and the bottom window holds a template for that routine, ready to be filled in.*

umes I through VI, and for all the functions you define in your own application. VIP displays a routine prototype in one window and a template for editing the prototype in a second window.

Templates are convenient if you don't use a particular call often or if you need to verify how you have defined a routine. If you can't remember a routine's exact name, you can type in a fragment of the name in the Find dialog box and it will list all routines that contain that

reference, VIP also maintains a complete set of global types, macro definitions, global variables, and resource constants for each project.

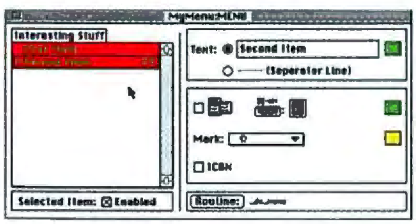
VIP-C lets you enter standard ANSI C code as you would with a normal editor, but you must enter definitions of all variables, macros, and types through a special dialog box. While this approach ensures that you create definitions properly and provides the interpreter with information it needs, it is also tedious to enter the dozens of variables when you're initially creating the code. However, what I like least about Mainstay's approach is that you can't add explanatory documentation to the defined value. In the example shown in the screen shot on page 199, it would be useful to describe the dialog box for which I am defining the pointer.

With VIP, you can add dated notes to a routine or a project. These notes to be seem designed mostly for maintaining the change history of a routine, since they are displayed in chronological order. A similar feature for definitions would greatly increase the product's usability.

The VIP structured-editor approach shines because it provides prototypes for all 500 of its built-in functions, for the complete interface to the Macintosh Toolbox contained in *Inside Macintosh* vol-

fragment. For example, to find `SFGetFilePrev`, I entered "sf" as the search parameter. VIP returned two dozen functions, ranging from the complete set of standard file routines to bit-map transformations.

VIP also features a palette that contains sets of frequently used functions. You access this palette by clicking on the small triangle that marks the current line in the edit window. The palette window comes up with 24 small icons, behind each of which is a list of related function calls. You can add and delete items in each palette list and even modify the icons shown on the palette.



A menu-item definition *dialog box allows you to set arbitrary marks, icons, and menu colors as well as link the menu item directly to an existing function. At the bottom right of the definition dialog box, you can see the routine that is executed whenever this menu item is selected.*

The one item that is lacking from the function templates is the same thing that is lacking from the variable definitions—documentation. Even a one- or two-line function description would help. As it is, you must resort to the written documentation, and that makes the template feature less valuable than it could be.

Besides providing complete access to all standard Macintosh Toolbox calls, VIP includes a set of higher-level library functions (see the table on page 204) that simplify Toolbox access and the creation of some relatively complex applications. For example, initiating and using an AppleTalk network socket becomes a matter of

The only Windows™ statistics package you'll ever need.

NEW
SYSTAT® for WINDOWS

#1 for DOS and Windows

Rated "the best general-purpose statistics program" for the PC by *Software Digest®*, SYSTAT for DOS is now joined by SYSTAT for Windows. This addition to the SYSTAT family takes full advantage of Windows, with pull-down menus, dialog boxes, sizable windows, and the ease of use you expect in a Windows package.

SYSTAT for Windows runs in standard and 386 enhanced modes and can take advantage of Windows advanced memory management. No matter how large or complex your analysis is, you can use SYSTAT.

SYSTAT delivers a balance of power and simplicity. It lets you analyze and manipulate data with a comprehensive range of advanced statistical procedures, and present your results with stunning graphics.

Just point and click

SYSTAT is a full-fledged Windows application. Just point and click. SYSTAT's QuickStat™ buttons give you simple, single-click shortcuts to common statistical analyses.

More statistics, from the basic to the most sophisticated

A full range of univariate and multivariate statistics–from *t* tests to multidimensional scaling. With a few clicks you can turn most statistics into graphs and perform:

- multiway crosstabs with log linear modeling
- nonparametric statistics
- principal components and factor analysis
- cluster analysis
- time series
- nonlinear estimation
- correlation matrices
- means, effect, and dummy models
- post hoc tests

SYSTAT offers the most advanced multivariate general linear model available for Windows.

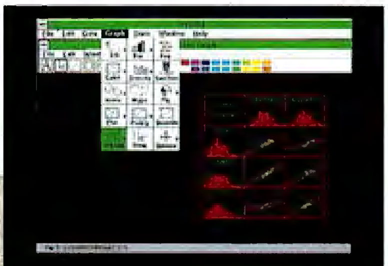
The most graphics

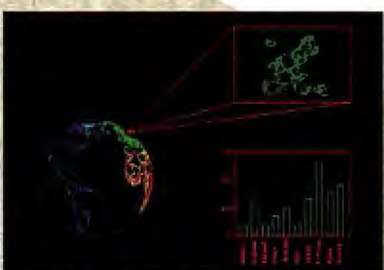
No other statistical or graphics package can produce all the scientific and technical graphs that SYSTAT can–nor surpass its ease of use. Graphics capabilities include:

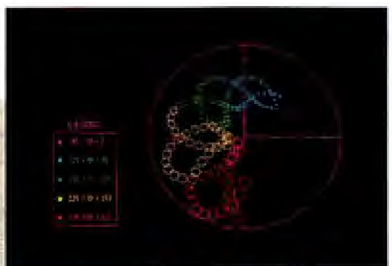
- histograms
- single, multiple, stacked, and range bar graphs
- single and grouped box plots
- stem-and-leaf diagrams
- pie charts
- scatterplot matrices
- 3-D data and function plots
- contour plots
- control charts
- maps with geographic projections
- Chernoff faces
- complete color spectrum
- log and power scales
- confidence intervals and ellipses
- linear, quadratic, step, spline, polynomial, LOWESS, exponential, and log smoothing

PC MAGAZINE EDITORS' CHOICE

"SYSTAT (for Windows) – with its superb graphics, high-quality statistical algorithms, and reasonable price – is an excellent choice." PC Magazine



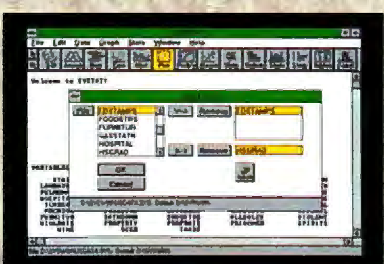


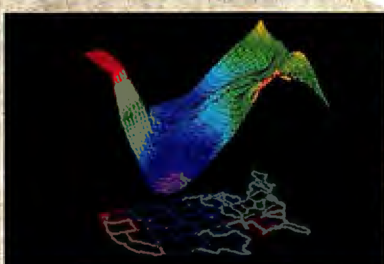


For more information, special offers for current users, and demo disks, call:

708-864-5670

For Windows circle 135,
For IBM/DOS circle 136.





SYSTAT®

For more information call or write: **SYSTAT, Inc.,** 1800 Sherman Avenue, Evanston, Illinois 60201-3793. Tel: 708.864.5670, Fax: 708.492.3567

Australia: Hearne Marketing 61.3.8661766, **Holland:** Oasis 31.34.0266336, **Denmark:** Agrolab 45.64.406575, **France:** Deltasoft 33.76.418508, **Germany:** STATCON 49.55.4272075, **Italy:** PiSoft 39.587.213640, **Japan:** HuLinks 81.33.5902311, **New Zealand:** Hoare Research 64.7.8562675, **Poland:** COMPANION 48.12.360791, **Spain:** AddLink 34.3.4157268, **Switzerland:** Fritschy & Partner 41.31.3125151, **SYSTAT UK:** 44.81.4620093

just two or three calls. As another example, the Grid library provides a simple interface to the Mac's 2-D list manager—something that interface builders such as AppMaker don't support.

Dispatcher and Resources

I found VIP's interactive interface designer to be its most useful feature. The combination of a simple interface builder, an even simpler application framework (which Mainstay calls Dispatcher), and the ability to immediately test the live environment is unbeatable.

Dispatcher is one of the simplest application frameworks you could ever hope to use. It is basically a central switching point for events moving from menus, to dialog boxes, to windows, to code. Since it has less than two dozen interface calls, you'll feel comfortable with it after just a few hours of experience.

Although you don't need to use Dispatcher in developing an application, doing so allows you to immediately attach your code to dialog boxes, controls, and menus. With this capability, you can quickly generate applications and test them in a live situation.

The resource editor itself is flexible and provides functionality not available in other interface builders. In defining a menu, for example, you can set menu-item colors, define an arbitrary marking character, and provide an icon on the item line. At the bottom right of the definition dialog box, you can see the routine that is executed whenever the menu item is selected. You change it by simply pressing the routine button and selecting another function. Similar capabilities exist for window and dialog-box designs.

Interpreting and Debugging

VIP's interpreter checks all code for syntactical correctness and parses it into an intermediate language as soon as you enter it. It interprets this intermediate language when you run the application. You can also build stand-alone applications that use the interpreter, thereby ensuring that your final applications run precisely the same code as they do in your development environment.

An interpretive environment has certain advantages over a compiler—even an incremental compiler. One advantage is that the interpreter usually maintains a lot of information for decoding and displaying complex data structures. Another advantage is the ability to use `#if` macro commands to selectively activate particular

VIP FUNCTION LIBRARIES

A list of the specialized function libraries available within VIP-C, with a sampling of functions from each. Most are identical to functions found in VIP-BASIC. In addition to these, VIP-C also provides a complete set of ANSI-standard C libraries.

3-D GRAPHICS LIBRARY	**GRAPHICS LIBRARY**	**RESOURCE LIBRARY**
_clip_3D_line	_back_pattern	_count_res_types
_pitch_3D	_diff_region	_get_res_attrib
_skew_3D	_draw_icon	_get_resource
_transform_3D	_scroll_rect	_set_res_scope
APPLETALK LIBRARY	**GRID LIBRARY**	**SOUND LIBRARY**
_get_request	_add_grid_columns	_new_channel
_lookup_entities	_draw_grid	_note_command
_open_socket	_grid_event	_play_tune
_send_response	_set_row_height	_set_voice
COLORQUICKDRAW LIBRARY	**MATH LIBRARY**	**STRINGS LIBRARY**
_animate_palette	_angle_from_slope	_append_character
_is_real_color	_annuity	_box_text
_load_color_cursor	_binary_log	_match_pattern
_pick_color	_fixed_divide	_string_to_scrap
DIALOGS LIBRARY	**MENUS LIBRARY**	**TEXTEDIT LIBRARY**
_append_dialog_item	_count_menu_items	_copy_text
_do_alert	_load_menu	_get_text_length
_set_dialog_event_proc	_new_tear_off	_search_text
_set_item_update_proc	_set_hierarchic_menu	_set_text_style
EVENTS LIBRARY	**PRINTING LIBRARY**	**UTILITY**
_dispatch	_control_printer	_bit_and
_get_key	_print_bits	_get_date_string
_set_timeout	_print_text	_get_system_globals
_still_down	_set_print_options	_test_bit
FILES LIBRARY	**RECORDS LIBRARY**	**WINDOWS LIBRARY**
_count_appl_files	_allocate_record	_clear_window
_create_dir	_get_field	_get_screen
_get_vol_space	_memory_free	_load_window
_write_MacPaint_pict	_set_record_size	_set_port_picture

routines without having to recompile the entire project. In effect, the macro construct `#if` or `#ifdef` becomes just another interpreter command. The VIP interpretive environment also ensures that programs don't exceed defined array bounds.

The built-in source-level debugger is simple to use and lets you step through your application, set breakpoints, and observe variables and structure values. It also contains several advanced features, such as the abilities to continue execution until a Boolean expression is true, alter variable contents, and continue execution until the program returns from the current function.

Although you can always expect an interpreted application to run more slowly than a fully compiled application, I found no significant speed differences with the VIP applications I built. Of course, you will get different results if you are performing serious numerical computations or spending a lot of time in code created within VIP-C, as opposed to calling the Toolbox.

Exports and Imports

VIP produces stand-alone applications without additional tools, but there are times when you simply want the speed of a compiled application. By working with third-party compilers, VIP lets you take advantage of compiler speeds in your final executable file while still maintaining the flexibility of an integrated environment.

Most simply, you can export an entire VIP-C or VIP-BASIC project to a standard ASCII file and run it through a compiler. VIP-C exports are compatible with Symantec's Think C, Apple's MPW C, and Metrowerks' CodeWarrior C compiler. VIP-BASIC exports will work with Microsoft QuickBasic. Exports generally appear as a single monolithic ASCII text file, which makes it a little difficult to navigate through for follow-up editing. However, the export files' clean layout makes them very readable.

VIP-C provides the optional ability to link to Symantec Think C 6.0 and Apple's MPW C through the use of AppleScripts, using ToolServer to completely automate the process of creating, compiling, and linking an externally compiled application. I did not test the MPW C link, but I did successfully send several sample applications to Think C 6.0.

Aside from your having to ensure that several original and well-documented files are available for the build process, this last process is completely automated. All you need to do is select one menu entry to create the project, one menu entry to set all the project parameters (e.g., application creator ID and sizes), and then one last menu entry to actually build the application. You can even run the Think C debugger from the VIP-C environment to examine the newly compiled application.

The VIP documentation also states that you can import preexisting text files into an existing VIP project. Although this appears feasible in principle, it is not practical for any large amount of preexisting code. That's because VIP-C has difficulty finding and decoding all the myriad include files in a complex application.

In particular, VIP can't find header files in one directory that are used with source files in another directory. Mainstay acknowledges this problem and recommends that you use precompiled headers that you can then redefine in your VIP project. I opted not to do this because I did not want to change the source code for a currently active project.

Another problem with importing existing projects is size. Many of my ongoing projects have become quite large over the years. The thought of moving them into a single monolithic file is troublesome. According to Mainstay, this is not an issue with its current customers, who are mostly creating new applications, not importing old code.

For the Future

Operating environments are always changing, and the Mac is no exception. Mainstay plans to maintain the timeliness of its VIP-C and VIP-BASIC products with its VIP Extender utility. This program converts into VIP interfaces new Toolbox manager include files distributed by Apple. Since it converts only include files, you can use this utility to provide interfaces to new Toolbox functions but not to functions in third-party libraries.

VIP-C and VIP-BASIC provide a fully integrated development environment that can help novice and experienced programmers alike rapidly develop new applications. The three-pronged solution of framework, resource editor, and interpretive-language environment provides a powerful development tool. The VIP solution will not work for everyone, partly because of individual preferences. But VIP-C in particular is well worth considering as a front-end designer for your Think C and MPW C applications.

For my own applications, I plan to use VIP-C to create the initial user interface and basic functionality. Then I'll switch over to Metrowerks' C for the final development cycle, creating programs for both the original 680x0 platform and the latest PowerMac systems. ■

About the Products

VIP-C 1.0.2 ....$495
VIP-BASIC 1.0.1 ....$295
Mainstay
591-A Constitution Ave.
Camarillo, CA 93012
(805) 484-9400
fax: (805) 484-9428
Circle 1091 on Inquiry Card.

Raymond GA Côté is a BYTE consulting editor and vice president of product development for Appropriate Solutions, Inc. (Peterborough, NH). He can be contacted on the Internet at rgacote@world.std.com or on BIX as "rgacote."

57 PCS THAT SET THE PACE

We test 20 Pentiums and 37 66-MHz 486DX2 systems to find the best performers for Windows, Unix, and DOS

HELEN E. HOLZBAUR AND STEPHEN M. PLATT

If speed is your only concern, choosing between a Pentium and a fast 486 is easy. After testing 20 Pentiums and 37 486DX2 systems, we found Pentiums averaged 30 percent faster in Windows performance than their venerable cousins. In fact, the slowest Pentium under Windows (DEC's DECpc 560ST) outran the fastest 66-MHz 486DX2 (Cornell Computers' Power Pak) by almost 10 percent.

However, Pentiums still command a significant price premium over fast 486s. The average price of the ISA-based 486DXs in our test sample is approximately $3500, while the average cost of an ISA-based Pentium system is about $1000 more.

To help you find the best high-performance PC for your application, we tested 60- and 66-MHz Pentiums and 66-MHz 486DX2s with ISA and EISA buses and with VL-Bus, PCI (Peripheral Component Interconnect), or proprietary local-bus implementations. We ranked the systems with the best mix of performance, price, features, and ease of use for Windows, Unix, and DOS applications. We also identified the system designs that offered the most room for expansion, as well as the models that boasted the lowest prices while still delivering a high level of quality.

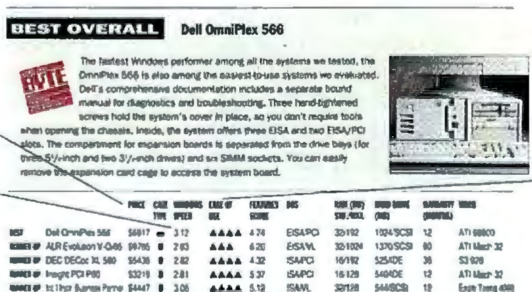
Among the Pentium systems we ranked for Best Overall status, PCI local-bus dominated: Six of these 10 systems were based on this design, while three of the remaining Pentiums used VL-Bus and the fourth relied on a proprietary local bus. PCI has also come down to the 486 platform, and although only three systems used this design, two of them—American Microsystems' Info Gold and MicroSource's Tempest IV—made it into Best Overall rankings. But VL-Bus continues to be the local-bus design of choice among 486 vendors.

How to use this guide

To find the best Pentium or 486 system for you, follow the main headings until you come to the applications category that most closely matches your own. Then look to the Best Overall, Most Expandable, or Low Cost summaries to find the appropriate models.

List prices are for the as-tested configuration.

Speed scores are calculated from Windows, Unix, and DOS tests. Higher numbers indicate better performance.



Rates how easily you can configure the system and the quality of its documentation.

Points awarded for presence of important features; higher numbers mean better scores.

PHOTOGRAPHY: STEVE BELKOWITZ © 1994

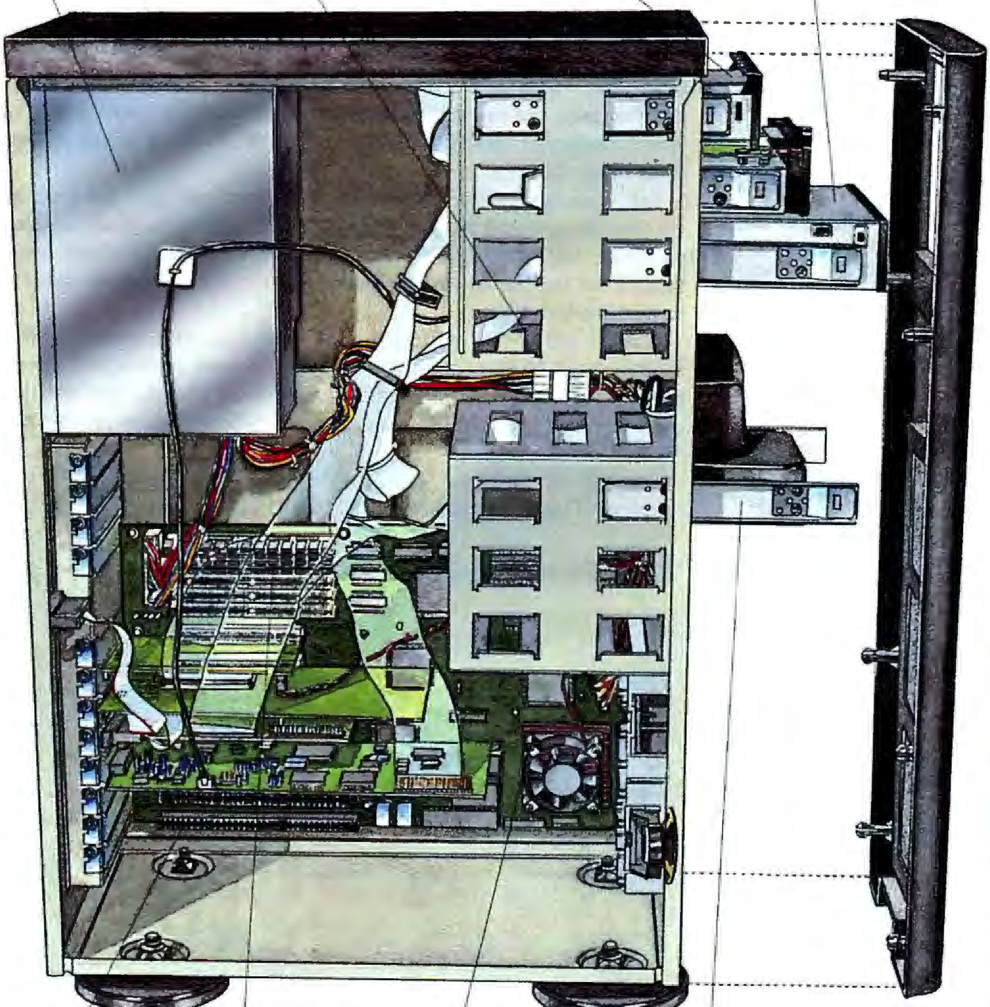
What to Look For

POWER SUPPLY
Pentium and fast 486 systems are meant to be workhorses, so you should specify a power supply that is at least 200 watts.

DRIVE BAYS
Choose a tower-case if you will be using the system as a server or in applications that require multiple drives (the roomiest designs in this roundup had five or more available bays).

FLOPPY DRIVES
The standard floppy configuration for most systems is a 1.44-MB, 3½-inch floppy drive. If the system will be used to transfer data from older machines, it is wise to also buy a 5¼-inch drive or choose dual drives that support both sizes of floppy drives but use only one drive bay.

CD-ROM
Buy a double-speed CD-ROM drive or faster. One distinguishing factor in choosing a drive is the manner in which the system will stand. If the system will stand on its side, choose a CD-ROM drive that has a caddy load.



EXPANSION SLOTS
If you plan to use the system for disk- or video-intensive applications, look for available local-bus slots, since local bus offers a higher throughput rate than ISA or EISA.

MEMORY
Most Pentium and high-end 486 systems we tested use standard SIMMs. When choosing a system, consider the degree of difficulty you may encounter in trying to increase the amount of RAM in your system. Avoid systems that require you to remove the drive bays to add SIMMs.

CPU
Pentiums outperformed 66-MHz 486DX2 chips by about 30 percent in our Windows tests. Pentiums also generate a lot of heat, so you should make sure the system design provides adequate cooling. The chip should be mounted on a heat sink or next to a cooling fan, and there should also be plenty of room around the chip for air to circulate.

HARD DRIVE
The hard drive subsystem is often the bottleneck in high-end performance machines. Since speed is the trademark of Pentium and 486DX2/66 systems, choose a hard drive with a fast controller and access time at or below 11 milliseconds. Local-bus (VL or PCI) SCSI-2 drives usually offer the fastest data transfer rates. The drive itself should be at least 500 MB.

BEST

Best Pentium for Windows

Dell OmniPlex 566

One of only two 66-MHz Pentiums that we tested, the OmniPlex was the fastest performer of all the systems in this report. Along with top speed, this desktop system also earned high marks for ease of use and features. **PAGE 209**

Best Pentium for Unix

ALR Evolution V-Q/66

By far the fastest machine we tested under Unix, this huge tower also was among the most flexible for adding memory, mass storage, and adapter cards. **PAGE 211**

Best ISA 486 for Windows

Cornell Computer Systems Cornell Power Pak

This system has the fastest Windows scores in its class. It also outperformed some of the Pentiums. **PAGE 215**

Best EISA 486 for Windows

Cornell Computer Systems EISA-VL SCSI-2

Like its ISA counterpart, the Cornell EISA-VL SCSI-2 is the fastest system in its class. The roomy tower system is also among the least expensive EISA machines we tested. **PAGE 217**

Best 486 for Unix

IBM ValuePoint 6387-W90

Loaded with features and plenty of growing room, the IBM ValuePoint 6387-W90 is easily the Unix speed leader in its class. **PAGE 219**

Best 486 for DOS

Cornell Computer Systems EISA-VL SCSI-2

This system outperforms the competition in DOS speed tests. The Cornell EISA-VL SCSI-2 is loaded with features and is easily upgraded. **PAGE 221**

ILLUSTRATION: BRUCE SANDERS © 1994

THE BEST

PENTIUMS FOR WINDOWS

The overall 30 percent Windows speed advantage of Pentiums over 486s isn't the whole story: The fastest Pentiums also provide a 40 percent increase over 486s in applications such as Windows spreadsheets, which rely on strong floating-point performance.

Of the 20 Pentiums we evaluated for this report, all but two use 60-MHz versions of the processor. The exceptions were Dell's OmniPlex 566 and Advanced Logic Research's Evolution V-Q/66. Each system ran a 66-MHz Pentium processor. This speed advantage helped the Dell win Best Overall honors and the ALR rank first for Most Expandable. However, speed wasn't the only factor in either selection (see page 209).

All the Pentiums we tested came with at least 256 KB of cache. Three Pentiums—including the Evolution V-Q/66—came with 512 KB of cache. Five others could be upgraded to at least this level, including the International Instrumentation Business Partner and the Micro Express MicroFlex-VL/Pentium, which can handle up to 2 MB of cache.

Pentiums offer significant performance gains compared to 486s, but the faster CPUs also present some design challenges for system vendors, thanks to the high heat Pentiums produce. We found a number of different solutions to the heat problem in our test sample. The Evolution V-Q/66 used multiple motherboard fans to cool the processor and system components. The Xinetron X/LAN 586 and Duracom Multimedia FilePro Pentium 60-PCI rely on fans attached adjacent to the CPU to keep things cool. DEC's DECpc XL 560 uses a plastic pipe to channel air directly onto the CPU.

Most of the systems in our sample came with at least 4 SIMM slots, which allow you to expand memory up to 128 MB. All the systems' SIMM slots accept the newer 72-pin, 32-bit SIMM packages. Although these sockets let you fit more memory into less space, you won't be able to move memory from older systems to your new Pentium.

Three of the five systems ranked for Best Overall use PCI (Peripheral Component Interconnect) local bus, and three of the top Pentium systems use video chip sets from ATI (the others use S3's and Tseng Labs' chips).

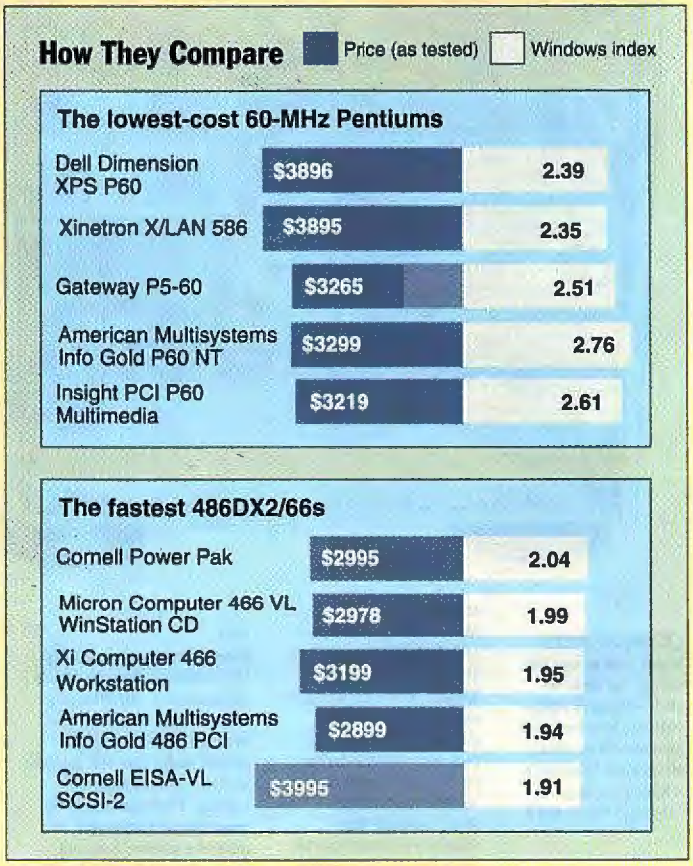
Among the Best Overall systems, International Instrumentation's 60-MHz Business Partner scored the second-highest Windows scores, beating out even the 66-MHz ALR Evolution. What's more, its fast video subsystem helped the system finish ahead of the 66-MHz Dell OmniPlex 566 (an EISA machine) in the BYTE low-level Windows benchmarks. The ISA-based Business Partner sells for

PENTIUM VS. 486: POWER OR PRICE?

PC buyers have long faced the question of whether to buy economical systems with the current standard CPU or pay premium prices for the fastest technology. When we first compared the price and performance of 486s and Pentiums, we saw wide differences (see "90 High-Speed 486 Systems," December 1993 BYTE). The market has changed quickly in that short time.

Today, our comparisons of price and performance indicate that you can get outstanding speed and economical prices in a Pentium. The chart compares the five fastest 486DX2/66 performers in our Windows tests against the five lowest-cost Pentiums. Each of these Pentiums outperformed the fast 486s.

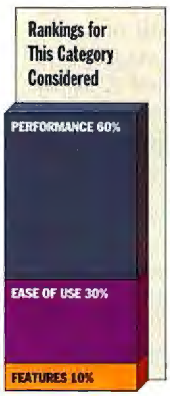
Is there still any reason to buy a fast 486? You can save money with a 486: about 30 percent on average. Also, if your applications stress hard disk or network performance, Pentiums won't benefit you like they will if you need fast computational speeds and floating-point processing.



The bars on the right indicate the performance of each product in the Windows tests as indexed against a Compaq Deskpro 4/33i. Longer bars represent better performance. The bars on the left represent the cost of the systems as tested. (Note: Most Pentiums had 32 MB of RAM and 1-GB hard drives. The 486s were equipped with 16 MB of RAM and 500-MB hard drives). Shorter bars indicate lower cost.

$2500 less than the OmniPlex 566, and the Business Partner is one of the lowest-priced Pentiums in our entire sample. Unfortunately, its documentation is incomplete and the fit-and-finish of the machine is rough. In particular, we were troubled by the poor ways in which the heat sink and the parallel-port cover were attached (see Dubious Achievements on page 222). If International Instrumentation solves its quality problems, the Business Partner can be a contender for Best Overall honors, thanks to its fine performance. Until then, however, we can only consider it a runner-up.

For Most Expandable, we only ranked full-size tower designs. Among the leaders in this group, Insight Direct's Insight PCI P60 Multimedia places second from the top thanks to its $3219 price (the lowest price in this group) and Windows performance, which places it second among the 60-MHz machines ranked here. The Insight also offers an impressive 10 available drive bays and five available slots in a design that keeps them free from wiring and cables.



American Multisystems' Info Gold P60 PCI won Low Cost honors (Pentium systems priced below the $5200 average, including ISA and EISA machines) thanks to its $3300 price and quality design, which included PCI local bus, a chassis that accommodates seven 5¼-inch drives, and the second fastest Windows score.

KEY

Ease of Use:

Poor ▲ Fair ▲▲
Good ▲▲▲ Excellent ▲▲▲▲

Case:

Desktop ▬ Tower ▮
Mini-tower ▯

Prop = proprietary.

BYTE BEST — PENTIUMS FOR WINDOWS

Want the fastest for Windows?

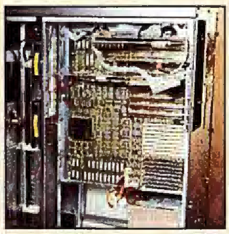
BEST OVERALL — Dell OmniPlex 566

The fastest Windows performer among all the systems we tested, the OmniPlex 566 is also among the easiest-to-use systems we evaluated. Dell's comprehensive documentation includes a separate bound manual for diagnostics and troubleshooting. Three hand-tightened screws hold the system's cover in place, so you don't require tools when opening the chassis. Inside, the system offers three EISA and two EISA/PCI slots. The compartment for expansion boards is separated from the drive bays (for three 5¼-inch and two 3½-inch drives) and six SIMM sockets. You can easily remove the expansion card cage to access the system board.

		PRICE	CASE TYPE	WINDOWS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	Dell OmniPlex 566[1]	$6917	▬	3.12	▲▲▲▲	4.74	EISA/PCI	32/192	1024/SCSI	12	ATI 68800
RUNNER-UP	ALR Evolution V-Q/66[1]	$9765	▮	2.83	▲▲▲	6.20	EISA/VL	32/1024	1370/SCSI	60	ATI Mach 32
RUNNER-UP	DEC DECpc XL 560	$5436	▮	2.82	▲▲▲▲	4.32	ISA/PCI	16/192	525/IDE	36	S3 928
RUNNER-UP	Insight PCI P60	$3219	▮	2.61	▲▲▲▲	5.37	ISA/PCI	16/128	540/IDE	12	ATI Mach 32
RUNNER-UP	Int.'l Instr. Business Partner	$4447	▮	3.06	▲▲▲▲	5.12	ISA/VL	32/128	544/SCSI	12	Eagle Tseng 4000

Need speed and room to grow?

MOST EXPANDABLE — Advanced Logic Research Evolution V-Q/66



This EISA/VL-Bus tower offers the greatest expansion potential of any system we tested—for a price: This $9765 system is the most expensive machine in this roundup. Easy-to-remove side panels let you access 11 5¼-inch and two 3½-inch drive bays (all with frontal exposure). A large fan cools the drives, and there is ample room for wiring. Two additional fans cool the motherboard. Six available slots (five EISA and one VL-Bus) and 16 SIMM sockets (supporting 1 GB of RAM) are free from obstructions. Thanks to its 66-MHz Pentium CPU and an ATI Mach 32 video adapter, the Evolution provides excellent Windows performance on both the applications and low-level tests, for a combined score of third-best among all systems tested in this report. For towers that have slightly less room for growth but have solid speed and are a third of the cost, consider the Insight PCI P60 and the Gateway P5-60.

		PRICE	CASE TYPE	WINDOWS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	OPEN BAYS 3½/5¼	AVAILABLE SLOTS	VIDEO
BEST	ALR Evolution V-Q/66[1]	$9765	▮	2.83	▲▲▲	6.20	EISA/VL	32/1024	1/8	6	ATI Mach 32
RUNNER-UP	Insight PCI P60	$3219	▮	2.61	▲▲▲▲	5.37	ISA/PCI	16/128	7/3	5	ATI Mach 32
RUNNER-UP	Gateway P5-60	$3265	▮	2.51	▲▲▲▲	5.19	ISA/PCI	32/128	3/3	6	ATI Mach 32
RUNNER-UP	EasternTech ET P60-PCI	$4995	▮	2.47	▲▲▲▲	5.16	ISA/PCI	32/192	2/1	4	S3 805
RUNNER-UP	AMS Info Gold P60 PCI	$3299	▮	2.76	▲▲▲	4.35	ISA/PCI	32/192	0/3	3	Weitek P9001

For Pentium power and economy...

LOW COST — American Multisystems Info Gold P60 PCI

With a suggested price of just $3299, the Info Gold P60 PCI is a good value in a Pentium system. The trade-off for low cost is only average Pentium speed. Nevertheless, the Info Gold outran most 486s and cost less than 22 of them.

		PRICE	CASE TYPE	WINDOWS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	AMS Info Gold P60 PCI	$3299	▮	2.76	▲▲▲	4.35	ISA/PCI	32/192	540/SCSI	12	Weitek P9001
RUNNER-UP	Insight PCI P60	$3219	▮	2.61	▲▲▲▲	5.37	ISA/PCI	16/128	540/IDE	12	ATI Mach 32
RUNNER-UP	Gateway P5-60	$3265	▮	2.51	▲▲▲▲	5.19	ISA/PCI	32/128	540/IDE	12	ATI Mach 32
RUNNER-UP	Int.'l Instr. Business Partner	$4447	▮	3.06	▲▲▲▲	5.12	ISA/VL	32/128	544/SCSI	12	Eagle Tseng 4000
RUNNER-UP	Dell Dimension XPS P60	$3896	▬	2.39	▲▲▲▲	4.81	ISA/PCI	16/128	450/IDE	12	S3

[1] 66-MHz Pentium

How We Tested

Testing Team (from left): Stephen Platt, Anthony Lennon, Alan Joch, Tom McAndrew (seated), Siva Kumar, Jim Kane, and Helen Holzbaur.

We tested each Pentium and 486 system under Windows 3.1, DOS 6.0, and SCO Unix ODT (Open Desktop) 3.0. DOS and Windows suites consisted of BYTE low-level tests and NSTL application tests.

The BYTE DOS low-level tests evaluate system performance by isolating CPU, FPU, memory, video, and hard disk subsystems. The BYTE Windows low-level tests exercise the Windows GDI (Graphical Device Interface) to determine how well a system can execute basic Windows graphics tasks, such as drawing a line, displaying text, or executing BitBlt operations.

The NSTL application tests use popular business applications that give a real-world representation of system performance. The DOS performance suite includes WordPerfect 5.1, Lotus 1-2-3 release 2.4, and FoxPro 2.0. The Windows tests consist of Microsoft Excel 4.0a, Microsoft Word 2.0b, and Lotus 1-2-3 for Windows 1.1. All applications execute macros that exercise common areas of each application. For instance, the Word for Windows test includes a number of subtests that measure a variety of activities, including accessing files, performing search-and-replace functions, changing fonts, scrolling by page and line, checking the spelling, previewing print jobs, and printing to a file.

FEATURES

We considered the following features most important for 486DX2/66 and Pentium systems:

- 32 MB or more of memory capacity for 486s
- 64 MB or more of memory capacity for Pentiums
- Bundled software that includes DOS and Windows
- Flash ROM BIOS
- 16550 UART (universal asynchronous receiver/transmitter) for optimal serial communication
- Available adapter slots and drive bays
- Display resolution of 1280 by 1024 pixels
- Security features
- Free lifetime technical support
- A minimum of one-year parts-and-labor warranty

All Windows tests were executed in 1024- by 768-pixel resolution with 256 colors. The DOS tests ran in the standard VGA resolution (640 by 480 pixels at 16 colors). The BYTE Windows low-level tests ran in both modes.

For comparison, we scaled all Windows and DOS test scores against a Compaq Deskpro 4/33i, a 33-MHz 486DX system, whose performance results equal a 1.0 in our index. Thus, a system with a performance index of 1.5 executed our tests 50 percent faster than the baseline Deskpro 4/33i.

Our Unix tests used SCO ODT 3.0, a Unix implementation incorporating the X Window System user interface. The tests covered processor, disk, and display-intensive activities, including both application-based and low-level benchmarks. The SPEC92 test suite consists of a variety of scientific and engineering applications. We used the integer-oriented CINT92 group for 486 workstations and both the CINT92 and CFP92 groups for Pentium workstations. A DEC VAX 11/780 equals 1.0 in our SPEC92 index. Additionally, we tested systems using BYTE's low-level Unix benchmarks. The BYTE Unix scores were indexed against the Deskpro 4/33i. The Unix test suite evaluated each system as a graphics workstation for typical computation and display-intensive activities, not as a file server or database query processor.

EASE OF USE

We also evaluated systems for design and documentation. We considered several factors when we looked at system design: How easy was it to open the system and install an adapter? Were any slots obstructed? Were the I/O ports labeled? Could the subsystems be disabled?

We gave points to systems that came with clear, well-indexed documentation. We also gave points if specifications were provided for the video and disk subsystems. Additionally, we considered whether jumpers and DIP switch settings were adequately detailed.

Although keyboard feel is important, evaluating keyboards is subjective and thus was not part of our scoring. We also did not evaluate monitors for this report. However, prices listed here are for as-tested configurations that include either a 14- or 15-inch, 1024- by 768-pixel (noninterlaced) monitor. Prices also include keyboard, mouse, CD-ROM drive, and sound card.

CONFIGURATION

Our testing was open to all 486-class systems with a 66-MHz DX2 processor as well as 60- and 66-MHz Pentiums, with ISA and EISA buses. We requested that all 486 systems have 16 to 20 MB of RAM and that Pentiums have 32 to 46 MB of RAM. We specified hard drives of at least 510 MB, using a controller that had no more than 1 MB of cache. Each system had at least a megabyte of video memory and supported 1024- by 768-pixel resolution at 256 colors. Finally, each system was equipped with a CD-ROM and a sound card.

Contributors

Helen E. Holzbaur, *Project Manager/NSTL, was a network manager and systems administrator at Temple University for 10 years before joining NSTL.*

Alan Joch, *Senior Editor/BYTE, coordinates the combined testing between the BYTE Lab and NSTL.*

Jim Kane, *Technical Analyst/NSTL, has tested network hardware and software, high-end systems, and peripherals during the past three years at NSTL.*

Siva Kumar, *Technical Analyst/NSTL, specializes in hardware and network-operating systems testing.*

Anthony Lennon, *Technical Editor/NSTL, tests systems, notebooks, and peripherals.*

Tom McAndrew, *Technical Analyst/NSTL, evaluates high-end PCs, operating systems, and peripherals.*

Stephen M. Platt, *Manager of Unix Development/NSTL, has a doctorate in computer science/computer graphics.*

The Lab Report is an ongoing collaborative project between BYTE Magazine and National Software Testing Laboratories (NSTL). BYTE Magazine and NSTL are both operating units of McGraw-Hill, Inc.

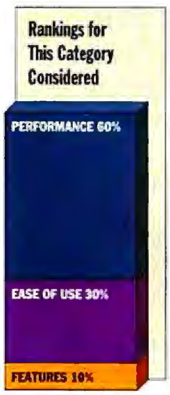
BYTE BEST

PENTIUMS FOR UNIX

Results from the BYTE Unix benchmarks (which were run under SCO Unix ODT 3.0) further illustrate the Pentium's overall speed advantages compared to the 486's. The top five Pentium systems ranked for Best Overall have an average BYTE Unix score of 2.15. By comparison, the 486 systems that ranked Best Overall for Unix achieved an average of 1.56. Much of the speed advantage of the Pentium rests with improve floating-point processing power over the 486.

Of the 20 Pentium systems we received, 14 used PCI local bus. But Pentium vendors' reliance on the PCI made Unix testing difficult because during our test cycle, we found little support for PCI video in the SCO Unix kernel. We found no such problems with VL-Bus display cards.

Advanced Logic Research's Evolution V-Q/66 and DEC's DECpc 560ST outpaced the other Pentiums ranked for Best Overall by almost 50 percent. These two systems, priced at over $9100 in our test configuration, also took honors for being the most expensive systems in our sample. For those who can accept average Unix performance, consider the Gateway and Dell runners-up, which sell for $3265 and $3896, respectively.



KEY

Ease of Use:

Poor ▲ Fair ▲▲

Good ▲▲▲ Excellent ▲▲▲▲

Case:

Desktop ▬ Tower ▮

Mini-tower ▯

Prop = proprietary.

For the Unix speed leader...

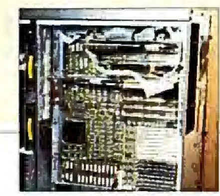
BEST OVERALL — Advanced Logic Research Evolution V-Q/66

For Unix-based scientific, engineering, and graphics applications, this EISA system led all other Pentiums in the SPEC integer and floating-point scores (61.5 and 52.0, respectively, compared to averages of 48.3 and 42.7). The system's graphics performance was also among the best, thanks to the ATI Mach 32 controller and VL-Bus implementation. The 1.3-GB SCSI hard drive includes 4 MB of cache. Other nice features include the advanced 16550 UARTs (universal asynchronous receiver/transmitters) on the serial port, which is essential for high-speed communications.

		PRICE	CASE TYPE	UNIX SPEED SPECINT	SPECFP	BYTE	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	ALR Evolution V-Q/66¹	$9765	▮	61.49	52.07	2.46	▲▲▲	6.20	EISA/VL	32/1024	1370/SCSI	60	ATI Mach 32
RUNNER-UP	DEC DECpc 560ST	$9131	▮	53.19	46.59	2.43	▲▲▲▲	5.18	EISA/Prop.	32/192	1024/SCSI	36	Amer. Meg.
RUNNER-UP	Dell Dimension XPS P60	$3896	▬	47.42	41.80	1.99	▲▲▲▲	4.81	ISA/PCI	16/128	450/IDE	12	S3
RUNNER-UP	Insight PCI P60	$3219	▮	47.04	41.41	1.90	▲▲▲▲	5.37	ISA/PCI	16/128	540/IDE	12	ATI Mach 32
RUNNER-UP	Gateway P5-60	$3265	▮	45.44	41.40	1.96	▲▲▲▲	5.19	ISA/PCI	32/128	540/IDE	12	ATI Mach 32

Need a tower of power?

MOST EXPANDABLE — Advanced Logic Research Evolution V-Q/66

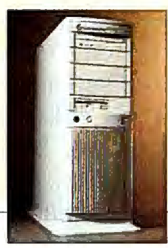


In addition to its high-performance design, this tower is built with expansion (see details in the Most Expandable category on page 209). Unlike other towers, the interior of the Evolution V-Q/66 is clean and open, so you won't have to contend with cables and wires to access expansion slots.

		PRICE	CASE TYPE	UNIX SPEED SPECINT	SPECFP	BYTE	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	OPEN BAYS 3½/5¼	AVAILABLE SLOTS	VIDEO
BEST	ALR Evolution V-Q/66¹	$9765	▮	61.49	52.07	2.46	▲▲▲	6.20	EISA/VL	32/1024	1/8	6	ATI Mach 32
RUNNER-UP	DEC DECpc 560 ST	$9131	▮	53.19	46.59	2.43	▲▲▲▲	5.18	EISA/Prop.	32/192	1/1	3	Amer. Meg.
RUNNER-UP	Insight PCI P60	$3219	▮	47.04	41.41	1.90	▲▲▲▲	5.37	ISA/PCI	16/128	7/3	5	ATI Mach 32
RUNNER-UP	Gateway P5-60	$3265	▮	45.44	41.40	1.96	▲▲▲▲	5.19	ISA/PCI	32/128	3/3	6	ATI Mach 32
RUNNER-UP	Duracom Multimedia FilePro	$5649	▮	46.62	41.74	1.79	▲▲▲	4.77	ISA/PCI	32/128	3/0	5	S3 #9GXE

When price matters...

LOW COST — Gateway 2000 P5-60



This excellent, entry-level Pentium system is built around a large tower case that can grow over time: as your applications demand more memory, you'll be able to add up to a maximum of 128 MB. There's also room for nine drives. The documentation is geared toward novice users and is well organized, containing everything you'll need to configure and run the system. Make no mistake, the Gateway P5-60 isn't a barn-burner among Pentiums, but at $3265, it is priced less than most of the 486-based systems in this report.

		PRICE	CASE TYPE	UNIX SPEED SPECINT	SPECFP	BYTE	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	Gateway P5-60	$3265	▮	45.44	41.40	1.96	▲▲▲▲	5.19	ISA/PCI	32/128	540/IDE	12	ATI Mach 32
RUNNER-UP	Dell Dimension XPS P60	$3896	▬	47.42	41.80	1.99	▲▲▲▲	4.81	ISA/PCI	16/128	450/IDE	12	S3
RUNNER-UP	Xinetron X/LAN 586	$3895	▮	45.36	38.75	1.86	▲▲▲	4.76	ISA/VL	32/128	520/SCSI	36	Tseng W32
RUNNER-UP	Micro Express MicroFlex-VL	$4699	▮	44.19	38.54	1.65	▲▲▲▲	4.48	ISA/VL	32/128	500/SCSI	24	Tseng W32I

¹ 66-MHz Pentium

"ZEOS®... lowest price for power."

-*PC World*, February 1994

We give you more, more and more...for less, less and less! *PC World* agrees. They awarded ZEOS the January and February 1994 Best Buy awards for our 486DX2-66! *PC World* reported the system tested was "a powerful Best Buy that has exceptional appeal for both performance and budget buyers."

There's more. *PC World* went on to say the 486 system is "the best all around value we've seen." Why? Because we provide our customers with the latest technological advancements at the best possible price. In fact, *we lowered prices* on most of our 486 Local Bus Upgradable configurations–*and* we now offer the options of the new Intel 486DX4 microprocessor running at 75MHz or 100MHz.

In addition to higher performance and lower prices, you get award-winning, Intel verified systems that offer many upgrade paths as your needs dictate. Choose from one of our money-saving packages (many ready to ship the same day you order) or custom configure a system to your exact needs.

"PROS: Excellent Performance, design, and support; low price. CONS: None."

–PC World, Feb 94

And all 486 Upgradables are 100% compatible with every major network operating system on the market, including Novell NetWare. It's a breeze to get connected!

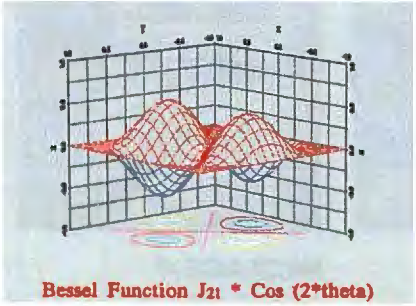
The value doesn't stop with your system. Many companies just talk about service. At ZEOS, our customers do the talking. ZEOS has won more *PC Magazine* Readers' Choice for Service & Reliability awards than any other company–five in all! And we were the first company to provide its customers with 24-hour, toll-free technical support–every day. You receive the best *service* and support in the business.

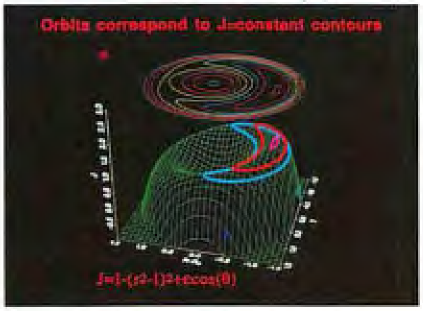
Plus all 486 Upgradables include One Year Limited Warranty, 30-Day Money Back Guarantee and Express Parts Replacement.

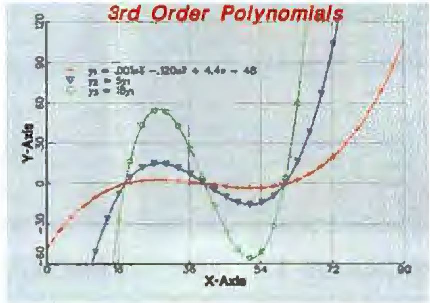
Feature for feature, *no one* gives you more than ZEOS. At any price, anywhere. ZEOS continues to be the best value. Call your Systems Consultant now at 800-554-5226.

486/Pentium Cross Platform Tools

The Fastest 32-bit Code NDP Fortran, NDP C|C++ and NDP Fortran-90


Bessel Function J_{21} * Cos (2*theta)





DOS

NDP Fortran has come with DOS screen graphics since it was introduced in 1987. The problem with this approach today is that just writing to the screen is not enough. You also have to be able to interface the 32-bit API that comes with your OS and possibly other API's. However, taking advantage of a single API is a time consuming tedious task.

OS/2

VGP solves the API interface problem with a universal vector output format that can be converted into EPS, TIF, GEM, HPGL2, CGM, WMF, etc. You create plots or graphics with calls to NDP Fortran or C. Included with the compiler is a DISPLAY program that runs on the OS you ordered. If you want to export your work, import PS or TT fonts or do real time screen plots by

Windows

binding **VGP** into your program, you can purchase one of several upgrades, or the source! Best of all, you get the same output independent of the OS you are using and **VGP** supports over 20 different types of plots, making it easy to create displays which communicate your ideas.

DISPLAY Export Extensions....................$145
Binary/C Source library.................$395/695

386, 486 & Pentium Compilers

Microway's NDP family of 32-bit compilers generate globally optimized mainframe quality code that runs on the 386, 486, Pentium and i860. They run on 32-bit operating systems such as OS/2, UNIX, Solaris, Coherent, and DPMI/VCPI DOS Extenders.

NDP Fortran-90™ a complete Fortran-90 which runs in conjunction with the NDP Fortran.

NDP Fortran™ is a full F77 with F66, DOD, VMS and MS extensions.

NDP C|C++ compiles K&R and ANSI C plus is C++ Release 2.1 compliant.

NDP Pascal™ is a full ISO Level 1 Pascal with BSD extensions that can interface the NDP C runtime libraries.

NDP Language Pricing

DOS versions include a VCPI/MM DOS Extender, DPMI interface layer, support for x87 and Weitek coprocessors, NDPLink, NDPLib and **GREX** - our DOS graphics library. The Pentium release adds new code generation, royalty free DPMI and VCPI plus symbolic debugging.

DOS 386/486 version.............................$695

DOS Pentium version..............................$995

OS/2 Developer's Pack includes IBM OS/2 WorkFrame and Toolkit. These tools use the IBM Linker. Deduct $100 if you don't need the Workframe. 386,486....................................$595
Pentium...$795

UNIX 386/486 use the native tools and are available for **SCO** or **ISC** UNIX.............. $1195

Coherent version.......................................$295

NDP Fortran-90...$395

i860 Supercomputers

Gigacube™ - Your choice of QuadPuters or ArrayProXPs - a Gigaflop starting at.......... $50K

ArrayProXP™ - EISA Array Processor - features a zero wait state 50 MHz 64-bit memory system. The 400 MB/Sec memory bandwidth in conjunction with 100 megaflop i860XP results in 28.96 Linpack megaflops, 94 megaflops doing dot products and 70 megaflops doing FFTs. The card bursts on the EISA bus at 33 MB/Sec and holds up to 256

QuadPuter™-**860** - The world's most cost effective Supercomputer. The QuadPuter includes four modules, each containing a 25 MHz i860 and two megabytes of local memory. The modules plug into an EISA card that provides 32 megabytes of shared memory. A single QuadPuter has an aggregate throughput of 200 megaflops! With software from..... $9995

Number Smasher™-**860** - our ISA 860 card comes with 8 or 32 megabytes. It includes an NDP Language - 80 megaflops of throughput starting at just..........................$2995

NDP Fortran™-**860** along with our C|C++ and Pascal utilize advanced scalar code generation techniques to optimize the i860's numeric scalar performance..........$1995

PPS™-**860** postprocessing scheduler, takes assembler output and converts scalar operations into pipelined operations running in dual instruction mode. Scalar speed ups in the range of 10 to 50% are common..............$500

VAST-II Vectorizer speeds up vector codes 100 to 300%. Includes a library of 700 vector primitives...$1495

Pentium/486 Workstations

486-BX Workstations - a Microway Tower is the ideal solution to your 486/Pentium needs. They feature industrial grade American power supplies, heavy duty cooling and easy access. All motherboards are carefully burned in and equipped with 50 Amp connectors. Some of our motherboards can be upgraded or purchased with Pentiums. Our BX Towers make great Workstations, file servers, and CAD/CAM stations. They were originally engineered to house i860 arrays, configured as NFS computational servers. Each system is customized with the OS of your choice, including ISC UNIX, OS/2, DOS and Windows. What differentiates Microway towers is our ability to integrate the peripherals you need, including SCSI tape drives and CD-ROMs, network cards and high quality hard disk and graphics adapters. 486-BX systems are used worldwide performing demanding tasks from testing jet engines to searching for oil. Call today for our BX Catalogue.

Search Engines & Libraries

MSE-160 - Free Text Search Engine ISA card processes 160 megabytes of data per second. Includes Text Retrieval software....................$950

IMSL Microway compiled and validated version of the IMSL mainframe libraries, available for the 386/486 or i860, Complete Package...$2,000

NAG Microway compiled and validated
Foundation x86/i860..........................$1195/1995
FortLP..$1195/1995
Workstation.....................................$2995/3995

KUCK & ASSOCIATES hand coded i860 libraries. DSP library does 1024 real FFT in 500 microseconds!
DSP......................$750 BLAS........................$500

LAPACK and BLAS, sources included.
386/486................$195 i860.........................$295

Microway® *Technology you can count on!*

Research Park Box 79, Kingston, MA 02364 USA (508) 746-7341 FAX 746-4678
U.K. 81-541-5466, Poland 22-414115, Greece 1-2915672, France 130-541767

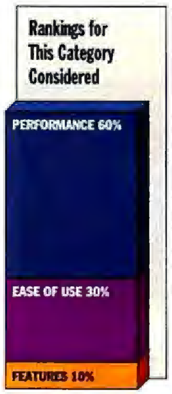
BYTE BEST

ISA 486S FOR WINDOWS

For fast performance and economy in high-end systems, ISA-based 486DX2s continue to set the standard for Windows applications. The 26 ISA-based 486 systems we tested average about $3500 in our test configuration.

Out of the five Best Overall systems, American Multisystems' Info Gold 486 PCI (which also ranked in Most Expandable and Low Cost) uses PCI, and Hewlett-Packard's Vectra 486 66/XM uses a proprietary local-bus design. Also, the PCI-based MicroSource Tempest IV/IPCI-66 qualified as a runner-up in Most Expandable and Low Cost, and Zenon's $1995 Z-Novus PCI, the lowest-price system ranked here, is also PCI-based.

Cornell Computer Systems' Power Pak, a VL-Bus system, swept all three Windows categories. Nevertheless, several runners-up also offered a good mix of performance and price. For example, in Most Expandable, the Info Gold 486 PCI scored nearly as fast as the Power Pak and costs $100 less than the Cornell system. Close behind is the MicroTech Ultima XV2/66, which has one drawback: Its four SIMM sockets are positioned near the expansion slots, which makes it difficult to install some full-length boards.



KEY

Ease of Use:

Poor ▲ Fair ▲▲

Good ▲▲▲ Excellent ▲▲▲▲

Case:

Desktop ▬ Tower ▮

Mini-tower ▯

Prop = proprietary.

Want the fastest Windows 486?

BEST OVERALL Cornell Power Pak

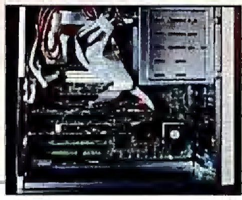
APRIL 1994 BYTE BEST 486DX2/66 (ISA) FOR WINDOWS

This ISA-based tower's Windows speed was the highest among all the 486 systems we tested, while its $3000 price tag ranks with the least expensive 486 systems. The Cornell Power Pak uses the Weitek P9000 video accelerator (which powered the top four Windows performers) and a Western Digital IDE hard drive. Micron's 466 VL WinStation CD Windows performance fell just shy of the Power Pak's and like the Cornell system, earned high marks for its ease of use. The Gateway 4DX2-66V's Windows performance was above the class average of 1.63 and like the Hewlett-Packard Vectra 486 66/XM, leads the Best Overall pack for systems designed in a desktop case.

		PRICE	CASE TYPE	WINDOWS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	Cornell Power Pak	$2995	▮	2.04	▲▲▲▲	5.77	ISA/VL	16/128	420/IDE	36	Weitek P9000
RUNNER-UP	Micron 466 VL WinStation	$2978	▬	1.99	▲▲▲▲	4.66	ISA/VL	16/64	340/IDE	Lifetime	Weitek P9000
RUNNER-UP	Gateway 4DX2-66V	$2795	▬	1.78	▲▲▲▲	5.48	ISA/VL	16/64	424/IDE	12	ATI Mach 32
RUNNER-UP	AMS Info Gold 486 PCI	$2899	▮	1.94	▲▲▲	5.15	ISA/PCI	16/128	540/SCSI	12	Weitek P9001
RUNNER-UP	HP Vectra 486 66/XM	$4757	▬	1.78	▲▲▲▲	5.78	ISA/Prop.	16/64	450/IDE	36	S3 928

Need speed and space?

MOST EXPANDABLE Cornell Power Pak



This system's large tower case holds four 5¼-inch and two 3½-inch disk drives. Four 16-bit ISA and one VL-Bus slot are available for additional boards. The four SIMM sockets are easily accessible on the motherboard. However, a cooling fan on top of the processor obstructs access to cache memory slots. The first runner-up, American Multisystems' Info Gold 486 PCI, conveniently has its power, turbo, and reset switches in the front panel.

		PRICE	CASE TYPE	WINDOWS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	OPEN BAYS 3½/5¼	AVAILABLE SLOTS	VIDEO
BEST	Cornell Power Pak	$2995	▮	2.04	▲▲▲▲	5.77	ISA/VL	16/128	2/4	5	Weitek P9000
RUNNER-UP	AMS Info Gold 486 PCI	$2899	▮	1.94	▲▲▲	5.15	ISA/PCI	16/128	0/3	5	Weitek P9001
RUNNER-UP	MicroTech Ultima XV2/66	$3999	▮	1.82	▲▲▲	5.10	ISA/VL	16/64	1/1	5	ATI Mach 32
RUNNER-UP	Data Storage DataStor	$4575	▮	1.71	▲▲▲▲	4.36	ISA/VL	16/128	4/1	3	S3 P86C928
RUNNER-UP	MicroSource Tempest IV	$2825	▮	1.72	▲▲▲	4.79	ISA/PCI	16/256	3/1	4	S3 805

Cost-conscious?

LOW COST Cornell Power Pak

By far the speed leader among low-cost 486s, the Power Pak offers a lengthy 36-month warranty. The Zenon Z-Novus PCI offers the lowest price in this category (and a warranty double the Power Pak's), but it has a slower Windows score than the Gateway 4DX2-66V, which offers the second lowest pace here and is the only other desktop design ranked for low cost.

		PRICE	CASE TYPE	WINDOWS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	Cornell Power Pak	$2995	▮	2.04	▲▲▲▲	5.77	ISA/VL	16/128	420/IDE	36	Weitek P9000
RUNNER-UP	Zenon Z-Novus PCI	$1995	▬	1.65	▲▲▲	5.47	ISA PCI	16/128	420/IDE	72	S3 428
RUNNER-UP	AMS Info Gold 486 PCI	$2899	▮	1.94	▲▲▲	5.15	ISA/PCI	16/128	540/SCSI	12	Weitek P9001
RUNNER-UP	Gateway 4DX2-66V	$2795	▬	1.78	▲▲▲▲	5.48	ISA/VL	16/64	424/IDE	12	ATI Mach 32
RUNNER-UP	MicroSource Tempest IV	$2825	▮	1.72	▲▲▲	4.79	ISA/PCI	16/256	425/IDE	12	S3 805

NSTL

PC Digest

RATINGS REPORT

NSTL Extends Coverage into the Far East

NSTL extends its coverage of computer products to the Far East with its testing partner LANBIT of Taiwan R.O.C. Using NSTL's proven testing methodology LANBIT provides an accurate and detailed look at leading notebook computers from Far Eastern suppliers. Look for an upcoming report on 16-bit Ethernet adapters, available in the Far East, in the April issue of ***PC Digest Ratings Report.***

National Software Testing Laboratories is the world's leading microcomputer and LAN hardware and software testing company. Publishers of ***Software Digest and PC Digest Rating Reports***, NSTL accepts no advertising and provides completely objective comparisons of computer systems, peripherals, and software from the industry's leading suppliers.

NSTL provides a detailed review of 12 notebook computers comparing performance, battery life, screen quality, ease of use and quality.

- Two of the products use a DX4- 75MHz clock speed 80486 microprocessor, four use a 486 DX/66 two the 50MHz version, one a 486 DX/40, two the 33MHz 486 chip while just one uses a 486 SX/25.
- Although five of the twelve products use an Intel 3.3 volt microprocessor the products with the best battery life used 5 volt versions.
- Products with active matrix color displays generally produced the best screen quality test scores. Only one of the twelve products used a monochrome display.
- Hard disk capacity ranged from 80 MB to 250 MB, all but two products provided internal 3.5-inch floppy disk drives.

For the full PC Digest report with complete features listing and test results call 1-800 220 NSTL. (Outside the USA call 1-610-941-9600) or Fax 1-610-941-9952

Comparison of 12 Notebook Computers

PC Digest Rating	Overall Evaluation	System	Processor	Monitor	Performance	Usability	Features	Battery	Screen
★★★★	8.7	Compal TS30AT	486DX/66	Color	▲	▲	▲	▲	▲
★★★★	8.7	Arima NotePro 486	486DX/66	Color	▲	▲	▲	▲	▲
★★★★	8.4	First Computer LEO DESIGNote	486DX/33	Color	■	▲	▲	▲	▲
★★★	7.8	Compal TS30MC	486DX/75	Color	▲	▲	▲	▲	■
★★★	7.6	AUVA NBE Plus 486C	486DX/75	Color	▲	▲	▲	▼	▲
★★★	7.5	Philips NB-402CT	486DX/66	Color	▲	■	■	■	▲
★★★	7.4	Jetta J-book 486	486DX/66	Color	▲	▲	▲	■	▲
★★★	7.3	Acer AcerNote 760CX	486DX/50	Color	■	▲	■	▲	▲
★★	6.9	Veridata JemPower 486E	486DX/50	Mono	■	▲	▲	■	■
★★	6.7	Arima Compact Note	486SX/25	Color	▼	▲	▲	■	▲
★★	6.6	Sunrex InnoVACE Hyperbook 320PEN	486DX/40	Color	■	▲	■	■	▲
★★	6.3	DTK DSN-3340C0	486DX/33	Color	■	▲	■	■	▲

Regular Price $125.

Special Offer for BYTE Readers $79.95

Ratings Key

(On a scale of 0 to 10)

OVERALL EVALUATION

★★★★★ 9.0 or higher
★★★★ 8.0-8.9
★★★ 7.0-7.9
★★ 6.0-6.9
★ 5.0-5.9

ALL OTHER RATINGS

▲ 7.0-9.9
■ 5.0-6.9
▼ under 5.0

When ordering please refer to the code PC494.

Circle 111 on Inquiry Card (RESELLERS: 112).

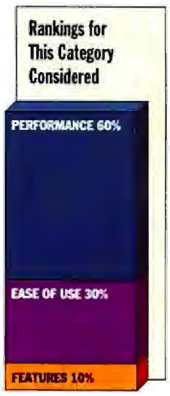
BYTE BEST

EISA 486S FOR WINDOWS

Out of the 37 486s we tested, 11 came with an EISA-bus architecture. EISA systems cost an average of $1400 more than a similarly equipped ISA system (however, some EISA prices reflect a configuration of 32 MB versus 16 MB in the ISA category). The high-performance EISA 486s even averaged about $500 more than ISA-based Pentiums. (EISA Pentiums cost $8000, on average.)

Also, out of the 11 EISA-based machines, 10 supported VL-Bus; the exception was AST Research's Premmia 4/66d, Model 343M, the first runner-up in Best Overall, which uses a proprietary local-bus design.

Despite the higher cost of EISA systems, we found little performance advantage in our Windows tests. For example, Cornell Computer Systems sent 486s that outran all others in our ISA and EISA Windows tests. The ISA-based Cornell Power Pak posted a Windows score of 2.04 versus the Cornell EISA-VL SCSI-2's leading score of 1.91. The faster speed overall in the ISA systems may be attributed partly to faster video systems in those machines. (The Weitek P9000 powered the Cornell ISA-based system and the Tseng Labs W32i accelerated the Cornell EISA system.)



KEY

Ease of Use:

Poor ▲ Fair ▲▲

Good ▲▲▲ Excellent ▲▲▲▲

Case:

Desktop ▬ Tower ▮

Mini-tower ▯

Prop = proprietary.

For the best in speed and usability...

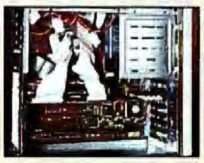
BEST OVERALL Cornell EISA-VL SCSI-2

This EISA system earned a Windows performance index of 1.91, the highest among systems ranked in this category and almost twice as fast as our baseline system. Besides scoring high in our performance tests, this system is also easy to use and offers a 16550 UART (universal asynchronous receiver/transmitter) for fast serial communication, as well as flash ROM for easy BIOS updates. The system sells for an economical price under $4500. The AST Premmia's Windows score of 1.87 nearly matches the Cornell's, and the Premmia also earned the best features rating in the category. This is the EISA machine to buy if you're looking for the best desktop-case system.

		PRICE	CASE TYPE	WINDOWS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	Cornell EISA-VL SCSI-2	$3995	▮	1.91	▲▲▲▲	6.14	EISA/VL	32/256	1024/SCSI	36	Tseng W32i
RUNNER-UP	AST Premmia 4/66d	$6852	▬	1.87	▲▲▲▲	6.25	EISA/Prop.	32/128	1024/SCSI	36	ATI Mach 32
RUNNER-UP	Micron 466 VLE WinServer	$4498	▮	1.80	▲▲▲▲	5.29	EISA/VL	32/64	540/SCSI	Lifetime	Weitek P9000
RUNNER-UP	CompuAdd C466De	$5806	▮	1.78	▲▲▲	4.88	EISA/VL	16/128	1024/SCSI	12	ATI Mach 32
RUNNER-UP	MIS Computer Systems M466EV	$4451	▮	1.76	▲▲▲	4.81	EISA/VL	32/64	1024/SCSI	12	Weitek

Need growth potential?

MOST EXPANDABLE Cornell EISA-VL SCSI-2

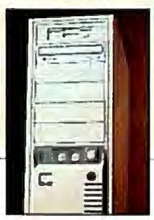


In addition to its superior performance, this huge tower also supplies growing room: It offers two 3½-inch drive bays and four 5¼-inch drive bays, along with three available EISA slots and one VL-Bus slot. CompuAdd's C466De Mini Tower posted the second-highest speed scores. Its sturdy tower chassis supports four 3½-inch and three 5¼-inch drives. Five 32-bit EISA and one VL-Bus expansion slot were available for additional cards.

		PRICE	CASE TYPE	WINDOWS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	OPEN BAYS 3½/5¼	AVAILABLE SLOTS	VIDEO
BEST	Cornell EISA-VL SCSI-2	$3995	▮	1.91	▲▲▲▲	6.14	EISA/VL	32/256	2/4	4	Tseng W32i
RUNNER-UP	CompuAdd C466De	$5806	▮	1.78	▲▲▲	4.88	EISA/VL	16/128	2/2	6	ATI Mach 32
RUNNER-UP	Micro Express MicroFlex	$4800	▮	1.76	▲▲▲▲	3.51	EISA/VL	32/128	4/4	8	Tseng W32i
RUNNER-UP	MIS Computer Systems M466EV	$4451	▮	1.76	▲▲▲	4.81	EISA/VL	32/64	2/4	4	Weitek
RUNNER-UP	DEC DECpc 466 MTE	$5715	▮	1.67	▲▲▲▲	5.56	EISA/VL	32/128	0/2	4	N/A

When you need speed and economy...

LOW COST Cornell EISA-VL SCSI-2



Fast performance, excellent features, and a price below the average of $4900 enabled this system to sweep our categories for EISA-based 486s. If your budget requires an EISA system that is less expensive than the Cornell and you can settle for slower Windows performance, consider the American Multisystems' Info Gold E-Server, the least expensive system we ranked in this class.

		PRICE	CASE TYPE	WINDOWS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	Cornell EISA-VL SCSI-2	$3995	▮	1.91	▲▲▲▲	6.14	EISA/VL	32/256	1024/SCSI	36	Tseng W32i
RUNNER-UP	AMS Info Gold E-Server	$3499	▮	1.66	▲▲▲	4.30	EISA/VL	32/256	1024/SCSI	12	S3 805
RUNNER-UP	MIS Computer Systems M466EV	$4451	▮	1.76	▲▲▲	4.81	EISA/VL	32/64	1024/SCSI	12	Weitek
RUNNER-UP	Micro Express MicroFlex	$4800	▮	1.76	▲▲▲▲	3.51	EISA/VL	32/128	1024/SCSI	24	Tseng W32i

N/A = not available.

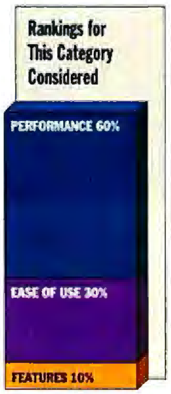
BYTE BEST

486S FOR UNIX

For Unix-based scientific and engineering applications, the Pentium systems we tested provided the fastest processing (see "Pentiums for Unix" on page 211). For example, IBM's ValuePoint 6387-W90 was the fastest 486 we ranked for Unix; its BYTE Unix benchmark score of 1.64 was almost 15 percent slower than the slowest Best Overall Pentium for Unix.

However, high-end speed comes at a high price: The average of Pentiums ranked for Best Overall was $5855. By contrast, the 486s we rank here for Best Overall offer solid Unix scores and an average price of $4183.

The IBM ValuePoint, a VL-Bus/ISA design, topped our tests, but we also discovered that Cornell's VL-Bus/EISA machine offers comparable Unix speed. Each of these machines come in tower cases. For top Unix speed in a desktop format, we recommend Hewlett-Packard's Vectra 486 66/XM, a $4757 ISA system.



Dyna Micro's 486 Business System, which sells for $3006, is the highest-priced system among the Low Cost 486s, but it offers the second fastest BYTE Unix score among these contenders. The Quantex Q486 is the lowest-priced system here.

KEY

Ease of Use:

Poor ▲ Fair ▲▲

Good ▲▲▲ Excellent ▲▲▲▲

Case:

Desktop ▬ Tower ▮

Mini-tower ▯

Prop = proprietary.

Want the best all-around performer?

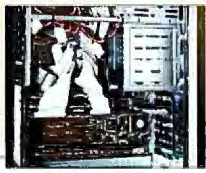
BEST OVERALL IBM ValuePoint 6387-W90

The fastest 486 system in the BYTE Unix benchmarks, the ValuePoint 6387-W90 also ranked among the fastest systems for SPEC integer scores. In addition, its S3 805 video and Maxtor hard disk systems were among the fastest tested. This ISA/VL-Bus tower accommodates up to 64 MB of RAM. (This system's keyboard uses the Trackpoint pointing device found in IBM's ThinkPad portables.) In addition, the ValuePoint earned among the highest scores for ease of use. If you require a desktop case, choose the Hewlett-Packard Vectra 486 66/XM, an ISA system that uses a proprietary local-bus design and a video system built around the S3 928 accelerator. The Vectra was also the only system we received that came with an integrated Ethernet port.

		PRICE	CASE TYPE	UNIX SPECINT	UNIX BYTE	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	IBM ValuePoint 6387-W90	$4994	▮	33.60	1.64	▲▲▲▲	6.26	ISA/VL	16/64	527/IDE	12	S3 805
RUNNER-UP	Cornell EISA-VL SCSI-2	$3995	▮	33.15	1.62	▲▲▲▲	6.14	EISA/VL	32/256	1024/SCSI	36	Tseng W32i
RUNNER-UP	HP Vectra 486/66XM	$4757	▬	32.63	1.51	▲▲▲▲	5.78	ISA/Prop.	16/64	450/IDE	36	S3 928
RUNNER-UP	Cornell Power Pak	$2995	▮	34.37	1.59	▲▲▲▲	5.77	ISA/VL	16/128	420/IDE	36	Weitek P9000
RUNNER-UP	ALR-Flyer VL 4/66d	$4174	▯	29.14	1.46	▲▲▲▲	5.19	ISA/VL	20/36	540/IDE	60	WD90C33

Want fast Unix and room to grow?

MOST EXPANDABLE Cornell EISA-VL SCSI-2



This EISA/VL-Bus tower provides the fastest performance in this category in the BYTE Unix tests, along with plenty of room to grow. It can hold up to eight drives, and it offers 16 SIMM sockets for up to 256 MB of RAM. The internal cabling is well placed, so you can access all internal components without a fight. Cornell's ISA-based cousin was the second-fastest most expandable system in BYTE's Unix tests.

		PRICE	CASE TYPE	UNIX SPECINT	UNIX BYTE	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	OPEN BAYS 3½/5¼	AVAILABLE SLOTS	VIDEO
BEST	Cornell EISA-VL SCSI-2	$3995	▮	33.15	1.62	▲▲▲▲	6.14	EISA/VL	32/256	2/4	4	Tseng W32i
RUNNER-UP	Data Storage DataStor (ISA)	$4575	▮	30.87	1.40	▲▲▲▲	4.36	ISA/VL	16/128	4/1	3	S3 P86C928
RUNNER-UP	Cornell Power Pak	$2995	▮	34.37	1.59	▲▲▲▲	5.77	ISA/VL	16/128	2/4	5	Weitek P9000
RUNNER-UP	MicroTech Ultima XV2/66	$3999	▮	32.87	1.55	▲▲▲	5.10	ISA/VL	16/64	1/1	5	ATI Mach 32
RUNNER-UP	Data Storage DataStor (EISA)	$5595	▮	33.59	1.42	▲▲▲▲	4.34	EISA/VL	32/128	2/1	3	S3 P86C928

A speed leader for under $3000...

LOW COST Cornell Power Pak

Only eight of the 37 systems we tested cost less than the Cornell Power Pak, which also posted the fastest (by up to 30 percent) BYTE Unix score among systems ranked for low cost. This solid tower holds up to six storage devices and four SIMM sockets for up to 128 MB of memory. If you need a desktop case, choose the Dyna Micro 486 Business System, which offers the second fastest BYTE Unix speed and a $3000 price. Gateway's 4DX2-66V was the only other desktop design ranked here; it sells for $200 less than the Business System.

		PRICE	CASE TYPE	UNIX SPECINT	UNIX BYTE	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	Cornell Power Pak	$2995	▮	34.37	1.59	▲▲▲▲	5.77	ISA/VL	16/128	420/IDE	36	Weitek P9000
RUNNER-UP	Dyna Micro Business System	$3006	▬	30.51	1.40	▲▲▲	4.61	ISA/VL	16/32	546/IDE	12	S3 805
RUNNER-UP	Quantex Q486 DX2/66	$2699	▮	20.24	1.00	▲▲▲▲	5.36	ISA/VL	16/N/A	425/IDE	12	Weitek 9000
RUNNER-UP	Mitsuba MIT486/66V	$2900	▮	26.90	1.24	▲▲▲	4.38	ISA/VL	16/32	544/IDE	24	Cirrus Logic 5428
RUNNER-UP	Gateway 4DX2-66V	$2795	▬	29.49	0.50	▲▲▲▲	5.48	ISA/VL	16/64	424/IDE	12	ATI Mach 32

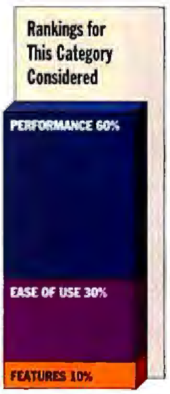
N/A = not available.

486S FOR DOS

When we tested EISA and ISA 486s for DOS, we found that the best machines for Windows weren't necessarily the best 486s for the more venerable operating system.

The Cornell EISA-VL SCSI-2 continued its winning ways (see page 217) with a pace-setting DOS score of 2.19. Also, in the Best Overall competition, IBM's ValuePoint 6387-W90 offered only average performance, but its range of features made it a strong contender. It offers flash ROM and a 16550 UART (universal asynchronous receiver/transmitter) for fast serial communication. Its internal design has no obstructed slots and its documentation is among the most complete we saw. However, ValuePoint didn't include a reset switch.

The strengths of the MicroSource Tempest IV/IPCI-66, which ranked as first runner-up in Most Expandable and as the leader for Low Cost, are its speed and price. Compared to the ValuePoint and the Premmia 4/66d, however, the Tempest received an inferior ease-of-use score. This was partly due to incomplete documentation that could force you to call the company's technical-support line to solve hardware problems.



KEY

Ease of Use:

Poor ▲ Fair ▲▲

Good ▲▲▲ Excellent ▲▲▲▲

Case:

Desktop ▬ Tower ▮

Mini-tower ▯

Prop = proprietary.

If you need the fastest DOS machine...

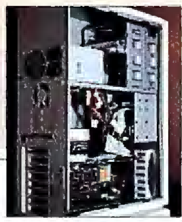
BEST OVERALL Cornell EISA-VL SCSI-2

This EISA/VL-bus tower ran our DOS tests faster than any other 486 we tested. It flew through the DOS application benchmarks 2.19 times faster than the baseline computer. The Cornell accepts a Pentium CPU upgrade, and it is one of a handful of 486s that can hold a megabyte of secondary cache. The Cornell uses a 16550 UART (universal asynchronous receiver/transmitter) that allows for much faster data transfers than the old 8550 version did, which much of the competition still uses. The prime drawback to the Cornell is that you must tie up one of the serial ports with a mouse because the system lacks a mouse port (it includes a 9- and 25-pin serial port, however). For the best ISA system for DOS, choose IBM's ValuePoint 6387-W90, a roomy tower that posted the fourth fastest DOS scores among the systems ranked here. AST's Premmia 4/66d, Model 343M is the top choice among desktop designs.

		PRICE	CASE TYPE	DOS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	Cornell EISA-VL SCSI-2	$3995	▮	2.19	▲▲▲▲	6.14	EISA/VL	32/256	1024/SCSI	36	Tseng W32i
RUNNER-UP	Micro Express Microflex-VE/66	$4800	▮	2.09	▲▲▲▲	3.51	EISA/VL	32/128	1024/SCSI	24	Tseng W32i
RUNNER-UP	IBM ValuePoint 6387-W90	$4994	▮	1.82	▲▲▲▲	6.26	ISA/VL	16/64	527/IDE	12	S3 805
RUNNER-UP	AST Premmia 4/66d	$6862	▬	1.70	▲▲▲▲	6.25	EISA/Prop.	32/128	1024/SCSI	36	ATI Mach 32
RUNNER-UP	MicroSource Tempest IV/IPCI-66	$2825	▮	1.96	▲▲▲	4.79	ISA/PCI	16/256	425/IDE	12	S3 805

For growth without compromise...

MOST EXPANDABLE Micro Express MicroFlex-VE/66



The MicroFlex-VE/66 is a roomy tower with a total of six 32-bit slots and two VL-Bus slots. There are 16 SIMM sockets that are conveniently placed on the motherboard away from the adapter slots, so you can easily upgrade the system to its maximum 128 MB of RAM. The system also accommodates four $5^1/_4$-inch and three $3^1/_2$-inch mass-storage devices.

		PRICE	CASE TYPE	DOS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX.	OPEN BAYS 3½/5¼	AVAILABLE SLOTS	VIDEO
BEST	Micro Express MicroFlex-VE/66	$4800	▮	2.09	▲▲▲▲	3.51	EISA/VL	32/128	3/4	8	Tseng W32i
RUNNER-UP	MicroSource Tempest IV/IPCI-66	$2825	▮	1.96	▲▲▲	4.79	ISA/PCI	16/256	3/1	4	S3 805
RUNNER-UP	AMS Info Gold 486 PCI	$2899	▮	1.73	▲▲▲	5.15	ISA/PCI	16/128	0/3	5	Weitek P9001
RUNNER-UP	Data Storage DataStor (ISA)	$4575	▮	1.69	▲▲▲▲	4.36	ISA/VL	16/128	4/1	3	S3 P86C928
RUNNER-UP	Acma Computers 486	$3295	▮	1.57	▲▲▲▲	5.06	ISA/VL	16/64	1/3	5	Cirrus Logic

When price matters...

LOW COST MicroSource Tempest IV/IPCI-66

This tower is almost twice as fast as the baseline system, while its price comes in under $3000. The trade-offs it makes for low cost include the slow 8550 UART (universal asynchronous receiver/transmitter) and the lack of flash ROM. Also, the machine's disk and video subsystems scores couldn't compete with the more expensive models listed in Best Overall. Dyna Micro's 486 Business System offers the fastest DOS performance among desktop systems ranked for low cost.

		PRICE	CASE TYPE	DOS SPEED	EASE OF USE	FEATURES SCORE	BUS	RAM (MB) STD./MAX	HARD DRIVE (MB)	WARRANTY (MONTHS)	VIDEO
BEST	MicroSource Tempest IV/IPCI-66	$2825	▮	1.96	▲▲▲	4.79	ISA/PCI	16/256	425/IDE	12	S3 805
RUNNER-UP	Zenon Computer Z-Novus	$1995	▬	1.42	▲▲▲	5.47	ISA/PCI	16/128	420/IDE	72	S3 428
RUNNER-UP	Dyna Micro Business System	$3006	▬	1.69	▲▲▲	4.61	ISA/VL	16/32	546/IDE	12	S3 805
RUNNER-UP	AMS Info Gold 486 PCI	$2899	▮	1.73	▲▲▲	5.15	ISA/PCI	16/128	540/SCSI	12	Weitek P9001
RUNNER-UP	Gateway 4DX2-66V	$2795	▬	1.58	▲▲▲▲	5.48	ISA/VL	16/64	424/IDE	12	ATI Macn 32

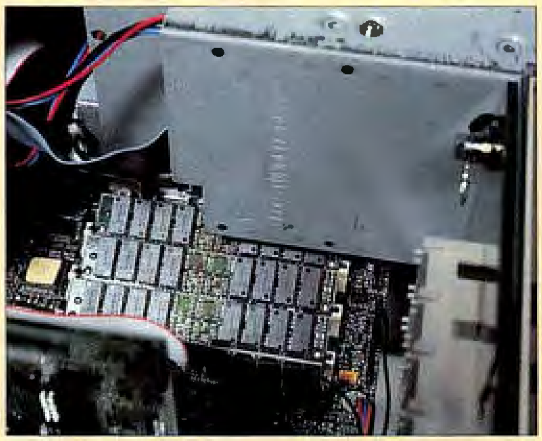
HONORABLE MENTIONS

The IBM ValuePoint 6387-W90 and the IBM ValuePoint P60/D offer an innovative idea in keyboard design: The integrated Trackpoint pointing device allows you to navigate graphical applications without taking your hands off the keyboard to use a mouse.

If you have a CD-ROM drive that loads CDs directly without a caddy, the drive must lie horizontally, unless your system uses Toshiba's XM-4101B CD-ROM drive, as do the Pentiums and 486s we received from DEC. This unique drive design uses three spring-backed ball bearings to hold a CD in place.

Dubious Achievements

International Instrumentation's Business Partner is one of the fastest machines we tested; unfortunately, the company needs to be more careful during the assembly process. The glue that fastens the heat sink to the CPU leaked into an unsightly mess on the motherboard. Also, this system's parallel-port casing is attached upside down.



To upgrade the RAM on the Ambra Computer DP60 PCI, you must dismantle the entire floppy drive bay. Once the drives are disconnected, you must remove the bay housing to reach the SIMM slots. ▷

The Acma 486 Tower includes both a 3½-inch and 5¼-inch floppy drive. Unfortunately, the manufacturer doesn't follow the convention of designating the 3½-inch drive as the A drive. We couldn't reverse drive designations from within the BIOS setup since both drives are on the same ribbon cable connector, and the documentation did not provide any information on changing jumpers.

The EasternTech ET P60-PCI, Mega Computer Systems Impact 486 DX2/66DT, and Xinetron X/LAN 586 each have the same basic design flaw: The shelf behind the expansion slots is too close to the chassis to connect a portable network adapter directly into the parallel port. We had to use extensions to install the adapters.

ROLL CALL OF SYSTEMS TESTED

PENTIUM

VENDOR	MODEL	PRICE	BUS TYPE	LOCAL BUS	CASE TYPE	PERFORMANCE DOS	WINDOWS	UNIX SPECINT	SPECFP	BYTE	EASE OF USE	INSTALLED RAM (MB)[7]
Advanced Logic Research, Inc.	**Evolution V-Q/66[1]**	**$9765**	**EISA**	**VL-Bus**	**▮**	**2.43**	**2.83**	**61.49**	**52.07**	**2.46**	**▲▲▲**	**32**
Ambra Computer Corp.	DP60 PCI	$4977	ISA	PCI	▬	2.01	2.76	45.56	42.00	1.97	▲	32
American Multisystems	Info Gold P60 PCI	$3299	ISA	PCI	▮	2.15	2.76	—[2]	—[2]	—[2]	▲▲▲	32
Dell Computer Corp.	Dimension XPS P60	$3896	ISA	PCI	▬	2.03	2.39	47.42	41.80	1.99	▲▲▲▲	16
Dell Computer Corp.	**OmniPlex 566[1]**	**$6917**	**EISA**	**PCI**	**▬**	**2.49**	**3.12**	**—[3]**	**—[3]**	**—[3]**	**▲▲▲▲**	**32**
Digital Equipment Corp.	DECpc 560ST	$9131	EISA	Proprietary	▮	2.06	2.23	53.19	46.59	2.43	▲▲▲▲	32
Digital Equipment Corp.	DECpc XL 560	$5436	ISA	PCI	▮	2.05	2.82	46.90	43.57	2.01	▲▲▲▲	16
Duracom Computer Systems	Multimedia FilePro Pentium 60-PCI	$5649	ISA	PCI	▮	1.93	2.44	46.62	41.74	1.79	▲▲▲	32
EasternTech Corp.	ET P60-PCI	$4995	ISA	PCI	▮	2.17	2.47	—[2]	—[2]	—[2]	▲▲▲▲	32
Gateway 2000	Gateway P5-60	$3265	ISA	PCI	▮	2.10	2.51	45.44	41.40	1.96	▲▲▲▲	32
IBM Personal Computer Co.	ValuePoint P60/D	$6075	ISA	PCI	▬	2.26	2.65	45.67	41.11	1.98	▲▲▲	16
Insight Direct	Insight PCI P60 Multimedia	$3219	ISA	PCI	▮	2.23	2.61	47.04	41.41	1.90	▲▲▲▲	16
International Instrumentation, Inc.	Business Partner	$4447	ISA	VL-Bus	▮	1.67	3.06	—[2]	—[2]	—[2]	▲▲▲▲	32
Micro Express	MicroFlex-VL/Pentium	$4699	ISA	VL-Bus	▮	1.88	2.41	44.19	38.54	1.65	▲▲▲▲	32
Micron Computer, Inc.	P60 PCI PowerStation CD	$5338	ISA	PCI	▬	2.14	2.43	45.78	41.69	1.93	▲▲▲	32
MIS Computer Systems	M560P	$4280	ISA	PCI	▬	1.75	2.27	—[4]	—[4]	—[4]	▲▲▲	32
Unisys Corp.	PW^2 Advantage Plus 5606	$6211	EISA	None	▬	2.19	2.54	—[5]	—[5]	—[5]	▲▲▲	32
Xi Computer Corp.	Xi P60 NTower	$5199	ISA	PCI	▮	1.85	2.30	—[2]	—[2]	—[2]	▲▲▲▲	32
Xinetron, Inc.	X/LAN 586	$3895	ISA	VL-Bus	▮	2.02	2.35	45.36	38.75	1.86	▲▲▲	32
Zenon Computer	Z-Optimus	$2645	ISA	PCI	▮	2.00	2.78	—[3]	—[3]	—[3]	▲▲▲	16

486DX2/66

VENDOR	MODEL	PRICE	BUS TYPE	LOCAL BUS	CASE TYPE	PERFORMANCE DOS	WINDOWS	UNIX SPECINT	SPECFP	BYTE	EASE OF USE	INSTALLED RAM (MB)[7]
Access Computers Technologies	ACT 486-66MHz	$3499	ISA	VL-Bus	▮	1.31	1.49	—[4]	—[6]	—[4]	▲▲▲	16
Acma Computers, Inc.	486 Tower	$3295	ISA	VL-Bus	▮	1.57	1.49	26.68	—[6]	1.28	▲▲▲▲	16
Advanced Logic Research, Inc.	Flyer VL 4/66d	$4174	ISA	VL-Bus	▯	1.61	1.27	29.14	—[6]	1.46	▲▲▲▲	20
American Multisystems	Info Gold 486 PCI	$2899	ISA	PCI	▮	1.73	1.94	—[2]	—[6]	—[2]	▲▲▲	16
American Multisystems	Info Gold E-Server	$3499	EISA	VL-Bus	▮	1.43	1.66	29.72	—[6]	1.44	▲▲▲	32
AST Research, Inc.	Premmia 4/66d, Model 343M	$6862	EISA	Proprietary	▬	1.70	1.87	32.33	—[6]	1.63	▲▲▲▲	32
Compaq Computer Corp.	Prolinea MT 4/66 Model 340/CDS	$3859	ISA	Proprietary	▮	1.51	1.42	25.10	—[6]	1.20	▲▲▲▲	20
CompuAdd Computer Corp.	C466D Mini Tower	$4062	ISA	VL-Bus	▯	1.73	1.83	32.99	—[6]	1.60	▲▲▲	16
CompuAdd Computer Corp.	C466De Mini Tower	$5806	EISA	VL-Bus	▯	1.79	1.78	—[5]	—[6]	—[5]	▲▲▲	16
Cornell Computer Systems	**Cornell EISA-VL SCSI-2**	**$3995**	**EISA**	**VL-Bus**	**▮**	**2.19**	**1.91**	**33.15**	**—[6]**	**1.62**	**▲▲▲▲**	**32**
Cornell Computer Systems	**Cornell Power Pak**	**$2995**	**ISA**	**VL-Bus**	**▮**	**1.59**	**2.04**	**34.37**	**—[6]**	**1.59**	**▲▲▲▲**	**16**
Data Storage Marketing, Inc.	DataStor 486-66 DX2 EISA VL	$5595	EISA	VL-Bus	▮	1.64	1.78	33.59	—[6]	1.42	▲▲▲▲	32
Data Storage Marketing, Inc.	DataStor 486-66 DX2 ISA VL	$4575	ISA	VL-Bus	▮	1.69	1.71	30.87	—[6]	1.40	▲▲▲▲	16
Dell Computer Corp.	Dimension XPS 466V	$3543	ISA	VL-Bus	▬	1.71	1.76	32.84	—[6]	1.58	▲▲▲▲	16
Digital Equipment Corp.	DECpc 466 MTE	$5715	EISA	VL-Bus	▮	1.63	1.67	31.42	—[6]	1.42	▲▲▲▲	32
Digital Equipment Corp.	DECpc 466d2 LPx	$4455	ISA	VL-Bus	▬	1.70	1.72	32.54	—[6]	1.51	▲	16
Dyna Micro, Inc.	486 Business System	$3006	ISA	VL-Bus	▬	1.69	1.57	30.51	—[6]	1.40	▲▲▲	16
Dyna Micro, Inc.	486 EISA Business System	$3115	EISA	VL-Bus	▬	1.49	1.44	28.84	—[6]	1.30	▲▲▲	16
Gateway 2000	Gateway 4DX2-66V	$2795	ISA	VL-Bus	▬	1.58	1.78	29.49	—[6]	0.50	▲▲▲▲	16
Hertz Computer Corp.	Hertz 486/D66X2e	$3595	ISA	VL-Bus	▬	1.50	1.38	26.83	—[6]	1.21	▲▲▲▲	16
Hewlett-Packard Co.	Vectra 486 66/XM	$4757	ISA	Proprietary	▬	1.68	1.78	32.63	—[6]	1.51	▲▲▲▲	16
IBC/Integrated Business Computers	EISA AD System	$5995	EISA	VL-Bus	▮	1.70	1.76	32.36	—[6]	1.64	▲▲▲	32
IBM Personal Computer Co.	**ValuePoint 6387-W90**	**$4994**	**ISA**	**VL-Bus**	**▮**	**1.82**	**1.65**	**33.60**	**—[6]**	**1.64**	**▲▲▲▲**	**16**
Insight Direct	Insight VL 486DX2-66MM	$3499	ISA	VL-Bus	▮	1.55	1.44	27.40	—[6]	1.38	▲▲▲▲	16
Mega Computer Systems	Impact 486 DX2/66DT	$3195	ISA	VL-Bus	▬	1.53	1.32	26.51	—[6]	1.27	▲▲	16
Micro Express	MicroFlex -VE/66	$4800	EISA	VL-Bus	▮	2.09	1.76	31.81	—[6]	1.46	▲▲▲▲	32
Micron Computer, Inc.	466 VL WinStation CD	$2978	ISA	VL-Bus	▬	1.59	1.99	34.05	—[6]	1.58	▲▲▲▲	16
Micron Computer, Inc.	466 VLE WinServer CD	$4498	EISA	VL-Bus	▮	1.46	1.80	30.98	—[6]	1.08	▲▲▲▲	32
MicroSource	Tempest IV/IPCI-66	$2825	ISA	PCI	▮	1.96	1.72	—[3]	—[6]	—[3]	▲▲▲	16
MIS Computer Systems	M466EV	$4451	EISA	VL-Bus	▮	1.08	1.76	22.52	—[6]	1.03	▲▲▲	32
MicroTech Computer Corp.	Ultima XV2/66	$3999	ISA	VL-Bus	▮	1.66	1.82	32.87	—[6]	1.55	▲▲▲	16
Mitsuba Corp.	MIT486/66V	$2900	ISA	VL-Bus	▮	1.52	1.43	26.90	—[6]	1.24	▲▲▲	16
NCR Corp.	NCR 3333	$4505	ISA	VL-Bus	▯	1.70	1.52	31.38	—[6]	1.43	▲▲▲▲	16
Quantex Microsystems, Inc.	Q486 DX2/66	$2699	ISA	VL-Bus	▮	1.09	1.13	20.24	—[6]	1.00	▲▲▲▲	16
Wyse Technology, Inc.	Decision 486GSI	$3400	ISA	VL-Bus	▯	1.47	1.32	25.52	—[6]	1.23	▲▲▲▲	16
Xi Computer Corp.	Xi 466 Workstation	$3199	ISA	VL-Bus	▬	1.65	1.95	32.47	—[6]	1.64	▲▲▲▲	16
Zenon Computer	Z-Novus PCI	$1995	ISA	PCI	▬	1.42	1.65	—[3]	—[6]	—[3]	▲▲▲	16

= BYTE Best. ✔ = yes.

Desktop ▬ Tower ▮ Mini-tower ▯

[1] 66-MHz Pentium

[2] Unable to complete Unix tests because system lacked 3½-inch boot-time-loadable driver disk

[3] Unable to run Unix tests because PCI video drivers weren't available for SCO Unix

[4] Could not complete tests, problem unresolved at press time

[5] Unable to install Unix; problem unresolved at press time

[6] Memory required to run SPECFP tests exceeded testing configuration for 486DX2 systems

[7] Prices reflect RAM amount listed; during testing, all 486 systems contained 16 MB of RAM, all Pentiums contained 32 MB

FEATURES CONTINUE ON NEXT PAGE

MAXIMUM RAM (MB)	HARD DRIVE INTERFACE	HARD DRIVE SIZE (MB)	HARD DRIVE VENDOR	VIDEO ADAPTER	VIDEO MAX. RESOLUTION (NONINTERLACED)	WARRANTY (MONTHS)	ENERGY STAR COMPLIANT?	TOLL-FREE PHONE	PHONE NUMBER	INQUIRY NUMBER
1024	SCSI	1370	Maxtor	ATI	1280×1024	60		(800) 444-4257	(714) 581-6770	1105
128	IDE	540	Western Digital	Diamond	1280×1024	12	✔	(800) 465-2227	(919) 713-1550	1106
192	SCSI	540	Maxtor	Weitek	1280×1024	12		(800) 888-6615	(408) 524-9091	1107
128	IDE	450	Seagate	S3	1280×1024	12		(800) 289-3355	(512) 338-4400	1108
192	SCSI	1024	DEC	ATI	1280×1024	12		(800) 289-3355	(512) 338-4400	1109
192	SCSI	1024	DEC	American Meg.	1280×1024	36		(800) 722-9332	(508) 493-5111	1110
192	IDE	525	Quantum	S3	1280×1024	36		(800) 722-9332	(508) 493-5111	1111
128	IDE	420	Western Digital	S3	1600×1200	12		(800) 551-9000	(214) 518-1200	1112
192	SCSI	1024	Micropolis	S3	1280×1024	24		(800) 289-8128	(718) 459-1407	1113
128	IDE	540	Western Digital	ATI	1024×768	12		(800) 848-2000	(605) 232-2000	1114
128	IDE	527	Maxtor	ATI	1280×1024	12		(800) 426-2968	(914) 766-1900	1115
128	IDE	540	Maxtor	ATI	1024×768	12		(800) 927-7848	(602) 902-1176	1116
128	SCSI	544	Conner	Eagle Mountain	1024×768	12	—*	(800) 543-3475	(805) 495-7673	1117
128	SCSI	500	Conner	Tseng Labs	1024×768	24	—*	(800) 989-9900	(714) 852-1400	1118
128	IDE	540	Maxtor	Weitek	1280×1024	12		(800) 347-3490	(208) 465-3434	1119
128	IDE	525	Quantum	Weitek	1280×1024	12		(800) 733-9188	(408) 730-9188	1120
192	SCSI	1024	Seagate	ATI	1024×768	12	—*	(800) 874-8647	(215) 986-4011	1121
192	IDE	520	Quantum	Diamond	1600×1280	12		(800) 432-0486	(714) 498-0858	1122
128	SCSI	520	Fujitsu	Tseng Labs	1280×1024	36	✔	(800) 345-4415	(408) 727-5509	1123
192	IDE	540	Maxtor	Matrox	1280×1024	72	—*	(800) 899-6119	(818) 935-1828	1124
32	IDE	540	Quantum	Diamond	1280×1024	12		None	(408) 247-4444	1125
64	IDE	540	Conner	Cirrus Logic	1280×1024	12		(800) 786-6888	(510) 623-1212	1126
36	IDE	540	Conner	Western Digital	1024×768	60	✔	(800) 444-4257	(714) 581-6770	1127
128	SCSI	540	Maxtor	Weitek	1280×1024	12		(800) 888-6615	(408) 524-9091	1128
256	SCSI	1024	Conner	S3	1024×768	12		(800) 888-6615	(408) 524-9091	1129
128	SCSI	1024	Quantum	ATI	1024×768	36		(800) 876-4278	(714) 727-4141	1130
64	IDE	340	Seagate	Cirrus	1024×768	36	—*	(800) 345-1518	(713) 378-8820	1346
64	IDE	525	Quantum	ATI	1280×1024	12	✔	(800) 999-7103	(512) 250-2930	1347
128	SCSI	1024	Quantum	ATI	1280×1024	12		(800) 999-7103	(512) 250-2930	1348
256	SCSI	1024	Toshiba	Tseng Labs	1280×1024	36		(800) 886-7200	(909) 594-5848	1349
128	IDE	420	Western Digital	Weitek	1280×1024	36		(800) 886-7200	(909) 594-5848	1350
128	SCSI	1325	Seagate	S3	1280×1024	36	✔	(800) 543-6098	(303) 442-4747	1351
128	IDE	540	Maxtor	S3	1280×1024	36	✔	(800) 543-6098	(303) 442-4747	1352
64	IDE	450	Seagate	#9GXE	1024×768	12		(800) 289-3355	(512) 338-4400	1353
128	SCSI	1024	DEC	S3	1280×1024	36		(800) 722-9332	(508) 493-5111	1354
64	IDE	525	Quantum	S3	1280×1024	36		(800) 722-9332	(508) 493-5111	1355
32	IDE	545.9	Conner	S3	1280×1024	12		(800) 336-3962	(408) 943-0100	1356
128	IDE	545.9	Conner	S3	1280×1024	12		(800) 336-3962	(408) 943-0100	1357
64	IDE	424	Western Digital	ATI	1280×1024		✔	(800) 846-2000	(605) 232-2000	1358
32	IDE	542	Micropolis	Weitek	1280×1024	12		(800) 232-8737	(212) 684-4141	1359
64	IDE	450	Seagate	S3	1280×1024	36	✔	(800) 752-0900	(408) 553-2922	1360
256	SCSI	540	Quantum	Tseng Labs	1280×1024	12	—*	(800) 468-5847	(818) 882-9007	1361
64	IDE	527	Maxtor	S3	1280×1024	12		(800) 426-2968	(914) 766-1900	1362
128	IDE	420	Western Digital	Cirrus Logic	1024×768	12		(800) 927-7848	(602) 902-1176	1363
32	IDE	540	Conner	Cirrus Logic	1280×1024	12	✔	(800) 438-6268	(619) 487-8888	1364
128	SCSI	1024	Maxtor	Tseng Labs	1024×768	24	—*	(800) 989-9900	(714) 852-1400	1365
—*	IDE	340	Conner	Weitek	1280×1024	Lifetime	—*	(800) 347-3490	(208) 465-3434	1366
64	SCSI	540	Maxtor	Weitek	1280×1024	12	—*	(800) 347-3490	(208) 465-3434	1367
256	IDE	425	Western Digital	S3	1280×1024	12	—*	(800) 848-5161	(818) 858-5161	1368
64	SCSI	1024	DEC	Weitek	1280×1024	12		(800) 733-9188	(408) 730-9188	1369
64	IDE	452.4	Seagate	ATI	1280×1024	12		(800) 342-6508	(404) 345-6508	1370
32	IDE	544	Conner	Cirrus Logic	1024×768	24	—*	(800) 848-7822	(909) 392-2000	1371
64	IDE	520	Conner	Cirrus Logic	1280×1024	36		(800) 225-5627	(513) 445-5000	1372
—*	IDE	425	Western Digital	Weitek	1024×768	12	—*	(800) 288-0566	(908) 563-4166	1373
64	IDE	424	Seagate	Cirrus Logic	1280×1024	12		(800) 438-9973	(408) 473-1200	1374
64	IDE	520	Quantum	Diamond	1600×1280	12		(800) 432-0488	(714) 498-0858	1375
128	IDE	420	Western Digital	S3	1280×1024	72	—*	(800) 899-6119	(818) 935-1828	1376

*Information not available at press time
N/A = not applicable.

Poor ▲ Fair ▲▲ Good ▲▲▲ Excellent ▲▲▲▲

ROLL CALL OF SYSTEMS TESTED

VENDOR	MODEL	MAXIMUM CACHE (KB)	FLASH ROM	EXPANSION SLOTS 16-BIT	EISA	VL-BUS	PCI	TOTAL	UART	SCSI PORT
PENTIUM										
Advanced Logic Research, Inc.	**Evolution V-Q/66[1]**	**512**	**✔**	**0**	**5**	**1**	**0**	**6**	**16550**	
Ambra Computer Corp.	DP60 PCI	256	✔	4	0	0	3	7	16550	
American Multisystems	Info Gold P60 PCI	512	✔	3	0	0	0	3	8250	✔
Dell Computer Corp.	Dimension XPS P60	256	✔	4	0	0	2	6	16550	
Dell Computer Corp.	**OmniPlex 566[1]**	**256**	**✔**	**0**	**3**	**0**	**1**	**4**	**16550**	
Digital Equipment Corp.	DECpc 560ST	256	✔	0	3	0	0	3	16550AF	✔
Digital Equipment Corp.	DECpc XL 560	256	✔	3	0	0	2	5	—[2]	✔
Duracom Computer Systems	Multimedia FilePro Pentium 60-PCI	256	✔	3	0	0	2	5	16550	
EasternTech Corp.	ET P60-PCI	512	✔	3	0	0	1	4	16450	✔
Gateway 2000	Gateway P5-60	256	✔	4	0	0	2	6	16550AF	
IBM Personal Computer Co.	ValuePoint P60/D	256	✔	2	0	0	2	4	16550	
Insight Direct	PCI P60 Multimedia	256	✔	3	0	0	2	5	16550	
International Instrumentation, Inc.	Business Partner	2048	✔	3	0	1	0	4	16550	✔
Micro Express	MicroFlex-VL/Pentium	2048		3	0	1	0	4	8250	✔
Micron Computer, Inc.	P60 PCI PowerStation CD	256	✔	3	0	0	1	4	16550	
MIS Computer Systems	M560P	256	✔	3	0	0	2	5	16450	
Unisys Corp.	PW² Advantage Plus 5606	—[2]	—[2]	0	3	0	0	3	8250	✔
Xi Computer Corp.	Xi P60 NTower	512	✔	3	0	0	1	4	8250	
Xinetron, Inc.	X/LAN 586	512		3	0	1	0	4	—[2]	✔
Zenon Computer	Z-Optimus	512	✔	3	0	0	1	4	16450	
486DX2/66										
Access Computers Technologies	ACT 486-66MHz	256		4	0	0	0	4	16550	
Acma Computers, Inc.	486 Tower	256		4	0	1	0	5	—[2]	
Advanced Logic Research, Inc.	Flyer VL 4/66d	256	✔	1	0	1	0	2	16450	
American Multisystems	Info Gold 486 PCI	512	✔	3	0	0	2	5	16550	
American Multsystems	Info Gold E-Server	512		0	2	2	0	4	8250	✔
AST Research, Inc.	Premmia 4/66d, Model 343M	512	✔	0	3	0	0	3	16550	
Compaq Computer Corp.	Prolinea MT 4/66 Model 340/CDS	128		4	0	0	0	4	16450	
CompuAdd Computer Corp.	C466D Mini Tower	256	✔	5	0	0	0	5	16550AF	
CompuAdd Computer Corp.	C466De Mini Tower	1024	✔	0	5	1	0	6	16550AF	
Cornell Computer Systems	**Cornell EISA-VL SCSI-2**	**1024**	**✔**	**0**	**3**	**1**	**0**	**4**	**16550**	**✔**
Cornell Computer Systems	**Cornell Power Pak**	**256**	**✔**	**4**	**0**	**1**	**0**	**5**	**16550**	
Data Storage Marketing, Inc.	DataStor 486-66 DX2 EISA VL	256		0	2	1	0	3	16450	
Data Storage Marketing, Inc.	DataStor 486-66 DX2 ISA VL	256		3	0	0	0	3	16450	
Dell Computer Corp.	Dimension XPS 466V	256	✔	4	0	1	0	5	16650	
Digital Equipment Corp.	DECpc 466 MTE	256	✔	0	3	1	0	4	16550AF	✔
Digital Equipment Corp.	DECpc 466d2 LPx	256		3	0	1	0	4	16550AF	
Dyna Micro, Inc.	486 Business System	256		3	0	0	0	3	16450	
Dyna Micro, Inc.	486 EISA Business System	256		0	4	0	0	4	16450	
Gateway 2000	Gateway 4DX2-66V	256	✔	5	0	0	0	5	16550AF	
Hertz Computer Corp.	Hertz 486/D66X2e	256		3	0	0	0	3	16550	
Hewlett-Packard Co.	Vectra 486 66/XM	256	✔	2	0	0		2	16550	—[3]
IBC/Integrated Business Computers	EISA AD System	1024		0	3	1	0	4	16450	✔
IBM Personal Computer Co.	**ValuePoint 6387-W90**	**256**	**✔**	**5**	**0**	**0**	**0**	**5**	**16550**	
Insight Direct	Insight VL 486DX2-66MM	256		2	0	0	0	2	16450	
Mega Computer Systems	Impact 486 DX2/66DT	256		3	0	0	0	3	8250	
Micro Express	MicroFlex -VE/66	512		0	6	2	0	8	8250	✔
Micron Computer, Inc.	466 VL WinStation CD	256	✔	4	0	1	0	5	16550	
Micron Computer, Inc.	466 VLE WinServer CD	512	✔	0	0	0	0	0	16550	✔
MicroSource	Tempest IV/IPCI-66	512		2	0	0	2	4	8250	
MIS Computer Systems	M466EV	512	✔	0	3	1	0	4	16550	✔
MicroTech Computer Corp.	Ultima XV2/66	256	✔	4	0	1	0	5	16550	
Mitsuba Corp.	MIT486/66V	256		1	0	0	0	1	8250	
NCR Corp.	NCR 3333	256	✔	4	0	0	0	4	16450	✔
Quantex Microsystems, Inc.	Q486 DX2/66	256		2	0	1	0	3	16550	
Wyse Technology, Inc.	Decision 486GSI	256		4	0	0	0	4	8250	
Xi Computer Corp.	Xi 466 Workstation	256		2	0	1	0	3	8250	
Zenon Computer	Z-Novus PCI	512	✔	1	0	0	3	4	16550	

= BYTE Best. ✔ = yes.

[1] 66-MHz Pentium
[2] Information not available at press time
[3] Includes Ethernet port; no SCSI

N/A = not applicable.
(2x) = double space.

FEATURES CONTINUE ON NEXT PAGE

FLOPPY DRIVES		AVAILABLE BAYS		POWER SUPPLY			CD-ROM		
3½ INCH	5¼ INCH	3½-INCH	5¼-INCH	OUTPUT (WATTS)	AC VOLTS IN	SWITCHABLE?	VENDOR	MODEL	FCC RATING
1	0	1	8	415	110/120, 220/240	✔	Texel	DM-3028	A
1	0	1	3	200	220/240	✔	LMSI	CM206	B
1	1	0	3	230	110/120, 220/240	✔	Sony	CDU 31A-3	Pending
1	1	1	1	200	90/130, 180/265	✔	Panasonic	CR563B	B
1	1	1	1	224	115/230	✔	Toshiba	XM3401B	B
1	0	1	1	254	110/120	—[2]	Toshiba	XM-4101B	B
1	0	0	2	300	110/120	—[2]	Toshiba	XM-4101B	B
1	1	3	0	250	110/120, 220/240	✔	Texel (Plextor)	DM-3028	Pending
1	1	2	1	250	110/120	✔	NEC	3xi	B
1	0	3	3	300	110,220	✔	Mitsumi	FX0010 (2x)	B
1	1	1	0	200	110/120, 220/240	✔	Panasonic	CR 563 BIA	B
1	0	7	3	230	220/240	✔	Mitsumi	FX001D	B
1	0	0	3	250	110/120	✔	Toshiba	3401	A
1	0	2	3	250	110/120, 220/240	✔	Toshiba	3401B	B
1	1	2	1	230	110/220	—[2]	Mitsumi	FX0010 (2x)	Pending
1	0	1	0	250	110/120	✔	Panasonic	562	Pending
1	0	0	2	—[2]	—[2]	—[2]	N/A	N/A	B
1	1	2	4	300	110/120	✔	Toshiba	SCSI-2	A
1	1	1	0	250	110/120	✔	Toshiba	340 LB	A
1	1	3	4	250	110/220	✔	Toshiba	3401	A
1	1	3	1	200	220/240	—[2]	Toshiba	3401	B
1	1	1	3	300	110/120	✔	TEAC	CDR-510	B
1	0	0	0	200	110/120, 220/240	✔	Texel	DM-3028	B
1	1	0	3	230	110/120, 220/240	✔	Sony	CDU 31A-3	B
1	1	0	3	230	110/120, 220/240	✔	Sony	561	B
1	0	1	1	200	110/220	✔	Toshiba	3401B (2x)	B
1	0	0	2	200	120/220	✔	Compaq	N/A	B
1	0	0	2	200	110/120	✔	Toshiba	3401B-S	B
1	0	2	2	200	110/120	✔	Toshiba	3401B-S	B
1	0	2	4	300	110/120	✔	Sony	31A-03	B
1	0	2	4	300	110/120	✔	Sony	31A-03	B
1	1	2	1	300	110/120	✔	Toshiba	3401A	B
1	1	4	1	300	110/120	✔	Toshiba	3401A	B
1	1	1	1	200	90/130, 180/265	✔	Panasonic	CR 563B	B
1	0	0	2	200	110/120	—[2]	Toshiba	4101	B
1	0	0	1	200	110/120	✔	Toshiba	XM-4101B	B
1	0	1	1	200	110/120	✔	Panasonic	CR-562-B	B
1	0	1	1	200	110/120	✔	Panasonic	CR-562-B	B
1	0	2	2	145	110/120	✔	Mitsumi	—[2]	B
1	1	0	0	200	110/120	✔	Panasonic	CR562-B	B
1	0	1	0	85	110/120, 220/240	✔	NEC	55	B
1	1	0	5	300	110/220	✔	Toshiba	MK3401B	A
1	1	0	1	200	110/120, 220/240	✔	Panasonic	CR 563 BIA	B
1	1	0	2	250	220/240	✔	Texel	3028	B
1	0	0	2	250	110/120, 220/240	✔	Toshiba	XM3401B	A
1	1	4	4	250	110/120, 220/240	✔	Toshiba	3401B	B
1	0	1	1	200	110/220	✔	Mitsumi	FX0010 (2x)	B
1	0	0	4	250	110/220	✔	Mitsumi	FX0010 (2x)	B
1	1	3	1	250	110/120, 220/240	✔	Toshiba	3401	B
1	0	2	4	300	110/120	✔	Panasonic	562	B
1	1	1	1	300	110/120	✔	NEC	3Xi	B
1	1	4	1	230	110/120, 220/240	✔	Mitsumi	CRMC-LU0055.35MS	B
1	0	1	1	200	110/120, 220/240	✔	Sony	CD ROM M CDU-561	B
1	1	4	2	200	110/120	✔	Sony	CDU-31A-03 (2x)	B
1	0	1	1	200	110/120	✔	Toshiba	3401B	B
1	1	1	1	224	110/120	✔	Mitsumi	(2x)	B
1	0	1	1	200	110/220	✔	Mitsumi	CRMC-FX001D	A

ROLL CALL OF SYSTEMS TESTED

VENDOR	MODEL	DISTRIBUTION CHANNEL: DIRECT	DEALER	SUPERSTORES	FREE TECH. SUPPORT	MONITOR: MAX. RES. NONINTERLACED	VENDOR	MODEL	SCREEN SIZE (INCHES)
PENTIUM									
Advanced Logic Research, Inc.	**Evolution V-Q/66**	✔	✔	—[1]	**Lifetime**	**1280×1024**	**TECO**	**FlexView 3xNI**	**14**
Ambra Computer Corp.	DP60 PCI	✔			Lifetime	1280×1024	Acer	7076L	17
American Multisystems	Info Gold P60 NT	✔	✔		Lifetime	1280×1024	AMS	IG3000	14
Dell Computer Corp.	Dimension XPS P60	✔			Lifetime	1280×1024	Dell	15FS	15
Dell Computer Corp.	**OmniPlex 566**	✔		✔	**Lifetime**	**1280×1024**	**Dell**	**15FS**	**15**
Digital Equipment Corp.	DECpc 560 ST	✔	✔		Lifetime	1280×1024	Capetronics	—[1]	14
Digital Equipment Corp.	DECpc XL 560	✔	✔	—[1]	Lifetime	1280×1024	Capetronics	—[1]	14
Duracom Computer Systems	Multimedia FilePro Pentium		✔	✔	Lifetime	1600×1200	ADI	3E+	14
EasternTech Corp.	ET P60-PCI	✔	✔		Lifetime	1280×1024	Samsung	3N	14
Gateway 2000	Gateway P5-60	✔			1 month	1024×768	Gateway 2000	Crystal Scan 1572 fs	15
IBM Personal Computer Co.	ValuePoint P60/D	✔	✔	✔	1 month	1280×1024	IBM	6324	14
Insight Direct	PCI P60 Multimedia	✔			Lifetime	1024×768	CTX	1561 LR	15
International Instrumentation, Inc.	Business Partner	✔	✔		Lifetime	1024×768	Samsung	CSJ 4927A	14
Micro Express	MicroFlex-VL/Pentium	✔			Lifetime	1024×768	Micro Express	FM-370	14
Micron Computer, Inc.	P60 PCI PowerStation CD	✔			Lifetime	1280×1024	Mag	LX1564	15
MIS Computer Systems	M560P	✔	✔		Lifetime	1280×1024	CTX	CVP-5468NI	14
Unisys Corp.	PW² Advantage Plus 5606	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]	—[1]
Xi Computer Corp.	Xi P60 NTower	✔			Lifetime	1600×1280	KFC	1428N	14
Xinetron, Inc.	X/LAN 586	✔			Lifetime	1280×1024	Socos	1488	14
Zenon Computer	Z-Optimus	✔			Lifetime	1280×1024	Mag Innovision	17 MXF MAG	17
486DX2/66									
Access Computers Technologies	ACT 486-66MHz	✔			None	1280×1024	NEC	3FGe	15
Acma Computers, Inc.	486 Tower	✔	✔		12 months	1280×1024	Mag Innovision	MX 15	15
Advanced Logic Research, Inc.	Flyer VL 4/66d	✔	✔	—[1]	Lifetime	1024×768	TECO	FlexView 3xNI	14
American Multisystems	Info Gold 486 PCI	✔	✔		Lifetime	1280×1024	AMS	IG3000	14
American Multisystems	Info Gold E-Server	✔	✔		Lifetime	1024×768	AMS	IG3000	14
AST Research, Inc.	Premmia 4/66d, Model 343M		✔		Lifetime	1024×768	Daewoo	ASTVision SL	15
Compaq Computer Corp.	Prolinea MT 4/66 Model 340/CDS		✔	✔	Lifetime	1024×768	Compaq	1024 Color Monitor	14
CompuAdd Computer Corp.	C466D Mini Tower	✔			Lifetime	1280×1024	CompuAdd	14" Color	14
CompuAdd Computer Corp.	C466De Mini Tower	✔			Lifetime	1280×1024	CompuAdd	14" Color	14
Cornell Computer Systems	**Cornell EISA-VL SCSI-2**	✔	✔		**Lifetime**	**1280×1024**	**ADI**	**3G**	**14**
Cornell Computer Systems	**Cornell Power Pak**	✔	✔		**1 month**	**1280×1024**	**ADI**	**3G**	**14**
Data Storage Marketing, Inc.	DataStor 486-66 DX2 EISA VL	✔	✔		1 month	1280×1024	Phillips	Spectra III	14
Data Storage Marketing, Inc.	DataStor 486-66 DX2 ISA VL	✔	✔		1 month	1280×1024	Phillips	Spectra III	14
Dell Computer Corp.	Dimension XPS 466V	✔		✔	Lifetime	1024×768	Dell	15FS	15
Digital Equipment Corp.	DECpc 466 MTE	✔	✔		Lifetime	—[1]	—[1]	—[1]	—[1]
Digital Equipment Corp.	DECpc 466d2 LPx	✔	✔		Lifetime	1280×1024	Capetronics	—[1]	14
Dyna Micro, Inc.	486 Business System	✔			Lifetime	1280×1024	Fora International	Addonics	14
Dyna Micro, Inc.	486 EISA Business System	✔			Lifetime	1280×1024	Fora International	Addonics	14
Gateway 2000	Gateway 4DX2-66V	✔			1	—[1]	Gateway 2000	Crystal Scan 1572 fs	15
Hertz Computer Corp.	Hertz 486/D66X2e	✔			1	1280×1024	Mag	1450	14
Hewlett-Packard Co.	Vectra 486 66/XM		✔		36	1280×1024	—[1]	—[1]	—[1]
IBC/Integrated Business Computers	EISA AD System		✔		Lifetime	1280×1024	CTX	1450	14
IBM Personal Computer Co.	**ValuePoint 6387-W90**	✔	✔	✔	**1 month**	**1280×1024**	**IBM**	**6324**	**14**
Insight Direct	Insight VL 486DX2-66MM				Lifetime	1024×768	CTX	1561 LR	15
Mega Computer Systems	Impact 486 DX2/66DT	✔	✔		Lifetime	1280×1024	MGC	1402N	14
Micro Express	MicroFlex -VE/66	✔			Lifetime	1024×768	Micro Express	FM-370	14
Micron Computer, Inc.	466 VL WinStation CD	✔			Lifetime	1280×1024	Mag	LX1564	15
Micron Computer, Inc.	466 VLE WinServer CD	✔			Lifetime	1280×1024	Mag	LX1564	15
MicroSource	Tempest IV/IPCI-66	✔			Lifetime	1280×1024	Tystar	3448	14
MIS Computer Systems	M466EV	✔	✔		Lifetime	1280×1024	CTX	CVP-5468NI	14
MicroTech Computer Corp.	Ultima XV2/66	✔			Lifetime	1280×1024	Proton	PM 1448A	14
Mitsuba Corp.	MIT486/66V		✔		Varies	1024×768	Mitsuba	M710VS	14
NCR Corp.	NCR 3333	✔	✔		36 months	1280×1024	NCR	3297-0271	14
Quantex Microsystems, Inc.	Q486 DX2/66	✔			Lifetime	1024×768	Goldstar	GS 1510	15
Wyse Technology, Inc.	Decision 486GSI		✔		Lifetime	1280×1024	Wyse Technology	WY-670	14
Xi Computer Corp.	Xi 466 Workstation	✔			Lifetime	1600×1280	KFC	1428N	14
Zenon Computer	Z-Novus PCI	✔			Lifetime	—[1]	Mag Innovision	LX 1564	15

= BYTE Best. ✔ = yes.

[1] Information not available at press time

NIC UPDATE

22 New Ethernet Cards

These 16-bit NICs are the latest to enter the Asian market. Our exclusive network tests identify the top performers.

Since our last Lab Report on network interface cards ("Network Connections: 100 Ethernet Cards," August 1993 BYTE), a number of new 16-bit Ethernet NICs have been introduced in Asia. Some of these cards may be available only in that market, but others are sold internationally. In either case, this group represents the latest levels of price and performance for 16-bit NICs.

LANBit Computer, an independent testing lab that licenses methodologies from BYTE's Lab Report collaborator NSTL, recently tested 22 new NICs. The Taipei, Taiwan–based lab found Accton's new EN1650 to be the performance leader. This card also earned an ease of use rating of excellent, thanks to its comprehensive documentation and easy configurability, among other factors.

Although the EN1650 led the way in speed, performance scores for the cards in this group didn't vary dramatically. For example, the slowest card in the Workgroups and Large Networks benchmarks, Info-Net's E2000WDC+, lagged behind the EN1650 by only 12 percent.

While the methodologies used for this NIC update were the same as in the original Lab Report, scores are not directly comparable. Differences in test-bed equipment resulted in the latest scores averaging approximately 12 percent higher for the Workgroups and Large Networks components, and 25 percent higher for the Transaction-Based Networks tests. However, the test suite does provide a relative ranking of speed within this group. Performance evaluations used nine tests to simulate six different applications. Five of the tests were Microsoft Windows–based, and the remainder ran under MS-DOS.

Tests ran with and without simulated network loads. For the latter, a traffic generator sent data packets using 25 percent of the network's bandwidth (about 2.5 Mbps). In the table below, the Workgroups scores are a composite of tests run without network traffic, while the Large Networks scores are results generated with the network load. The Transaction-Based Networks scores are based on tests that consist of small files (128 to 1024 bytes) and are meant to simulate large database-search applications (e.g., a request for an airline ticket).

Ease-of-use evaluations considered hardware configuration, driver installation, and the quality of technical documentation. ■

ROLL CALL OF NICS TESTED

COMPANY	MODEL	PRICE[1] ($US)	SPEED RATINGS (TPM)[2] WORKGROUPS	LARGE NETWORKS	TRANSACTION-BASED NETWORKS	EASE OF USE	PHONE	FAX	INQUIRY NUMBER
Accton Technology	EN1650	$128	32.48	31.82	614.87	Excellent	+886 35 770270	+886 35 770267	1000
Addtron Technology	AE-200LC	$89	29.59	28.86	563.90	Fair	+886 2 4514507	+886 2 4514614	1001
Addtron Technology	AE-200JL	$109	29.60	28.88	564.71	Good	+886 2 4514507	+886 2 4514614	1002
CNet	CN600E	$89	29.24	28.52	554.76	Fair	+886 35 782211	+886 35 782458	1003
CNet	CN650E+	$99	29.51	28.82	563.11	Good	+886 35 782211	+886 35 782458	1004
CT Continental	CT-16TB	$52	29.54	28.75	558.25	Good	+886 2 7913812	+886 2 7912685	1005
Grand Computer	TE-2000AD	$79	30.05	29.29	568.38	Good	+886 2 7859197	+886 2 7855724	1006
GVC	NIC-2003	$45	29.54	28.82	563.22	Good	+886 2 7552226	+886 2 7552413	1007
Info-Net	E2000C	$79	29.96	29.18	568.65	Good	+886 2 7647786	+886 2 7647166	1008
Info-Net	E2000WDC+	$99	29.10	28.33	567.95	Good	+886 2 7647786	+886 2 7647166	1009
Katron Computers	ET-200T/X	$85	29.66	28.90	566.94	Good	+886 2 7991064	+886 2 7994020	1010
Katron Computers	ET-16TB	$59	29.24	28.55	551.76	Good	+886 2 7991064	+886 2 7994020	1011
Lantech Computer	LTC EN2000/CT	$79	30.09	29.31	567.14	Good	+886 2 7667088	+886 2 7666892	1012
Lantech Computer	LTC E-NET/21CT	$89	30.76	30.08	591.33	Poor	+886 2 7667088	+886 2 7666892	1013
Longshine	LCS-8634L-TBA	$89	29.67	28.93	562.47	Good	+886 2 3634958	+886 2 3626810	1014
Pheecom	PTC-1001SCT	$59	29.62	28.91	561.53	Fair	+886 2 7613142	+886 2 7615764	1015
R.P.T.I. International	E2003UC	$49	29.77	28.99	563.10	Fair	+886 2 9183006	+886 2 9183096	1016
R.P.T.I. International	E2015WC	$59	29.85	29.08	565.61	Good	+886 2 9183006	+886 2 9183096	1017
Surecom	NE-12	$70	29.75	28.98	562.71	Fair	+886 2 5922327	+886 2 5912675	1018
Surecom	EP301	$95	30.33	29.54	575.76	Good	+886 2 5922327	+886 2 5912675	1019
Zero One	N2000E3+	$60	29.47	28.74	566.85	Good	+886 2 5652323	+886 2 5714698	1103
Zero One	N2000E2/M	$50	29.21	28.52	557.41	Good	+886 2 5652323	+886 2 5714698	1104

[1]Estimated Taiwanese street price [2]Transactions per minute

C, C++ and BASIC programmers, now you get much more than xBase compatible DBMS power.

Thousands of programmers have already discovered how to get dBASE, FoxPro and Clipper compatibility from their favorite language and hardware platform. For example, one customer has C programs running on PC and Sun workstations sharing data with concurrently running FoxPro for Windows applications. You see, CodeBase technology is simply the best way to add multi-user xBase compatible DBMS power to C, C++, or BASIC.

You still get high speed & small size

CodeBase users really appreciate our small executable size. Unlike SQL engines which are a Meg or so in size, CodeBase 5.1 EXE's can be as small as 45K! You'll also like the speed–with our Intelligent Queries you get the execution speed of C plus stunning query performance from our smart use of available index information.

Introducing CodeControls

Now formatted data entry in Windows is as easy as point & click!

Introducing the new CodeControls, a unique set of data-aware custom controls. Now simply drop them into your Windows applications via your favorite visual interface builder.

NEW–You get formatted data entry

Experienced Windows programmers know **formatted** data entry is difficult to program under Windows. But with our new ***CodeControls***, you can simply 'Point & Click' to design data entry windows for date, numeric, and character information–formatted just the way you want it.

NEW–Data-aware controls

Our custom controls are ***data-aware,*** so now you can easily build a scrolling list box that's tied to a data file, or look up matching combo box entries–even as the user types.

Introducing CodeReporter 2.0

Now use the new Instant Report Wizard to create a variety of reports–instantly.

Introducing the new CodeReporter 2.0, our interactive xBase report writer. We designed it with developers in mind, but end-users will love it.

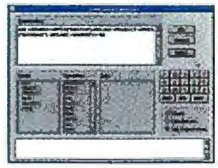
NEW–You get instant reports

Use our new Instant Report Wizard to quickly create a wide variety of reports–in an instant, then easily refine them as necessary, or let your end users build their own special reports!

NEW–You get drag & drop

We've added drag & drop capabilities to ***CodeReporter***, so regardless of whether you want data, totals, or text, simply drop a report object onto your layout screen.

NEW–You get interactive queries, sorts, & relations



Use CodeReporter to visually design reports easier than ever. For example, you can quickly build query and sort expressions using our calculator-style expression builder. In addition, you can easily relate data files together using our graphical relation builder.

"There's never been a better time to buy into CodeBase technology. You get complete xBase compatibility, full DBMS power, plus an interactive report writer and a set of unique data-aware custom controls for Windows."
-Ken Sawyer, President, Sequiter Software

Buy One, Get Two FREE.

Now when you buy any one of our xBase library products: ***CodeBasic, CodeBase++,*** or ***CodeBase*** (for the language of your choice), you'll get both the new ***CodeReporter 2.0*** AND the new ***CodeControls*** absolutely **FREE**–for a limited time only.

To Order Now Call 403-437-2410

Unconditional 90-Day Money-Back Guarantee

SEQUITER SOFTWARE INC.
FAX 403•436•2999
UK Tel. +44-81-317-4321
France +33.20.24.20.14
P.O. Box 575 Newmarket NH 03857-0575

Circle 130 on Inquiry Card.

Developing Applications in Perl

This public domain language now runs on every major operating system and has solved countless problems for developers

TOM CHRISTIANSEN

Perl, an interpreted programming language originally designed for text processing and manipulation of files and processes, provides a rich environment for systems programming. While the language was originally written by Larry Wall, then a harried Unix system administrator, as an alternative to the Unix shell for high-level systems programming, it turns out that many general programming problems of short to medium degrees of complexity can be easily expressed in Perl.

By combining the high-level primitives of several Unix workhorses into one easy-to-use, highly efficient, interpreted language, Perl provides a versatile power tool for crafting a custom solution with a minimum of time and effort. It is an effective way to manipulate text, data, files, and even processes. While it was first developed for Unix and runs on virtually any Unix system, Perl now also runs on a multitude of operating systems, including VMS, MS-DOS, Windows NT, and the Amiga and Apple Macintosh operating systems.

Although users of Unix systems will be quick to pick up much of the philosophy and style of approach embodied by Perl due to its roots in Unix shell and C programming, users of other operating systems stand to gain even more. That's because non-Unix systems seldom come with a good tool set for crafting quick solutions to the myriad little text-related problems that crop up. Once you put Perl on your system, you've got everything you need for such tasks in just one application.

With Perl, those two hobgoblins of programming, data typing and memory allocation, disappear as issues. Data typing is trivial because everything in Perl is a string. You can, however, have lists and tables of strings to build up more complex data types. If you perform a numeric or Boolean operation on a Perl value, it gets converted for you automatically. No more remembering whether a variable is a string, a character, a byte, a short integer, or a double-precision floating-point number. For example,

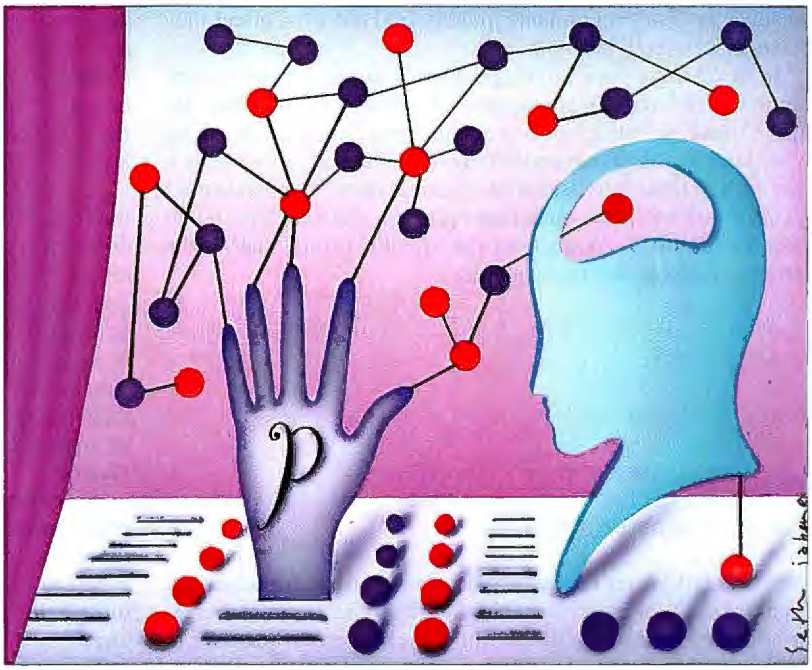
```
print "How many days? ";
$days = <STDIN>;
$months = $days / 30;
print "That's around $months months\n";
```

Notice that you can operate directly on the `$days` variable without first converting the string just read into a numeric value.

The interpreter takes care of all memory handling. You don't have to declare anything if you don't want to, since variables spring into existence when you first mention them—although, as you'll see, there may be times when you'll want to use local variables. You don't have to concern yourself with whether a string is long enough to hold a value or whether an array has enough elements in it. You just do whatever you want, and Perl automatically allocates (and later deallocates, if necessary) any memory needed.

That means it's perfectly fine to do something like this as the first line in your program:

```
$a[500] = "hello";
```



SETH JABEN © 1994

You never bothered to declare any array, but right away you assign to the 500th element of it. The procedure couldn't be easier.

Rapid Prototyping

One thing that Perl is great for is rapid prototyping. It provides an easy way to take care of your quick-and-dirty programming. This is an attractive aspect of interpreter programming that users of BASIC will recognize

PHOTOGRAPHY: GEOFFREY WHEELER PHOTOGRAPHY © 1994 and appreciate. You simply think about what you need to do to solve the problem, and then you type it in using straightforward but high-level constructs. You needn't be a systems programming wizard to do pretty sophisticated systems programming.

A program may take a bit longer to run in Perl than in C—usually around e times longer (e = 2.71828...)—but it takes only one-tenth the time to write it. You're trading cheap machine cycles for expensive people cycles. The flexibility of interpreted languages makes them an easier medium than compiled languages for quickly developing application code.

When prototyping, don't get bogged down with little details, efficiency concerns, or aesthetic appeal. The most important thing about your prototype is that it should work. It doesn't have to be particularly efficient, nor particularly pretty. And it certainly doesn't need to be clever—that just gets in the way. After all, it's just a prototype. In writing, you often throw away the first draft or two; you should consider doing the same thing with most programs. By the second rewrite, you'll have code that's cleaner, more efficient, and more maintainable than your first stabs at sketching out the problem.

Once you're done with your prototype, you may choose to convert into C (this has to be done by hand) and then compile it all the way into machine code. Or maybe not—it may well be that you'll decide it's plenty fast enough as it is, or that a bit of performance tuning in Perl will suffice to make it so.

Even if you do choose to convert your code into C, you'll find you've spared yourself most of the laborious effort of developing and debugging your original algorithm. Because Perl is not only an interpreter but also a forgiving one, it's easy to make small changes in your program and quickly find out what effect they have on its overall behavior.

In developing your prototype, there's no reason not to continue to use a reasonable amount of software engineering. By this I mean, to use a bit of structured programming: Break up your large problem into smaller, manageable problems and then put each of these into its own subroutine. Even when you aren't going to call a function more than once, you should still put it into its own routine to abstract out the low-level stuff; that's what prototyping is about. For example,

```
sub do_it_all {
  &do_this();
  &do_that();
  &do_the_other_thing();
}
sub do_this {}
sub do_that {}
sub do_the_other_thing {}
```

Notice that I haven't filled in what those other subroutines do. That's OK. When first sketching out how the program works, it's more important to figure out what happens when than to know the low-level details of precisely *how* something's happening. Those you can fill in later.

At the topmost level, it's perfectly all right to have functions without parameters; these might adjust some global variables and then call things further down. But at the lower-level functions, you really should pass each routine its own arguments and have those routines maintain their own local variables. Avoid even looking at global variables if you can help it, and if you can't, make sure they're clearly marked out. In small programs, this doesn't matter so much; in larger ones, it's essential.

Perl has a notion of global versus local variables that may seem curious at first but actually makes things easier for the kind of programming you're most likely to use it for. All variables are global unless declared local, and global variables themselves aren't declared at all: Variables just spring into existence when first mentioned. This makes it much easier to sketch out your quick-and-dirty program than if you had to declare every possible variable. But it means it's easy to touch a global variable even if you don't mean to.

Another thing that may surprise you about Perl's local variables is that they are dynamically scoped, not lexically scoped. That means that a subroutine inherits all the local variables that were visible in its caller. In practice, this feature should get you into trouble only if you're intentionally modifying global variables while at the same time creating local variables named exactly the same as the global ones—hardly a good idea in anyone's book.

All in all, Perl is just trying to be helpful and convenient, letting you create and access variables without a lot of the rigmarole you have to go through in more exacting languages. But if this fast-and-loose sort of programming puts pitfalls in your path, there are some strategies you can use to help you through it without mishap.

By far the most important way you can help yourself is by using Perl's `-w` flag. It catches semantic mistakes and error-prone constructs that you might otherwise miss, such as using a variable before you've assigned a value to it or trying to write to a file that isn't open. It gives both compile-time warnings when the program is first parsed and run-time warnings while it's executing. If you're a C programmer, think of it as a `lint` for Perl—except it's a `lint` that's resident during program execution as well as at compile time. This allows Perl to catch mistakes that `lint` never could. The number of bewildered programmers who come to me with Perl problems that the `-w` flag would have instantly alleviated is lamentably large.

Another simple mechanism you can use to help you (and more important, those who come after you) know which variables are doing what is to use the variables' case to provide a clue to their intended scope. This technique is sometimes used in large C programs (in C++, it's not really necessary). Since case is significant in identifiers, use all uppercase to indicate a constant and sometimes use all lowercase to indicate a local variable, with mixed case indicating a global variable. Thus, `$START` would be something that doesn't ever change in the program, `$tempfile` would be some local variable, and `$Update_Time` would be a global variable.

Which particular scheme (if any) you select for this is much less important than simply being consistent about it. While you shouldn't become overly complacent and assume that case always conveys scope as defined by the language, it can be a useful style for helping readers of your program understand its structure.

This strategy is probably less important in rapid prototypes (that's manager talk for *quick hacks*) than in larger programs. It may also make sense in a program that's going to be sticking around for a while and needs to be maintained by other folks—and remember that, three years down the road, you yourself might as well be another person.

A more sophisticated technique for controlling access to identifiers is to employ packages. Perl packages provide for module initializations, variables and functions private to a function or set of functions, and static variables. This last group consists of

variables whose values don't change between the function's invocations. You'll often see these used in robust library code. They help assure you that you aren't messing with someone else's variables and someone else isn't messing with yours. A package also lets you define code to be executed at run time before any routines in that package can be called—something you can't guarantee in C (although you can in C++).

Using a Library Function

```
&Getopts("vnf:") ||
  die "usage: $0 [-v] [-n] [-f configfile] [files ...]\n";

if ($opt_v) { $verbose++;          }
if ($opt_n) { $fakeit++;           }
if ($opt_f) { $config = $opt_f; }
```

Now that Perl has taken care of your need to worry about nitty-gritty, low-level programming matters like typing and allocation, you can get down to the business at hand: coding up your problems. As you do this, though, you're likely to make some small but mysterious mistakes along the way whose nature won't be immediately obvious. When that happens, you'll want to debug your program.

If you're programming in the shell, that means inserting echo commands. If it's an awk program you're coding up, then you'll probably be using print statements. Unfortunately, neither of these methods helps much—at least, not when you compare them to a real debugger.

One of the tremendous advantages of using Perl over shell scripts for many programs is that Perl comes with a full-fledged, integrated symbolic debugger. It's so integrated into the language that it isn't even a separate process: It's just a compilation mode and customizable library file (enabled by the -d switch) of the existing interpreter.

Combine this with the way the Perl interpreter allows you to access much of its internal state (e.g., symbol tables) through special variables, and you can get at everything right from the debugger. You can set breakpoints, examine and change variables, search for source lines with regular expressions, get stack backtraces, and do pretty much everything that you're used to doing in a C-level debugger like dbx or gdb. Because you're running with the full Perl interpreter under your belt, you can type in any legal Perl code and have it executed on the fly for you—a convenient way to test out new constructs.

Perusing the Perl Library

While a rapid prototype is all well and good, there's no reason to rewrite everything from scratch every time you code up an application. Use existing wheels, don't reinvent them. As you become more experienced, you will want to extract your most useful subroutines and place them in your own private library. Then later you can load your archived function into your new application to use as though it were from a system-supplied library.

But before you write your own library functions, you should know that the Perl distribution already comes with a fair allotment of standard libraries. These include functions for handling option processing, unlimited precision numbers, screen manipulations, binary searches on sorted files, and recursive directory processing.

Just how do you get at these libraries from Perl? The basic statement to load a library from within your program is require, as in

```
require 'getopts.pl';
```

Once this is done, you're free to call any functions loaded by that library, although you do have to know the name of the function or functions that you have just loaded. In the above case, the function will not automatically be called getopts—in fact, it will be called Getopts (remember that, as in C, identifiers are case-sensitive). The listing "Using a Library Function" shows how to use &Getopts().

Like nearly everything in the language (including local variable "declarations"), require is a run-time event, not a compile-time one. Perl loads the required file only once, no matter how many times you ask for it. This is a feature, because it lets you write code that includes library routines willy-nilly. You don't have to worry that you're doing extra work if the routines you've required have themselves already required something you're about to load: It won't get loaded twice.

Requires don't always succeed. The require will fail by raising a trappable but otherwise fatal exception if any of these occur: The file can't be found in your include path (the @INC variable); the code in the required file has syntax errors in it; or the file doesn't return a true value. This last may need a little explaining. It's there so that you can try to run some routine-specific start-up code and have a clean way to indicate whether it has succeeded or failed. In practice, few library functions take advantage of this; they just finish off the file with a line containing a 1;, which is certainly a true value.

One standard routine that is worth special note is the find.pl library. Its entry point is the &find() function, as you might have predicted. This library is used by the standard Perl utility find2perl.

You invoke find2perl as you would the regular Unix find utility, just changing the name of the command, and it outputs Perl code to do exactly the same thing as the equivalent find command. It even knows about the special GNU find options. You can then inspect this output to learn how you might, from a Perl perspective, do the things that the find program does. On systems without a find program or with an inadequate one, find2perl and find.pl become even more useful.

Pass the &find() function a list of directories to traverse. Then for each file in that directory, &find() calls a user-defined function of yours called &wanted(). If it encounters a directory, it recurses down the directory. Your routine gets called with two variables set: $name is the full path name, whereas $_ is just the filename component.

The program in the listing "Findbig.pl" goes through your whole file system and prints out the full name of any file greater than 100 KB in length. It is a simple example of how to use the &find library function. If you're on a Unix system, the following is also an interesting &wanted() function; it prints out any path names of files that are symbolic links pointing to nonexistent files:

Findbig.pl

```
require 'find.pl';
&find('/');
sub wanted {
  if ( (-s $name) > (100 * 2**10) ) {
    print "$name\n";
  }
}
```

```
sub wanted {
  if (-e && !-l) {
    print "$name\n";
  }
}
```

continued

Perl Jamming

OK, I think you're ready for this month's application. I call it the `lst` program. It's supposed to work something like the Unix command `ls -Rt`, which recursively lists out all files sorted by modification time. The problem is that `ls` sorts the files within each directory separately, whereas what you often really want is to have all files sorted against each other irrespective of which directory they occur in. That way you can tell what is the newest file in an entire subtree. So the goal here is to make something like a recursive `ls` but which does sorting on the whole subtree.

The Core of lst Program

```
if ($opt_i) {
  local(*name) = *_;  # $name is now an alias for $_
    warn "file args ignored due to -i" if @ARGV;
    while (<STDIN>) { chop; &wanted; }
} else {
  require 'find.pl';
  &find(@ARGV);
}

@sorted_names = sort { $time{$b} <=> $time{$a} }
                        keys %time;
@sorted_names = reverse @sorted_names if $opt_r;

foreach (@sorted_names) {
  if ($opt_l) {
    @stats = split(' ',$stat{$_});
    chop($now = &ctime($stats[$TIME_IDX]));
    printf "%6d %04o %6d %8s %8s %8d %s %s\n",
      $stats[$ST_INO],
      $stats[$ST_MODE] & 07777,
      $stats[$ST_LINK],
      &user($stats[$ST_UID]),
      &group($stats[$ST_GID]),
      $stats[$ST_SIZE],
      $now,
      $_;
    } else {
    print "$_\n";
  }
}
```

Instead of writing the whole thing from scratch, you'll use several well-known, standard Perl libraries that are included with every Perl distribution. This will shorten the code considerably.

Here's how the program works. First, require some standard Perl library files. Next, use one of the routines loaded from them to check what options were given. If you didn't get a good option, abort the program with a long usage message. Examine the set of options given to determine what kind of sorting the user wants. Then, you either process the files given on standard input, passing each file off to `&wanted()` for further processing, or else call the `&find()` function, which in turn calls `&wanted` indirectly.

The Wanted Subroutine

```
sub wanted {
  @stats = stat($_);
  -f _ || return;
  $time{$name} = $stats[$IDX];
  $stat{$name} = "@stats" if $opt_l;
}
```

So in either case it's `&wanted` that's doing the work (see the listing "The Wanted Subroutine"). What it does is `stat` each file that comes into it in `$_`, skipping it unless it's a plain file (as opposed to, for example, a directory). Inside the `%time` associative array (i.e., hash table), squirrel off the thing you're going to be sorting on, and save off all the `stats` you got into another table if you're going to be making a long listing. Both of these hash tables are indexed by the full path name of the file.

Since the long output format (to be compatible with `ls`) is going to print out the user and group ownerships on the file, you needed to convert these from their internal numeric form to their more frequently used text version; for example, `uid 0` should print out as "root," not "0." To do this, call the C library routines `getpwuid()` and `getgrgid()`, which are available directly through Perl. But you don't want to call them every time you need that information; that would be far too inefficient. Instead, remember that you already did the conversion by storing the returned value in a Perl array and just fetch the cached name on any subsequent calls that use the same numeric ID.

Back in the main routine, all that's left to do is sort and print. Sort the keys (i.e., indexes) of the `%time` table, which are the names of the files given. Reverse the resulting list of sorted keys if the user selected the `-r` option. If what's wanted is a long listing, then retrieve the saved `stat` information and split it up again into a list. Convert the correct time to print in standard form and then dump out the whole thing using a `printf()`, as in C. If all that's wanted is a short listing, just print the filename directly, remembering to add the trailing new line. ■

Editor's note: *The* `lst` *program runs under version 4.036 of Perl, which is the current release and is available for many kinds of operating systems and hardware. The full text is available electronically.* *See page 5 for details.*

Tom Christiansen is a freelance consultant living in Boulder, Colorado. He serves on the board of directors for the USENIX Association. When he's not on the road lecturing on Perl, he's getting the libraries, utilities, and documentation for the 5.0 release of Perl into production shape. Tom also maintains the Frequently Asked Questions list for the USENET newsgroup comp.lang.perl. He can be reached on the Internet at tchrist@usenix.org or on BIX c/o "editors."

For More About Perl

If you want to learn more about Perl and you have access to USENET, then you should check out the USENET comp.lang.perl newsgroup for discussions on the Perl language, bugs, features, history, humor, and trivia. It's the best place for the latest information on Perl.

The Frequently Asked Questions list (which I maintain) for that newsgroup contains a wealth of information, ranging from the mundane to the esoteric. This list is retrievable via anonymous FTP from the host rtfm.mit.edu (currently 18.70.0.209) in /pub/usenet/comp.lang.perl/*. It includes information on where to get Perl binaries for some non-Unix architectures.

The ports most likely to be of interest to you are those for MS-DOS, Windows NT, and the Mac. The DOS version is called "bigperl" (actually, BIGPERL4). It's Perl 4.036 that has been compiled using the Watcom C/386 compiler (a 32-bit, flat-memory-model C compiler). It's packed with useful features, including support for up to 32 MB of virtual memory, debugger support, and support for gdbm (the GNU database management routines) for the newer BSD 4.4 db package. A 386/486 with at least 4 MB of RAM is required, and a third-party memory manager is strongly recommended. This version passes those Perl regression tests that do not depend on Unixisms, and it comes complete with full source code, all freely distributable.

The NT version of Perl is also alleged to work well (I have no personal experience with it). It includes support for getting at sockets from Perl, so even on non-Unix systems you can use Perl for networking applications. The source code builds out of the box and contains some NT-specific tests.

Both of these ports, along with the Macintosh version, are available via FTP from ftp.cis.ufl.edu (128.227.100.252) in the /pub/perl directory. Here you'll find a veritable treasure trove of Perl tidbits. Inside that directory, look in the src/ subdirectory for other subdirectories called 4.0/, 5.0/, macperl/, msdos/, and ntperl/.

Essential Reading

Four recommended books on Windows NT, Win32, and OLE 2

JON UDELL

Among the recent profusion of Windows NT books are four that I've found especially interesting: Martin Heller's *Advanced Win32 Programming*, Jeffrey Richter's *Advanced Windows NT*, Russ Blake's *Optimizing Windows NT*, and Kraig Brockschmidt's *Inside OLE 2*.

Heller Investigates Win32

Advanced Win32 Programming by Martin Heller, John Wiley & Sons, $44.95, 463 pp., ISBN 0-471-59245-5 (one disk).

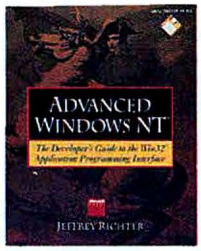
Advanced Win32 Programming isn't a Win32 encyclopedia. Instead, it's a personal memoir that chronicles how a seasoned Windows programmer—Martin Heller—evolved into a Win32 programmer. Because C++ is fast becoming the lingua franca of Windows, he investigates that as well. "I'm the last person who should teach C++," Heller says, "as I've fought it, kicking and screaming, for years."

That's precisely what makes his assessment of C++ so intriguing. Like many Windows programmers, he's torn between wanting to learn object-oriented programming and having to get software out the door. The tension between desire and duty yields a refreshingly candid analysis of the benefits of C++. Because this is, after all, a book about porting from Win16 to Win32, the discussion leads naturally to MFC (Microsoft Foundation Classes), which hide many differences between the two.

One of the book's core examples is an image-viewing program that first appeared in Heller's earlier *Advanced Windows Programming*. A first pass through that code yields a quick-and-dirty Win32 version of the program. A second pass turns it into a quick-and-dirty C++ version. A third pass, intended to make it a truly object-oriented program, wanders entertainingly around in the MFC framework exploring document and view classes and their bit-map-related derivatives. However, it ultimately never delivers the promised object-oriented result. A cop-out? "I learned an awful lot along the way," Heller says now. So does the reader.

Other topics are advanced graphics (i.e., Bézier curves, paths, and world transforms), thread synchronization, Win32s and universal thinking, the multimedia subsystem, enhanced metafiles, and networking (i.e., WNet APIs, named pipes, NetDDE, sockets, and RPCs [remote procedure calls]). Heller picks an eclectic variety of subjects and dissects them in a literate and engaging way.

Richter on Win32



Advanced Windows NT by Jeffrey Richter, Microsoft Press, $39.95, 700 pp., ISBN 1-55615-567-0 (one disk).

Advanced Windows NT by Jeffrey Richter *is* a Win32 encyclopedia, more specifically a detailed guide to the most interesting and important Win32-only APIs. Highlighted subjects include thread synchronization, heap and virtual memory management, memory-mapped files, DLLs, asynchronous I/O, structured exception handling, and Unicode. Every chapter is enlightening, and the book is packed with concise code samples that isolate the APIs of interest.

How does the multithreaded C run-time library work, and why are both single-threaded and multithreaded versions necessary? Why are the heap APIs useful? When should you use sparse virtual memory? Richter's methodical research yields authoritative answers to these and many other questions.

The best client of the Win32 services is Windows NT itself, and Richter often motivates the discussion by showing how NT uses Win32 features to get its job done. Memory-mapped files and thread-local storage, for example, aren't just conveniences for the applications programmer. NT uses memory-mapped files to optimize program loading; thread-local storage is used so the multithreaded C run-time library can store per-thread data. Insights like these make *Advanced Windows NT* more than an API cookbook. It greatly enriched my understanding of the base operating system as well.

Two extended examples will prove especially valuable to students of Win32. A supermarket simulation nicely demonstrates the use of both semaphores and mutexes in a complex synchronization scenario involving lots of threads. A file-copying example highlights NT's potent asynchronous I/O features, contrasting the extended (i.e., alertable) read, write, and wait functions with their standard (i.e., nonalertable) counterparts.

Much of this Win32 exegesis applies not only to NT, but also to Chicago. So even if Windows NT isn't part of your current plan, there are still compelling reasons to get up to speed on threads, sparse virtual memory, memory-mapped files, and other Win32 features common to NT and Chicago. Richter offers comprehensive and reliable guidance.

Blake on Performance Monitoring

Optimizing Windows NT documents the use of the NT Performance Monitor in exhaustive detail. That's a subject Russ Blake knows intimately—he not only wrote the book, but also the tool itself. On another level, the book is a profound meditation on how to identify and eliminate performance bottlenecks in computer systems. Finally, it's a tribute to the first-class instrumentation that's built into Windows NT.

The object-based architecture of NT gave its designers convenient hooks on which to hang counters that monitor the system's vital signs as it runs. For each class of system object—processor, process, thread, cache, disk, network transport, and others—NT maintains a variety of counters that measure the usage of objects of that class. Performance Monitor retrieves the numbers and displays them as charts and tables.

***Optimizing Windows NT* by Russ Blake, Microsoft Press, $34.95, 581 pp., ISBN 1-55615-600-6 (one disk).**

Optimizing Windows NT shows how a savvy user of Performance Monitor can gain extraordinary insight into the dynamics of a running NT system. In Blake's hands, the data clearly exposes system bottlenecks and enables him to state with certainty that a given system's upgrade dollars should be spent on a faster disk, more disks, more memory, or a better network adapter. To show the rest of us how to interpret the data as effectively, Blake works through dozens of examples. Along the way, he teaches an entire methodology of performance analysis and animates the inner workings of NT: the working set tuner, the cache manager, and the scheduler.

Applications can create their own counters for use by Performance Monitor—SQL Server does, for example. The ability to unify application and system counters is one of the things that makes Windows NT such a compelling platform for high-performance applications. To illustrate how to create application-specific counters, Blake modifies the sample VGA driver from the DDK (Device Driver Development Kit), adding counters for BitBlt and text operations.

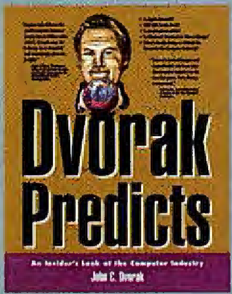
The technique is relatively arcane. While Performance Monitor queries the registry to collect data (other applications can, too), those queries vector through "performance library" DLLs that in turn communicate with applications. The sample code provides a framework that will make adding your own counters doable, although admittedly not trivial.

I hope Microsoft generalizes this technique at some point, perhaps as part of MFC. Widespread use of such a framework would usher in a generation of applications that benchmark themselves continuously, as NT does, and that would be invaluable.

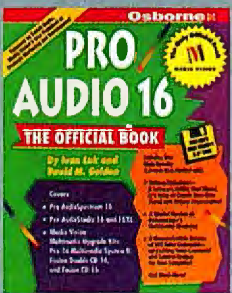
You wouldn't think that hundreds of pages of NT performance analysis would make for a readable book. Surprisingly it does, thanks in part to Blake's irrepressible humor. "To determine the precise location of the bottleneck in your computer, you must become as one with the computer," he jests. "To achieve this state requires years of meditation, prayer, and insanity." He goes on to say that NT's careful instrumentation lays the foundation for a sane approach to the analysis of system and application performance. I wholly agree.

Brockschmidt on OLE 2

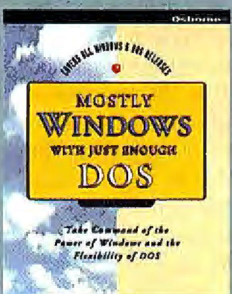
Inside OLE 2 can't really be considered an NT book, because the NT version of OLE 2 has yet to ship. On the other hand, OLE plays an even bigger role in Cairo (NT's successor) than in Chicago (Windows 3.1's replacement). Cairo's shell is made up entirely of user-modifiable OLE objects. Initially pegged as a compound-document technology, OLE 2 turned out to be some-



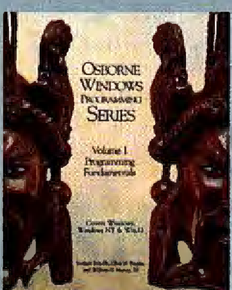
Dvorak Predicts: An Insider's Look at the Computer Industry
by John C. Dvorak
$16.95, Hardcover
ISBN: 0-07-881981-4



Pro Audio 16: The Official Book
by Ivan Luk and David M. Golden
Includes One 3.5-Inch Disk
$34.95, Book/Disk
ISBN: 0-07-881979-2



Mostly Windows With Just Enough DOS
by Herbert Schildt
$24.95 ISBN: 0-07-881976-8



Osborne Windows Programming Series Vol.1 - Programming Fundamentals
by Herbert Schildt, Chris H. Pappas, and William H. Murray, III
$39.95 ISBN: 0-07-881990-3

Vol. 2 - General Purpose API Reference
$49.95 ISBN: 0-07-881991-1

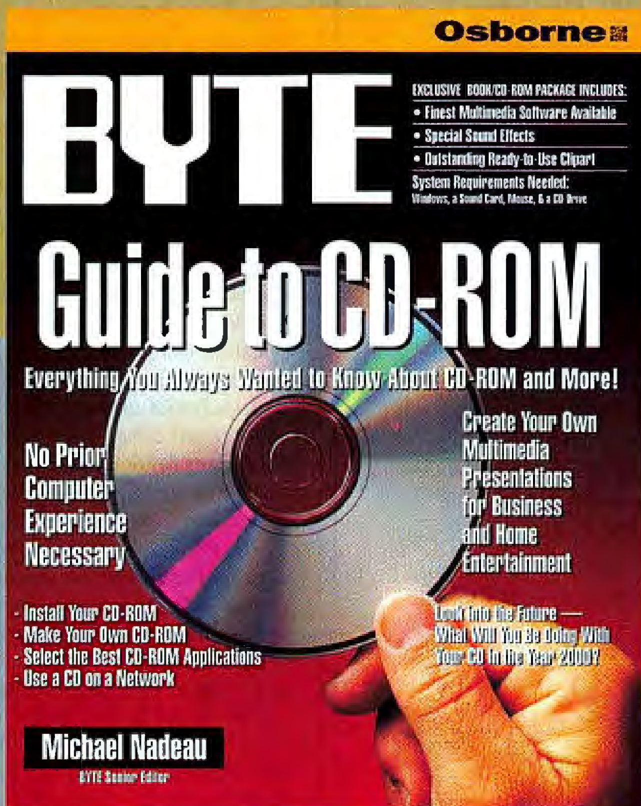
Vol. 3 - Special Purpose API Functions
$49.95 ISBN: 0-07-881992-X

When It Comes to CD-ROM... We Wrote the Book

Everything You Always Wanted to Know About CD-ROMs and More!

This Exclusive Book/CD-ROM Package Includes
- Sound and Clip Art
- Samples of CD-ROM Applications
- Multimedia Authoring Tools

Part buyer's guide, part standards guide, and part troubleshooter, the **BYTE Guide to CD-ROM** discusses all aspects of this proliferating technology so you can take full advantage.



BYTE Guide to CD-ROM
by Michael Nadeau, BYTE Senior Editor
Includes CD-ROM Disk
$39.95
ISBN: 0-07-881982-2

Osborne
Get Answers—Get Osborne
For Accuracy, Quality and Value

Available Now At Your Local Book & Computer Stores

SUPER CROWN — Three times more books. Same great Crown prices.
Barnes & Noble — Booksellers Since 1873
BOOKSTOP — The Complete Discount Bookstore
MICRO CENTER
BOOKSTAR — The Complete Discount Bookstore

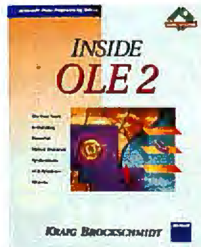
or Call Toll-Free: 1-800-822-8158 Any Time

Mention key code #SP44BYL and use your VISA, American Express, Discover or MasterCard

Circle 113 on Inquiry Card.

thing far more ambitious: Microsoft's foundation for object-oriented Windows.

The design of object-oriented operating systems is a hot topic right now. Taligent, IBM, Sun, Next, and Hewlett-Packard are advancing their own initiatives and forming alliances with one another. Thus, Kraig Brockschmidt's thousand-page manifesto is essential reading not only for the Windows crowd, but for anyone who needs to evaluate the kind of object system Windows is becoming.



Inside OLE 2 **by Kraig Brockschmidt, Microsoft Press, $49.95, 977 pp., ISBN 1-55615-618-9 (two disks).**

OLE 2 is big and scary, and Brockschmidt doesn't pretend otherwise. Undaunted, he lays out the architecture of the Component Object Model at the heart of OLE 2 and then explores key interfaces, including structured storage, data transfer, embedding, and in-place activation.

A controversial aspect of the OLE 2 Component Object Model is that it tosses inheritance in favor of an alternative scheme called *aggregation*. Brockschmidt's argument for aggregation—that it's the most reliable way to preserve rigorous contracts among components—will receive close scrutiny. Microsoft's approach to reusable components could well prove out. The current plan reflects important lessons learned from the VBX (Visual Basic extensions) experiment, arguably the most successful component architecture to date.

But I'm not yet wholly convinced, in part because Brockschmidt's explanation of the rules for implementing aggregation makes my head spin. Significant encapsulation of that mechanism will be required before most programmers will be able to consider using it. Of course, C++ will be the most likely means of encapsulation. He shows how C++ and OLE 2 can work together. The sample applications that evolve chapter by chapter from straight Windows to OLE 2 are written in terms of a homegrown C++ application framework and, in fact, make good use of inheritance.

When you control the source code, inheritance works well, Brockschmidt argues. But when you don't, inheritance cannot support effective reuse. Perhaps when some future version of MFC does for aggregation what MFC 2.5 now does for in-place activation and OLE automation, we'll find out whether aggregation works as advertised.

The book does make a convincing case for less abstract OLE 2 technologies that you can apply now. If you use the structured-storage interfaces, you can tap features of a next-generation file system, including transactioning and object persistence. If you implement data objects, they will unify Clipboard, drag-and-drop, and other modes of data transfer.

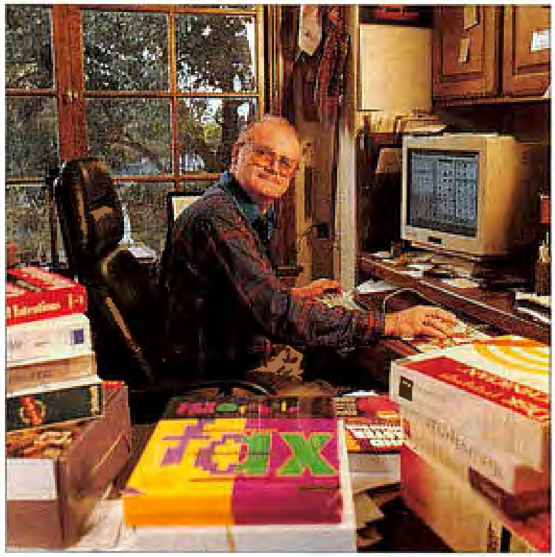
Detailed explanations show how to convert standard Windows code into OLE 2 code. The mechanics of DLL versus .EXE object implementations, and the merits of object handlers and in-process servers (both DLL-based), and local servers (.EXE-based), are also explored in detail.

Does anyone need to know all this, given that frameworks like MFC 2.5 will hide this complexity from even experienced programmers? Yes. Competent users of an abstraction need to know what lies behind it. Also, the technologies that make up OLE 2 define the future of Windows as an object-oriented operating system. That future is clearly discernible in *Inside OLE 2*. ■

Jon Udell is a BYTE senior technical editor at large. You can reach him on the Internet or BIX at judell@bix.com.

JERRY POURNELLE

What's Hot, What's Not


AMY ETRA © 1994

The annual Orchid and Onion Parade issues forth from Chaos Manor

It's January. Because I stubbornly insist that a year ends on 31 December, not when the deadline for the January issue comes around, it's now time for the annual User's Choice Awards, and the Chaos Manor Orchid and Onion Parade. Usual warning: although BYTE distributes the award certificates, the Chaos Manor User's Choice Awards are entirely my responsibility. My ground rules are that, with very rare exceptions, I won't endorse a product I haven't used; and since it's impossible for any person or committee to look at everything going on in this industry, I can't guarantee there aren't better products. I can guarantee that the ones I give awards to are good enough because I've used them to do productive work.

Let's start with video boards. Provided that you have a reasonably fast system, nothing will speed up Windows operations like a good video board. Top honors this year go to the Hercules Dynamite VL Pro (for the VESA Local Bus, alias VL-Bus): in SuperCow, the Gateway 2000 486DX2/66, we got an astounding score of 58.49 with the Win Tachometer benchmark.

Moreover, installation was simple and easy, and so far we have found no incompatibilities: SuperCow has the Maximum Storage Duette optical drive and a Creative Labs Digital Edge Multimedia Kit with CD-ROM, all buffered by Norton Speedrive. It all works splendidly.

The Dynamite VL Pro board makes Microsoft Video for Windows tolerable. We're getting quite acceptable full-screen, full-motion video off a CD-ROM, along with other miracles. Blazing speed, great color, sharp images: this is where the video world is headed, and we're pleased to give the Hercules Dynamite VL Pro a User's Choice Award as the Video Board of 1993.

The previous speed record (see last month's column) was held by the Number Nine #9GXE Professional Graphics Accelerator in exactly the same slot in SuperCow that the Hercules Dynamite VL Pro now occupies; but the #9GXE is not a VL-Bus board, so it used only the (16-bit) ISA portion of the slot. The #9GXE had a Win Tachometer benchmark score of 42.57, which earned it a "Wow!" when we first saw it; prior to that we thought a Win Tachometer score of 30 or more was impressive.

We couldn't test the #9GXE's performance with externally supplied video because the model we have doesn't have a VGA feature connector (as used by Creative Labs' Video Spigot, Sigma Design's ReelMagic, and the like). Future models of the #9GXE will, and you should be sure that the one you get has that feature; you may not think you'll need it, but chances are good that one day you will. If you don't have local-bus video and you need superspeed performance from your 486, the #9GXE is the way to go. It gets a User's Choice Award in the ISA video board category.

I mentioned Norton Speedrive: this is one great program, and unlike many cache programs it will work not only with CD-ROM drives, but with external hard drives working through the parallel port. It speeds up disk operations something fierce, it's easy to install, and it just plain works. We're happy to give

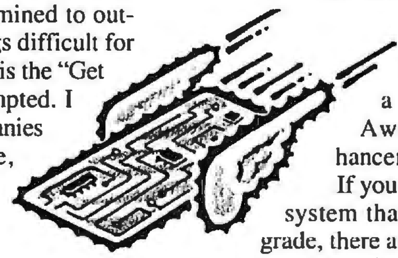
ILLUSTRATIONS: HENRIK LANGSDORF © 1994

Symantec's Norton Speedrive a User's Choice Award.

I can't give it an award because I don't use it, but one of the most important computer programs of the year was Integrated's Matrix X, a "connect the boxes" CASE tool that allowed the McDonnell Douglas team to write the flight-control software for the DC/X rocket ship on time and within budget. The resulting program had enough flexibility to allow the flight controllers to recover from a near disaster when one of the engines didn't perform properly on takeoff.

The DC/X is a one-third-scale model of the SSX spaceship that Max Hunter, General Daniel O. Graham, and I proposed to National Space Council Chairman Dan Quayle back in 1989; Mr. Quayle caused the ship to be built and tested. Bureaucratic hassles delayed the program's start for a couple of years, but then it rolled out in March, flew in August, and so far has done everything expected of it. I truly believe that if we can get funding for the full-scale SSX we'll revolutionize access to space. A large Chaos Manor Orchid to the McDonnell Douglas DC/X team headed by Dr. William Gaubatz, another to the USAF management team of Peter Worden and Jess Sponable, and one to Integrated's Matrix X.

The Onion of the Year goes to the Novell-versus-Microsoft wars, in which each company seems determined to outdo the other in making things difficult for users. Alex suggests I call this the "Get a Life Award," and I'm tempted. I really, truly wish both companies would stop this nonsense, which does neither of them any good and harms the growth of the industry.



The Crystal Ball Award goes to Sigma Designs for their ReelMagic video board. This thing works extremely well, and it shows just what MPEG compression can accomplish when fed into a really good video board. Since the ReelMagic runs through the VGA feature connector, it works well with any VGA card; since the decompression happens on the ReelMagic board, it's not I/O bound by an ISA machine.

There is still a dearth of MPEG images available; while the ReelMagic board can decompress video images on the fly, the compression still takes quite a lot of computing power as well as time. That, too, will change as really powerful systems become more common and MPEG is used in more consumer-oriented systems. The ReelMagic board is out there at the edge of video technology, and it gets a User's Choice Award for video enhancement.

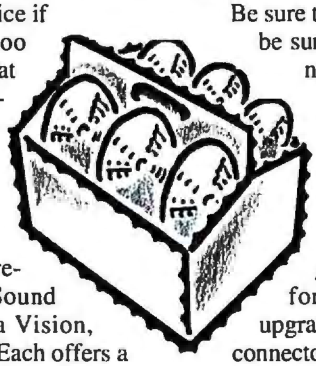
If you have an older 386 system that you want to upgrade, there are several possible routes, including using one of Texas Instruments' new replacement motherboards, but about the simplest is to get the less-than-$300 Cyrix CX486SRX2 chip, which converts a 20- or 25-MHz 386 to a 40- or 50-MHz 486SX. The chip is simplicity to install, and it really works. I haven't tried a Number Nine #9GXE board in a Cyrix-upgraded 386, but I suspect it will fly; then, later, when you get a real 486 system, you can keep the upgraded 386 as a net asset (that's what we've done with our old Cheetah 386) and put the #9GXE board in your new machine. The CX486SRX2 conversion chip from Cyrix gets a User's Choice Award; it really works.

This was the year that video hardware became good enough that multimedia could go from potential to reality. There's still a little fear, uncertainty, and doubt in the video standards, although they're settling out. Alas, there's far more FUD, etc., on the sound side of multimedia: things are really up in the air, there are almost no agreed-upon (as opposed to de facto) standards, and there are a number of competing products, many good, and some excellent.

I can offer some guidelines. First, most games are written in DOS, and while you may not be interested in games, you need to know the reason most are in DOS: Windows is a very discouraging (and slow) environment for game programmers—and the game programmers are the leading edge in multimedia effects. What gamers do this year becomes the technology for other multimedia in the future, and this is especially true for educational software.

This means that for the next couple of years, DOS multimedia software will be at the leading edge; that means your soundboard equipment had better be able to handle DOS sound standards. On the other hand, there is some Windows multimedia software, and the best of it is pretty good. You'll want to run that, too.

You will also want a good CD-ROM player. The big sellers are double-speed (300-Kbps) CD-ROM devices. Triple- and quad-speed systems are just coming out; the only one I have is the new Pioneer DRM-604X, the six-pack CD-ROM player. Double-speed systems can throw out video images faster than most video boards—especially if there is a lot of processing required. We did note that, with the Hercules Dynamite VL Pro, the limiting factor seemed to be how fast we could get data off the double-speed CD-ROM drive.



Get a triple-speed device if you don't have to pay too much, but understand that for most applications double-speed devices will be good enough for the equipment you have.

There are two major companies making multimedia upgrade kits: Creative Labs, with their Sound Blaster line, and Media Vision, with their Pro 16 series. Each offers a number of choices: Creative Labs offers a bewildering variety of kits and boards. The basic components of the kits are a double-speed CD-ROM drive; a sound board, which will also run the CD-ROM drive; and a lot of software. Some of the bundled-in third-party software is spectacular, with combined list prices that are nearly as much as the street price of the upgrade kit.

Some of the older kits have single-speed CD-ROM drives. I don't recommend single-speed drives unless you have an older, slow computer and don't intend to upgrade it. Some of the multimedia kits offer "full standard SCSI," which includes the ability to run your computer's hard disk. There was a time when I thought that that would be a good thing, but I no longer believe it. My advice is not to get one of the "full standard SCSI" kits unless special circumstances dictate it. Instead, figure that your multimedia upgrade kit is for that job and that one alone, and if you need additional standard SCSI devices, get an Adaptec or Future Domain SCSI board, or a DPT SCSI drive controller.

Be sure to get a 16-bit sound card, and be sure it has a Wave Blaster connector. Wave Blaster is Creative Labs' wave-sound add-on, but the connector has become standard; nearly the same add-in board is available for The One-Stop Music Shop on an Amiga. Wave input greatly enhances music performance: think of this as an upgrade path like the VGA feature connector on your video board. With a Wave Blaster connector, you'll be able to buy the best sound libraries (in ROM) for at least the next year, and probably longer.

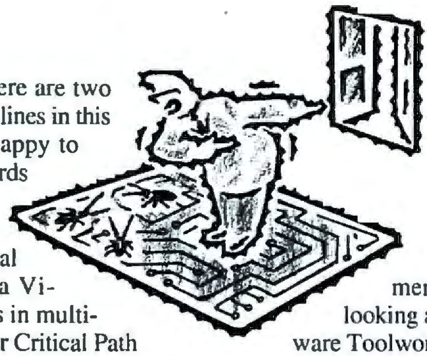
Both Creative Labs and Media Vision offer kits with surprisingly good small speakers. If you care about sound at all, you'll find these worthwhile: I'm partly deaf, and I can very much hear the difference between those and the inexpensive Radio Shack speakers I used to use. The kits offer good speakers at a fair price.

There are kits with and without microphones, kits with more and less MIDI connector cables, and a bewildering amount of software. The microphones are pretty good, and if you don't have one you may want one, although just now there isn't a lot of use for them.

You do want to pay attention to the bundled-in software. You'll want a good multimedia encyclopedia. Compton's Interactive Encyclopedia for Windows (also available for the Mac) is quite good, and it comes with some Media Vision kits. You'll also want a good dictionary and thesaurus. Microsoft Bookshelf, one of the original CD-ROMs and still one of the best (it includes *The American Heritage Dictionary*, *Roget's Thesaurus*, *Bartlett's Familiar Quotations*, and more), is bundled with many Creative Labs packages and runs seamlessly with many Microsoft products, including Word.

We have both the Creative Labs and Media Vision kits installed on a variety of machines, and we've had no problems with either; and in my judgment you won't go wrong with either company. Media Vision has a chip deal with Logitech, ensuring support from that fine company; Media Vision also has aggressive marketing and is doing some very innovative things in multimedia (see below). On the other hand, *everyone* supports Creative Labs and their Sound Blaster line; you're extremely unlikely to encounter a program you can't run in a Creative Labs multimedia system.

Look at both and think about what you want to do; be sure to get 16-bit, dual-speed CD-ROM and a Wave Blaster connector, and make your own decision. Me, I'm tickled pink that there are two good competing product lines in this critical area, and I'm happy to give User's Choice Awards to both Creative Labs and Media Vision.



One reason for this dual award has been Media Vision's innovative efforts in multimedia. In particular, their Critical Path game, while in a genre I'm not fond of, breaks considerable new ground: live actors, real scripts, and smooth transitions within story lines. If you haven't seen this, you certainly should: it's more than just a game—it's a good indicator of things to come.

While we're discussing sound, let me renew the User's Choice Award for The Software Toolworks' Miracle Piano Teaching System. This is a no-nonsense, very good keyboard that will play through your computer system, and it comes with some really excellent software for teaching piano. Every music teacher we know who has seen this product has recommended it. With that, and a Wave Blaster, you can buy all kinds of music sounds and control them with the Miracle Piano Teaching System's keyboard; some of the wave-sound recordings are really splendid. Highly recommended. While you're looking at this, get The Software Toolworks' CD-ROM catalog: they publish a line of really good educational and reference CD-ROMs.

I have several useful peripherals on my network, but the most useful one I've acquired this year is the Pioneer DRM-604X six-pack CD-ROM player. It's very fast, speedy at changing from one disk to another, and really fast in peeling data off the CD-ROM; it works on the network just fine; and it has given me very little trouble.

CD-ROM has become an absolutely vital part of the modern computer world, and it's extremely convenient to have more than one on-line. My usual practice is to keep Microsoft Bookshelf, Compton's Interactive Encyclopedia, DeLorme Mapping's Street Atlas USA, and a couple of other reference CD-ROMs on the DRM-604X and thus available at all times, leaving the CD-ROM player on my local machine for whatever I'm doing at the moment. The time saved by having all those resources instantly available is considerable: moreover, like most authors, I work in spurts, and when I'm really turning out the text, any glitch in the flow can be hideously expensive. At those times, anything that lets me keep working without interruption is worth a very great deal.

Pioneer has another winner in the DRM-604X player, and it gets the User's Choice Award for the most useful CD-ROM player of the year.

Microsoft has two "networks" that issue periodic CD-ROMs containing vital information: TechNet ((800) 344-2121 ext. 160, 24 hours a day, $295 per year for monthly CD-ROMs), which is the technical information network, and the Microsoft Developer CD network. If you're at all involved in developing applications for Windows, or enhancements or tools for any Microsoft application, you should run to enroll in the Developer CD network. It gives vital information about interfacing with Microsoft programs, and it's often the *only* source of such information. Whether you write Microsoft applications or write applications in competition with Microsoft, you need this bad.

In addition, if you install or maintain Microsoft products, you really can't afford not to be enrolled in TechNet. The TechNet CD-ROMs contain an organized database of technical-support information on all Microsoft products, from DOS to Windows NT to FoxPro and Word. Updated monthly, they contain all the information developed by the Microsoft technical-support people: answers to questions users ask. Now that Microsoft charges product managers for technical-support costs, it's much in the product manager's interest to see that the TechNet database is complete; and knowing what problems users have can't hurt either support or development people.

TechNet isn't for every casual user, but it's a natural for computer clubs and users groups, as well as those who install and maintain computer systems; and Microsoft deserves a User's Choice Award for this innovative addition to technical support.

Having said that, I'm still worried about technical-support trends. Software is getting more complicated, the interactions among programs can produce obscure and incomprehensible problems, and a lot of software doesn't know how to uninstall itself; nor does Windows know what has gone wrong. I have great sympathy for Microsoft when someone attempts to

A Message to Our Subscribers

From time to time we make the BYTE subscriber list available to other companies whose products or services would be of interest to our readers. We take great care to screen these companies, choosing only those who are reputable. Furthermore, subscriber names are made available for direct mail purposes only; telemarketing calls are strictly prohibited.

Many BYTE subscribers appreciate this carefully managed program, and look forward to receiving information of interest to them via the mail. While we believe this information is of benefit to our subscribers, we firmly respect the wishes of any subscriber who does not want to receive promotional literature. Should you wish to restrict the use of your name, please send your request (including your magazine mailing label, name, address, and subscription account number) to:

BYTE Magazine
Subscriber Services
PO Box 555
Hightstown, NJ 08520

BYTE
The Magazine of Technology Integration

install some new Windows application, lets it write all over WIN.INI and SYSTEM.INI, and then panics when Windows won't come up.

On the other hand, I have a lot less sympathy for Microsoft when people try to install Windows for Workgroups and discover that at disk 3, the SETUP program has forgotten how to read a floppy disk, so the only workaround is to boot up in DOS and copy all the installation disks to a temporary subdirectory on your hard disk and install from there; and yes, not only can that happen, but it happened to me.

I don't know of a really elegant solution to the technical-support problem, but I do have a suggestion: Microsoft ought to give a very deep discount on their TechNet subscription to every establishment that sells and installs Microsoft software. While I don't think $295 a year is an excessive fee for TechNet, it's enough to discourage some small companies—and those are often the ones who need it most. Novell has a similar technical-support CD-ROM service that they give free to their Gold and Platinum dealers and make available to others on a subscription basis. My guess is that offering TechNet discounts to Microsoft dealers would be a cost-effective, competitive move.

I also wish mightily that Microsoft would develop a good AI program to examine WIN.INI and SYSTEM.INI and make suggestions. Some of the TechNet information deals with INI problems, but not enough. WIN.INI and SYSTEM.INI can get cluttered with needless and even contradictory stuff, and few users understand them well enough to hack into them. My major wish for 1994 is a good user-level Windows debugger.

It's a bit like kicking them while they're down, but I have no choice: a large Chaos Manor Onion to Borland, who still hasn't published dBase for Windows. Microsoft shifted attention to Access and then fumbled that, giving Borland a splendid opportunity to catch up: but they've just about blown that. Down but not out, Borland gets a Chaos Manor Orchid for Paradox. It doesn't excuse them for not getting dBase for Windows out, but they do deserve the Orchid.

There were two important operating-system product releases last year: Windows for Workgroups 3.11, which is a better Windows, not merely an upgrade of W4WG; and OS/2 2.1, which is more than just an upgrade of OS/2.

There was also a dark horse: It's called OS/2 for Windows, but it ought to be called OS/2 for Windows Users; and if it has been done right, as I am told it has been, it's even more significant than OS/2 2.1 itself.

I am a fan of W4WG, especially the 3.11 release. I like the 32-bit file and disk access. I very much like the improved File Manager. I find W4WG a painless way to solve my rather simple networking needs: with it I can transfer files from one machine to another; Niven and I can work on different parts of the same document and get quick access to each other's changes; and I have access to the new and improved Pioneer DRM-604X CD-ROM drive. It has other features as well, but those are vital and easy to set up and use.

On the other hand, while W4WG has some 32-bit features, it's not really a 32-bit operating system; and while it's not too bad at task switching, it's not really a multitasking system. It knows about objects, but it's not truly an object-oriented system. It will run some DOS programs well enough, but it's really awful with others. It's a bad gaming environment. Most DOS games lose a lot when they're ported to Windows—and the DOS versions won't play well under Windows, no matter how careful you are in constructing a PIF (program information file).

The plain truth is that if you're running a lot of DOS programs, you'll really be better off with OS/2. On the other hand, while OS/2 is a better DOS than DOS, and is a darned good 32-bit object-oriented operating system in its own right, it's not a better Windows than W4WG 3.11; and IBM took its own sweet time developing a networking system that would let you tie an OS/2 machine to anything but another one. Artisoft LANtastic would let you link Windows and OS/2 machines, but it didn't work with W4WG either, and the setup requires more work than W4WG.

Thus, I was dithering over which operating system: OS/2 2.1 or W4WG 3.11, would get the User's Choice Award.

I finally decided that OS/2 2.1 was the more significant development. There's no doubt of its technical excellence, and while IBM still hasn't demonstrated that they know much about marketing—as I write this, John Patrick and Lucy Baney, the two IBM people who convinced me that it was worth giving IBM one more chance, are no longer part of Team OS/2—they did manage to do some things right. OS/2 2.1 works, for some users it's the right choice, and Microsoft needs the competition.

Then came OS/2 for Windows. This highly significant development allows you to install OS/2 right over your existing Windows system; the result is that you have your old Windows desktop and installed applications, and OS/2 as well.

Then, just yesterday, I learned that IBM has a way to use OS/2 for Windows and their new networking program to allow you to link an OS/2 system to W4WG. I haven't done this, but the source has been reliable in the past. We'll see, because I don't really believe anything that I haven't got running at Chaos Manor; but if it holds up, that will really be the development of the year, posthumously.

For all these reasons, Microsoft gets a Chaos Manor Orchid for W4WG 3.11, but the Chaos Manor User's Choice Award for Operating System of the Year goes to IBM's OS/2 for Windows.

I don't have any awards for printers, because we didn't get any new printers this year: no one sent any. I am quite content with our Hewlett-Packard LaserJet III, and Roberta is ecstatic over getting the Kyocera Ecosys when her ancient Mannesmann Tally died after seven years of faithful service. Both the LaserJet III and the Ecosys are, you may recall, previous recipients of the User's Choice Award.

There are many exciting developments in printer technologies, with increased speeds and resolutions. HP continues to dominate, but that 800-pound gorilla is hotly pursued by outfits such as Kyocera and Lexmark; and for printer add-ons, it's hard to beat LaserMaster.

We did get one color printer this year, the Fargo Primera Color Printer; this uses two cartridges, so it can print in low-cost thermal transformation for proof copies, and then in dye-sublimation when you're ready for the more expensive copies. Ours is for Windows; there are versions for the Mac and the Amiga, and for the money, the Primera is a pretty good deal. Installation for Windows consisted of plugging it in and installing the drivers: no problems at all, and it works over the W4WG network. Fargo gets a big Chaos Manor Orchid for the Primera Color Printer.

On the laptop scene, the best new machine this year was the HP OmniBook 425, a very lightweight, full-width laptop that runs Windows. It has no hard disk; rather, there are four PCMCIA slots. There is no floppy drive (although a third-party external floppy drive is said to be available). The mouse is built in and swings out on an arm; it's a bit awkward to use, but you get used to it, or at least I have. There is no backlit screen.

The advantages are its considerable power and light weight. Prior to getting the OmniBook 425, it was my practice to carry an ancient Zenith Mastersport with a Microsoft BallPoint mouse; I used this on airplanes if I needed Windows—the batteries will last just long enough for a trip across the country—and then installed in my hotel room. Then I carried a Gateway HandBook to meetings. The HandBook is smaller than the Mastersport and the OmniBook, and it weighs about the same as the OmniBook.

This dual system was made possible because I've acquired one of those carry-on bags with wheels, the kind that flight crews have. Thus, so long as it's not so heavy as to leave ruts in the sidewalk, I don't really care what my two portables and their battery chargers weigh, and I very much like the convenience of a hard disk and a backlit screen. On the other hand, this means that I don't have Franklin Ascend with me outside my hotel room, because Ascend is a Windows program and the Gateway HandBook doesn't do Windows. [Editor's note: *The new Gateway HandBook 486 does support Windows.*]

I find now that I still carry the Mastersport to use in hotel rooms, and I carry the OmniBook where the Gateway HandBook used to go. This works very well, since I don't do a lot of writing or computing out on field trips, and when I come back to the hotel room where I do write a lot, I have the Mastersport with its nifty keyboard and backlit screen. It's the work of a moment to use LapLink to transfer any files I may have changed during the day.

Some friends really like the OmniBook 425, and others really hate it; it seems more a matter of temperament and ability to use that strange little mouse than anything else. Me, I like it just fine, and it gets a User's Choice Award in the portable category.

This year saw some important developments in computer languages. Most of my readers know that I am no great fan of the C programming language; and while C++ corrects some of C's deficiencies, it doesn't do anything about the worst problem of all—namely that C will compile nonsense, including unwanted type changes and pointers to nothing at all. C programmers have to simulate the compiler in their heads when they code; me, I prefer to have the computer catch my mistakes for me, meaning that I want a highly structured language with a compiler that complains when I do something stupid.

For years I thought that Modula-2 would evolve into the most important of the computer languages; then Turbo Pascal incorporated most of Modula-2's features. Alas, while Turbo Pascal still lives, even at Borland it takes a back seat to C++. Nowadays the only real rival to C++ is one or another form of compiled BASIC and/or Visual Basic.

There are two of these: Microsoft Visual Basic and Computer Associates' CA-Realizer. Both have strong points. Microsoft Visual Basic is compatible with their DOS Basic Compiler language, and their secret weapon is Crescent Tools, a line of assembly language routines that can be called in Visual Basic programs. CA-Realizer, on the other hand, comes with compilers for both Windows and OS/2—something you're unlikely to see in a Microsoft program for a while, and it has a wonderful programming environment. Both are surprisingly easy to learn.

I have dithered over this for a week, and it's time to make a choice: it's a pure judgment call, but I give the Chaos Manor Orchid to CA-Realizer, and the User's Choice

For More Information

We're pleased to give the **Hercules Dynamite VL Pro** (1 MB of DRAM, $249; 2 MB of DRAM, $299) a User's Choice Award. Contact **Hercules Computer Technology, Inc.**, 3839 Spinnaker Court, Fremont, CA 94538, (800) 532-0600 or (510) 623-6030; fax (510) 623-1112. **Circle 1313 on Inquiry Card.**

If you don't have local-bus video and you need superspeed performance from your 486, the **#9GXE Professional Graphics Accelerator** ($345 to $1095) is the way to go. Contact **Number Nine Computer Corp.**, 18 Hartwell Ave., Lexington, MA 02137, (800) 438-6463 or (617) 674-0009; fax (617) 674-2919. **Circle 1314.**

Norton Speedrive ($99) speeds up disk operations something fierce. Contact **Symantec Corp.**, 10201 Torre Ave., Cupertino, CA 95014, (800) 441-7234 or (408) 253-9600; fax (408) 252-4696. **Circle 1315.**

The **ReelMagic** board ($499) is out there at the edge of video technology. Contact **Sigma Designs, Inc.**, 47900 Bayside Pkwy., Fremont, CA 94538, (800) 845-8086 or (510) 770-0100; fax (510) 770-2640. **Circle 1316.**

The **Cyrix CX486SRX2** conversion chip (20-MHz 386 to 40-MHz 486SX, $269; 25-MHz 386 to 50-MHz 486SX, $299) is simplicity to install, and it really works. Contact **Cyrix**, 2703 North Central Expy., Richardson, TX 75080, (214) 994-8388; fax (214) 994-8764. **Circle 1317.**

You're extremely unlikely to encounter a program you can't run in a Creative Labs multimedia system (**Discovery CD16 Multimedia Kit**, $649.95; **Edutainment CD16 Multimedia Kit**, $749.95; **Digital Edge CD Multimedia Kit**, $999). Contact **Creative Labs**, 1901 McCarthy Blvd., Milpitas, CA 95035, (800) 998-5227 or (408) 428-6600; fax (408) 428-6611. **Circle 1318.**

We have the **Media Vision Pro 16 Multimedia System** upgrade kit (System 1, $1049; System 2, $1195) installed in a variety of machines, and we've had no problems. Media Vision's **Critical Path** ($79.95) game breaks considerable new ground: live actors, real scripts, and smooth transitions within story lines. Contact **Media Vision**, 47300 Bayside Pkwy., Fremont, CA 94538, (800) 348-7116 or (510) 770-8600; fax (510) 770-9146. **Circle 1319.**

The **Miracle Piano Teaching System** (IBM, $479.95; Mac, $499.94; software only, $149.95) is a no-nonsense, very good keyboard that will play through your computer system, and it comes with some really excellent software for teaching piano. Highly recommended. Contact **The Software Toolworks**, 60 Leveroni Court, Novato, CA 94949, (800) 234-3088 or (415) 883-3000; fax (415) 883-3303. **Circle 1320.**

Pioneer has another winner in the **DRM-604X** ($1795), and it gets the User's Choice Award for the most useful CD-ROM player of the year. Contact **Pioneer New Media Technologies, Inc.**, 2265 East 220th St., Long Beach, CA 90810, (800) 527-3766 or (310) 952-2111; fax (310) 952-2990. **Circle 1321.**

I am a fan of Windows for Workgroups 3.11 ($249.95). I like the 32-bit file and disk access. I very much like the improved File Manager. With **Crescent Tools**, the **Microsoft Visual Basic Programming System 3.0** (Standard Edition, $199; Professional Edition, $495) lets you write bigger and faster programs. Contact **Microsoft Corp.**, 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080; fax (206) 883-8101. **Circle 1322.**

OS/2 2.1 (disk version, $179; CD-ROM version, $152) works, and for some users it's clearly the right choice. With **OS/2 for Windows** (disk version, $49; CD-ROM version, $39), you have your old Windows desktop and installed applications, and OS/2 as well. Contact **IBM Corp.**, 1 Old Orchard Dr., Armonk, NY 10504, (800) 342-6672 or (914) 765-1900; fax (313) 225-4020. **Circle 1323.**

Fargo gets a big Chaos Manor Orchid for the **Primera Color Printer** ($995). Contact **Fargo Electronic Services, Inc.**, 7901 Flying Cloud Dr., Eden Prairie, MN 55344, (800) 327-4622 or (612) 941-9470; fax (612) 941-7836. **Circle 1324.**

The advantages of the **OmniBook 425** (with 40-MB hard drive, $1795; with 10-MB flash disk, $2095) are its considerable power and light weight. Contact **Hewlett-Packard Co.**, 1000 Northeast Circle Blvd., Corvallis, OR 97330, (800) 433-1254 or (503) 757-2004; fax (800) 333-1917. **Circle 1325.**

CA-Realizer ($99) comes with compilers for both Windows and OS/2. Contact **Computer Associates International, Inc.**, 1 Computer Associates Plaza, Islandia, NY 11788, (800) 225-5224 or (516) 342-5224; fax (516) 342-5734. **Circle 1326.**

Masters of Orion ($59.95) is the best space strategy game I have ever encountered. Contact **Microprose**, 180 Lakefront Dr., Hunt Valley, MD 21030. (410) 771-1151; fax (410) 771-1174. **Circle 1327.**

Doom ($40) is so startlingly real and does such wonderful visual effects that you won't believe it. Contact **id Software, Inc.**, 18601 LBJ Frwy., Suite 615, Mesquite, TX 75150, (800) 434-2637 or (214) 613-3589; fax (214) 686-9288. **Circle 1328.**

Award for Language of the Year to Microsoft Visual Basic, largely because Visual Basic with Crescent Tools lets you write bigger and faster programs. Both are excellent, and I encourage readers to look into one or the other. Get your hands dirty: programming can be fun, it's a lot easier to learn than you think, and a competent compiled BASIC programmer can turn out large programs that work *much* faster than C++ programmers can.

Every year I get bribes: chocolate, T-shirts, sweatshirts, coffee mugs, fruitcakes: but the oddest this year comes from Quanta Press, who publish a good line of CD-ROMs, often winning my CD-ROM of the month category; it's worth being on their mailing list. Anyway, these madmen (they must be mad: why else would their symbol be the Cow Ouroborous, which, like the Midgard Serpent, encircles the world holding its own tail in its mouth) sent me a hand-carved wooden plaque sporting a cut-out model guernsey cow and the legend "THIS HOUSE IS UDDER CHAOS."

Longtime readers may recall that BYTE headquarters in Peterborough occupies the building that was once the headquarters of the American Guernsey Cattle Club; for years, the editorial offices were decorated with pictures of cows, and I still have mine hanging on the office wall here in Chaos Manor, making Quanta's plaque the bribe of the year.

Which brings us to the Game of the Year: Masters of Orion, usually called MOO in on-line discussions. MOO is the best space strategy game I have ever encountered. It has some weaknesses. In particular, the battles (which, thank heaven, have no arcade elements whatever) tend to be limited, with little reward for tactical skill; but overall this is an excellent game, one that can be played over and over. If you like strategy games at all, you will love this one. MOO gets the User's Choice Award as Game of the Year.

Did you ever see Castle Wolfenstein? Originally done in assembly language on the Apple II, and ported amazingly well to the PC, it's a search-the-castle-and-kill-the-Nazis-in-real-time game, and with its follow-ons has an addicted throng. The same people have now produced Doom, a game that is so startlingly real and does such wonderful visual effects that you won't believe it.

Doom, like Castle Wolfenstein, is shareware, sort of: that is, you can download the first installment from most BBSes and run it for free. Register that, and you'll get more episodes. (Call it "heroinware"—the first dose is free. . . .) Doom is dark and eerie, and realistic, and Rick Heimlich, who tests games for a living, reports that of all the thousands of games that have passed through his house, this is the first one his wife Cheryl has become addicted to. That should tell you something. Doom receives the User's Choice Award for Shareware of the Year.

I'm out of space, so next month more User's Choice Awards, including drive controllers, word processors, suites, and books; and the Orchid and Onion parade will continue. ■

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

What's New Hardware

PLUG-AND-PLAY X TERMINALS

The HP Entria X graphical desktop systems (from $995) show

performance ratings of up to 104,000 Xstones. From Hewlett-Packard (Santa Clara, CA), the terminals are compliant with the Dynamic Host Configuration Protocol (i.e., plug-and-play), with the IP address automatically assigned to the terminal when the terminal is connected to the network. The HP Entria terminals have an intuitive start-up screen and include energy-saving features such as automatic shutdown after a period of inactivity. Other features include multiple keyboard support with a dynamic keyboard mapper and quiet, fan-free operation.
Phone: (800) 637-7740 or (415) 857-1501.
Circle 1063 on Inquiry Card.

RISC-BASED PRINTING

The NPS 530 multiprotocol Ethernet pocket print server ($599) from Axis Communications (Danvers, MA) has a data throughput of up to 1200 Kbps. The palm-size 32-bit RISC device simultaneously supports TCP/IP, NetWare, EtherTalk, LAN Manager, and LAN Server. It is based on the company's Etrax chip.
Phone: (800) 444-2947 or (508) 777-7957.
Circle 1068 on Inquiry Card.

CHANGE RESOLUTION ON THE FLY

Able to display 24-bit images at resolutions as high as 1152 by 882 pixels, the LeMansGT ($2999) has 3 MB of VRAM and a 72-Hz refresh rate in 24-bit mode at a resolution of 1280 by 1024 pixels. From Radius (San Jose, CA), the card's customized ASICs are designed to deliver 32-bit QuickDraw acceleration. The LeMansGT includes Dynamic Desktop software that lets you design in WYSIWYG mode, switch resolution for detailed work, and then change to two-page resolution to view the entire document.
Phone: (800) 227-2795 or (408) 434-1010.
Circle 1064 on Inquiry Card.

NETWORK SECURITY

The 12-port Online 10Base-T Security Module (Model 5112-TPLS, $1995) provides two levels of protection for your UTP Ethernet network. The Chipcom (Southborough, MA) module prevents unauthorized listening and keeps unauthorized users from accessing the network and transmitting information. Network managers can assign as many as four authorized addresses per port; the Security Module can automatically learn the authorized addresses.
Phone: (508) 460-8900.
Circle 1066 on Inquiry Card.

PUT PC PERIPHERALS ON YOUR MAC

KeyStone ($99) from Silicon Valley Bus (San Juan Bautista, CA) lets you use PC-compatible keyboards and mice with your Mac while continuing to use your Mac keyboard and mouse. The unit's Control Panel software lets you use three-button mice and trackballs and maps your custom commands to the three mouse buttons. KeyStone, which attaches to the Apple Desktop Bus socket, has a Start-up button and an extra ADB socket.
Phone: (408) 623-2300.
Circle 1070 on Inquiry Card.

A COLOR PRINTER TO BE SHARED

Designed for presentation graphics and color printing, the DECcolorwriter 1000 ($3999) directly connects to Macs and PCs with simultaneously active ports via its resident AppleTalk, serial, and parallel interfaces. From Digital Equipment Corp. (Maynard, MA), the printer has 8 MB of memory in addition to optional EtherTalk, LAT, NetWare, and TCP/IP interfaces. RISC processing provides a printing speed of 2 pages per minute; print resolution is 300 by 600 dpi.

Phone: (800) 777-4343 or (508) 493-5111.
Circle 1065 on Inquiry Card.

PARALLEL-PORT NETWORKING

Able to link 32 computers with as many as 16 printers at distances of up to 1200 feet, PrimaNet (starter kit, $329) has a data transfer rate as high as 1 Mbps. From Primax Electronics (Campbell, CA), PrimaNet provides file sharing, file transfer, E-mail, and chat capabilities. Multiple print jobs can be completed simultaneously on different computers; the network redirection TSR program provides networking capabilities such as remote file sharing, application launching, and disk operations.
Phone: (800) 338-3693 or (408) 364-2800.
Circle 1067 on Inquiry Card.

GAIN WIRELESS CONTROL OF YOUR PC

DOS- and Windows-compatible, the RediDockit wireless docking system gives you wireless remote control of your desktop computer's keyboard and screen. The system consists of an ISA-bus Ethernet adapter with an RF module installed in your desktop PC, a PCMCIA RediCardrf Ethernet adapter with an RF module installed in your notebook computer, and Inside/Out software. Operating at 2.4-GHz connectivity with a 9.5-MBps data transfer rate, the system has a modified collision-avoidance protocol at a range of 30 to 100 feet. The system lets you transfer and synchronize files and update or copy programs from the notebook to the desktop or vice versa. You also get wireless remote access of your LAN resources, such as printers and disk drives. Cost is $1299.

Contact: Data Race, San Antonio, TX, (800) 329-7223 or (210) 558-1900.
Circle 1060 on Inquiry Card.

WAVES OF SOUND

SoundMan Wave ($349), from Logitech (Fremont, CA), is a 16-bit stereo card based on wave-table synthesis. Windows- and DOS-compatible, the card provides 44 wave-table and FM voices, full SoundBlaster and AdLib compatibility, 16- or 8-bit stereo or mono digital audio, 44-kHz sampling, MIDI support, a five-channel stereo mixer, and a SCSI CD-ROM connection.
Phone: (510) 795-8500.
Circle 1069 on Inquiry Card.

100 PLATTERS OF STORAGE

Pinnacle Micro's (Irvine, CA) Cascade CD 100 CD-ROM jukebox ($9995) stores up to 65 GB (i.e., 100 CDs) of audio, video, or data CDs in a single CD-ROM library system. The 39.7-pound unit has a disc transfer rate of 376 KBps and a disc-load time of less than 6 seconds. The jukebox is Mac and PC compatible.
Phone: (800) 553-7070 or (714) 727-3300.
Circle 1071 on Inquiry Card.

SPLIT KEYBOARD ▼

An ergonomic keyboard that enables you to physically arrange the keypad in multiple positions, the Ergo Max ($99) from Maxi Switch (Tucson, AZ) includes a 72-key main keypad and a 30-key numeric keypad. You can divide the main keypad in half and then separate the halves. You can raise and lower each half, locking each into place at your optimum typing level. The numeric keypad fits on either side of the main keypad. Options include a 40-key keypad with built-in calculator functions and LCDs and a wrist pad with a built-in trackball module.
Phone: (602) 294-5450.
Circle 1072 on Inquiry Card.

A WIRELESS INTERFACE FOR YOUR PC AND PHONE

DigiDial lets you auto-dial directly from your computer to your PBX-system phone. The wireless interface consists of a receiver that connects to the main circuit within your phone and a transmitter that connects to a 9- or 25-pin serial port on your computer. Since DigiDial responds to the standard Hayes-AT modem command set, it is compatible with contact-manager software programs that permit auto-dialing, such as PackRat, Cardfile for Windows, ACT, and TeleMagic. The interface is based on 315-MHz wireless RF technology. Cost is $139.

Contact: Datalogic, Grand Rapids, MI, (800) 397-2200 or (616) 698-3030.
Circle 1061 on Inquiry Card.

STEREO SOUND FOR YOUR LAPTOP

A pocket-size box for recording and playing sound, PC*Max (from $199) attaches to the parallel port of your laptop or desktop system. From Gilltro-Electronics & Associates (Santa Clara, CA), the PC*Max comes with two integrated speakers, an internal microphone, and a dynamic range of 72 dB. Windows-compatible, the unit uses up 480 KB of disk space for 60 seconds of sound.
Phone: (408) 727-6422.
Circle 1073 on Inquiry Card.

DATA IN THE FAST-AND-WIDE LANE

The SiliconExpress IV SCSI-2 accelerator card ($995) supports sustained 16-bit SCSI-2 data transfer rates of 20 MBps, according to Atto Technology (Amherst, NY). The card supports up to 15 peripherals without disabling the Mac's built-in SCSI port. The bus-mastering feature supports bus throttling, which smooths out the overall bandwidth of the bus, thus increasing overall data throughput. Bus mastering also transfers data independently of the CPU. The SiliconExpress IV supports fast NuBus block-mode transfers and contains an on-board RISC processor.
Phone: (716) 691-1999.
Circle 1133 on Inquiry Card.

SCSI HOST ADAPTER

The AMM-1572 SCSI Audio Host Adapter ($349) has a SCSI-2-compatible programmed I/O interface that supports synchronous bursts of up to 10 MBps. From Adaptec (Milpitas, CA), the board is SoundBlaster compatible and includes 16-bit audio, a DSP, XA-Audio for enhanced CD-ROM performance, a CD-ROM software cache, and an on-board BIOS that lets you boot from a SCSI hard disk.
Phone: (408) 945-8600.
Circle 1131 on Inquiry Card.

SHORT-RANGE MODEM

A short-range modem that you can operate at distances of up to 2000 feet over UTP wire, the Model 1225 ($65) from Patton Electronics (Gaithersburg, MD) works in pairs. You connect a transmitter unit to your PC's parallel port and a receiver unit to the parallel port of the output device, such as a printer or a fax. Designed to connect parallel devices within a building, the modem accepts data from a PC and sends it serially at data rates of 40 Kbps.
Phone: (301) 975-1000.
Circle 1134 on Inquiry Card.

FAULT-TOLERANT FILE SERVER

The San Francisco 466DS, a 66-MHz 486DX system, contains two completely redundant file servers in one chassis. Each server has 16 MB of RAM on its motherboard (which is upgradable to 256 MB), 1 MB of cache memory, two 500-MB hard drives, and two dual-channel SCSI connectors. Each server also has two modems, five network-interface cards, dual video cards, and two UPSes. The GUI-based MIS Manager software instantly pages or sends a fax to your designated technical-support engineers if either of the servers stops operating. The system ($9999) is from MicroAccess (Fremont, CA).

Phone: (800) 442-2221 or (510) 249-9988.
Circle 1074 on Inquiry Card.

MULTIPURPOSE PERSONAL PLAYER

Mac- and PC-compatible, the Reno Personal CD-ROM Player (from $399) is operable via nickel-cadmium batteries or AC power. The double-speed external drive has a 64-KB memory buffer and a standard SCSI-2 connection. You can use the drive as either a stand-alone audio CD player or a multisession Photo CD player. The unit has data transfer rates of up to 306 KBps and an access speed of less than 180 ms.

Contact: Media Vision, Fremont, CA, (800) 845-5870 or (510) 770-8600.

Circle 1062 on Inquiry Card.

FAXING WITH THE POWERBOOK DUO

The PowerPort/Mercury fax/modem for the PowerBook Duo ($399) is based on the V.32terbo standard, enabling it to transfer data at speeds of up to 19.2 Kbps and send and receive faxes at 14.4 Kbps. The Global Village (Mountain View, CA) unit includes GlobalFax OCR software, which lets you convert incoming faxes into word processing, spreadsheet, or database format and save them anywhere on your desktop or hard disk.

Phone: (800) 736-4821 or (415) 390-8200.

Circle 1136 on Inquiry Card.

POWER MULTIMEDIA ▼

MediaQuad ($5495) from Quadrant Components (Fremont, CA) features 16 MB of RAM (which is upgradable to 32 MB), 256 KB of cache memory, and a 1-GB hard drive. The 66-MHz 486DX system provides CD-quality audio via its Labtec speakers, and full-motion video with a real-time MPEG capture/compression card. MediaQuad includes eight 16-bit AT-bus expansion slots and two 32-bit VL-Bus slots; it also has five drive bays, a built-in fax/modem, and a CD-ROM drive.

Phone: (510) 656-9988.

Circle 1132 on Inquiry Card.

PERSONAL PRINTER

A color-upgradable 24-pin impact dot-matrix printer, the ActionPrinter 3260 ($299) from Epson America (Torrance, CA) has the ability to print up to 270 cps at 15 characters per inch in draft mode. In letter-quality mode, it can print 99 cps at 15 cpi with a noise level of 46.5 dB. The 360- by 360-dpi printer includes 10 built-in fonts, four of which are scalable.

Phone: (800) 289-3776 or (310) 782-0770.

Circle 1137 on Inquiry Card.

FOUR POUNDS OF POWER

The 4-pound Aspen 486 Color Subnote (from $1995) has 4 MB of RAM (expandable to 20 MB), 512 KB of VRAM, a removable 80-MB hard drive that's expandable to 120 MB, and a PCMCIA Type II slot. Its display is an 8-inch 640- by 480-pixel CCFT backlit VGA screen with enhanced passive color. The Aspen Computer (Buffalo, NY) system's expansion features include an AT-bus port for an optional docking station and an external VGA/CRT port.

Phone: (800) 472-3273 or (716) 626-0315.

Circle 1138 on Inquiry Card.

PENTIUM AND THE PCI LOCAL BUS

Micron Computer's (Nampa, ID) Pentium PCI Local Bus systems (from $2799) are designed for advanced graphics and memory-intensive applications. The low-end P60PCI ValueLine CD system features a 60-MHz Pentium processor, a double-speed CD-ROM drive, MPC-2 compliance, 8 MB of RAM (expandable up to 128 MB), 256 KB of 15-ns write-back cache, and a 340-MB hard drive. The PCI graphics accelerator has 2 MB of RAM.

Phone: (208) 465-3434.

Circle 1139 on Inquiry Card.

WATCH TV IN A SCALABLE WINDOW

WatchIt Pro ($595) from New Media Graphics (Billerica, MA) receives and displays live TV in a scalable window on your PC screen in up to 16.7 million colors. Completely self-contained, the board will not slow down other applications. An on-screen remote control lets you select channels and adjust the video. Available for Windows or DOS, the board supports noninterlaced resolutions of up to 1024 by 768 pixels, as well as local-bus and 32,000-color VGA for the rest of your display. With the board, you can grab individual frames of video in PCX, BMP, SVW, and TGA file formats and clips of video and sound under Video for Windows AVI format.

Phone: (508) 663-0666.

Circle 1140 on Inquiry Card.

GRAB IMAGES FOR SCIENCE

The DT55-LC ($695), a scientific-quality square-pixel frame grabber, uses Global Lab Acquire software to capture, save, and print images. The Windows-compatible board captures images from video cameras, VCRs, and still-video devices in real time and saves them in TIFF, PCX, or DT-IRIS format. From Data Translation (Marlborough, MA), the DT55-LC has four on-board input lookup tables. Operations include addition and subtraction of a constant as well as reverse video.

Phone: (800) 525-8528 or (508) 481-3700.

Circle 1141 on Inquiry Card.

A BRIDGE FOR ETHERNET

The LB2 Ethernet Bridge, a local bridge with a forwarding rate of 14,600 packets per second and a filtering rate of 28,000 pps, has

two AUI ports and a serial port for an ASCII terminal that's acting as a local management console. From Lantronix (Irvine, CA), the $1695 unit is compatible with Telnet, DECnet, SNMP, SunNet Manager, and HP OpenView and has configuration utilities for use with AppleTalk and NetWare.

Phone: (714) 453-3990.

Circle 1135 on Inquiry Card.

Introducing Win/TV-Celebrity

Advanced features .. from $349.-

The best overlay/capture board. Period!

The new Win/TV-Celebrity combines the features that multimedia producers and video watchers have been asking for. It supports the video overlay and capture capabilities required by desktop publishers, presentation developers and kiosk builders. Watch television or capture, cut, edit and title your videos. The Win/TV-Celebrity uses a simple external connection, making it the easiest overlay/capture card to install!

Advanced family.

For sophisticated multimedia applications, other Win/TV family members include:

- **Motion JPEG capture** for full frame production-quality video capture (30 fields per sec.) with sound capture for a single slot audio/video editing solution
- **Recordable video output** for making high quality video tapes of your multimedia productions.
- **Multi-video breakout box**, to make professional A/V cabling a snap.

Advanced features no other overlay/capture board can deliver.

The Celebrity is the *only* video capture board with built-in overlay and these advanced features:

- **Full motion video** on VGA monitors up to 1280x1024 with up to 16 million colors
- **Video overlay** for displaying full motion video from VCR or camcorder. And watch TV with the CelebrityN.
- **Easy to install.** No memory size limitations. Celebrity works with all SVGA boards in all graphics modes. No VGA limitations since the Celebrity does not use a feature connector!
- **Fast 320x240 clip capture** with built-in compression.
- **S-Video and 4:2:2 operation** for crystal clear video display and pro-quality 24-bit image captures.
- **Windows and Windows/NT compatible** (OS/2 coming soon).

Low price.

Win/TV-Celebrity is just **$349.-**
Win/TV-CelebrityN with cable ready 122 channel tuner is only **$449.-** The Win/TV family: single slot solutions for your TV viewing, multimedia production, desktop publishing or video kiosk applications. Developers can get our Win/TV Programmers Toolkit so you can add full motion video to your C or Visual Basic applications.

Hauppauge!

Hauppauge Computer Works, Inc.
91 Cabot Court, Hauppauge, NY 11788
Telephone: 516-434-1600 Fax: 516-434-3198
1-800-443-6284
GSA# GS00K92AGS6156 PS01

Available through your local computer dealer or by mail: PC Connection, MicroWarehouse and Misco.

Circle 89 on Inquiry Card (RESELLERS: 90).

STATE-OF-THE-ART WORD PROCESSING FOR UNIX

An object-based word processing program for Unix, Rapport Script combines ease of use for the casual user with sophisticated elements for creating complex documents and presentations. To access functions in Rapport Script's basic mode, you point and click on the control panel; an advanced mode lets you access high-level layout and formatting options. You can create and edit nontext elements, such as spreadsheets, without having to open a new window. You can also use multiple flows on a page, mix portrait and landscape pages, and automatically align paragraphs horizontally. Slide-presentation support includes master slides, slide templates, and a thumbnail view of the slide set. You can drag and drop material that you've prepared in other applications. The FLEX (Facility for Linkage and Extension) feature lets you customize the menus and control panel; it works with standard programming languages and interface tools. A floating license costs $695.

Contact: Clarity Software, Mountain View, CA, (800) 235-6736 or (415) 691-0320.

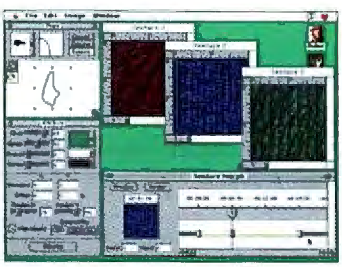
Circle 1271 on Inquiry Card.

CREATE TILEABLE TEXTURES ▼

Specular TextureScape ($195) from Specular International (Amherst, MA) enables you to create high-resolution synthetic textures and images on your Macintosh that you can animate and morph over time. The textures are tileable and can be rendered at any resolution; each texture can contain multiple layers that you can rearrange at any time. Each layer is defined by a grid that lets you tile the shapes and randomize each shape position. Each layer also has as many as four lights; each light has an angle, direction, and intensity setting. Surface settings include gloss, bump, transparency, softness, and color. The software has the ability to write image files as PICT or TIFF and animation files as PICS, numbered PICTs, and QuickTime movies.

Phone: (413) 253-3100.

Circle 1275 on Inquiry Card.



RAID FOR OS/2

With EZRAID for OS/2 ($795) you can create your own OS/2 RAID subsystem using most off-the-shelf drives and drive controllers. Your software-managed disk array can use RAID levels 0, 1, 4, and 5. EZRAID provides seamless compatibility with industry-standard drives and host adapters and supports all the major interfaces, including HIPPI, ESDI, SCSI, and IDE, according to the manufacturer, Pro Engineering (Ottawa, Ontario, Canada). The software includes support for non-SCSI equipment and works transparently with any OS/2 or DOS/Windows application.

Phone: (613) 738-3864.

Circle 1276 on Inquiry Card.

NEW LIFE FOR YOUR RAM DISK

Designed to make file access faster and extend the battery life of Mac PowerBooks, Atticus RAMDiskSaver ($69.95) makes scheduled automatic backups of your installed RAM disk. From Atticus Software (Stamford, CT), the utility lets you shut down your PowerBook without losing files stored on your RAM disk; file synchronization automatically maintains identical copies of files on the hard disk and the RAM disk. With the disk saver installed, you can use the RAM disk as a start-up disk.

Phone: (203) 348-6100.

Circle 1278 on Inquiry Card.

ELECTRONIC PUBLISHING

The graphical interface of the NeoBook electronic publishing package (from $45) consists of a tool palette and a command bar. To create a publication, you draw frames to contain your text and images; you then add command buttons that let the reader turn pages, exhibit additional information, and pop up comic book–style speech balloons. Tools are provided that allow you to add other graphical elements, which you can display on one page or over many pages. From NeoSoft (formerly OSCS Software Development, Bend, OR), NeoBook links to existing text editors and paint programs.

Phone: (800) 545-1392 or (503) 389-5489.

Circle 1279 on Inquiry Card.

GATHER INFORMATION IN REAL TIME

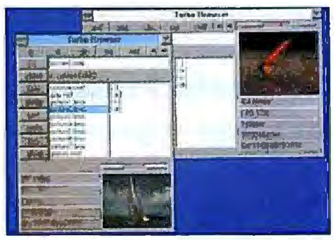
A Unix server for rapid storage and retrieval of time-critical transaction data, TickBase (from $500 per end user) allows you to rapidly access, review, and analyze vast amounts of real-time information. Initially targeted toward users of real-time financial data, TickBase also supports most other data sources. From Leading Market Technologies (Cambridge, MA), TickBase stores the "tick" data in real time and builds a central, shareable reservoir of tick-data history. You can set filters to trap bad data and specify optional time frequencies with which to normalize or reduce captured data as it is stored. Multiple simultaneous queries and data captures are supported; an open API lets you interface to your own data-analysis and calculation program.

Phone: (617) 494-4747.

Circle 1280 on Inquiry Card.

QUICK PREVIEW BROWSING

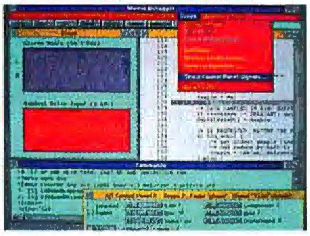
A preview and file manager for Windows, Turbo Browser ($69) automatically previews thumbnail video and animation clips, graphical images, and sound bites



along with a tabulation of associated file data. You can copy and delete files, save files in different formats, and print them with an audiovisual association. You can convert bit-mapped files and file-compression options to different file formats and link the files directly to an associated editor or program. Turbo Browser supports multimedia file formats, such as AVI, FLC, FLI, MID, and WAV, and most image file formats, as well as a full range of color. The package is from Pacific Gold Coast (Glen Cove, NY).

Phone: (516) 759-3011.

Circle 1277 on Inquiry Card.



TOOLKIT FOR MWAVE

Intermetrics' (Cambridge, MA) Mwave Developers Toolkit ($495) provides a link for building multimedia applications for IBM's Mwave technology. You can write Windows-based applications and incorporate capabilities such as voice, audio, fax, modem, telephony, and images. You can add or enhance Mwave system capabilities using the MDK's C development tools to program the Mwave technology platform's DSP. The Mwave Developers Toolkit includes APIs, tools, and sample code.
Phone: (800) 356-3594 or (617) 661-1840.
Circle 1281 on Inquiry Card.

VISUAL NETWORK MANAGEMENT

LANtastic Management Services software (from $199) provides basic visual monitoring of a network from a Windows-based platform. The Artisoft (Tucson, AZ) software graphically displays information about an entire network, enabling administrators to view how the network is performing at any given time. Features include node discovery, preset alarms, trouble reports, and icons that let the administrator organize the network into a virtually unlimited hierarchical schematic. The advanced version adds inventory management, which runs automatically when users start up the network; user-definable alarms and data gathering; and DDE support.
Phone: (602) 670-7100.
Circle 1282 on Inquiry Card.

CLIP-ART MANAGER

Corel Gallery ($129) contains a collection of 10,000 clip-art images that you can drag and drop into any OLE-compatible application. From Corel (Ottawa, Ontario, Canada), the package lets you export images to a variety of standard file formats. Compatible programs include Word for Windows, WordPerfect for Windows, Ami Pro, Microsoft Publisher, and Harvard Graphics for Windows.
Phone: (613) 728-8200.
Circle 1283 on Inquiry Card.

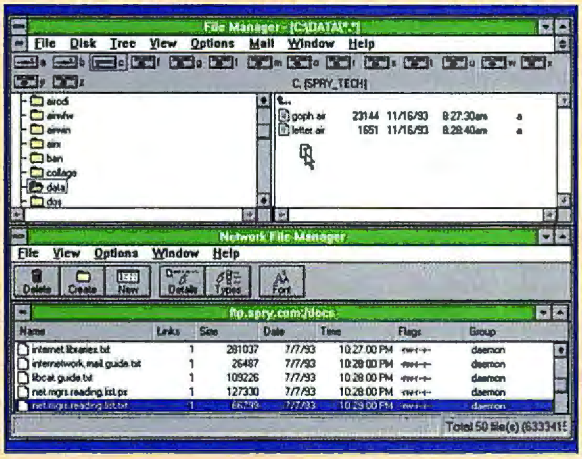
PROACTIVE TIME MANAGEMENT

A time management program for long- and short-term planning, First Things First Proactive ($149) helps you define priorities and goals and then determine the daily path to achieving them. The Macintosh program, from Visionary Software (Portland, OR), consists of five integrated modules: an outliner, a calendar, reminders, a linker of calendars or task lists, and a means to attach related files to an item and then launch them from an outline, calendar, or reminder.
Phone: (503) 246-6200.
Circle 1284 on Inquiry Card.

3-D ANIMATION SAVES SCREENS

A Windows screen saver from Forté (Carlsbad, CA), 3DPC ($19.99) combines photo-realistic, 3-D animation with surrealism. The animation includes visual effects such as morphing, texture mapping, 3-D imaging, montages, video fusion, opacity mapping, and virtual reality.
Phone: (619) 431-6400.
Circle 1297 on Inquiry Card.

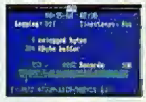
TRAVEL THE INFORMATION HIGHWAY ON YOUR PC



Developed jointly by Spry and O'Reilly & Associates, Internet-In-A-Box lets you easily access the Internet from your PC. Spry's graphical network applications provide FTP, Telnet, Gopher, mail, news, WAIS, and Mosaic to let you access O'Reilly's Global Network Navigator as well as other Internet applications. The point-and-click tools are virtually transparent, according to Spry. In addition to Spry's TCP/IP applications, the package includes O'Reilly's The Whole Internet User's Guide and Catalog. NovX InterServ provides TCP/IP-based Internet services via SprintLink toll-free data services. The single-user version costs $100; the LAN version is $250. A Mac version is in the works.
Contact: Spry, Inc., Seattle, WA, (800) 777-9638 or (206) 447-0300.
Circle 1272 on Inquiry Card.

Software Update

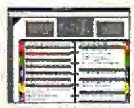
MicroTap 3.0, Paladin Software (San Diego, CA), adds EGA/VGA font maps with an integrated font-map editor, a Hypertext reader with direct links to program-setup fields, expanded log capacity to 64 MB, and PostScript file exportation. $349.



Phone: (619) 490-0368.
Circle 1298 on Inquiry Card.

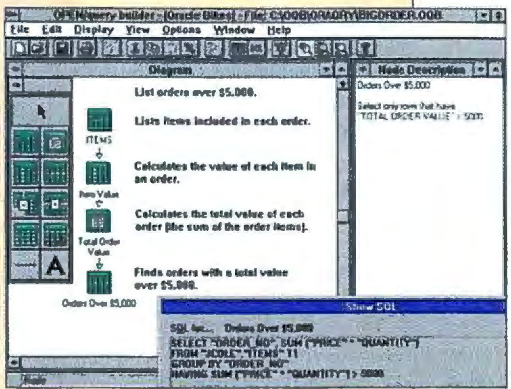
TeamOffice 3.0, TeamWare Division, ICL (Santa Clara, CA), integrates seamlessly with your existing Windows applications via TeamFlow, supports Windows NT, adds a Windows interface for asynchronous dial-up client connection, provides forum support for X.400 addresses for senders external to TeamOffice, and supports Windows for Workgroups Microsoft Mail clients using a TeamOffice back end. $495 per user for 10-user starter license.
Phone: (800) 240-8326 or (408) 982-9141.
Circle 1299 on Inquiry Card.

Calendar Manager 5.0, Russell Information Sciences (Laguna Hills, CA), lets you more easily schedule meetings and send messages to meeting schedulers; create to-do lists; and view and select Calendar Manager users, resources, and facilities across all enterprise servers. It also includes a Windows client GUI and has an optional Executive Desktop that lets you use the software as a personal appointment book and scheduler in diary format. $60 to $300 per seat; first server, $995; subsequent servers discounted.



Phone: (714) 362-4000.
Circle 1300 on Inquiry Card.

INTUITIVE QUERIES



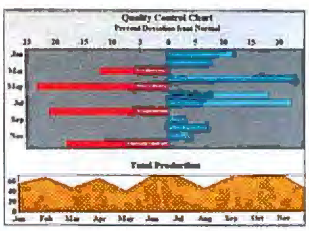
An intuitive client/server, decision-support, and data-retrieval tool, Open/query builder helps you access databases such as dBase, SQL Server, Sybase, and Oracle via ODBC. The software's graphical step-by-step approach lets you develop ad hoc queries by pointing and clicking on icons; at each step, the software prompts you for the required information. Each step is automatically documented, letting you modify, maintain, reuse, and share the results as well as the query diagram. The program costs $395.

Contact: Wang Laboratories, Lowell, MA, (800) 421-8006 or (508) 459-5000.

Circle 1273 on Inquiry Card.

FLIP THROUGH GRAPHICS IN FOXPRO

Flipper for FoxPro ($349) is a graphics library that simplifies adding charts and drawings to FoxPro for Windows programs. From ProWorks (Hermiston, OR), the software is an FLL (FoxPro DLL), which lets you use it directly from the command Window or from a FoxPro executable program. Flipper for FoxPro can display data in 2-D or 3-D and permits multiple graph types on one screen and unlimited graphs on a page. You can rotate 3-D charts to any angle or elevation and reverse *x* and



y axes on 2-D charts. The program also includes automatic axis scaling and permits two independent *y* axes. Low-level drawing functions are also available.

Phone: (503) 567-1459.

Circle 1285 on Inquiry Card.

REAL-TIME BACKUP FOR NT

Real-time backup and recovery software for Windows NT, Octopus (from $3975) protects against loss of data from problems such as electrical failure and accidental human interference. From P&W Technologies (Washington Crossing, PA), Octopus is based on electronic vaulting technology. All transactions on one computer system are automatically shadowed on another. In the event of a system failure, Octopus immediately notifies the user and begins to log the unsent file activity; recovery and restart are automatic. The one-to-many and many-to-one data-recovery system can be LAN- or WAN-based.

Phone: (215) 321-2250.

Circle 1286 on Inquiry Card.

IMPROVE YOUR WINDOWS DISPLAY

DisplayMate for Windows ($79 until May 31; $129 thereafter) improves monitor picture quality by improving sharpness and contrast, reducing certain forms of geometric distortion, minimizing or eliminating moiré patterns, and improving color and gray-scale accuracy. The Sonera Technologies (Rumson, NJ) software provides step-by-step advice on how to obtain optimum picture quality from your monitor and video board. It supports all color modes, from monochrome up through full 24-bit color.

Phone: (800) 932-6323 or (908) 747-6886.

Circle 1287 on Inquiry Card.

LISTEN TO YOUR E-MAIL

The eNote for cc:Mail package ($49), a front end to cc:Mail, lets you filter important mail messages and route them directly to the screen. From the E Ware division of Visual Cybernetics (New York, NY), the program uses cc:Mail's filtering ability so that you can screen messages by user name, priority, or subject. When both the sender and the recipient are using eNote for cc:Mail, eNote-specific data, such as sound and voice files, can be attached to the message. With the text-to-speech feature, you can tell the software to read your eNote messages aloud.

Phone: (800) 743-8645 or (212) 564-7791.

Circle 1288 on Inquiry Card.

SCANNING IN UNIX

The PixelScan plug-in module for Adobe Photoshop 2.5 ($499 until June 30; $799 thereafter) enables you to connect to scanners from most major companies while using Silicon Graphics and Sun versions of Photoshop. From Mentalix (Plano, TX), the module lets you scan all types of images and adjust and reposition an image or a portion of it; you can also control image attributes, such as contrast, intensity, and gamma, before you start scanning.

Phone: (214) 423-9377.

Circle 1289 on Inquiry Card.

Software Update

Conversion Artist 2.0, North Coast Software (Barrington, NH), supports Photoshop CMYK TIFF files and features for image color correction, stylized filters, and color separation. It also adds image editing, JPEG image compression, and a JPEG-based viewer and self-extractor. $149.95.

Phone: (603) 664-6000.

Circle 1301 on Inquiry Card.

MacFortran II 3.3, Absoft (Rochester Hills, MI), includes a full-screen source-level symbolic debugger; improved support for the 68040 CPU; MIG, a graphics library integrated with the company's Macintosh Runtime Window Environment; a software FPU; and a software emulator for machines without a math coprocessor. $595.

Phone: (313) 853-0050.

Circle 1302 on Inquiry Card.

TeleFinder 3.2, Spider Island Software (Irvine, CA), lets you view GIF files while online and automatically decompress and view graphics files while downloading them. It also has built-in drivers for V.Fast modems and supports Internet Mail access. $425.

Phone: (714) 669-9260.

Circle 1303 on Inquiry Card.

Progress 7, Progress Software (Bedford, MA), adds graphical and event-driven extensions to the 4GL and enhances the DataServer Architecture and the RDBMS. From $1400.

Phone: (617) 280-4000.

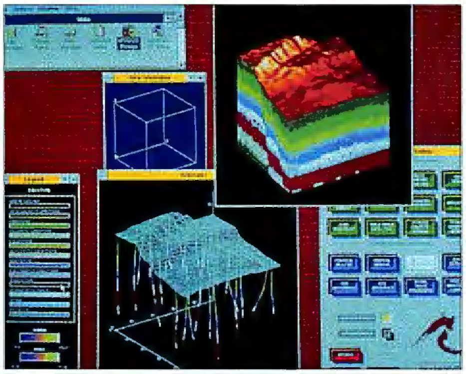
Circle 1304 on Inquiry Card.

Koyn Fractal Studio 2.0, Koyn Software (St. Louis, MO), adds color, an easy-to-use

graphical editor, high-resolution rendering capability, templates, and floating-point coprocessor support. Single-user version, $149.95.

Phone: (314) 878-9125.

Circle 1305 on Inquiry Card.



VISUAL DATA ANALYSIS ▲

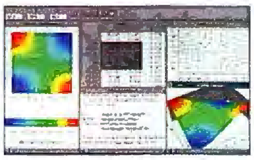
PV-Wave Personal Edition ($695), a native 32-bit application for Windows, lets you visually analyze large amounts of complex data. You can use the Visual Numerics (Boulder, CO) software to interactively explore, manipulate, analyze, and present large amounts of data quickly. Features include integrated 2-D and 3-D graphics; surface and vector plot types; image and signal processing; and support for time-series data.
Phone: (303) 530-9000.
Circle 1291 on Inquiry Card.

ERROR-LOG MONITORING

The LANStor RedAlert network management utility ($295) has the ability to proactively monitor NetWare error-log events and automatically distribute the information via a twenty-fifth line console, a pager, a workstation broadcast, cc:Fax, or cc:Mail. From Storage Dimensions (Milpitas, CA), the LANStor RedAlert utility collects and reports error information originating from any vendor-independent server, software, or peripheral that reports to the NetWare error log, according to the company. The software includes queue management and lets you customize reporting options for specific personnel.
Phone: (408) 954-0710.
Circle 1292 on Inquiry Card.

DATA ANALYSIS FOR WINDOWS ▼

Spyglass Transform ($595) has expanded to Windows and Windows NT. The visual data-analysis tool enables you to quickly analyze large matrix and image data sets. You can use the Spyglass (Savoy, IL) point-and-click options to create surface plots, color raster images, line graphs, contour plots, and vector plots from matrix data arrays. You can import data sets from ASCII spreadsheets or binary data files and add floating-point annotations, titles, axis labels, numerical scales, tick marks, and color bars.



Phone: (217) 355-6000.
Circle 1290 on Inquiry Card.

NEURAL OCR SCANNING

CharacterEyes OCR software ($695), from Ligature Software (Burlington, MA), uses advanced neural network technology to let you capture text at up to 300 characters per second with a recognition accuracy of up to 99.6 percent. You scan a document with a single click of a mouse button; the software then analyzes the page layout and recognizes and captures the text, which you can export directly into your word processor. CharacterEyes supports obscure typefaces and can read faxes, small typefaces, dot-matrix text, and degraded documents. Available for Windows and the Mac, the software runs in 32-bit mode and incorporates Hewlett-Packard's AccuPage scanning technology.
Phone: (800) 888-0060 or (617) 238-6734.
Circle 1293 on Inquiry Card.

.INI FILE CONTROL

A Windows .INI file editor, iniExpert ($34.95) has a comprehensive on-line reference. From Chattahoochee Software (Atlanta, GA), iniExpert helps you to fine-tune your .INI files by speeding up performance, avoiding system crashes, changing hardware drivers, and customizing the look and feel of Windows. By using the menu-driven interface, you can turn entries on and off without removing them.
Phone: (404) 633-3872.
Circle 1294 on Inquiry Card.

INTERACTIVE DOCUMENT CONFERENCING

Based on Unix and X Window System 11, Sietec's jointX is an independent component placed between an X server and an X client to permit interactive document conferences composed of participants in different locations. Changes made by any participant are instantly shown on the terminals of all other participants, according to the company. The package allows any TCP/IP network connection.

Three basic components make up jointX: The sharing component distributes the X events, the coordination component structures communication, and the administration component controls document access and security. The audio and video components of jointX are integrated into the system via the conference control process and run on the user's computer rather than on the conference server. Cost for the package starts at 7000 deutsche marks.

Contact: Sietec GmbH, Berlin, Germany, +49 30 386 28244; fax +49 30 386 23780.
Circle 1274 on Inquiry Card.

Software Update

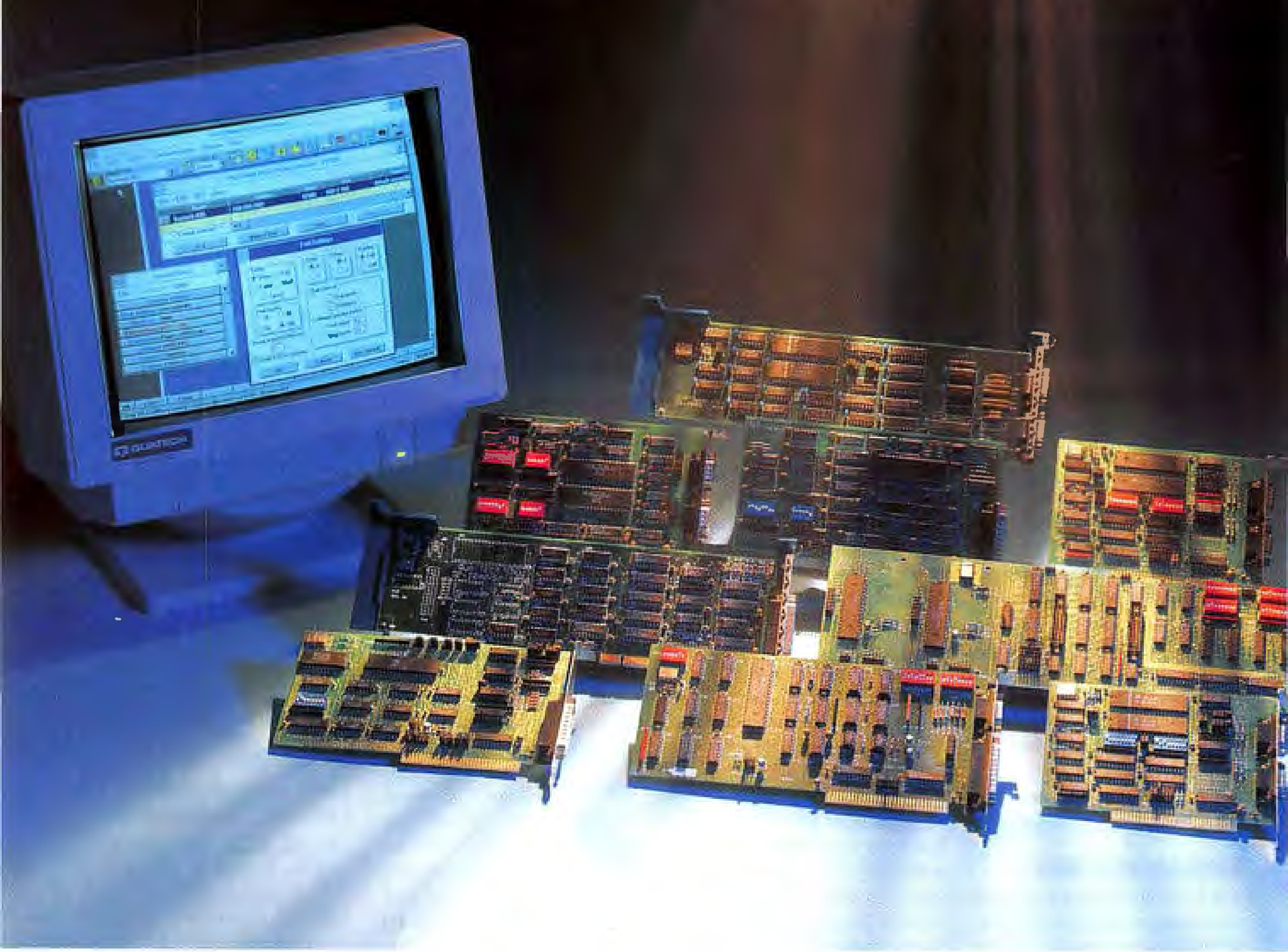
PixelFX 2.5, Mentalix (Plano, TX), adds user-transparent links to FrameMaker and Interleaf programs; supports additional input, output, and image-compression file formats; enhances OCR capabilities; supports additional Unix operating systems; integrates with the ER Mapper earth-science image-processing application; and expands scanner support. $1599.
Phone: (214) 423-9377.
Circle 1306 on Inquiry Card.

Forest & Trees 3.1, Trinzic (Palo Alto, CA), includes the ability to call external DLLs; adds four database interfaces; enhances the reporting feature so you can add pictures, business graphics, and color to reports; adds a "drill down" capability to get to the appropriate level of graphical or numerical detail; expands its graphical data-analysis capabilities; and increases user-interface options. $695.
Phone: (603) 427-0444.
Circle 1307 on Inquiry Card.

Remotely Possible/LAN and Dial 4.0, Avalan Technology (Holliston, MA), includes DOS and Windows in one package, supports full-screen DOS and data transfer speeds of up to 230.4 Kbps, adds DES encryption security, supports more than 150 modems and asynchronous modem pooling, and adds remote keyboard- and screen-disabling capability and printer redirection. $199.
Phone: (508) 429-6482.
Circle 1308 on Inquiry Card.

MetaCard 3.1, MetaCard (Boulder, CO), can import and run stacks developed in HyperCard 1.2.5 and 2.1, supports object-oriented graphics and the import and display of PostScript EPS graphics, plays back FLI/FLC format animation, and adds functions for spawning and managing external processes. $495.
Phone: (303) 447-3936.
Circle 1310 on Inquiry Card.

Quatech, your communication source for RS-232, 422 and 485 adapters.



Quatech manufactures a complete line of communication adapters for PC/XT/AT®, Micro Channel® and compatible buses to meet asynchronous and synchronous, serial and parallel communication requirements with protocols such as RS-232, RS-422, RS-485, Current Loop and IEEE488.

Software support for SCO Unix®, Windows®, Xenix®, OS/2® and DOS.

Data Acquisition and Industrial I/O products manufactured by Quatech are also available. Call for a free Data Acquisition and Communication Handbook today.

Communication adapters featuring: selectable/shareable interrupts, 16550 availability (baud rates up to 256K on standard asynchronous adapters) and address configurable as any COM port. Multiport adapters feature 2, 4, and 8 ports with independent serial interfaces. Most adapters provide AT interrupts (IRQ 2-7, 10-12, 14, 15).

Technical support for our products are available free of charge.

800-553-1170

FAX: 216-434-1409

BBS: 216-434-2481

QUATECH

662 Wolf Ledges Parkway, Akron, Ohio 44311 U.S.A. (216) 434-3154. International: Australia/Interworld Electronics 03-563-5011, Canada (Western)/Interworld VCR 604-984-4171 (Toronto office 905-513-7027), Denmark/Jes Rasmussen Aps. 45 4281 6838, England/ Diamond Point International 634-722-390, Finland/Lab Hitech OY 358-0-682-1255, France/ Elexo 33-1-69302880, Germany/ Jupiter Electronic Systems 06181/75041, Israel/RCM Ltd. 972-03-6487885, Italy/N.C.S. Computer Italia 03311 770-016, Korea/Sam Boo Enterprise Co. 82-2-135-280, Netherlands/ACAL Auriema 040-502602, Saudi Arabia/Integrated Computer Operations 966 3 895 1827, Singapore/ Bliss Services Pte Ltd (65) 338-1300, South Africa/Eagle Electronics 27 21 234943, Spain/ SANTA Barbara SA 343-4188116, Sweden/ SYSTEC 46 13 1101 40. IBM PC-XT, AT, and Micro Channel are registered trademarks of IBM Corp. All other trademarks are of their respective companies.

Made in U.S.A.

Circle 125 on Inquiry Card.

BYTE BUYER'S GUIDE

BUY IT THROUGH BYTE

Mail Order

The latest offerings from vendors supplying products of all leading manufacturers at extremely competitive prices.

262

Hardware/Software Showcase

This *categorized* four-color display section makes it easy to find Hardware and Software products from a wide variety of manufacturers and suppliers.

288

Buyer's Mart

From Accessories to Laptops to Word Processors, you can easily find the dealers you are looking for in this directory of products and services.

296

& MUCH MORE . . .

MONEY BACK 30 DAY GUARANTEE

MULTIMEDIA SPECIALS!

$161

MEDIA VISION

With the award winning ProAudio Studio 16 acheive extraordinary stereo sound. Featuring high performance SCSI CD-ROM interface, 16 bit PC interface & 20 voice synthesizer. Includes voice recognition, sound editor, custom microphone and much more!

- Media Vision Pro Audio Spectrum Basic $99
- Media Vision Pro Audio Spectrum 16 .... $129
- Media Vision Pro Audio Studio 16 .... $161

SOUND CARDS

Creative Labs

- Sound Blaster Deluxe $75
- Sound Blaster Pro Deluxe $89
- Sound Blaster 16 Basic Addition $139
- Sound Blaster 16 Multi CD $166
- Sound Blaster 16 SCSI-2 .... $191
- Sound Blaster 16 Multi CD with ASP $204
- Sound Blaster 16 SCSI-2 with ASP $219

MULTIMEDIA KITS

Creative Labs

- Creative Labs Discovery 8 -bit, Internal $379
- Creative Labs Discovery 16- bit, Internal $439
- Creative Labs Edutainment 16 -bit, Internal $508
- Creative Labs Digital Edge CD, Internal $669

Media Vision

- Media Vision Double Fusion LX, Internal $379
- Media Vision Double Fusion CD16, Internal $499
- Media Vision Pro16 Multimedia SYS II, Internal $519
- Media Vision Pro16 Multimedia SYS III, Internal $779

MEGAHERTZ

Of All The PCMCIA Modems For Your Notebook,

One Really Sticks Out.

Megahertz
Linking Your Worlds

PCMCIA 2.0 Data/Fax with XJACK

- 14,400bps FAX/Modem $299
- 24/9600bps FAX/Modem $179

HOT DEAL

Pocket Modems for any serial port

- 14,400bps FAX/Modem $239
- 96/9600bps FAX/Modem $219

VIDEO CARDS

Diamond

- Stealth Pro 1MB $259
- Stealth Pro 2MB $349
- Stealth Pro VLB 1MB $259
- Stealth Pro VLB 2MB $359
- Viper VLB 2MB $399
- Stealth 24 1MB $169

ATI

- Graphics Ultra Plus 2MB $239
- Graphics Ultra Pro 2MB $359

CHINON

CHINON 535 CD-ROM DRIVES

Dual Speed, Multisession - A Multimedia Workhorse!

- Exceeds MPC2 and QuickTime standards
- Multisession Photo CD compatible
- 220ms average access time
- Double-speed 300K/sec. data transfer rate
- Features a 256K data buffer

- CDS-535 Internal with caddy w/o controller $349
- CDX-535 External with caddy w/o controller $469
- CDS-535 Internal with caddy, controller & cable .. $389
- CDX-535 External with caddy, controller & cable . $509

HERCULES

AWARD-WINNING SPEED COMBINED WITH HIGH RESOLUTION AND TRUE COLOR!

These VRAM-based boards for ISA AND VL-bus computers support ultra-high refresh rates making extended work sessions more comfortable.

- Graphite Pro ISA or VL 1MB $249
- Graphite Pro ISA or VL 2MB $379

Fast DOS - Fast Windows - Runs Everything!

For ISA and VL-bus computers. Screaming fast Windows performance and complete compatibility with all ET4000 drivers. 1MB, upgradeble or 2MB DRAM models.

- Dynamite Pro ISA or VL 1MB $159
- Dynamite Pro ISA or VL 2MB $199

FAX/MODEMS

USRobotics
The Intelligent Choice in Data Communications

- Sportster 14,400 fax, External $173
- Sportster 14,400 fax, Internal $156
- Courier V.32 turbo fax with ASL, External $404
- Courier V.32 turbo fax with ASL, Internal $365
- Courier V.32 turbo with ASL, External $385
- Courier V.32 turbo with ASL, Internal $345

HOT DEAL

BOCA RESEARCH INC

PC MAGAZINE EDITORS' CHOICE

External 14,400bps data, 14,400 send and recieve fax. V.32, V.32bis, V.42bis, MNP5 protocol, throughput to 57,600bps. Includes communications software for DOS and Windows! $169

PRINTER ACCESSORIES

Pacific Data Products

- PacificPage 4 HPLJ 4 .... $269
- PacificPage PE $279
- PacificPage PE/XL includes 4 MB IIP, III, IIID, IIIP $769
- Pacific DirectNet (512K) $339
- Pacific Connect XI (256k) 5 ports II, IID, III, IIID $329
- Pacific Connect XI (256k) 7 ports IIISi, 4 .... $489
- 25 in One! $259

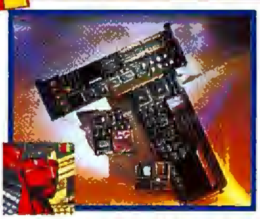
ADI

"Mainstream Choices!"

MicroScan/ADI

- MicroScan 3E+, 14", 0.28mm, 1024x768 NI @ 72Hz Microprocessor-based digital controls, 30K - 60KHz $349
- MicroScan 4G, 15" FST, 0.28mm, 1280x1024 NI @ 60Hz Microprocessor-based digital controls, 30K - 64KHz $429
- MicroScan 5A, 17" FST, 0.26mm, 1280x1024 NI @ 60Hz Microprocessor-based digital controls, 30K - 64KHz $819

KINGSTON



UPGRADE YOUR 286 TO A 386 OR 486!

SX/Now! 386 CPU upgrade

- 25MHz (SX) .... $169 / 33MHz (SX) $199

SLC/Now! 386 or 486 CPU upgrade

- 25MHz (SLC) .... $219 / 50MHz (SLC) $299

486/Now! 486 CPU upgrade

- 25MHz (SX) .... $399 / 33MHz (DX) $579

MCMaster 486 CPU and up to 64MB or RAM

- 25MHz (SX) 0MB .... $699 / With 4MB add $181
- 33MHz (DX) 0MB .... $959 / With 8MB add $354

HARD DRIVES

Seagate

- 106MB ST3120A, 15ms, 1H, 3.5" IDE $189
- with 16-bit kit $209
- 130MB ST3144A, 15ms, 1H, 3.5" IDE $199
- with 16-bit kit $219
- 260MB ST3290A, 16ms, 1H, 3.5" IDE $279
- with 16-bit kit $299
- 1420MB ST41650N, 15ms, FH, 5.25" SCSI $1899
- with 16-bit kit $2049

PROCESSORS

Intel Math Coprocessors

- 80387SX 16, 20, 25MHz $85
- 80387DX 16, 20, 25, 33MHz $89
- 80387SL Mobile 16, 20, 25MHz $85

Intel OverDrive Processors

- 486SX20 with socket $325
- 486SX25 with socket $438
- 486DX25 without socket $439
- 486DX33 without socket $554
- 486DX33 or 486SX33 with socket $555

Cyrix

- Cx486DRx²-16/32 .... $269
- Cx486DRx²-20/40 .... $319
- Cx486DRx²-25/50 .... $369
- Cx486SRx²-16/32 .... $269
- Cx486SRx²-20/40 .... $369

MONITORS

Hitachi

- SuperScan 15, 1024x768 NI @ 70Hz, .28mm $469
- SuperScan 17, FST, 1280x1024 NI @ 60Hz, .28mm $969
- SuperScan 20s, FST, 1280x1024 NI @ 60Hz, .31mm $1429

ADI

- MicroScan 2E, 14" .28 dot pitch, 1024x768 NI $289
- NEW MicroScan 3E+, 14" .28 dot pitch, 1024x768 NI @ 72 Hz .. $349
- MicroScan 3G, 14" .28dot pitch, Hi-res. RGB color adjust $349
- MicroScan 4G, 15" .28 dot pitch, Flat, Hi-res monitor $429
- MicroScan 5A, 17" .26dot pitch, Flat, Hi-res, mon. degauss . $819

WE SET THE STANDARD:

- MEMORY GUARANTEED - 100% COMPATIBLE IN FORM, FIT, AND FUNCTION
- ALL PRODUCTS USER INSTALLABLE
- INSTALLATION INSTRUCTIONS INCLUDED WITH MOST MEMORY PRODUCTS
- FREE TECHNICAL SUPPORT
- THOUSANDS OF ITEMS IN STOCK
- CORPORATE PO'S, APO/FPO'S WELCOME
- GOVERNMENT AND EDUCATIONAL PRICING
- INTERNATIONAL ORDERS WELCOME
- SPECIAL VOLUME PRICING
- OVERNIGHT DELIVERY AVAILABLE
- NO SURCHARGE ON CREDIT CARDS

DON'T SETTLE FOR LESS!

CALL FOR ANY MEMORY UPGRADE NOT LISTED

WE STOCK MEMORY UPGRADES FOR THOUSANDS OF COMPUTERS AND PRINTERS

TOLL FREE FROM THE US OR CANADA
800-459-9866

INTERNATIONAL ORDERS
714-448-7750

FAX ORDERS
714-448-7760

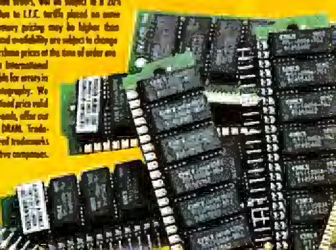
BUSINESS HOURS:
Monday - Friday, 8am-5pm, P.S.T.
Saturday, 9am-3pm, *(Orders Only Please)*

The Only Source
First SOURCE International
For Computer Hardware & Software

MAIL OR FAX ORDERS TO:

First Source International, Inc.
7 Journey
Aliso Viejo, CA 92656

Terms and Conditions: Memory products are third party, manufacturer's numbers are for your convenience. Freight charges are non-refundable. All opened software products are non-returnable. An RMA number is required for all returns. All non-defective returns, exchanged, refused, or cancelled orders, will be subject to a 20% restocking fee. Due to I.T.C. tariffs placed on some manufacturers, memory pricing may be higher than advertised. Prices and availability are subject to change without notice. Purchase prices at the time of order are final. First Source International cannot be responsible for errors in typography or photography. We will beat any advertised price valid only on identical brands, offer not good for SIMMs or DRAM. Trademarks and registered trademarks are of their respective companies.



▸ 800-459-9866 ◂

HIGH PERFORMANCE

19" Rack Mount Super Server

Rack Mount Chassis

300 WATT Power Supply
Extra Fan & Filter
(3) Front Drive Bay Openings

Starting from **$450**

Rack Mount Monitors

14" .28 Super VGA color (NI)
Rear CRT cover
Optional Touch Screen
17" & 20" models available

$785

Rack Mount Disk Array

- Hot Plug Pwr Supply
- Hot Plug Drives
- Each Drive has own Power supply
- Fault Tolerant
- Diagnostic LEDS
- Audible Alarms
- Variable Speed Fans

The MEGA TOWER

- Dimensions: 25.5" (H) x 11" (W) x 17.5" (D)
- 2 color options: Black, 2-Tone Beige
- Lockable Doors
- 3 Cooling Fans
- Room for 14 Slots
- 12 Drive Bays
- 4 lockable wheels
- Slide-in Drive Rails

Rapid RAID™ Super Servers

- Easy to Configure
- Fault Tolerant
- Hot Swap Power Supply
- Hot Swap Drives
- Drives have their own power supplies
- Up to 70 high capacity removable drives.

486-66/80 MHz

486-33 - $ 998
486-50 - $1160
486-66 - $1283
486-80+ - CALL
Pentium - CALL

System Includes:

- Intel 486 CPU Upgradeable to Pentium based processor with Intel Pentium Overdrive ready ZIF socket.
- Programable Flash EPROM (optional).
- Easy to configure frequency synthesizer.
- 256K Cache (Exp. To 1 meg)
- Five 16-bit Expansion Slots
- Three VL Bus / 32 bit slots
- 4MB RAM(Upgradable to 128MB)
- IDE HD/FD Controller with 2s/1p/1g
- 1.2MB or 1.44MB Floppy Drives
- 101 Enhanced NMB Keyboard
- 7 Bay Mighty Tower (Beige or Black)
- 2 Low Noise Cooling Fans with filters
- 300W UL CSA Power Supply
- Black Mouse/KB/Monitor Options

Video Options
ATI,STB Wind\X, Diamond Viper, 2 The Max Hi Color, Number 9, Metheus, Matrox

Monitor Options
Sampo, Nec, Idek, Hitachi, ViewSonic, CTX, MAG, KFC

Hard Drive Options 120 Meg to 70.0 Gig
Conner, Fujitsu, Maxtor, Micropolis, Seagate, Quantum, Hewlett Packard, Western Digital. Call about CD-ROM and optical drives

486 EISA System

CCSI 486-33-$1198
CCSI 486-50-$1374
CCSI 486-66-$1497

Call for AMI Pricing!

Configured As Above 256K Cache On MB, 8 EISA and 1 VLB Slots

Complete Interactive Kiosks

- Point of Purchase Displays
- Demonstration Console
- Data Collections Terminal
- Training Center

5 Models Available!

Features Include:
Touchscreen monitors (14" & 17") - 19" Rack Base Unit - Stylish & Modular Design - Credit Card Reader - Telephone / Videophone - Printers - Custom Programming

Digital Video Editing

CCSI Video Blender™ Series

- 30 fps Frame Capture Full Screen!
- Editing Software Included
- Complete Non-Linear Solution!
- Text and Graphic Overlay
- Full Array of Transistion Effects!
- Capture Video up to 16.7 Million Colors!
- Supports all video Standards!

Less than $1000

High Performance Multimedia

- Sound Blaster 16 Discovery CD Kit w/Dual Speed CD ROM & 5 titles
- CANON RC-360 & RC-570 Cameras
- SLIDE SCANNERS
- DIGITAL FILM RECORDERS by Polaroid
- BRAVO Slide Maker by Polaroid -
- UMAX 24-bit 600-1200 DPI Color Scanners
- COLOR POINT CH4104 6MB RAM A-Size
- HITACHI Video Printers
- MITSUMI CD ROM (FAST 340MS access)
- PANASONIC CR562 (320/300KB)
- TOSHIBA XM3401 (200MS/327KB transfer)
- Sony & JVC CD-ROM Recorders
- PROMOTION Real Time Frame Grabber
- TARGA Boards 16 and 32+
- MATROX multimedia products
- ALDJS PHOTOSTYLER
- Image Q Multimedia Software
- MULTIMEDIA EXPLORER for Windows
- ANIMATOR PRO
- 3-D STUDIO (with systems only)
- TV Bridge Professional (VGA-NTSC)
- TV Bridge External (Ext. VGA-NTSC)
- JVC HiRes CamCorder (410,000 Pixels)
- ShadowPro Image database software

Call For Pricing

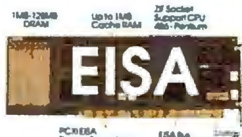
THE DOMINATOR

The Mother of all Boards!

- Up to 256 MB RAM onboard
- Up to 512K write-back CACHE
- 12 32-BIT EISA Slots, with 8 Bus master slots
- Supports 486-33, 50, or DX/2 66
- Made in USA

EISA Bus 486/P24T CPU Card

The Ultimate Single Board Computer
(ISA and PC/104 Versions also available)



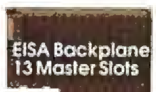
- 32 Bit EISA / Pentium Ready
- Up to 128 Meg RAM / 1 Meg cache memory
- Compatible with PCXI EISA Backplane Standard
- Reliable design is ideal for industrial applications

EISA Bus 14 Slot Backplane

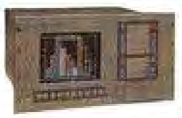
Supports EISA and PCXI Standard cards

ISA Bus 4-20 Slot Backplanes

4, 5, 6, 8, 12, 14, 18, & 20 slot configurations.
Segmented versions also available.



19" Rack Color Workstations



- Easy access to boards, power supply, and disk drives
- Holds up to 7 full length boards
- Cooling fan controls operating temperature of boards
- Built in membrane keyboard and keypads / external keyboard port

"Power Lunch" Cases Start From $849

For demanding TechnoWizards on the go!

386 and 486 EISA, ISA, or VL MotherBoards Available

6 Expansion Slots
3 Drive Bays
LCD & Gas Plasma Cases Available

Color LCD and Color Portable Systems NOW AVAILABLE!

Computer & Control Solutions Inc.

TEL : (404)491-1131
FAX : (404)493-7033
1510 Stone Ridge Dr.
Stone Mountain, GA 30083

Call: 1-800-775-3525

Major credit cards accepted. Personal & corporate leasing available. All prices reflect cash discount. Fortune 1000 companies, universities, and government PO's welcome. 2% fee on all PO's apply. Specifications, pricing and availability are subject to change without notice. Always call for current prices.

2 Year Limited Warranty On All Custom Configured Computers

Now Celebrating 10th ANNIVERSARY

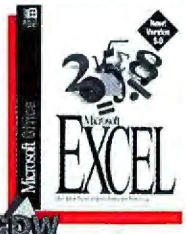
Rapid RAID, MegaTower, Dominator, Universal Bus and Imagination Station are trade marks of Computer & Control Solutions, Inc. Other trademarks are property of their respective holders

Circle 178 on Inquiry Card.

COMPUTER DISCOUNT WAREHOUSE™

CDW

Microsoft Excel V5.0 for Windows



New features:

✔ In-cell Editing ✔ Wizards to Automate Complex Tasks ✔ Workbook Tabs ✔ Improved Scenario Manager ✔ Common Interface with MS Word 6.0 and PowerPoint 4.0

CDW TOP SELLER

Version Upg .... **$89.47** CDW 33553

WHY PAY RETAIL?

CDW® Sells For Less

TEXAS INSTRUMENTS

PRICE DROP!

Best-selling Texas Instruments Notebooks with New Lower Prices!

TM4000E WinSX/25 Monochrome 120MB	$1748.57	CDW 32070
TM4000E WinDX2/50 Monochrome 200MB	$2529.84	CDW 32678
TM4000E WinDX2/50 Dual Scan Color 200MB	$2529.84	CDW 32679

HARDWARE, SOFTWARE & PERIPHERALS AT DISCOUNT PRICES

NETWORKING PRODUCTS

NOVELL

Netware V4.01

5 USER CD	889.00
10 USER CD	2084.00
25 USER CD	3035.00
50 USER CD	3989.00

Netware V3.12

5 USER 3.5"	606.00
10 USER 3.5"	1584.00
25 USER 3.5"	2316.00
50 USER 3.5"	3131.00
100 USER 3.5"	4385.00

Call for Pricing on NetWare CD ROM Versions and Upgrades

PERSONAL NETWARE V1.0 NEW

1 USER	67.57
5 USER	265.52

NOVELL PRICING IS SUBJECT TO CHANGE. PLEASE CALL CDW FOR THE MOST CURRENT PRICING

COACTIVE

COACTIVE STARTER KIT	189.99
COACTIVE ADD-ON KIT	139.89

THOMAS-CONRAD

TC5143 ETHERNET COAX	119.87
TC5143 ETHERNET COAX 6PK	699.55
TC5143 ETHERNET 10BT	89.95
TC5143 ETHERNET 10BT 6PK	483.60
TC6242 ARCNET 8 BIT COAX CARD	69.59
TC6245 ARCNET COAX CARD	179.99
TC6242 ARCNET+ TP CARD	95.94
TC6245 ARCNET ALL-IN-ONE CARD	256.48
TC6040 ARCNET PASSIVE 4 PORT HUB COAX	39.50
TC5055 ETHERNET 8 PORT CON 10BT	328.74
TC4035 TOKEN RING 4MBPS CARD	279.89
TC4045 TOKEN RING 16/4 CARD	349.69

CDW Carries the Complete Line of TCNS Products. Call for Details!

ARTISOFT

NODERUNNER 2000A	217.34
NODERUNNER 2000T	174.47
NODERUNNER 2000C	172.47
NODERUNNER/SI 2000A	119.88
NODERUNNER/SI 2000T	94.44
NODERUNNER/SI 2000C	89.44
CENTRAL STATION II	389.89
10BT 5 PORT INTERNAL HUB	255.33
NODERUNNER STARTER KIT WINDOWS	479.29
LANTASTIC AI V5.0	79.17
LANTASTIC AI V5.0 WINDOWS	79.19
LANTASTIC SOFTWARE	67.80
LANTASTIC FOR WINDOWS SW	129.68
SIMPLY LANTASTIC START KIT NEW	204.03
SIMPLY LANTASTIC V1.0 NEW	58.89
T-RUNNER 8 PORT 10BT	299.88
T-RUNNER 12 PORT 10BT	488.41

SMC®

ULTRA16 ETHERNET COAX	105.25
ULTRA16 ETHERNET COAX 6PK	583.68
ULTRA16 ETHERNET 10BT	105.25
ULTRA16 ETHERNET 10BT 6PK	578.54
ULTRA16 ETHERNET COMBO	125.35
ULTRA16 ETHERNET COMBO 6PK	693.49
ETHERCARD+ ELITE COAX	119.64
ETHERCARD+ ELITE COAX 6PK	628.73
ETHERCARD+ ELITE MCA COAX	189.26
ETHERCARD+ ELITE 10BT	119.64
ETHERCARD+ ELITE 10BT 6PK	619.22
ETHERCARD+ ELITE MCA 10BT	189.55
ETHERCARD+ ELITE EISA 10BT	579.78
ETHERCARD+ ELITE COMBO	139.57
ETHERCARD+ ELITE COMBO 6PK	753.59
3608 ETHERNET 8 PORT CON 10BT	329.61
3512 ETHERNET 12+2 PORT CON 10BT	614.76
PC600WS ARCNET CARD COAX	119.93
PC650WS ARCNET CARD TP	119.88
PC600FS ARCNET CARD COAX	199.29
PC130 ARCNET CARD COAX	68.50
ARCNET 8 PORT ACTIVE HUB COAX	229.41
TOKENCARD ELITE 16/4	265.88

3Com®

3C503 ETHERLINK II COAX	154.84
3C509 ETHERLINK III COAX	115.50
3C509 ETHERLINK III COAX 5 PK	529.12
3C509 ETHERLINK III 10BT	115.50
3C509 ETHERLINK III 10BT 5 PK	527.97
3C509 ETHERLINK III COMBO	135.88
3C509 ETHERLINK III COMBO 5 PK	578.84
3C579 ETHERLINK EISA COAX	229.91
3C579 ETHERLINK EISA 10BT	229.91
3C1627 12 PORT LINKBUILDER 10BT	638.95

NETWORKING PRODUCTS

OTHER TOP-QUALITY NAME BRANDS

EAGLE NE2000+ COAX	109.90
EAGLE NE2000+ 10BT	99.90
EAGLE NE3200 THIN COAX w/TPA	484.32
NATIONAL SEMI NE2000+ COAX	89.54
NATIONAL SEMI NE2000+ 10BT	84.59

If You Don't See What You Are Looking For, Call CDW Carries the Best Networking Selection in the Industry!

Xircom

PE3108C POCKET ETHERNET COAX	309.89
PE310B2 POCKET ETHERNET COAX	258.00
PE310BT POCKET ETHERNET 10BT	268.31
PA202B6 POCKET ARCNET COAX	229.30
POCKET TOKEN RING III	455.89
PPX03 PARALLEL PORT MULTIPLEXOR	77.80
XIRCOM 14.4K POCKET MODEM	506.19

IBM TOKEN RING

IBM TOKEN RING 16/4 ISA	501.40
IBM TOKEN RING 16/4 MCA	609.35
IBM TOKEN RING MAU	458.88

intel

ETHEREXPRESS 16 COAX	99.33
ETHEREXPRESS 16 COAX 5PK	454.13
ETHEREXPRESS 16 COAX 20PK	1698.38
ETHEREXPRESS MCA COAX	166.52
ETHEREXPRESS 16 10BT	99.33
ETHEREXPRESS 16 10BT 5 PK	454.13
ETHEREXPRESS 16 10BT 20PK	1698.38
ETHEREXPRESS MCA 10BT	166.52
ETHEREXPRESS 16 COMBO	116.77
ETHEREXPRESS 16 COMBO 5PK	545.09
ETHEREXPRESS 16 COMBO 20PK	2036.93
ETHEREXPRESS FLASH 10BT	111.88
ETHEREXPRESS FLASH 10BT 5PK	515.62
ETHEREXPRESS FLASH COMBO	131.82
ETHEREXPRESS FLASH COMBO 5 PK	599.00
ETHEREXPRESS EISA COAX	415.30
TOKENEXPRESS 16/4	399.53
NETPORT II COAX	368.85
NETPORT II 10BT	368.85
ETHEREXPRESS ISA HUB	519.93
ETHEREXPRESS ISA HUB EXP	449.96

TAPE, REMOVABLE & FLOPPY DRIVES

COLORADO MEMORY SYSTEMS INC.

JUMBO 120MB INTERNAL	99.21
JUMBO 250MB INTERNAL	167.34
TRAKKER 120MB PARALLEL PORT	209.45
TRAKKER 250MB PARALLEL PORT	328.88
POWERTAPE 2.4GB SCSI INTERNAL	946.91
POWERTAPE 2.4GB SCSI EXTERNAL	1087.99
POWERDAT 4GB SCSI INTERNAL	1197.79

IOMEGA

TAPE 250MB INTERNAL	169.57
TAPE 250 INTERNAL PLUS	185.13
FLOPTICAL 21MB INSIDER	379.27
BERNOULLI 150MB INSIDER SCSI	479.11
BERNOULLI 150MB INSIDER IDE	472.59
BERNOULLI 150MB PC POWERED	477.87
BERNOULLI 150MB TRANSPORTABLE	579.26

SUMMIT MEMORY SYSTEMS INC

SE120 120MB INT TAPE B-U	136.66
SE250 250MB INT TAPE B-U	163.29
SE305 305MB INT TAPE B-U	259.90

MICROSOLUTIONS

BackPack 3.5" 1.44MB FLOPPY PARALLEL	177.84
BackPack 5.25" 1.2MB FLOPPY PARALLEL	177.72
BackPack 170MB HD PARALLEL	334.56
BackPack 200MB HD PARALLEL	427.59
BackPack 2X CD-ROM PARALLEL	377.44
BackPack 250MB TAPE B-U PARALLEL	355.05

TAPE, REMOVABLE & FLOPPY DRIVES

SyDOS

PRO NOTE 42MB PARALLEL	418.17
PUMA 88MB PARALLEL	442.44
PUMA 105MB PARALLEL	519.80
MARLIN 105MB INT IDE	478.26
88MB EXT SCSI W/ADPT	538.00

Mountain

TD-250 250MB INT IDE	189.32
FS8500 305MB INT IDE	449.50
SIDECAR II 305MB PARALLEL TBU	358.77
1200-4 4GB EXT SCSI	2045.39
750MB-1.5GB INT TBU W/ADPT	1036.19
750MB-1.5GB EXT TBU W/ADPT	1254.89

WYSE TERMINALS

WYSE 30 AMBER OR GREEN	272.89
WYSE 50 AMBER OR GREEN	355.50
WYSE 55 AMBER, GREEN, WHITE	238.36
WYSE 60 AMBER, GREEN, WHITE	279.60
WYSE 150 AMBER, GREEN, WHITE	265.45
WYSE 160 AMBER, GREEN, WHITE	329.88
WYSE 325 COLOR	519.40

MULTIMEDIA, SOUND, CD

ALTEC LANSING ACS300 SPKRS/SW	274.26
CDW 5 CD BUNDLE*	129.17
CDW 5 CD BUSINESS BUNDLE*	119.66
CDW 5 CD ENTERTAINMENT BUNDLE*	79.33
CDW 4 CD EDUTAINMENT BUNDLE *	65.15
CREATIVE LABS DISCOVERY 16 INT	418.80
SOUND BLASTER PRO DLX	114.30
CREATIVE LABS SB 16 MCD	157.07
SOUND BLASTER 16 ASP MCD	187.73
CREATIVE LABS SB 16 SCSI	177.90
MEDIA VISION PRO AUDIO 16 BASIC	107.74
MEDIA VISION PRO AUDIO SPECT 16	129.30
MEDIA VISION PRO AUDIO STUDIO 16	159.45
MEDIA VISION PRO 16 SYSTEM II BUNDLE	609.40
MEDIA VISION MEMPHIS SYS	609.00
MEDIA VSION CRITICAL PATH	44.53
MS MULTIMEDIA BEETHOVEN	52.88
MICROSOFT BOOKSHELF CD	119.89
MICROSOFT WIN SND SYS V2.0	52.95
MS ENCARTA 1994	85.24
MS WIN SND SYS V2.0 W/BOARD	139.20
MICROSOFT CINEMANIA 1994	52.88
ORCHID SOUNDWAVE 32	219.72
ORCHID GAMEWAVE 32	138.40
PROCOM INT MULTIMEDIA STATION	739.16
PROCOM EXT MULTIMEDIA STATION	789.46
SONY DSKTOP LIBRARY INT 2X	267.04
SONY DSKTOP LIB INT W/SND 2X	467.73
SONY DSKTOP LIB EXT W/SND 2X	546.54
TURTLE BEACH MULTISOUND	427.88
TURTLE BEACH MONTEREY SND CRD	349.77

*AVAILABLE ONLY WITH CD ROM DRIVE PURCHASE CALL FOR DETAILS

CD-ROM & OPTICAL DRIVES

CHINON CDS535 INT CD-ROM KIT	385.60
CHINON CDX535 EXT CDROM KIT	455.88
HITACHI 1900S EXT CD-ROM	499.85
HITACHI CDR1950 EXT	539.64
HITACHI 6700 INT CD-ROM	409.85
HITACHI CDR6750 INT	417.78
NEC 3XI INTERNAL	479.90
NEC 3XE EXTERNAL	558.92
NEC 3Xp Portable	427.59
ORCHID CDS3110 INT	229.63
Pioneer DRM604X 6 DISC QUADRASPIN	1149.00
PROCOM 200MS INT SCSI CD-ROM	452.09
PROCOM 200MS EXT SCSI CD-ROM	557.65
SONY CDU535 INT CD-ROM	265.72
SONY CDU561 INT SCSI 2X CD-ROM	289.83
SONY CDU7205N EXT CD-ROM	454.88
SYDOS PARALLEL PORT CD-ROM	299.51
PLEXTOR 3028 240MS INT KIT	CALL!
PLEXTOR 3028 W/PA SPECTRUM 16	CALL!
PLEXTOR 5028 240MS EXT KIT	CALL!
PLEXTOR 5028 W/PA SPECTRUM 16	CALL
TOSHIBA 3401 Int SCSI CD-ROM	382.60
TOSHIBA 3401 Int SCSI CD-ROM w/Adpt	535.14
TOSHIBA 3401 Ext SCSI CD-ROM	485.81
TOSHIBA 3401 Ext SCSI CD-ROM w/Adpt	619.50
TOSHIBA 3401 Ext SCSI 4 Drive Tower	2535.08

PLOTTERS, DIGITIZERS & SCANNERS

KURTA®

IS/ONE 12 X 12 4 BUTTON	295.25
IS/ONE 12 X 12 12 BUTTON	298.82
XLP 12 X 12 4 BUTTON & STYLUS	219.55
XLP 12 X 18 16 BUTTON	442.60
XGT 12 X 12	343.98

CalComp

DB III 12X12 4 BUTTON	306.37
DB III 12X12 16 BUTTON	306.37
DB III 12X18 W/PRES PEN	399.86
DB III 12X18 16 BUTTON CORDLESS	696.85
SLATE 12X12 W/PRES PEN	363.40

Canon

IX4015 COLOR SCANNER	1339.62

Summagraphics CORPORATION

SUMMASKETCH III 12 X 12 16 BUTTON	253.90
SUMMASKETCH III 18 X 12 4 BUTTON	524.44

HOUSTON INSTRUMENT

HI 7100 A-D SIZE 8 PEN	2598.78
HI 7200 A-F SIZE 8 PEN	3387.22

HEWLETT PACKARD

HP SCANJET IIP	734.61
HP SCANJET IIP DOCUMENT FEEOER	269.93
HP SCANJET IICX W/ ISA	998.50
HP SCANJET IICX DOCUMENT FEEDER	474.72

EPSON

ACTIONSCANNER ES600C	796.86
ACTIONSCANNER ES800C	1065.00
ACTIONSCANNER ES800C PRO	1238.53

VIDEO PRODUCTS

VGA & SUPER VGA MONITORS

AST VISION 4N 14"	369.91
MAG INNOVISION MX15F	515.00
MAG INNOVISION MX17F	877.40
MAG INNOVISION MX17FG	927.53
MAGNAVOX CM2079 14" .39	215.20
MAGNAVOX CM2089 14" .28	268.90
MAGNAVOX CM2099 14" .28 NI	289.80
MAGNAVOX CM9217 17"	599.50
MAGNAVOX 20CM64 20" SPECIAL!	999.00
NANAO F340IW 15"	697.00
NANAO F550I 17"	1047.77
NANAO F550IW 17"	1149.00
NEC 3V 15"	499.82
NEC 3FGE 15"	577.17
NEC 4FGE 17"	722.72
NEC 5FGE 17"	1079.27
NEC 5FGp 17"	1227.21
NEC 6FGp 21"	2368.94
PANASONIC C1381i 14"	335.76
PHILIPS 1764DC 17"	719.50
PHILIPS BRILLIANCE 17"	1109.00
PHILIPS BRILLIANCE 21"	2288.82
SONY CPD1430 14"	497.00
SONY CPD1730 17"	897.00
SONY 17SE 17"	1147.00

VGA & SUPER VGA DISPLAY CARDS

ADS VGA TO TV ELITE	224.57
ATI GRAPHICS ULTRA+ 2MB	237.58
ATI GRAPHICS ULTRA PRO 2MB	357.56
ATI GRAPHICS ULTRA PRO 2MB EISA	394.92
CARDINAL WARPSPEED 2MB VLB	487.21
CREATIVE LABS VIDEO BLASTER	339.02
CREATIVE LABS VIDEO SPIGOT	249.00
DIAMOND STEALTH PRO 1MB	249.83
DIAMOND STEALTH PRO 2MB	336.61
DIAMOND SPEEDSTAR PRO 1MB	107.43
DIAMOND VIPER VLB 2MB	387.86
HERCULES GRAPHITE PRO 1MB	258.46
HERCULES GRAPHITE 2MB	388.45
HERCULES DYNAMITE VLB	157.30
INTEL SMART VIDEO RECORDER	486.88
ORCHID FAHRENHEIT 1280+	157.84
ORCHID FAHRENHEIT VA	172.97
ORCHID CELSIUS VLB 1MB	238.97
ORCHID CELSIUS VLB 2MB	297.96

If You Find a Better Price, Call CDW® Before You Buy (800) 959-4CDW

NASDAQ

BUY WITH CONFIDENCE CDW® IS A NASDAQ TRADED COMPANY

TICKER SYMBOL CDWC
D & B Rated 4A1
Duns 10-762-7952

No Surcharge For Credit Cards

AMERICAN EXPRESS · VISA · DISCOVER · MasterCard

Credit Card charges are not submitted until time of shipment. Freight is calculated as the carrier's actual freight charge plus insurance and packaging material. The cost of insurance is 0.30% (0.0030) of the order total. Packaging materials will not exceed $4.00 per 1 package order or $6.00 per multi-package shipment. For your protection we ship only to your verified billing address. Non-defective returns subject to restocking fee. Allow 10 business days for shipping when paying by personal check. Software, chips and other electronic components are not returnable. All pricing subject to change. ™ - Trademarks of all companies listed in this ad.

CDW® HOURS

Sales 7:00 -9:00 CDT Mon-Fri.
9:00-5:00 CDT Sat.
Tech Support for Customers
8:00-7:00 CDT Mon-Fri.
9:00-5:00 CDT Sat.

Check These Pages for Our Most Current Prices!

COMPUTER DISCOUNT WAREHOUSE™

COMPUTER DISCOUNT WAREHOUSE™

CDW

PRACTICAL PERIPHERALS.

Practical Peripherals 14.4K bps Data/Fax MiniTower Modem

- ✔ V.32bis Data, V.42 Error Correction, V.42bis Data Compression
- ✔ Includes DOS and Windows Software, Vertical Stand
- ✔ Lifetime Warranty

14.4FXMT .... **$179.55** CDW 26163

WHY SETTLE FOR LESS?

CDW® SERVICES YOU BETTER

Megahertz Linking Your Worlds

CDW TOP SELLER

Megahertz 14.4K bps Data/Fax PCMCIA Modem with XJACK

● Only Megahertz has the XJACK® Extendable Connector ● XJACK Lightens Your Load: No Awkward External Connectors ● Auto Installation ● Hot Swappable
● Advanced Error Correction
● 5 Year Warranty

ONLY .... **$309.31** CDW 27680

CDW® CARRIES OVER 15,000 PRODUCTS. IF YOU DON'T SEE IT, CALL!

COMPUTERS

TOSHIBA

T1910 120MB MONO	1477.64
T1910CS 120MB DUAL CLR	2067.56
T1910CS 200MB DUAL CLR	2277.11
T1950/120MB MONO	1877.10
T1950/200MB MONO	2087.80
T1950CS/120MB PAS CLR	2477.17
T1950CS/200MB PAS CLR	2697.78
T1950CT/120MB ACT CLR	2799.00
T1950CT/200MB ACT CLR	2999.00
T1950CT/320MB ACT CLR	3399.00
T3400/120MB MONO	2197.00
T3400CT/120MB ACT CLR	3428.00
T4600/120MB Mono	1999.00
T4600/200MB Mono	2299.00
T4600C/120MB ACT CLR	3869.00
T4600C/200MB ACT CLR	3999.00
T4600C/340MB ACT CLR	4369.00
T4700CS/200MB DYNAMIC CLR	3897.00
T4700CS/320MB DYNAMIC CLR	4238.00
T4700CT/200MB ACT CLR	4499.00
T4700CT/320MB ACT CLR	4849.00
T6600C/510MB ACT CLR	6099.00
T6600C/510MB CD ACT CLR	6599.00

AST BRAVO SERIES

LC 4/25S 120MB	995.25	LP 4/25S 340MB	1599.35
LC 4/33S 120MB	1059.00	LP 4/33D 170MB	1415.64
LC 4/33D 120MB	1257.27	LP 4/33D 340MB	1882.77
LC 4/33D 210MB	1497.97	LP 4/66D 170MB	1838.52
LC 4/50D 120MB	1448.21	LP 4/66D 340MB	2264.57
LC 4/50D 210MB	1697.59	MT 4/33D 170MB	1495.97
LC 4/66D 120MB	1728.34	MT 4/33D 340MB	1929.46
LC 4/66D 210MB	1968.89	MT 4/66D 170MB	1919.15
LP 4/25S 170MB	1139.68	MT 4/66D 340MB	2375.82

NOTEBOOK 80MB MONO	1592.15
NOTEBOOK 120MB MONO	1719.70
NOTEBOOK 120MB COLOR	2227.35
NOTEBOOK 170MB MONO	1799.45
NOTEBOOK 170MB COLOR	2437.20
NOTEBOOK 170MB COLOR+	2894.60

Canon

NOTEJET 4/25 180MB	2591.74
NOTEJET 4/25 120MB COLOR	2829.25
NOTEJET 4/25 200MB COLOR	3139.63
INNOVA 4/33L SX 170MB	929.84
INNOVA 4/33L SX 240MB	1025.71
INNOVA 4/50L 170MB	1349.56
INNOVA 4/50L 240MB	1428.96

NEC VERSA NOTEBOOKS

4/40 120MB MONO	2584.43
4/40 120MB COLOR	3817.30
4/40 250MB MONO	2999.87
4/40 250MB COLOR	4226.81
4/50 209MB MONO	3258.00
4/50 209MB COLOR	4497.44
4/50 340MB MONO	3858.79
4/50 340MB COLOR	4917.59
READY 4/25S 170MB Multimedia	1447.16
READY 4/33S 210MB Multimedia	1879.89
IMAGE III 4/50 210MB	1796.14
IMAGE III 4/50 420MB	2049.82
POWERMATE 4/25SX 170MB	1039.68
POWERMATE 4/33SX 170MB	1129.54
POWERMATE 4/50DX2 210MB	1498.68

SHARP NOTEBOOKS

486/33 200MB PAS Clr w/Trkball	2597.37
SHARP 486/33 200MB ACT Clr w/Trkball	2997.76

TEXAS INSTRUMENTS

TM4000E 4/25SX 120MB MONO	1748.57
TM4000 4/25DX 200MB MONO	2177.86
TM4000E 4/25S 120MB ADV COLOR	2098.43
TM4000E 4/40 200MB PAS COLOR	2677.44
TM4000E 4/50 200MB MONO	2529.84
TM4000E 4/50 200MB DUAL COLOR	3068.00

DOT MATRIX & LASER PRINTERS

OKIDATA

184 TURBO	219.14	ML591	585.87
ML320	304.45	PACEMARK 3410	1222.92
ML321	432.43	OL400E	499.98
ML380	214.95	OL410E	649.31
ML395	909.32	OL810	905.50
ML395C	1039.74	OL830+	1079.11
ML520	369.82	OL850 PS	1198.20
ML521	499.18	DOC-IT 4000	2909.48
ML590	429.51		

Canon

BJ10SX	255.88
BJ200E NEW	298.00
BJ230	388.00
BJC600 COLOR	588.50
LBP430 LASER	588.50
LBP860 600DPI 8PPM NEW	1389.51

DOT MATRIX & LASER PRINTERS

EPSON

AP2250	115.83	LQ870	444.91
AP3250	171.95	LQ1170	609.83
AP3260	198.15	LQ2550	898.08
LX810	167.90	DFX5000	1319.84
FX870	267.59	DFX8000	2269.45
FX1170	355.95	STYLUS 300	229.95
LQ570+	237.97	STYLUS 800*	252.97
LQ1070+	365.35		

ACTION LASER 1500	656.70
ACTION LASER 1500 W/2MB	716.22

*AFTER $25 MANUFACTURER REBATE (ENDS 5/30/94)

IBM LEXMARK

4037 5E 5PPM	657.17
4029-10 10PPM	1127.42
4039-10R 10PPM	1339.46
4039-10RD 10PPM DUPLEX	1639.77
4039-12R 12PPM	1689.76
4039-12L 12PPM	2399.86
4039-16L 16PPM	2735.36

NEC

P3200	224.78	Silentwriter 640	798.59
SuperScript 610	567.78	Silentwriter 95F	867.70
SuperScript 640	835.80	Silentwriter 1097	1377.80

Panasonic

1150	133.49	2624	409.49
1624	385.20	3123 NEW	254.67
2023	202.97	4410 LASER	547.15
2123	243.37	4430 LASER	659.88
2124	318.41	4440 LASER	1039.00

TEXAS INSTRUMENTS

MICROMARC INKJET	277.97
MICROWRITER BASIC	517.16
MICROWRITER PS35	677.22
MICROWRITER PS65	837.20
MICROLASER PRO 600 PS23*	1315.02
MICROLASER PRO 600 PS65	1528.25
POWERSTEP UPG- mL600	274.68

* AFTER $60.00 MANUFACTURER REBATE (ENDS 3/31/94)

SHARP PRINTERS

SHARP JX9400 300DPI 4PPM	497.09
SHARP JX9460PS 600DPI 6PPM	949.86

HEWLETT PACKARD

Deskjet Portable 310	387.40	LaserJet 4P	999.92
HP Deskjet 500	299.09	LaserJet 4MP	1469.89
HP Deskjet 550C	499.20	LaserJet 4	1489.56
HP Deskjet 1200C	1449.61	LaserJet 4M	1869.64
HP Deskjet 1200C	2095.47	LaserJet 4Si	2999.95
HP PaintjetXL300	2258.93	LaserJet 4Si MX	4509.36
LaserJet 4L	689.97		

HARD DRIVES & CONTROLLERS

Maxtor

131MB IDE	199.10	345MB IDE	307.61
170MB IDE	222.75	345MB SCSI	365.63
245MB IDE	249.67	540MB IDE	637.87
245MB SCSI	264.44		

MICROPOLIS

1050MB IDE	912.15	1.050GB SCSI AV	989.35
1050MB SCSI	912.15	1.765GB SCSI AV	1289.38
1.7GB SCSI	1239.29	3GB SCSI	2199.00

CONNER

210MB IDE	225.67	540MB IDE	535.17
343MB IDE	305.67	540MB SCSI	549.23
343MB SCSI	335.99	1GB SCSI	977.21
426MB IDE	399.89		

Seagate

200MB IDE	225.75
261MB IDE	249.56
341MB IDE	299.99
452MB IDE	405.54
535MB SCSI-2	648.44
1.0GB SCSI-2	887.20
1.05GB SCSI	944.33

CONTROLLERS

ACCULOGIC IDE W/1PAR, 2SER, 1GAME	35.06
ACCULOGIC IDE W/BIOS	48.90
ACCULOGIC VLB IDE	98.76
ADAPTEC 1510A SCSI-2 CD KIT	94.56
ADAPTEC 1542CF SCSI-2	265.46
ADAPTEC 2742T EISA SCSI-2	339.22
ADAPTEC 2842 VLB SCSI-2	299.45

MODEMS & COMMUNICATIONS

USRobotics SPORTSTER MODEMS

14.4 INT	139.50
14.4 INT W/FAX	149.50
14.4 EXT	159.50
14.4 EXT W/FAX	169.50
WORLDPORT 14.4	149.00

COURIER MODEMS

V.32TERBO INT	333.60
V.32TERBO INT W/FAX	345.64
V.32TERBO EXT	378.23
V.32TERBO EXT W/FAX	395.08
DUAL STD TERBO INT W/FAX	679.01
DUAL STD TERBO EXT W/FAX	732.63

Hayes

ACCURA 2400B Int/Ext	59.10/69.25
ACCURA 24EC + FAX 96 Int.	89.49
ACCURA 96 + FAX 96 Int/Ext.	159.05/169.36
ACCURA 14.4 + FAX 14.4 Int/Ext.	169.73/179.45

OPTIMA 2400 V.42BIS Ext.	112.04	14.4 Ext.	374.30
OPTIMA 24 + Fax 96 Ext.	119.34	OPTIMA 14.4 + Fax 14.4 Pocket	298.93
OPTIMA 9600 Ext.	339.50	OPTIMA 28.8K V.FC Ext.W/Fax	439.13
OPTIMA 96 + Fax 96 Ext.	364.42	Ultra 9600 Ext	589.18
OPTIMA 14.4 Ext.	363.80	Ultra 14.4 Ext.	634.56
OPTIMA 14.4 + Fax		ESP Accelerated Single/Dual Serial	79.50/116.94

PRACTICAL PERIPHERALS

2400B INT	61.66
2400 EXT	69.95
PM2400FX 2400 INT W/FAX	79.95
PM2400EF 2400 V.42 EXT W/FAX	107.40
PM9600FX 9600 INT W/FAX	139.77
PM9600FXMT 9600 EXT W/FAX	156.68
PM14400FX 14.4 INT W/FAX	159.50
PM14400FXMT 14.4 EXT W/FAX	179.55
PM14400FXSA 14.4 EXT W/FAX, LCD	374.45
PM14400FXP 14.4 POCKET W/FAX	287.50

intel SATISFAXTION MODEMS

100 INT	98.66	400 INT	273.06
200 INT	209.50	400 EXT	309.59

FAX MODEMS

2400 V.42BIS Int	104.70	9600 Ext. W/FAX	149.60
2400 V.42BIS Ext.	112.52	14.4 Int W/FAX	156.15
9600 Int W/FAX	133.76	14.4 Ext. W/FAX	174.28

BOCA

BOCA 14.4K INT W/FAX	117.22
BOCA 14.4K EXT W/FAX	147.61
V.FC 24K BPS INT W/FAX	199.59
V.FC 24K BPS EXT W/16550 I/O BOARD	229.64

BATTERY BACKUP AND UPS

BC250	99.11	BC600 LAN	249.00
BC400	152.59	BC750 LAN	313.90
BC500	191.42	BC900 LAN	359.67
BC500 LAN	199.40	BC1250 LAN	449.59

SMART UPS SERIES NEW

SMART 250 LAN	232.46
SMART 400 LAN	279.87
SMART 500 LAN	309.09
SMART 600 LAN	334.91
SMART 750 LAN	428.53
SMART 900 LAN	525.64
SMART 1250 LAN	659.66
POWERMISER 4 OUTLET	49.50
ISOBAR 4 OUTLET	38.95
ISOBAR 6 OUTLET	46.38

AMERICAN POWER

BACK UPS 250	99.34	BACK UPS 900	374.15
BACK UPS 400	169.83	BACK UPS 1250	498.77
BACK UPS 450	189.88	SMART UPS 400	299.95
BACK UPS 600	263.67	SMART UPS 600	363.38

SURGEARREST NETWORK NEW	36.87
SURGEARREST PRO NEW	33.58
SURGEARREST PLUS W/TEL	49.65
LINE-R 600	119.00

MICE

LOGITECH TRACKMAN PORTABLE	72.50
LOGITECH MOUSEMAN CORDLESS	89.93
LOGITECH MOUSEMAN COMBO	66.85
LOGITECH DEXXA SERIAL MOUSE	24.98
LOGITECH 2 BUTTON	28.57
LOG FOTOMAN PLUS	549.76
MICROSOFT MOUSE V2.0 SERIAL*	59.00
MICROSOFT MOUSE V2.0 PS/2*	59.00

* WHILE SUPPLIES LAST

PCMCIA

BOCA 14.4K DATA/FAX	259.70
DATARACE 14.4K W/FAX	238.24
DATARACE 2400 W/FAX	168.70
EAGLE NE200T ETHERNET	209.35
HAYES OPTIMA 14.4 W/FAX	315.00
IBM TOKEN RING 16/4	452.64
INTEL 14.4 W/FAX	299.00
INTEL 2400 W/FAX	189.00
INTEL 9600 W/FAX	249.00
LINKSYS ETHERNET 10BT	197.91
LINKSYS ETHERNET COAX	197.91
MAXTOR MOBILEMAX 105MB HD	499.27
MEGAHERTZ 14.4 W/FAX	295.49
MEGAHERTZ 14.4 XJACK W/FAX	309.31
MEGAHERTZ 2400 XJACK W/FAX	197.82
MEGAHERTZ 9600 XJACK W/FAX	277.07
MINISTOR 42MB HARD DRV	399.61
NAT SEMI NE4100T ETHERNET	69.95
NOVELL/EAGLE ETHERNET COAX	242.80
PRACTICAL 14.4K DATA/FAX	279.16
T. CONRAD ETHERNET COAX	228.44
TRANTOR SLIM SCSI-2	285.49
USR WORLDPORT 14.4 W/FAX	285.22
XIRCOM TOKEN RING ADAPTER	439.77
XIRCOM ETHERNET 10BT	229.41
XIRCOM ETHERNET COAX	228.79
XIRCOM ETHERNET COMBO	265.55

MEMORY UPGRADES

CDW® Features Delkin, Kingston, Pacific Data and Simple Technology Memory.

AST BRAVO 486LC 2MB	CALL!
AST POWEREXEC 486 4MB	CALL!
AST PREMIUM II 1MB CUPID SIMM	CALL!
AST PREMMIA 8MB UPG	CALL!
COMPAQ DESKPRO 8MB	CALL!
COMPAQ CONTURA 486 8MB	CALL!
COMPAQ CONTURA 4MB	CALL!
COMPAQ DP 386/16 4MB	CALL!
COMPAQ LITE 4/25C 4MB	CALL!
COMPAQ PROLINEA 486/33 4MB	CALL!
COMPAQ PROSIGNIA 16MB	CALL!
EPSON ACTION LASER 2-8MB	CALL!
HP DESKJET 500 & 500C 256KB	CALL!
HP LASER 4L 1MB MEM UPG	CALL!
HP LASERJET 2P/III 2MB	CALL!
HP LASERJET 3SI 4MB	CALL!
HP LASERJET 4 4MB	CALL!
HP PAINTJET XL300 4MB	CALL!
IBM DESKTOPS-ALL MODELS	CALL!
IBM THINKPAD 700 4MB	CALL!
NEC SILENTWRITER 95 2MB	CALL!
NEC VERSA 4MB	CALL!
OKILASER 400 2MB	CALL!
OKILASER 800 2MB	CALL!
PANASONIC 4410, 4430 2-4MB	CALL!
PANASONIC P4450I 2MB	CALL!
TI MICROLASER 1MB	CALL!
TI TM4000 4MB	CALL!
Toshiba 1800, 1850, 2000SX/E, 2200SX 2MB	CALL!
Toshiba 1800, 1850, 2000SX/E, 2200SX 4MB	CALL!
Toshiba 1900C, 4500C, 4600C 8MB	CALL!
Toshiba 4400, 4400SX/C 4MB	CALL!
Toshiba T1800, 1850, 2000SX/E, 2200SX 8MB	CALL!
Kingston Memory	CALL!

Due to an Industry-Wide Memory Shortage, Please Call CDW for the Best, Most Current Pricing and Availability Information.

PROCESSOR/UPGRADES

CYRIX 486DRX/2 UPGRADE	295.25
INTEL OVERDRIVE 16/20MHZ	299.44
INTEL OVERDRIVE 25MHZ	309.88
INTEL OVERDRIVE 33MHZ	499.55
KINGSTON SX/NOW 25MHZ	189.45
KINGSTON SX/NOW 33MHZ	196.25
KINGSTON 486/NOW 25MHZ	328.76
KINGSTON 486/NOW 33MHZ	508.03

MATH COPROCESSORS

INTEL 287XL	84.80
INTEL 387SX 16/20/25MHZ	76.84
INTEL 387SX 33MHZ	81.20
INTEL 387SL	76.22
INTEL 387DX	81.13

CDW Computer Centers, Inc.
1020 E. Lake Cook Road
Buffalo Grove, IL 60089

CDW® Sells for Less and Services You Better!

(800) 959-4CDW

FAX (708) 465-6800

CALL FOR FREE CDW® CATALOG

COMPUTER DISCOUNT WAREHOUSE™

Circle 198 on Inquiry Card (RESELLERS: 199).

PC-COMPANION *Plus*™

Add a second keyboard, monitor and mouse to your PC up to 250 feet away!

- Supports PC/AT, PS/2 and 100% compatibles
- Combine monochrome and color VGA monitors
- Mouse support available at both local and remote workstations
- Switch selectable privacy mode

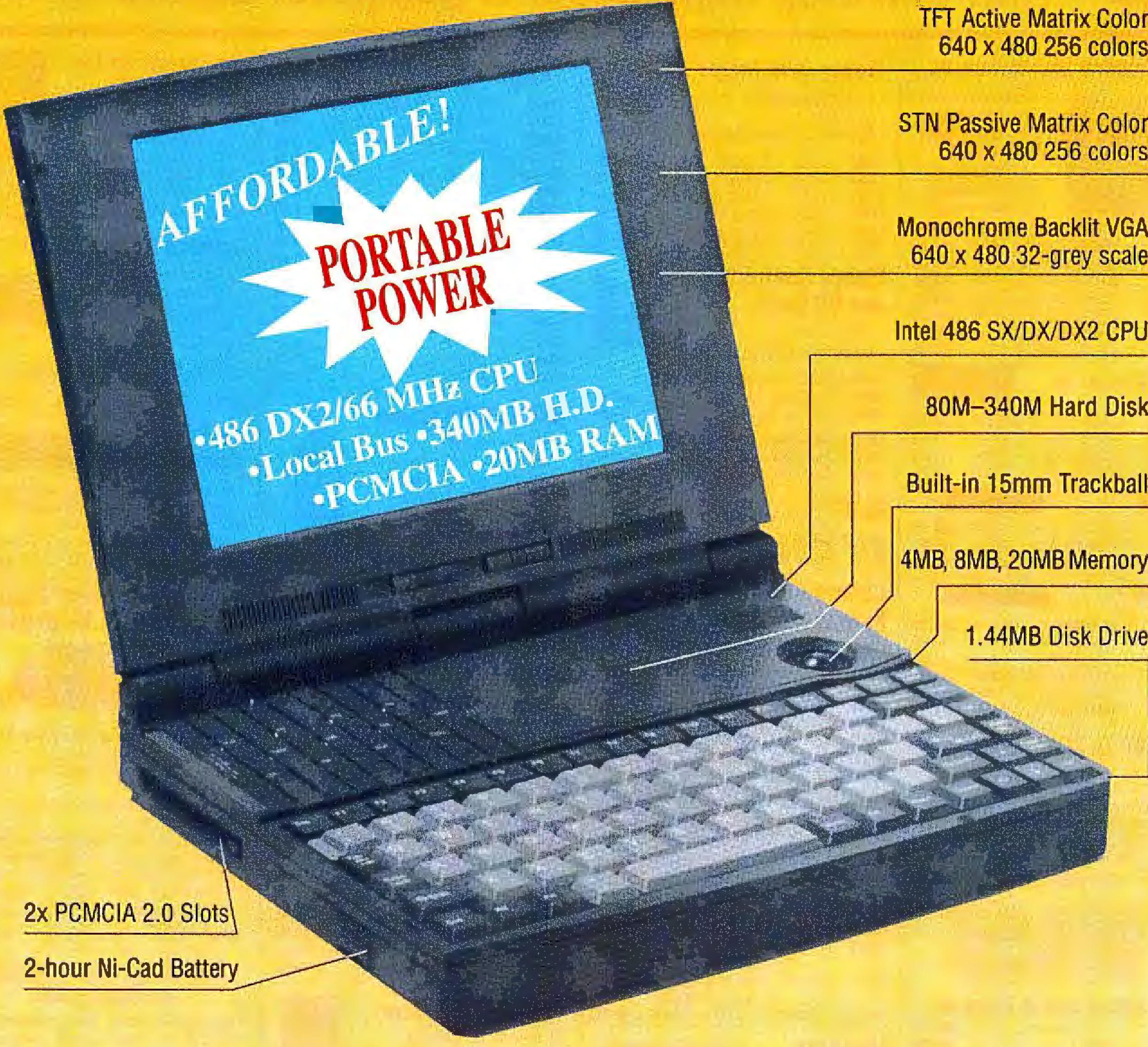
For Macintosh support, ask about our new Mediator for Macintosh!

Cybex Corpration
4912 Research Drive • Huntsville, AL 35805 USA
(205) 430-4000 • FAX (205) 430-4030
Dealer Program Available **Made in USA**

CYBEX™

Circle 177 on Inquiry Card (RESELLERS: 178).

Circle 183 on Inquiry Card.



Need the fastest Windows performer?

High Performance Micro-International HCP Model 65681M

"If you need a notebook with processing power for massive spreadsheets and databases, to perform gray-scale imaging, or for other demanding tasks, the HCP 65681M is for you. It ran our Windows performance test twice as fast as the Compaq LTE lite 4/25E,... In fact, this was the fastest monochrome notebook in our entire test sample. The HCP 65681M's monochrome screen quality is the best we saw from passive-matrix monochrome displays... and an excellent keyboard."

October 1993 BYTE/NSTL LAB REPORT

MICRO-INTERNATIONAL, INC. 10850 Seaboard Loop, Houston, Texas 77099
National Sales:(800) 967-5667•Local Sales:(713) 495-9096•FAX:(713) 495-7791

$2740 for a monochrome 4862/66M system with MS-DOS 6.0, Windows 3.1, 8MB RAM, and 250MB hard disk.
Prices for other configurations are available upon request.

Office hours Monday–Friday 8:00–6:00 • Saturday 10:00–1:00 • Sunday–Closed

BREAKTHROUGH PENTIUM™ PERFORMANCE

FOR 12 YEARS, WE'VE BEEN BUILDING COMPUTERS AND SUB-SYSTEMS

The system you need at a price you can afford.

Platform for platform, the fastest, most cost-effective and reliable systems and motherboards

386SX+40 MHz	= 53.1 Landmark
386DXC+33 MHz	= 58.7 Landmark
386DXC+40 MHz	= 64.0 Landmark
486SX 25 MHz	= 114.0 Landmark
486SX 33 MHz	= 151.0 Landmark
i486DXC+33 MHz	= 151.9 Landmark
i486DXC+40 MHz	= 183.7 Landmark
i486DX-2 50 MHz	= 19.7 MIPS*
i486DX-2 66 MHz	= 26.9 MIPS*
i486DX-2 75 MHz	= 30.5 MIPS*
i586DXC Pentium 66 MHz	= 45.0 MIPS*

VESA Available in 386DX, 486, 586

C= 64K Write-back Cache (256K available)
*Powermeter - too fast for Landmark Software

ISA or VESA. Your choice

SVC's new VESA Local Bus systems are ultra-fast, yet affordable answers for file servers, graphics, workstations and other data intensive applications. SVC VESA Local Bus systems offer up to 32 MB per second performance on Disk Channel.

Exceptional performance

All SVC motherboards are designed, assembled, tested and supported by SVC. Each is designed to offer the highest reliability in the industry (300,000 hours MTBF). All conform to FCC Class A or Class B emission standards. All run the full gamut of PC operating systems. The result is unequaled flexibility, performance and reliability. Dollar-for-dollar, platform-for-platform, you can't buy more performance and reliability for less.

Total compatibility

Software: Microsoft DOS 3.1 to 6.2; Windows; Windows for Workgroups; Windows NT; OS/2 2X; SCO UNIX/Xenix; AT&T UNIX; Interactive UNIX; Novell 2.X, 3.X and 4.X

Hardware: accepts all standard 8 and 16-bit ISA expansion cards. Enhanced 104-key keyboards, any current hard disk or floppy. VESA LB 32-bit available with all CPUs.

Total expandability

- Up to 16/32/128 Megabytes of fast DRAM on the Motherboard
- Fast SRAM write-back cache to 512K
- Up to 8 hard and floppy drives depending on chassis
- 1:1 interleave available on all disk controllers

INDUSTRIAL QUALITY SYSTEMS AT AFFORDABLE PRICES

ALL SYSTEMS INCLUDE: Three-year limited warranty. MTBF: 300,000 Hours

- 4 MB 70ns zero wait state DRAM
- 1.44 MB Teac FDD
- 210 Megabyte Conner IDE Hard Drive
- 20 MBPS HD Interface
- (2) Serial, (1) Parallel, (1) Game Port
- Real time clock & battery backup
- 3-button Mouse
- 15,000V static discharge drains
- 250 W Power Supply Peak/Venting Fan
- 104-key enhanced keyboard
- Complete technical manuals
- Microsoft software package
- Audio speaker
- 72-hour dynamic burn-in.

66 MHz Pentium DXC VESA LB System — $1695

- Pentium™ Processor 45 MIPS
- On-board DRAM to 128 MBytes
- 50 MHz VESA Local Bus/256K cache

75 MHz 30.5 MIPS 486DX275 — $1195

- 486DX2 Processor @ 75 MHz
- 256K cache
- 2 VESA slots, 37.5 MHz

66 MHz 486DX2 ISA/VESA LB and EISA/ISA/VESA Systems — $995

- 486DX2 Processor 26.9 MIPS
- 64K cache (expandable to 256K)
- EISA/VESA/ISA Motherboard add: $195

33 or 40 MHz 486DXC VESA LB Systems — $945

- 486DXC Processor
- 64K Cache (expandable to 256K)

33MHz 486SXC VESA LB System — $765

- 486SXC Processor
- 64K Cache (expandable to 256K)

Drives and upgrades

Drives and upgrades	Add
VESA Mirror Board and 2nd 210 MB Hard Drive (upgrade)	$299
Conner 420 MB IDE HD (upgrade)	$125
Conner 540 MB IDE HD (upgrade)	$265
1 Gigabyte IDE HD (upgrade)	$595
250 MB Conner Tape Drive, cable and backup software	$149
Dual-speed CD-ROM, dual-media controller & software	$199
SoundBlaster™ compatible card, speakers, mike, 2 games	$79
14.4 Fax/Modem & software	$129

Monitors & Accellerators

14" SVGA Interlaced (Hitachi tube)	$219
14" SVGA .28 NI VESA-ready (Hitachi)	$349
15" SVGA .28 NI VESA-ready (Hitachi)	$445
17" SVGA .26 NI VESA-ready (Hitachi)	$845
ISA 16-bit video adapter	$ 39
VESA 32-bit accellerator 1MB	$ 79
VESA 32-bit accellerator (S3) 1MB	$169
VESA 32-bit accellerator (Weitec) 2MB	$389

Intel & Pentium are Registered Trademarks of Intel Corp.

AT A BREAKTHROUGH PRICE: $1695

RIGHT WHERE IT ALL STARTS: SILICON VALLEY, U.S.A.

U.S. Made Business, Industrial and Scientific Computers

High-performance business and industrial systems. Factory-direct prices

Since 1982, Silicon Valley Computer Corporation has delivered over a million computer systems and subsystems worldwide. All motherboards and high-speed I/O cards are designed, built, tested and supported by SVC. Our location in California's Silicon Valley means we are among the first to hear of and implement new designs in microprocessor, chip and board technologies. SVC has a worldwide reputation for the design and manufacture of PCs, IDE I/O cards and motherboards. SVC I/O delivers up to 5 times the throughput of competing cards. Thus, platform-for-platform, SVC provides the highest overall computing performance available. Today, SVC systems are running in thousands of industrial, business, and governmental locations around the world. 300,000 hours MTBF and SVC's three year limited warranty provide an unparalleled level of reliability. And, SVC technical support lines give you access to the finest designers in the world.

Add automatic, fail-safe hard disk backup at all times with SVC's proprietary Mirror Boards and a spare drive you may already own.

Here's how they work:

SVC Mirror Boards control sets of 2 identical IDE drives. All data written to the primary drive is simultaneously written to the second drive. If either drive fails, an alarm sounds and you are automatically shifted to the other drive. The average life of a hard disk is 4 years. If data integrity is important to your business, there is no safer, faster or more trouble-free data insurance.

Technical details:

On-board 33MHz or 75MHz (equivalent to Intel™ 8051) CPU. 16K Static Cache. On-board BIOS is self installing and totally transparent to the operating system, other controller cards on the bus, and network software. Operates at the full speed of the bus. No software or expensive software upgrades are ever required. RAID1 compatible. Far faster than software based RAID solutions. Only available from SVC. World leaders in fast I/O.

ISA 16-bit Mirroring IDE Drive Controllers:

ADP104 - Controls 2 sets of 2 hard drives to 8GB **$75**

ADP108 - Controls 2 sets of 2 hard drives to 8GB plus 4 mixed capacity floppy drives to 2.88MB **$125**

VESA 32-bit Mirroring IDE Drive Controllers:

ADP111VL Super I/O - Single-board control for 2 sets of 2 mirrored hard drives to 8GB, plus 2 IDE devices (HD, tape or CD-ROM) and 2 mixed floppy drives to 2,88 MB. 2 serial, 1 parallel and 1 game port **$145**

VESA 32-bit Super I/O Controller

ADP90VL - Controls 4 independent IDE hard drives of any capacity to 8GB, plus 2 mixed floppy drives to 2.88 MB. Provides 2 serial, 1 parallel and 1 game port **$59**

Universal IDE Controllers

ADP60F 16-bit IDE Controller. Works with all 16-bit ISA systems. Controls 2 IDE drives to 1.6 Gigabytes. Controls 2 floppies of any capacity. On-board intelligent BIOS is relocateable. **$49**

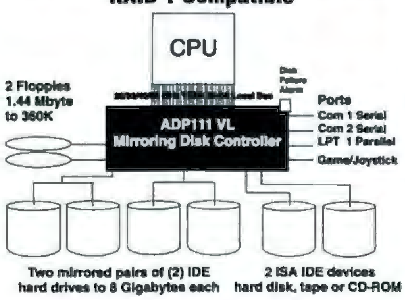
ADP50 8-bit IDE Controller. Interfaces 2 16-bit IDE hard drives to the 8-bit bus. Works with all XT compatibles including IBM, Compaq, Tandy and ATT. **$39**

Building or upgrading systems?

Ask about SVC's wide selection and lowest prices on US-designed and built motherboards.

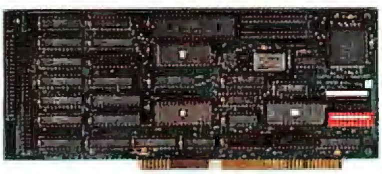
All Trademarks are the property of their respective owners

32-Bit VESA Local Bus Super I/O, Floppy and Mirroring IDE Hard Disk Controller. RAID 1 Compatible



Sustained Transfer Rate (Core Test 2.7)
3624 Kb or 3.6 Mbytes per second in SVC 486
Meets IEEE VESA Standards

Mirroring IDE Drive Kits



ISA 16-bit ADP104 plus 1 drive

210 MB	14ms Conner Drive	$295
420 MB	14ms Conner Drive	$395
540 MB	10ms Conner Drive	$495
810 MB	10ms Conner Drive	$695
1080 MB	10ms Conner Drive	$795

Above kits with ADP111 32-bit VESA Mirroring (automatic backup) add: $45

SVC 8-bit or 16-it Hard Drive Kits Featuring Fast Conner Hard Drives

These kits work with any 8 or 16-bit ISA Bus PC or AT machine including Compaq, IBM, AST, Tandy, ATT, Dell, Gateway and other ISA-bus compatibles. On-board ROM BIOSs are self-installing and co-exist with other controllers on the bus.

All kits include: High-speed SVC IDE controller, Conner caching drive, cables and installation instructions.

Capacity	Speed	Throughput	Price
210 MB	14ms	7.5 MBPS	$224.00
420 MB	14ms	7.5 MBPS	$314.00
540 MB	10ms	8.0 MBPS	$444.00
810 MB	10ms	8.0 MBPS	$644.00
1080 MB	10ms	8.0 MBPS	$724.00

8-bit kits interface 16-bit drives to any ISA PC or AT 8-bit slot. Controllers are available separately.

You can't buy more performance for less. All SVC systems, subsystems and boards are designed, built, manufactured and warrantied by SVC. All incorporate the latest technologies to be developed in Silicon Valley, our home. We offer technical support from 9AM to 5PM PST, and a 24-hour bulletin board for questions and the latest device drivers available. We are now in our twelfth year of delivering high-speed systems, boards and sub-systems.

Better Boards
Better Systems
Better Prices

SILICON VALLEY
C O M P U T E R

1-800-600-8111

441North Whisman Road, Bldg. 13, Mountain View, CA 94043
Phone: 415-967-1100, Fax: 415-967-0770

Circle 201 on Inquiry Card.

Actual screens may vary.

FLEET DEFENDER™

The F-14 Tomcat Simulation!

It's all up to you! The skies are swarming with bandits. Only you stand between the threat and your carrier battle group.

Lock on your radar and launch the Navy's advanced weapons to destroy the most sophisticated enemy targets ever developed for a MicroProse simulation. Roll, turn, climb, and dive to out-maneuver enemy aircraft using an artificial intelligence developed right out of Soviet and Third World military doctrine.

A computer-controlled wingman responds to your every command. And, you'll interact with strike packages that include F/A-18 Hornets, A-6 Intruders, A-7 Corsairs and E-2C Hawkeye AWACS.

Featuring the latest in 3-D terrain technology derived from digitized information taken from LANDSAT geological surveys, you'll pilot your F-14 through actual locations.

Fleet Defender from MicroProse. We brought you the F-15 Strike Eagle, now try the F-14 Tomcat featuring the most authentically modeled F-14 systems available anywhere outside of the Navy.

MICRO PROSE®
ENTERTAINMENT • SOFTWARE

For IBM-PC/Compatibles.

Circle 307 on Inquiry Card.

To get our free catalog, call **1-800-879-PLAY** Mon.-Fri., 8:30 am - 5:00 pm EST or fill out the coupon and mail it to: MicroProse Software, Inc., 180 Lakefront Drive • Dept. D10 • Hunt Valley, MD 21030-2245

Name: ____________________

Address: ____________________

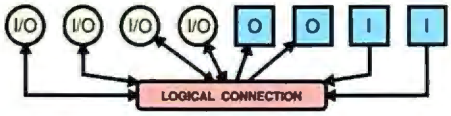
City: ____________ State: ______ Zip: ______

NAK

Circle 193 on Inquiry Card

PRINTER SHARING & MEMORY

I/O = input /output
○ = serial
□ = parallel



800-238-9415

LCX-1000 (1Mb) $495
8 ports; 4 serial I/O; 57,600 bps
2 parallel in, 2 parallel out

LC-256 (256Kb) $399
LC-512 (512Kb) $449
8 ports; 4 serial I/O; 19,200 bps
2 parallel in, 2 parallel out

LXFR-ETC $49
PC-to-PC File Transfer for DOS, Windows & OS/2, 4 user license

PB-42PP-256Kb $249
PB-42PP-1Mb $299
PB-42PP-4Mb $449
6 parallel ports; 4 in / 2 out
Upgradable to 4Mb; 25,000 cps

LC Jr.-256 (256Kb) $199
LC Jr.-512 (512Kb) $249
5 ports; 4 serial in, 1 parallel out
Up to 115,200 bps

LC-41PAS $69
5 parallel ports; 4 in / 1 out
Smart-switch; 25,000 cps

SPPS (NO Xon/Xoff) $49
9600 bps to 115,200 bps,
Serial / Parallel Converter

PB-11PP-1Mb $199
2 parallel ports; 1 in / 1 out
Upgradable to 16Mb; 25,000 cps

PC SIMMs
EISA SIMMs
HP4 & HPIIIsi
PCMCIA
TOSHIBA
MAC SIMMs
POWERBOOK

LOGICAL CONNECTION® 4660 Portland Road NE #108 Salem, OR 97305-1658 Tech.: (503) 390-9375 **FAX: (503) 390-9372**

Some people think that by copying their software they'll make out like a bandit. They're right.

Copy software illegally and you're committing a federal crime with fines of up to $100,000. Help your organization comply with the law by ordering the Software Publishers Association's Software Management Guide. For only $80 you'll receive SPAudit for DOS and Macintosh,™ comprehensive auditing software, a video and procedures for keeping your organization's software legal. And your record clean.

Keep your software legal. 13

To order, call the Software Publishers Association at 1-800-388-7478, or include credit card information or a check and send or FAX this coupon to: SPA Management Guide, P.O. Box 79237, Baltimore, MD 21279-0237, FAX (202) 223-8756.

Name ______
Company ______
Title ______
Address ______
City ______
State ______ Zip ______
Phone ( ) ______ Ext ______
Please send me ____ copies at $80 each.
Total $ ______ (DC residents add 6% sales tax)
☐ Check enclosed ☐ American Express
☐ VISA® ☐ MasterCard®
Card Number ______
Exp. Date ______
Signature of Cardholder ______
Name of Cardholder ______

spa

Don't copy that floppy.

HIGH SPEED HEAT SINKS FOR PENTIUM™ µPS

IERC's µP dissipators are designed for use with Intel Pentium™ and other standard PGA 21x21 packages. Using IERC's long-proven clip* technology, the quick connect clip easily attaches to the µP and accommodates heat spreader. These high performance heat sinks offer circuit designers an ideal solution to their thermal problems. Custom and standard µP dissipators as well as cooling fan/heat sink assemblies are available.

™Pentium is a registered trademark of Intel Corp. *Patent pending.

IERC

International Electronic Research Corp.
135 W. Magnolia Blvd. • Burbank, CA 91502
TEL: (818) 842-7277 • FAX: (818) 848-8872

Circle 242 on Inquiry Card.

2 ADDITIONAL RS-232 PORTS FOR WINDOWS & OS/2!

- Two RS-232 Ports with Full Modem Control Signals
- 16 Bit Address decode allows Windows & OS/2, COM3:, COM4: etc.
- Individually Selectable Address & Interrupt (2-5,10,11,12 & 15)
- 16550s Standard
- FREE Technical Support
- MasterCard, VISA, & COD accepted
- 30 Day Money Back Guarantee
- Part #3088 Price: $89.00

SEALEVEL COMMUNICATIONS & I/O

SEALEVEL SYSTEMS, INC
P.O. Box 830
Liberty, SC 29657
803-843-4343 FAX 803-843-3067

Circle 215 on Inquiry Card.

Thinking of Bar Codes...

Think Videx!!

If you need a quality bar code reader small enough to fit in the palm of your hand, Videx has a bar code reader for you.

The TimeWand I offers credit-card sized portability, ideal in time and document tracking applications. The rugged DuraWand can take the punishment typically found in delivery and security applications. The TimeWand II offers the durability and computing power necessary in applications ranging from hospital patient care to warehouse inventory.

Call today to receive a free information kit on Videx portable bar code readers.

1105 N.E. Circle Blvd., Corvallis, OR 97330
503-758-0521 • Fax 503-752-5285

Videx

Videx, TimeWand, and DuraWand are registered trademarks of Videx, Inc. GCO462B

Circle 225 on Inquiry Card.

Barcoding with Windows!

WindowBar™

The bar coding software that's easy to install *and* easy to learn!

Ideal for Compliance Labeling!

- Full-featured, Network-ready. Fully DDE compatible!
- Supports most popular symbologies, bar code printers and databases
- Interactive and automatic printing tools via Windows, not DOS.
- Full design capabilities; Full Windows implementation.
- Variable graphics (WYSIWYG)

Call Now for a Free Demo Disk
1-800-289-6293

Mayer Automation Group • Division of Mayer Electric Supply Co, Inc.
3405 4th Ave. So., Birmingham, AL 35222 • (205) 583-3500 • FAX: (205) 323-0886

Circle 252 on Inquiry Card.

Light-Speed Serial Communications

PCSS-8FX Intelligent Serial Coprocessor

BBS Fossil Drivers Included

- Better than 1Mbyte/second transfer rate.
- No load on Host Processor!
- I/O Mapped - No host memory used.
- NEW - Supports DMA transfer. Faster than Dual Ported Memory!
- Looks like IBM Uart with Huge QUEUE!
- 8 ports per card. RS-232, 422, 485.

ORDER TOLL-FREE 800-282-4835

GTEK INC.

GTEK, INC. • DEVELOPMENT HARDWARE & SOFTWARE • P.O. Box 2310
Bay St. Louis, MS 39521-2310 USA • Mississippi & Technical Support 601-467-8048
Fax: 601-467-0935 • OEM & Dealer Inquiries Welcomed!

Circle 206 on Inquiry Card (RESELLERS: 207).

LET YOUR COMPUTER DO THE TALKING!

Integrated Voice/Fax Mail

Integrates major voice/fax applications plus program control into one full-featured high performance software. PC-AT/386/486 based. Menu driven. Easy to use. Full support for Rhetorex, New Voice, Dialogic, Bicom, Pika, TTI and Intel voice and fax hardware. Supports up to 32 voice lines and up to 8 fax lines.

Hardware+Software Kits
2 voice lines kit starts at **$650**

Fax-on-Demand lines: 818-368-4566 or 818-368-8848

- Automated Attendant
- Unlimited Audiotex
- Voice Mail
- Talking Yellow pages
- Telemarketing
- Fax Mail
- Fax-on-Demand
- Fax Broadcasting
- Date/Party lines
- Int'l Call Back

SigmaTech Software
Tel: (818) 368-6132 Fax: (818) 368-7859
10801 Bismarck Ave., Northridge, CA 91326 USA
(Resellers/Dealers/OEMs/Private labels are welcome)

Circle 233 on Inquiry Card (RESELLERS: 234).

CONTROL
ALL YOUR PC SERVERS
FROM ONE KEYBOARD & MONITOR
with MasterConsole®

COMPARE QUALITY AND PRICE PERFORMANCE!

- Save Space, Cut Costs & Centralize Control with 100% Reliability
- "Plug and Play" Any Mix of PC/ATs & PS/2s; Supports All Video
- Desktop or 19" Rackmount Models for 2, 4, 8, 16 PCs, Expand to 64
- Keyboard Emulator for Error Free PC Autoboot and PC Operation
- AUTOSCAN™ to Monitor All PCs
- MouseShare™ for PS/2 & Serial Mouse
- Remote Access up to 150 Feet
- Thousands in Use Worldwide GSA Schedule for US Fed. Govt.

"No other solution stacks up."

CALL TODAY! (908) 874-4072 X 71

RCI®

RARITAN COMPUTER, INC. 10-1 Ilene Court, Belle Mead, NJ 08502 Fax (908) 874-5274

30-DAY MONEY BACK GUARANTEE FULL 1-YEAR WARRANTY

See us in San Francisco at NETWORKS EXPO Booth #1147
Germany - Elsner Computertechnik, Tel: 49-521-889877 Fax: 49-521-889925
Japan - Proside Corp., Tel: 81-3-3254-6131 Fax: 81-3-3254-6134
Taiwan - Raritan Computer Taiwan, Inc., Tel: 886-2 218-1117 Fax: 886-2 218-1221
The Netherlands - Artelcom B.V., Tel: 31-1-442-3313 Fax: 31-10442-3443
United Kingdom - Kemitron LTD, Tel: 44-244-536123 Fax: 44-244-531043
For List of Latin American and Canadian Dealers contact RCI (908) 874-4072

Circle 246 on Inquiry Card (RESELLERS: 247).

PC Systems in ROM

$149

Use 'C' Code

KS-7 AT equivalent card $289 - q1
NEC V53 CPU 512K Ram, AT bus, Options: PCMCIA, 4M Ram, 2M Eprom, 512K NV Sram, Clock, VGA, 5 Serial, 2 Parallel, Keybd, Flop, Modem, 12 bit A/D.

Run with DOS

KS-2 XT equivalent card $149 - q1
NEC V40 CPU 256K Ram, XT bus Options: PCMCIA, 512K Eprom, 384K Sram, Clock, 3 Serial, 2 par., Modem, A/D.

Burn in ROM

Complete Development Support
We provide development systems and utilities to download, test, and burn your DOS programs into ROM.

KILA
Boulder, Colorado 80301
303-444-7737
fax: 303-786-9983

Circle 210 on Inquiry Card.

DON'T BE OUT OF TOUCH!

Talking Technology has multi-line voice and fax processing systems so you can stay in touch with your world.

For Sales and Technical Information Call:
1-800-685-4884
Demo: 1-510-522-3800 ext. 120

Complete multi-line packages start at $699!

TALKING TECHNOLOGY, INC.
1125 Atlantic Avenue Alameda California 94501

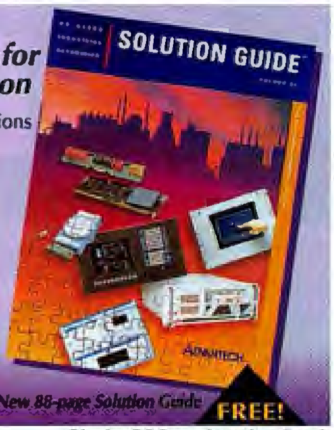
Circle 216 on Inquiry Card.

PC-based Solutions for Industrial Automation

- Industrial PCs & Workstations
- Enclosures and Card Cages
- 486/386/286 CPU Cards
- RAM/ROM Disks
- Industrial I/O Cards
- RS-232/422/485

1-800-800-6889
1-408-245-6678 in CA
Fax: 408-245-8268

ADVANTECH
750 East Arques Ave.
Sunnyvale, CA 94086



New 88-page Solution Guide FREE!

Circle 203 on Inquiry Card.

Rackmount Solutions

RACKMOUNT COMPONENTS – QTY 25 PRICING

Rackmount Chassis 19"x7"x17"	$183
Rackmount VGA Monitor	$531
Rackmount Monitor Shelf	$113
Rackmount Cherry Keyboard Drawer	$200

RACKMOUNT PLATFORMS – Qty 1 Pricing

RMS486DX2-66 EISA	$1593	RMS486SX-33	$915
RMS486DX-33	$1136	RMS386SX-33	$665

RACKMOUNT CHASSIS – 15 Models up to 20 Board Slots
SLOT CPU BOARDS – EISA/ISA 486, 486SX, 386, 386SX
RACKMOUNT MONITORS – Super VGA & Monochrome
RACKMOUNT KEYBOARDS – High Quality Cherry KB
RACKMOUNT SWITCH – Video/KB up to 12 CPUs
RACKMOUNT CABINET – Modular from 21" to 96" high

Exclusive International Distributor Program now Available

VALLEY TECHNOLOGY INC.
2468 Armstrong Street, Livermore CA 94550
(510) 447-2030 FAX: (510) 447-4559

Circle 228 on Inquiry Card.

DaqBook/100™

Data Acquisition
for Notebook PCs

- High-speed, PC parallel-port connection
- 2-ch D/A & 16-ch, 100-kHz A/D
- 32 digital I/O
- 16 high-speed digital inputs
- 5 counter/timer channels
- AC or battery operable
- MS Windows graphical software

IOtech
IOtech, Inc. · 25971 Cannon Rd · Cleveland, OH 44146
(216) 439-4091 · Fax (216) 439-4093

Circle 209 on Inquiry Card.

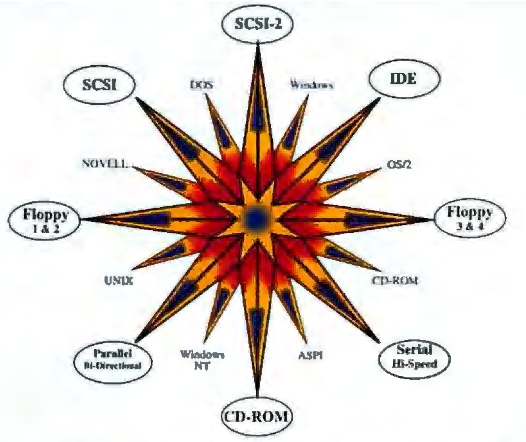
Data Acquisition

Data Acquisition • Diagnostic Equipment

SCSI ★ IDE ★ FLOPPY SERIAL ★ PARALLEL

(Hi- Speed) (Bi-Directional)

Host Bus Adapter/Controller



Standard (7 SCSI, 2 IDE, 2 Floppy, 2 Serial, 1 Parallel)...$175
Enhanced (7 SCSI, 2 IDE, 4 Floppy, 4 Serial, 2 Parallel)...$195
Price includes cables, software & complete documentation

DISCOVER NOVUS · VISA · MasterCard

Control Concepts, Inc.
8500 Executive Park Avenue
Fairfax, Virginia 22031
Tel: (800) 922-9259 Fax: (703) 876-6416

Circle 238 on Inquiry Card.

DISK FACTORY

- Automatically loads, formats, copies, verifies and prints labels on 3.5 & 5.25 diskettes.
- Designed for use with network or any data distribution application.
- Perfect for serializing or otherwise identifying specific diskettes.

VICTORY ENTERPRISES
Austin Texas

1-800-727-DISK (3475)

Circle 224 on Inquiry Card.

Rugged Rackmount Keyboards

Elma offers high quality industrial ruggedized keyboards. Features include:

- 19" rackmount keyboards
- Take 1 U or 1.75" space
- Over 25 models to select from
- Available in full travel and membrane types
- IBM PC XT/AT, PS2 compatible
- US and International versions
- Spring-lock front panel
- 8mm, 2 button trackball with serial output

Call Elma at **510-656-3400**

ELMA

Elma Electronic, Inc.
44350 S. Grimmer Blvd.
Fremont, CA 94538
Tel: 510-656-3400
Fax: 510-656-3783

Circle 250 on Inquiry Card (RESELLERS: 251).

Increase Speed & Fix Problems!

SCSI Vue™ Terminator

High- Performance Active Diagnostic

SCSI 1/2/3

$59 Retail

Features:
- Active Regulation
- Status Indicators
- Gold Contacts

Benefits:
- Improves SCSI Bus Performance
- Less Errors; More Reliable Data Transfer
- Diagnoses Problems
- Analyzes Signal Quality

patent pending • DOS • MAC • UNIX •

SCSI Vue™ Gold Cables

From $39

The Ultimate SCSI Cables

Features:
- Diagnostic Indicators
- Triple Shielding
- Double Gold 20u" Plated Connectors
- Extra Heavy 26 Gauge Wire

Benefits:
- No Loss Of Important Data
- Faster Performance
- Test Cable Integrity

Granite D•I•G•I•T•A•L

Ph: 510-471-6442
Fax 510-471-6267
3101 Whipple Rd.
Union City, CA. 94587

Circle 235 on Inquiry Card (RESELLERS: 236).

CUSTOMIZE YOUR KEYBOARD

- Custom Key Imprinting - all brands!
- Custom Colored keys for IBM®, DEC®, Wyse®, Key Tronic®, Cherry®, and more!
- Custom and stock keytop label kits for software support & languages.
- Full color keyboard templates made to your exact specifications.
- Word Perfect Keyboards.
- Cyrillic, Arabic, Hebrew, etc. Keyboards

CUSTOM HOTLINE 800 937-1337

from the leader in Keytop Innovations™

Hooleon CORPORATION

Dept. BYTE, 260 Justin Dr.
Cottonwood, AZ 86326
602 634-7515
FAX 602 634-4620

Circle 208 on Inquiry Card.

THE BUYER'S MART

A DIRECTORY OF PRODUCTS AND SERVICES

THE BUYER'S MART is a unique classified section organized by product category to help readers locate suppliers. Each ad has Inquiry numbers to aid readers requesting information from advertisers.

AD FORMAT: Each ad will be designed and typeset by BYTE. Do NOT send logos or camera-ready artwork. Advertisers should furnish typewritten copy. **2"x1 7/16"** ads can include headline (23 characters maximum), descriptive text (300 characters is the maximum recommended) plus company name, address, telephone and fax number. **2"x2 7/8"** ad has more space for descriptive text (850 characters is the maximum recommended).

DEADLINE: Ad copy is due approximately 2 months prior to issue date. For example: November issue closes on September 8. Send your copy and payment to: THE BUYER'S MART, BYTE Magazine, 1 Phoenix Mill Lane, Peterborough, NH 03458. For more information call: Margot Swanson at 603-924-2656. FAX: 603-924-2683.

RATES (Jan. 1994)

	3-5 issues	6-11 issues	12 issues	13 issues
2"x1 7/16"				
1 ad	$696	$668	$585	$557
2 ads/issue	–	–	557	529
3 ads/issue	–	–	529	501
2"x2 7/8"				
1 ad	$1,392	$1,336	$1,170	$1,114
2 ads/issue	–	–	1,114	1,058
3 ads/issue	–	–	1,058	1,002

Inquiry 654.

BAR CODE

Bar Code Printing Software
LabelWorks for Windows

- Prints all Popular Bar Code Types (19 Types)
- Desktop Publishing Features: WYSIWYG, Scalable Fonts, Rulers, Guides, Lines, Shapes, Page Zooms (25%-400%), Templates
- Rotates Text, Bar Codes, and Graphics
- Supports Windows Compatible Fonts
- Choose From Over One Hundred Popular Label Formats or Design Your Own
- Rich Text Support: Mix Styles, Types, & Sizes
- Automatically Prints Serial Numbers
- Imports & Exports Graphic Files: TIFF, GIFF, BMP, PCX, WPG, WMF, TARGA
- Supports Virtually all Windows Compatible Printers (PostScript, Laser, & Dot Matrix)
- 30-day Money-Back Guarantee, $295

CALL FOR FREE DEMO SOFTWARE

AMERICAN MICROSYSTEMS
2190 Regal Parkway, Euless, TX 76040
(800) 648-4452 (817) 571-9015 FAX (817) 685-6232

BAR CODE EXPERT

- Keyboard wedge readers for PC/XT/AT, PS/2, Mac and Terminals.
- Readers w/RS-233, RS-485 and multidrop protocol.
- Reader w/DTMF output, data transmission over phone line
- Accepts Wand, Slot, CCD, Laser, Magstripe and **MICR check reader.**
- Reseller's discount available. Please call for free catalog.

IBS-Intelligent Barcode systems, Inc.
16031 Kaplan Ave., City of Industry, CA 91744
(800) 765-2271 (818) 968-6265 Fax: (818) 968-5527

Inquiry 655.

NEED A ONE STOP SOURCE FOR YOUR BAR CODE SOLUTIONS?
NO PROBLEM! WE OFFER Quality • Performance • Value

A full line of **READERS • PRINTERS • PORTABLES • BAR CODE READERS FOR NOTEBOOKS • HEWLETT-PACKARD SCANNERS • MAGNETIC STRIPE READERS.** Our readers plug and play with your existing system without additional software. **CALL ABOUT OUR 30 DAY GUARANTEE • TECHNICAL SUPPORT • OEM/VAR DISCOUNTS.**

INTERNATIONAL TECHNOLOGIES & SYSTEMS
Eastern USA (800) 826-1688 804-272-0138 Intl.
Western USA (800) 228-9487 804-272-0357 Fax

Inquiry 656.

DOS & WINDOWS BAR CODING
Bar code readers designed for fast, reliable, cost-effective data entry. They work just like a second keyboard. Numerous scanners (wand, credit card, CCD, laser etc). **Bar Tender for Windows** designs labels on screen & outputs on almost any printer. DOS printing, too. Generous reseller discounts. Great warranty. 30-day money-back guarantee.

Seagull Scientific Systems, Inc.
15127 N.E. 24th, Suite 333, Redmond, WA 98052
800-758-2001 206-451-8966 FAX 206-451-8982

DATA INPUT DEVICES
Bar Code, Magnetic Stripe Readers for microcomputers & terminals, including IBM PS/2 & others, DEC, Macintosh, AT&T, CT, Wyse, Wang. All readers connect on the keyboard cable & are transparent to all software. UPC & 39 print programs, magnetic encoders, & portable readers are also available.

TPS Electronics
4047 Transport, Palo Alto, CA 94303
415-856-6833 AppleLink: BARCODE
1-800-526-5920 FAX: 415-856-3843

Inquiry 657.

BAR CODE

VARIANT MICROSYSTEMS
BAR CODE READERS DELIVER
WAND/LASER/MAGNETIC CARD CONNECTIVITY

- Keyboard wedges (Internal/External) for IBM PC/XT/AT, PS/2, and portables
- RS232 wedges for WYSE, Link, Kimtron terminals
- Bar code and label printing software
- Full two-year warranty
- **30-Day Money-Back Guarantee**
- **Extensive VAR/Dealer Discounts**

46560 Fremont Blvd., Suite 105/ Fremont, CA 94538/ (510) 440-2870
800-666-4BAR FAX: (510) 440-2873

Inquiry 658.

BOOKS

Earn Your High-Tech Degree While Working Full Time

High-Technology Degree Alternatives shows how to get your college degree without quitting your job, attending night school for years, or breaking your budget. $21.95 + $3.75 s/h. Use VISA/MC.

Professional Publications Inc.
Dept. 808.
(800) 426-1178

Inquiry 659.

C++ & DATABASE

C++ Libraries to access and fax to/from your database:

SyPLUS & OraPLUS C++ Libraries for Sybase & Oracle	$189.00
SyPLUS & OraPLUS w/source code	$589.00
Sy FAX & OraFAX C++ Libraries for Sybase & Oracle	$129.00
Sy FAX & OraFAX w/source code	$529.00
Other C++ Products:	
In-depth C++ video course; DOS/UNIX examples, support	$249.00
The C++ TOOLBOX, MS/Win, DOS Libraries	$89.00
The C++ TOOLBOX w/source code	$289.00

Universal Information Systems (UniInfo)
(800) 793-7491
72 Van Riepen Avenue, Jersey City, NJ 07306-2806

Inquiry 660.

CAD

ELECTRONICS CAD
Schematic Capture & PCB CAD
Analogue Simulation, Digital Simulation, etc.
Prices from $195. Credit cards welcome.
For brochure use Inquiry # or contact us at:

NUMBER ONE SYSTEMS
1795 Granger Avenue, Los Altos, CA 94024
Tel/Fax: 415 968 9306

Inquiry 661.

CAD/CAM

CONTOURING MOTION CONTROL FROM A PRINTER PORT!
Indexer LPT™ software
NEW **VERSION 3** **$249** VISA/MC

- Controls up to six step motors simultaneously.
- Linear and Circular Interpolation.
- New features to accommodate machine control.
- Easy-to-use DOS device driver. Super Manual.
- CAD-CAM interface available.

Ability Systems Corporation 1422 Arnold Ave. Roslyn, PA 19001 (215) 657-4338 FAX: (215) 657-7815

Inquiry 662.

CD RECORDABLE

Geared to CD-technology
GEAR, the ultimate CD-Recordable tool for any CD-Standard
If you demand a simple, easy to use solution to create CD's, GEAR is everything you need. GEAR supports all major CD-Recorders; JVC, Kodak, Philips, Ricoh, Sony and Yamaha. GEAR is available on DOS, Windows, Apple Macintosh, Sun Unix and Hewlett Packard Unix.

Elektroson
America, 31 Waterloo Avenue, Berwyn, PA 19312, USA
tel 1-215-660-9038, fax 1-215-667-9387
Europe & Asia, P.O. Box 2436, 5600 CK Eindhoven, The Netherlands
tel 31-(0) 40-515065, fax 31-(0) 40-514920.
E-mail Elektro@sci.kun.nl

Inquiry 663.

CD-ROM

A-LINK is YOUR LINK to CD ROM TECHNOLOGY
From the heart of Silicon Valley
*** CD Rom Titles ***
*** CD Rom Drives ***
*** Multimedia ***
Low Prices .... Large Selection
Call for free product list and information
800-529-9222 or **Fax (408) 255-6281**
Visa/MC

Inquiry 664.

* TOSHIBA * TEXEL * NEC *
* SCSI INTERFACE *
* MEDIA VISION * TRANTOR *
• CD-ROM TITLES, MAC & DOS
• CD-ROM CADDIES & ACCESSORIES

Computers at Large
Saratoga, CA
Dedicated to CD-ROM technology.
PLEASE CALL FOR OUR PRICE LIST
800-642-4194 • 408-255-1081
Fax 408-255-2388 VISA & MasterCard accepted

Inquiry 665.

FREE CD ROM*
CD ROM Sampler contains complete directories, interactive demonstrations, and fully functional applications from ALL of Knowledge Media's CD ROM Libraries... 12 titles in all!
Plus $20 worth of coupons for Knowledge
*$6.95 shipping and handling MO/Check, VISA, MC accepted
To order call:
1 800 78 CD ROM or 916 872-7487
KNOWLEDGE MEDIA
436 Nunneley, Paradise, CA 95969

Inquiry 666.

Put All Your Documents on CD-ROM for less!
We can assist you in your CD-ROM Development by converting paper documents, microfilm or fiche, catalogs and images on to CD-ROM. We also develop search engines for retrieval purposes.
Competitive prices and excellent customer service
Call for information.

Media Conversion Corp.
800 Roosevelt Road, Building D/Suite 106
Glen Ellyn, IL 60137
(800) 860-1033 or Fax (708) 469-1277

Inquiry 667.

CD-ROM Networking for Peer-to-Peer Networks
Introducing OPTI-NET® *Lite*
OPTI-NET *Lite* employs data caching and prefetching technologies to improve the response times for clients sharing CD-ROM resources on peer-to-peer networks. Call for your free catalog featuring our line of CD-ROM solutions including the complete OPTI-NET software family, OPTI-CD*cache*™ CD-ROM caching, multi-drive CD-ROM hardware, and networked CD-ROM titles!

ONLINE COMPUTER SYSTEMS, INC.
FlashFAX Information Hotline 301-601-2120
301-428-3700 or FAX us at 301-428-2903.

Inquiry 668.

COMMUNICATIONS

PC VOICE MAIL KIT $1795
• Voice Processing on your PC • Software and 4 line board included • Order Taking • AUDIOTEX • Voice Messaging • Never miss another call! • HUNDREDS OF USES • Don't pay $1,000s CALL TODAY FOR Free DETAILS • 2 yr warranty

Amerifax Services Corp.
572 W. Market St. #5, Akron, OH 44303
(216) 253-8787 • (216) 762-6050 Demo

Inquiry 669.

THE BUYER'S MART

CD-ROM

New and Updated CDROM Titles

Cica MS Windows CDROM, Thsnds of Windows prgrms..$29.95
Giga Games CDROM, Games for DOS/Windows $39.95
Space and Astronomy, Thsnds NASA images/data $39.95
C User Group Library, C source code Dec 93. ....$49.95
Simtel MSDOS CDROM, DOS Shareware/Freeware..........$29.95
QRZ Ham Radio CDROM, FCC Callsign Db & Shrwar......$29.95
Hobbes OS/2 CDROM, OS/2 Shareware/Freeware...........$29.95
Source Code CDROM, 650 Mb source, DOS/Unix............$39.95
Gutenberg Project, Literature and docs.............................$39.95
Linux Operating Sys, 386/486 OS, X11, full src.................$49.95
FreeBSD Operating Sys, Ver 1.0, krnl src, X/GNU $39.95
Libris Britannia, MSDOS Tech/Sci/Engineer.......................$69.95
X11R5/Gnu CDROM, Full src, SPARC binaries....................$39.95
Nebula for NeXTSTEP, Prgms for Intel NeXTSTEP.............$59.95
Ada Programming CDROM, Compilers, source, docs.........$39.95
Aminet CDROM, Amiga Shareware/Freeware.......................$29.95
CDROM Caddies, Lifetime Guarantee $4.95

Top quality CDROMs. 100% satisfied or full refund.

WALNUT CREEK CDROM
4041 Pike Lane, Ste D-212, Concord, CA 94520
1-800-786-9907 Visa/MC AMEx, Fax: 1-510-674-0821

Inquiry 670.

CELLULAR PHONES

TWO CELLULAR PHONES WITH ONLY ONE NUMBER

Our cellular software will allow you to change phone numbers and electronic serial numbers on

MOTOROLA • MITSUBISHI • PANASONIC NEC • RADIO SHACK • NOKIA

WHY PAY TWO CELLULAR BILLS?
Put the same number on as many phones as you like!
Only $495!
We can also sell you a hand held cellular phone with your existing number for only $395.00!

Cellular Press
421 N. Rodeo Dr. #15318, Beverly Hills, CA 90210
Phone: 310-289-2174
Fax on Demand: 305-346-7674
Call from your fax handset and follow the voice prompts to receive complete technical specifications

Inquiry 671.

COMPUTER BOOKS

COMPUTER BOOKS at a discount
Personal, technical service. 15% discount off most books from 140+ publishers. Networks, Windows, architecture, CD-ROM, C++, UNIX, OOP, Internet, Macintosh, TCP/IP, Novell, Pentium. Worldwide shipping. GO CBK or E-mail 70007.1333 @compuserve.com from Internet. MC, VISA, AMEX, DISC, JCB cards. Free 16-page catalog.

CompuBooks
Rt. 1, Box 271-D 512-321-9652
Cedar Creek, TX 78612 Fax 512-321-4525
800-880-6818

Inquiry 672.

COMPUTER INSURANCE

INSURES YOUR COMPUTER
SAFEWARE Computerowner's 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.

1-800-800-1492
SAFEWARE, The Insurance Agency Inc.
PO Box 02211, 2929 N. High St., Columbus, OH 43202
Now available in Ontario!!!

Inquiry 673.

CROSS ASSEMBLERS

PC BASED DEVELOPMENT TOOLS
We offer low-cost efficient **CROSS ASSEMBLERS** and a superb line of **SIMULATOR-DEBUGGERS** with full built-in **DISASSEMBLERS** for Intel's **MCS-48, 51, 85** and **96**, and for the **Z80** families of embedded controllers. Our new simulators for the **80C196KB** and **80C196KC** are unique in the market, and have been received with rave reviews. The price of our software includes unlimited free upgrade privileges!

Lear Com Company
2440 Kipling St., Ste. 206, Lakewood, CO 80215
(303) 232-2226 FAX (303) 232-8721

Inquiry 674.

Cross Assemblers
Simulators
Disassemblers
New Advanced Release!

PseudoCorp
716 Thimble Shoals Blvd. Newport News, VA 23606
(804) 873-1947 Fax (804) 873-2154
BBS (804) 873-4838

Inquiry 675.

DATA RECOVERY

Ontrack
DATA RECOVERY
• Professional service recommended by major hard drive manufacturers • Expertise in virtually every operating system & media storage device • 24-hour support with weekend, priority, & on-site service available • For fast, successful results, call:
MN:1-800-872-2599 • CA: 1-800-752-7557
UK: 44-81-974-5522 • GERMANY: 0130-815-198
Corp. Headquarters: 6321 Bury Drive, Eden Prairie, MN 55346

Inquiry 676.

Tape & Optical Data Recovery
Any Tape, Optical, Cartridge of any format whether partially overwritten or damaged, Vogon the world leaders in Tape & Optical Data Recovery can recover any data anywhere on the surface. Recoveries from 1/2", 1/4", DC2000, 4mm, 8mm Exabyte, DEC TKxx, 3480, Worm, Magneto Optical etc.

VOGON International Ltd.
USA: 405-321-2585 Fax: 405-321-2741
UK: +44 (0) 734-890042 Fax: +44 (0)734-890040
Conversion & Duplication Systems & Bureau

Inquiry 677.

DATA/DISK CONVERSION

THE #1 CHOICE
in disk & tape conversion
for many leading corporations, government agencies, law firms, and companies in every industry–world-wide.
Free test • Satisfaction guaranteed

Graphics Unlimited Inc.
3000 Second St. North, Minneapolis, MN 55411
(612) 588-7571 FAX: (612) 588-8783
1-800-745-7571

Inquiry 678.

CONVERSION SERVICES
Convert any 9-track magnetic tape to or from over 5000 formats including 3½", 5¼", 8" disk formats & word processors. Disk-to-disk conversions also available. Introducing CD-ROM conversions. Call for more info.

Pivar Computing Services, Inc.
165 Arlington Hgts. Rd., Dept. #B, Buffalo Grove, IL 60089
(800) Convert (708) 459-6010

DISK DUPLICATION

FULL SERVICE DISKETTE DUPLICATION
- All disk formats, 100% virus checked
- Available in a variety of colors
- Custom silkscreening
- Bulk diskettes also available

Manufacturing diskettes in the U.S. since 1978

Syncom Technologies, Inc.
1000 Syncom Drive, Mitchell, SD 57301
1-800-843-9862

Inquiry 679.

EDUCATION

B.S. & M.S. in COMPUTER SCIENCE
The American Institute for Computer Sciences offers an in-depth home study program to earn your Bachelor of Science and Master of Science degrees in Computer Science at home. B.S. subjects covered are: MS/DOS, BASIC, PASCAL, C, File Processing, Data Structures & Operating systems. M.S. program includes subjects in Software Engineering and Artificial Intelligence.

AMERICAN INST. for COMPUTER SCIENCES
2101-BY Magnolia Ave. South, Ste. 200, Birmingham, AL 35205
800-767-2427 205-323-6191

FLOPPY DISKETTE

3.5" FLOPPY DISK
RELIABLE & DURABLE
- We are a manufacturer under the licence of Sony corporation.
- Our disks are all 100% Tested & Certified Error Free with guaranteed Clipping Level.
- Available products: 2HD, 2DD, Clam Shell.
- Our own brand MEGA and OEM or bulk are also available.
- Duplicator & wholesaler are welcome.

INMARK IND. LTD.
(HK)
1A Man Foong Industrial Bldg.
7 Cheung Lee Street
Chai Wan, Hong Kong
Tel: (852) 558-2203 Fax: (852) 897-3700

YHC CASSETTE IND. LTD.
(TORONTO)
75 Saintsbury Square, Scarborough
Ont. Canada M1V 3K1
Tel: (416) 321-1179 Fax: (416) 321-8451

Inquiry 680.

FLOW CHARTS

FLOW CHARTING 3

- High resolution print outs... dot matrix or laser
- Multi-page charts... portrait or landscape
- Import/export capabilities
- 35 shapes, 10 fonts, 4 line styles

ONLY $250

Call for free demo disk!

PATTON & PATTON 800-525-0082 ext. 1317
Software Corporation 485 Cochrane Cr., Morgan Hill, CA 95037

Inquiry 681.

WINDOWS FLOWCHARTER $129
RFFlow 3.0 is a professional drawing tool for flowcharts & org. charts. Requires Microsoft Windows; 200 shapes auto adjust in size; diagonal lines and curves; auto line routing and re-routing; OLE server; click on a shape to bring up a sub-chart; import/export bitmaps and metafiles; Call for free trial disk.

RFF ELECTRONICS
1053 Banyan Court, Loveland, CO 80538
Phone: (303) 663-5767 FAX: (303) 669-4889

FOREIGN LANGUAGES

FOREIGN LANGUAGES

Arabic, Hebrew, Russian, Chinese, Japanese, Indian, S.E. Asian – all the world's languages in Windows. Full support for mixing Arabic, Persian, Urdu, Hebrew + English. Chinese and Japanese type vertically/horizontally. Easy to use! *From $149.95. Call or write the WinLanguage™ experts!*

Gamma Productions, Inc.
Tel 310-478-6774 Fax 310-478-7765
2130 Sawtelle Blvd. #305, Los Angeles, CA 90025

Inquiry 682.

HARDWARE

486

Upgrade slow 386 with 486 50 or 66 Mhz motherboards* from $198.

***MADE by IBM–3 YEAR WARRANTY**

486 Systems from $698.

1 Year Parts, **LIFETIME LABOR** warranty

Money Back Guarantee

Fulmark Corp. 73 Spring St., #407, NY, NY 10012

1 (800) FULMARK or
(212) 274-1194, fax (212) 274-0803

$198

Inquiry 683.

IBM BUY • SELL • TRADE DCA

NEED TO BUY
IBM CAU'S, LAMS, SDLC Card, MC Store Loop Adapter, Any Quantity

CONNECTIVITY

IBM	4MB TOKEN RING	49.00
IBM	4MB TOKEN RING MC	99.00
IBM	16/4 TOKEN RING MC	249.00
IBM	16/4 TOKEN RING AT	349.00
IBM	5250 EMULATION AT/MC	249.00
IBM	3270 EMULATION AT/MC	99.00
IBM	8228 MAU	225.00
IBM	8218 COPPER REPEATER	275.00
IBM	8220 FIBER OPTIC CONV	675.00
DCA	*IRMA I BLOWOUT*	*49.00*
DCA	IRMA III	199.00
DCA	IRMATRAC 16/4	299.00
MADGE	*TOKEN RING 4MB (NEW)*	*69.00*

SOFTWARE

IRMA WORKSTATION WIN	249.00
IRMA WORKSTATION DOS	249.00
ATTACHMATE EXTRA	200.00
ATTACHMATE EXTENDED	249.00
IBM 3270 PC EMULATION	149.00
IBM PERSONAL 3270 V.2	200.00

IDEA 5250 EMULATION 99.00 MC

Piedmont Data Systems
Atlanta, Georgia
Phone (404) 449-3425 FAX (404) 441-1961

Inquiry 684.

Pre-Owned Electronics, Inc™

THE Independent Provider, serving the Dealer, Professional, Corporate, Government, and Educational Buyer since 1985

APPLE II® & MACINTOSH®
SYSTEMS • PARTS • EXCHANGE REPAIRS

Call for a Catalog... **800-274-5343**
INT'L: 617-275-4600 • FAX: 617-275-4848
205 BURLINGTON ROAD • BEDFORD, MA 01730

Inquiry 685.

HARDWARE

HEWLETT-PACKARD
Buy – Sell – Trade

LaserJet	ColorPro
DeskJet	DraftPro
RuggedWriter	DraftMaster
Electrostatic Plotters	DesignJet

HP 9000 Workstations and Vectras also available.

Ted Dasher & Associates
4117 Second Ave., S. Birmingham, AL 35222
Phone: (205) 591-4747 Fax: (205) 591-1108
(800) 638-4833

Inquiry 686.

DC POWER? PC APPLICATION?
•We have solutions
•12, 24, 48, 72, 125, 250 VDC
• Panel Mount, Rack Mount
Computers and Power Supplies
•Sales and Service Support Since 1976

TRANSDUCTION LIMITED
5155 SPECTRUM WAY, BLDG. 23
MISSISSAUGA, ONTARIO, CANADA L4W 5A1
U.S. and Canada Sales 1-800-268-0427
International:
Tel: 905-625-1907 - Fax: 905-625-0531

Inquiry 687.

HARDWARE/COMPUTERS

NEW! 20MHz 16-bit FORTH Single Board Controller with 8ch 10-bit A/D, 3ch 8-bit D/A

TDS2020 FORTH CONTROLLER AND DATA-LOGGER–4"x3" board uses Hitachi 16-bit H8/532 CMOS µP. Screams along at 3MIPS, but runs on only 30ma. On-board high-level easy FORTH language and assembler–no need for in-circuit emulation! Up to 512K NVRAM, 45K PROM. Attach keyboard, lcd, I²C peripherals. Interrupts, multi-tasking, watchdog timer, editor. 33 I/O, 2xRS-232, 6-16v 300µA data-logging! Free ready-made software solutions. Program with PC. Use for machine control, data-logging, inspection, robotics, remote monitoring, etc. **$299** (25s). STARTER PACK **$499**.

CALL NOW FOR DETAILS! *Sale-or-return*

Saelig Company
European Technology
tel: (716) 425-3753
fax: (716) 425-3835

Inquiry 688.

LANS

The $25 Network
Try the 1st truly low-cost LAN

- Connect 2 or 3 XTs, ATs, 386s, 486s
- Uses serial ports and null modem cable
- Runs at 115K baud - approx 8500 bytes/sec
- Runs in background, totally transparent
- Share disks and printers, etc.
- Needs only 15K of RAM

Little Big LAN
The most flexible network

- Peer to Peer LAN to 250 nodes
- $75 total software cost, not per node!
- Link via serial, parallel, or Modems
- Link via Ethernet or Arcnet
- Mixed mode routing
- Typically only 40K of RAM

Skeptical? We make believers!

Information Modes
P.O. Drawer F, Denton, TX 76202
Tech 817-387-3339 Orders 800-628-7992
Hours 1-5 Mon/Wed, 9-5 Tue/Thu/Fri CST

Inquiry 689.

NOTEBOOK PERIPHERALS

Auto & Aircraft Power Adapters

Battery adapters available to power portable computers and printers. Proprietary designs from Empire Engineering, through distribution, or OEMs.

• Small package with high efficiency
• Plugs between computer and lighter receptacle
• $99 • Designed and made in USA!!

Custom adapters designed for OEMs • Serial interface cards for Texas Instruments, Toshiba, and Everex/Sanyo.

Empire Engineering
California USA
tel 805/543-2818 fax 805/543-2820

Inquiry 690.

MAILING/SHIPPING SOFTWARE

★★★ SHIPMASTER ★★★

$79.95 ***Mailing & Shipping Software***
Reg $299.00 ***Limited Offer!!!***

* *Generates Address Labels, COD Tags & UPS Manifest*
* *Eliminates UPS Calculations & Multi-Chart Look-up*
* *Easy-to-follow Menu Screens & Pop-Up Colored Windows*
* *Interfaces with DBS Invoicing/Accounting Packages*

Free Bonus! >>> Includes Built-in Message Scheduler

❐ $79.95 ShipMaster (Mailing & Shipping Software)
❐ $49.95 CheckMaster (Personal/Business Check Book)
❐ $29.95 BudgetMaster (Financial Budgetary Forecaster)

+ $7.00 Shipping & Handling (Calif Residents add 7.75% Sales Tax)

❐ Visa ❐ MasterCard ❐ Check ❐ COD Cash only

Card #________________ **ExpDate**____

❐ 3.5" IBM-PC ❐ 5.25" IBM-PC ❐ Apple Macintosh

Please FAX your order w/company name, address & phone #

Data Business Systems *(Dept. 2)*
122-A 31st St. Newport Beach, CA 92663
(800) 675-0731 Fax: (714) 675-0741

Inquiry 691.

SCIENTIFIC SOFTWARE

Scientific & Technical Software
Call for our latest FREE catalog
1.800.622.3345

SciTech is your source for the best value in scientific and technical software. More than 1250 products.

1.312.472.0444 2231 N. Clybourn Ave.
FAX 1.312.472.0472 Chicago, IL 60614

Inquiry 692.

SECURITY

FIGHT PIRACY!
★ The New EVERLOCK ★
SOFTWARE COPY PROTECTION
New Option Board Safe-New Remote Registration
New CPU LOCK-CD ROM LOCK and more
★ EVERKEY HARDWARE LOCKS ★

Az-Tech Software, Inc.
Call for a FREE Demo **(800) 227-0644**
201 East Franklin, Richmond, MO 64085
(816) 776-2700
FAX (816) 776-8398

Inquiry 693.

THE ULTIMATE SOFTWARE SECURITY

- STOPCOPY family – UNCOPIABLE copy protection
- STOPVIEW software encryption
- NETLIMIT network license metering
- DOS, Windows, Macintosh, OS/2, support
- No source code changes required - for ANY of our products in ANY environment
- Our products destroy ALL of our competition
- Call for FREE demo disk, or to discuss our products' MANY options

BBI Computer Systems, Inc.
14105 Heritage Lane, Silver Spring, MD 20906
800/TRY-ABBI • 800/879-2224 • 301/871-1094 • FAX:301/460-7545

Inquiry 694.

KEY-LOK™ SECURITY

Piracy survival 11 years proves effectiveness of powerful multilayered security. Algorithmic response. Programmable memory. Economical. Transparent to PARALLEL/SERIAL port, Counters/Real-Time-Clock. Multi-product/feature licensing. DOS/UNIX/OS2. Also, access control system and disk drive locks.

MICROCOMPUTER APPLICATIONS
3167 E. Otero Circle, Littleton, CO 80122
(303) 770-1917 FAX: (303) 770-1863

Inquiry 695.

THE BUYER'S MART

SERVER MIRRORING

No★Stop Network
The software solution to provide full Level 3 Fault Tolerance for PC LANs.
- Server Mirroring
- Uninterrupted Processing
- Continuous Backup
- Any Network Operating System or Server environment

Nonstop Networks Limited, NY, NY
212-481-8488, Fax 779-2956

Inquiry 696.

SOFTWARE PACKAGING

FREE SOFTWARE PACKAGING CATALOG
Everything you will need to Package, Distribute, and Ship Your Software!! From manuals and binders to mailers and shippers

LABELS • LABELS • LABELS
For your diskettes, plain or custom printed dot matrix or laser printer . . . free samples
•••FREE CATALOG•••
Hice & Associates
8586 Monticello Dr., West Chester, OH 45069
Phone/Fax: 513-777-8586

Inquiry 697.

STOCK PACKAGING
to help you
market your software
ask for catalog 93QS2
Call **708 390-7744**
or fax 708 390-9886
PolyQuick Co.
1243 Rand Road, Des Plaines, IL 60016

Inquiry 698.

SOFTWARE/BUSINESS

DATA ENTRY SOFTWARE
Full featured, heads-down data entry with two-pass verification, edit language, operator stats, much more! Designed for the PS/2®, PC, XT, AT or compatibles.
PCs from $395 LAN version available
FREE 30 day trial
Computer Keyes
21929 Makah Rd.,
Woodway, WA 98020
Tel: 206/776/6443
Fax: 206/776-7210
USA: 800/356-0203

Inquiry 699.

SOFTWARE/EDUCATION

***DERIVE*® NOW HALF-PRICE!**
***DERIVE*®, A Mathematical Assistant** combines the power of computer algebra with the ease of a menu-driven interface. It solves symbolic & numeric equations, and does calculus, trig, vector & matrix algebra and more. It is programmable, & plots in 2 & 3D. Suggested List Price now only $125!
Req: MS-DOS PC compatible & 512K.
SOFT WAREHOUSE, INC.
3660 Waialae Ave. Ste. 304, Honolulu, HI 96822
Ph: (808) 734-5801 Fax: (808) 735-1105

Inquiry 699.

SOFTWARE/ENGINEERING

SAUNA: 3D THERMAL ANALYSIS
• Models: PCBs, stacked plates, heatsinks, multiboard enclosures. • All heat transfer modes: convection, radiation, conduction • Interactive menu-driven • Thermal parameters library • Fast "What if": dimension, mat'l, finish, analyses • Easy to learn & use • IBM PC & Macintosh II
Call or FAX for free evaluation program
Tatum Labs, Inc.
1287 N. Silo Ridge Drive, Ann Arbor, MI 48108
313-663-8810 FAX 313-663-3640

Inquiry 700.

SOFTWARE/ENGINEERING

Circuit Simulation
New Windows/Windows NT CAE Tools

Introducing The First and Only
Interactive SPICE
Experience Analog and Mixed signal simulation like you've never seen before
"Just like being at the Bench."
includes:
- **New IsSpice4; Interactive Circuit Simulator**
- **Real Time Cross Probing between Schematic editor and Simulator**
- **Model Libraries, more than 5000 Parts**
- **For PC, DEC Alpha, Mips, Macintosh**

Full SPICE programs starting at $95. Complete systems with schematic entry, IsSpice4, models, and waveform graphics only $2595.

Call or Fax for your Free Demo kit
P.O. Box 710 San Pedro, Ca 90733-0710
Tel (310) 833-0710
FAX (310) 833-9658
intusoft

Inquiry 701.

SOFTWARE/GRAPHICS

TIFF, PCX, TARGA, GIF, DIB, BMP, DCX, EPS, WMF, WPG, PICT, JPEG
AccuSoft Image Format Library 4.0
(new version)
"The most comprehensive raster support library on the market"
Import, export, convert, display, and print all above formats! Includes several sample programs with source code. Supports all languages. **Format compatibility guaranteed!** G3, G4, TIFF-F, multi-page images etc. Rotate, zoom, scale, color reduction, sharpen, special-effects etc. Versions for DOS, Windows, NT, Watcom, OS/2, MAC, and others.
AccuSoft Corporation
112 Turnpike Road, Westboro, MA 01581
(800) 525-3577 (508) 898-2770 FAX (508) 898-9662

Inquiry 702.

CAD/CAM/CAE Developers Kits–Windows/DOS
NEW RELEASE! TG-CAD Professional v.5.0.
Replaces TG-Professional v.4.0. Includes upgraded 2D & 3D geometric development kits, DXF In/Out release 12 and (NEW) TG-CAD Draw v.1.0. All in C. This four part development kit is truly "The Ultimate CAD/CAM/CAE Programming Engine." Comes with or without source code. 30 day guarantee. Free 30 page technical paper.
DISK SOFTWARE, Inc.
109 S. Murphy Rd., Plano, TX USA 75094-9971
Tel (214) 423-7288 Fax (214) 423-7288

Inquiry 703.

Sirlin's CAD ++ ENGINE
- Read and Write AutoCAD DWG and DXF files.
- Object oriented, modular, database-like access to CAD data.
- View, Print (rasterize), Plot (vectorize), and Pick (interact) modules.
- Available for C/C++ for DOS, Extended DOS, Windows, Sun, Macintosh and other Unix systems.

Sirlin Computer Corporation
25 Orchard View Dr., Londonderry, NH 03053 USA
Phone: (603) 437-0727 • Fax: (603) 437-0737

Inquiry 704.

SOFTWARE/MODELING

Announcing GMS 2.0 from Probots, Inc.
Easiest & most powerful modeling & simulation tool avail.
- Now with Super Spread Sheet, Super User Interface & Intelligent Agent Modeling capabilities!
- Specify & validate models, run simulations, analyze results, optimize systems & generate spectacular graphics in minutes!
- No special training or programming required!
- Ideal for planning and predicting tasks!

Act now for special intro prices! DEALERS WANTED.
Probots, Inc.
80 Damon Road, Ste. 3307
Northampton, MA 01060
413-586-8929
800-Sim-Easy

Inquiry 705.

SOFTWARE/SCIENTIFIC

VT$_E$X Scientific Desktop Publishing
• Scalable Fonts • Font effects • Typeface customization • Equations • Tables • Graphics • Foreign languages • Multi-lingual spell & hyphenation • IDE • On-line help • Dos, Dos-32 and Windows versions • From $199
"T$_E$X of Tomorrow"–Notices of AMS, March 1991
Call now for a ***FREE DEMO DISK***
MicroPress, Inc.
68-30 Harrow Street, Forest Hills, NY 11375
Tel (718) 575-1816 Fax (718) 575-8038

Inquiry 706.

EXPERIMENTAL DATA-FITTING
SCIENTIST, now on Windows™, fits experimental data to any combination of user-defined algebraic and differential equations, Laplace transforms and complex numbers – also determines best-fitting splines, polynomials and interpolating functions.
MicroMath Scientific Software
800-842-6284 fax: 801-942-0299

Inquiry 707.

SOFTWARE/TYPESETTING

PC T$_E$X
The next step beyond desktop publishing
This complete publishing system makes all your documents look their best. There is no limit to what you can do with PC T$_E$X.
Systems for DOS or Windows

PC T$_E$X excels at typesetting:
- High quality books and articles
- Scientific notation/math formulas
- Professional technical documents
- Foreign languages

PC T$_E$X is the difference between average and expert!
Personal T$_E$X, Inc.
800/808-7906 or 415/388-8853
12 Madrona St., Mill Valley, CA 94941
Fax: 415/388-8865

Inquiry 708.

SOFTWARE/VOICE/FAX

HIGH LEVEL C LIBRARIES
Multi-Voice and Multi-Fax are complete development C toolkits to access all the features for most voice and fax processing boards available today. It helps you write MULTI-LINE VOICE (and/or) FAX APPLICATION in minutes. Many example programs and libraries are delivered wit h fully commented source code. VISA/MC Accepted
Multi-Voice for Dialogic, Rhetorex, or Powerline II: **$599**
Multi-Voice for Single Line Watson Board: **$99**
Multi-Fax for CAS (Intel SatisFAXtion): **$199**
ITI SOFTWARE
Fax-On-Demand for information: (514) 835-2216

STATISTICS

NCSS 5.x Series – $125
Easy-to-use menus & spread sheet. Multiple regression. T-tests. ANOVA (up to 10 factors, rep. measures, covariance). Forecasting. Factor, cluster, & discriminant analysis. Nonparametrics. Cross Tabulation. Graphics: histograms, box, scatter, etc. Reads ASCII/Lotus. Many new add-on modules.
NCSS
329 North 1000 East, Kaysville, UT 84037
Phone: 801-546-0445 Fax: 801-546-3907

Inquiry 709.

TRANSLATORS

EASY TRANSLATORS TO "C"

- ASM-IBM ASM/370, Intel ASM86, MASM
- COBOL - COBOL 68, 74, 85
- PL/1 - 13 dialects, IBM, DRI, VAX, STRATUS etc.
- PL/M - Intel PL/M 51, 80, 86, 96, 286, 386
- Translation service; custom dialects; MS-DOS

Micro-Processor Services, Inc.
92 Stonehurst La., Dix Hills, N.Y. 11746
Tel. (516) 499-4661; Fax (516) 499-4727

Inquiry 710.

UNIX ON CD-ROM

UNIX Clone for $39.95

Trans-Ameritech presents LINUX Plus and BSD CD-ROM. Latest versions of LINUX and BSD with X-windows, TCP/IP development environments.

ALL SOURCES ARE INCLUDED.
! REAL UNIX POWER for the PRICE of DOS !
ONLY *$39.95*

Trans-Ameritech Enterprises
2342A Walsh Ave., Santa Clara, CA 95051
408-727-3883 FAX 408-727-3882

Inquiry 711.

UTILITIES

PEN PLOTTER EMULATOR

FPLOT turns your printer into an HP pen plotter. Fast hi-res, no jagged lines. Vary line width, color. Screen preview – zoom, pan. Works with most CAD programs. Supports most printers. Requires DOS 2.1 or higher. $119+$3 S&H. VISA/MC/Chk/MO.

FPLOT Corporation
24-16 Steinway St., Suite 605, Astoria, NY 11103
718-545-3505

Inquiry 712.

Serial Troubles?
Watch Your Serial Port Problems Disappear with *DATASCOPE*®

DATASCOPE shows you the data that is transferred between serial devices. A must have for problems with your computer, mouse, modem, plotter, any serial device!

Only **$89.95**US from **SEIMAC RESEARCH**
Call **902-468-3007**
for a faxed brochure on this amazing utility

Inquiry 713.

WINDOWS

THE ULTIMATE BBS
FREE FREE FREE FREE FREE FREE FREE

Latest Windows and DOS Utils, Pgms, Source Code, Lively CHAT, online games, Internet Access and more and all FREE. Call from home or office up to 14.4K and download for FREE. (n/8/1)

217-792-3663
Customer Service 415-281-4429

Inquiry 714.

YOUR SALES MESSAGE
about the special computer product or service that you provide belongs in print

THE BUYER'S MART
can help you reach computer professionals and produce valuable inquiries for your company!

Call **Margot Swanson** for more information
603-924-2656
or
Fax: 603-924-2683

Inquiry 715.

Something Missing?

Complete your BYTE collection by ordering Back Issues today!

	1990	1991	1992	1993	1994
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
Special Issues	IBM	Outlook '92	Windows '92	Windows '93	
			Portability '92	B Guide Summer '93	
				B Guide Fall '93	

Special Issues U.S. Delivery $3.00 Foreign $4.00
1990 through 1994 U.S. Delivery $6.00, Foreign Delivery $8.00, Canada & Mexico $6.50
All issues prior to 1990 U.S. Delivery $3.00, Foreign Delivery $4.00

All checks must be in U.S. funds and drawn on a U.S. bank.

Please indicate which issues you would like by checking (√) the boxes. Send requests with payment to:

BYTE Back Issues
One Phoenix Mill Lane
Peterborough, N.H. 03458
(603) 924-9281

☐ Check enclosed Charge: ☐ VISA ☐ MasterCard

Card# ____________________

Exp. Date ____________________

Signature____________________

Name____________________

Address ____________________

City/State ____________________

Zip ____________________

All orders must be prepaid.
Please allow four weeks delivery.

The Magazine of Technology Integration

YOUR DIRECT LINK

ADVERTISER CONTACT INFORMATION

To order products or request FREE information, call advertisers directly or send in the Direct Link Card by mail or fax! ***Let them know you saw it in BYTE!***

Inquiry No.		Page No.	Phone No.
	A		
61-62	ABACUS SOFTWARE	88	800-451-4319 ext. B4
253-254	ADDA	292	800-863-ADDA
543	ADDTECH COMPUTERS INC	284NE 4	908-805-0900
257	ADVANCED LOGIC RESEARCH	135	714-581-6770
298	AERONICS, INC	187	512-258-2303
287-288	AGE LOGIC (N.A.)	121	619-455-8600
64	AITECH INTERNATIONAL	83	800-882-8184
63	ALADDIN KNOWLEDGE SYS	71	800-223-4277
190	ALLMICRO	264	800-653-4933
542	ALTEX ELECTRONICS	284NE 2-3	800-531-5369
•	AMBRA COMPUTER CORP (N.A.)	32B-33	800-200-3184
203	AMERICAN ADVANTECH	289	800-800-6889
258-259	AMERICAN MEGATRENDS	127	800-892-6843
•	AMERICAN POWER CONV	64A-B	
65	AMERICAN POWER CONV	64-65	800-800-4APC DPT.A2
66-67	AMERICAN SMALL BUSN COMP	90	918-825-4844
166	ANGOSS SOFTWARE INT'L	203	416-593-5077**
150-151	ANTEX ELECTRONICS	245	310-532-3092
•	APPLE COMPUTER INC	129	
188	APPRO INTERNATIONAL INC	277	800-927-5464
155-156	ARISTO GRAPHIC SYS (INT'L)	93	+49-40-54747-111**
155-156	ARISTO GRAPHIC SYS (U.S.)	93	800-631-7646
157	ASK ME MULTIMEDIA CTR	238	612-531-0603
68	ATI TECHNOLOGIES INC	20-21	905-882-2600 ext. 444
241	ATRIE TECHNOLOGY INC	292	
528	AXIS COMMUNICATIONS (INT'L)	307	+46-46136130**
255-256	AZ-COM	290	510-254-5400
	B		
450	BIX (N.A.)	307	800-695-4775
69-70	BORLAND INTERNATIONAL	CII-1	800-336-6464 ext. 7853
•	BUSINESS WEEK	284NE-1	800-821-1329
•	BUSINESS WEEK	284PC-1	800-821-1329
•	BUSINESS WEEK (INT'L)	48	+41-21-617-44-11
•	BUSINESS WEEK (INT'L)	49	212-512-6012
300-301	BUZZWORDS INTERNATIONAL	295	314-334-6317
•	BYTE BACK ISSUES (INT'L)	197	+603-924-2603**
•	BYTE COMING IN MAY (INT'L)	160	800-257-9402
•	BYTE DECK	247	603-924-2596
•	BYTE ENTERPRISE COMPUTING (INT'L)	146	800-257-9402
•	BYTE EURODECK (INT'L)	196	+603-924-2683**
•	BYTE EUROPEAN RESELLER (INT'L)	147	+603-924-7507**
•	BYTE INTERNATIONAL (INT'L)	161	800-257-9402
•	BYTE REPRINTS	284PC 4	603-924-2618
•	BYTE SHOW SERVICE (INT'L)	30-31	800-257-9402
•	BYTE SUB MESSAGE	245	
	C		
303	CADSOFT COMPUTER, INC	294	800-858-8355
231	CARDIFF SOFTWARE	294	800-659-8755
•	CD SELECT	79	800-344-2495 ext. 520
526	CHAPLET	40IS 11	+886-2-298-8989
527	CHAPLET	40IS 13	+886-2-298-8989
501	CHERRY MIKROSCHALTER GMBH (INT'L)	182-163	+49-9643-180
72-73	COLORADO MEMORY SYSTEMS	19	800-451-0897
•	COMMUNICATION INTELLIGENCE	15	415-802-7888
74	COMPAQ COMPUTERS (N.A.)	8-9	
318	COMPAQ SERVERS (N.A.)	138B-D	800-345-1518
502-503	COMPEX INC (INT'L)	133	714-630-7302
78	COMPUTER ASSOCIATES	81	800-225-5224 Dept. 62500
75	COMPUTER ASSOCIATES	175	800-225-5224 Dept. 62500
•	COMPUTER BOOK CLUB (N.A.)	204A-B, 205	717-794-2191
•	COMPUTER DISC WAREHOUSE	268A-P	800-959-4CDW
176	COMPUTER DISC WAREHOUSE	268-269	800-959-4CDW
504	COMPUTER QUICK (INT'L)	214	415-861-8330
175	COMPUTER & CONTROLS SOLU	285	800-775-3525
236	CONTROL CONCEPTS, INC	291	800-922-9259
204	CONTROL VISION	292	316-231-6647
77	COREL SOFTWARE	29	800-554-1635
•	CREATIVE EXPO	163	
145	CREATIVE LABS INC	95	800-998-LABS
164-165	CRYSTALOGIC, INC	235	615-391-4412
78-79	CURTIS INC	243	612-631-9512
260-261	CYBEX CORP	141	205-430-4030**
177-178	CYBEX CORP	272	205-430-4030**
505-506	CYBEX CORP (INT'L)	CIV	205-430-4030**
555-556	CYBEX CORP (INT'L)	108	205-430-4030**
	D		
153	DALLAS SEMICONDUCTOR	148	800-258-5061
202	DATACAL DIRECT	282	800-251-3364
•	DATAPRO (INT'L)	12-13	609-764-0100 ext. 277
80	DATAPRODUCTS	101	800-334-3174
507	DATATRONICS TECHNOLOGY	40IS 20	+886-2-782-0305**
262-263	DCA	113	800-348-3221 ext. 59Z
549	DECUS / TALLEY MANAGEMENT GROUP	285	609-845-7258**
•	DELL COMPUTER CORP (N.A.)	CIII	800-626-8260
•	DELL COMPUTER CORP (N.A.)	CIV	800-626-8260
243	DIALOGUE TECHNOLOGY	292	+886-2-9317814**
524	DIGICOM INC (INT'L)	CIII	+886-2-917-9099**
•	DIGITAL EQUIPMENT CORP	170-171	800-332-2717
304-305	DISPLAY RESEARCH LAB	293	+852-877-8810**
265-266	DISTRIBUTED PROCESSING TECH	159	800-322-4378
179-180	DISTRIBUTED PROCESSING TECH	274	800-322-4378
	E		
81	EASTERN SYSTEMS	102	508-366-1520**
82-83	ELIASHIM MICROCOMPUTERS	238	813-744-5177
250-251	ELMA ELECTRONIC	291	510-656-3400
508-509	EUTRON	40IS 8	+39-35-692-229**
267-268	EXABYTE CORP (N.A.)	108	800-866-6002
	F		
510-511	FAST HARDLOCK	40IS 7	+49-89-53980020
169-170	FAST MULTIMEDIA (INT'L)	223	+49-89-50206-199**
169-170	FAST MULTIMEDIA (U.S.)	223	800-248-FAST
523	FIRST INTERNATIONAL COMP	40IS 2	+886-2-717-4500**
181-182	FIRST SOURCE INT'L	262-263	714-588-9866
84	FRAME TECHNOLOGY (N.A.)	73	800-U4FRAME ext. 926
85-86	FUTURESOFT ENGINEERING	246	713-496-9400
	G		
•	GATEWAY 2000	96A-J, 97	800-846-2058
237	GENERAL TECHNICS	290	800-487-2538
205	GENOVATION, INC	292	714-833-3355
87-88	GLENCO ENGINEERING	103	800-562-2543
531-532	GLOBAL INFO MANAGEMENT, INC	40IS 19	415-325-8071
235-236	GRANITE DIGITAL	291	510-471-6442
512	GREY MATTER LTD	40IS 14	+44-0364-53071**
206-207	GTEK INC	288	800-282-4835
	H		
89-90	HAUPPAUGE COMP WORKS	255	800-443-6284
545	HERGO ERGONOMIC SUPPORT	284	800-232-8737
•	HEWLETT PACKARD	35	800-443-1254 ext. 785
217-218	HI-LO SYSTEMS	293	510-623-8860
208	HOOLEON CORP	291	602-634-7515
269	HUMMINGBIRD CCMMNCTNS	152-153	905-470-1207**
	I		
533	IBM (INT'L)	121	+44-256-812704
534	IBM (INT'L)	123	+44-256-812704
91	IBM PC DIRECT (N.A.)	188A-D	800-426-8533
92	IBM PC DIRECT (N.A.)	196-197	800-426-7920
•	IBM PERSONAL S/W PROD	116-117	800-3-IBM-OS2
535	IBM PERSONAL SOFTWARE	40IS 5	
93	IBM SERVERS	69	800-772-2227
•	IBM WORKSTATIONS (N.A.)	146-147	800-IBM-6676 ext. 652
242	IERC	288	213-849-2481
94	INTEGRAND RESEARCH	92	209-651-1203
95	INTEL CORP	16-17	800-538-3373
97	INTEL CORP (N.A.)	16A-B	800-538-3373
96	INTEL CORP (N.A.)	40A-D	800-538-3373
272-273	INTERGRAPH (N.A.)	180-181	800-345-4856
540-541	INTERSTELLAR SYSTEMS LTD	40IS 12	+44-506-460120
209	IO TECH	289	216-439-4091
98	IOMEGA	244	800-777-4045
143-144	ITERATED SYSTEMS	242	800-437-2285
•	IVI PUBLISHING	104	800-278-5533 ext. 418
	J		
183	JAMECO ELECTRONICS	275	800-831-4242
•	JDR MICRODEVICES	287	800-538-5000
	K		
99	KEA SYSTEMS LTD / ATTACHMATE CANADA	94	800-663-8702
274	KFC (N.A.)	165	800-253-2872
210	KILA	289	303-444-7737
100-101	KINGSTON TECHNOLOGY	177	714-435-2600
513	KUO FENG CORP (INT'L)	205	+886-2-754-8498*
	L		
198-199	L A TRADE	270	800-433-3726
211	LAGUNA DATA SYSTEMS	293	800-938-TAPE
133-134	LANDMARK RESEARCH INT'L CORP	184	800-683-6696
536	LANSOURCE	40IS 18	+44-223-237778
212	LAWSON LABS INC	290	800-321-5355
196-197	LEAD TECHNOLOGIES	286	800-637-4699
552	LIGATURE LTD	40IS 10	
245	LITECH CORP	293	800-548-3246
557	LOGIC PROGRAMMING ASSC (INT'L)	240	+44-81-874-0449**
193	LOGICAL CONNECTION	264	800-238-9415
159	LOGICIELS ET SERVICES DUHEM	240	+33149700455
308-309	LOGITECH INC	87	800-936-0012 6K
	M		
147-148	MAG INNOVISION	187	800-827-3998
514	MAGIC / MSE	40IS 21	+972-3-751-1901**
530	MANNESMANN TALLY	40IS 9	+44-0628-527782**
319-320	MANNESMANN TALLY (N.A.)	138A	800-843-1347 ext. 19
162-163	MARX DATENTECHNIK GmbH	86	+49-8403-1555
103	MATHSOFT INC	249	
104	MATROX VIDEO PRODUCTS GRP	198	514-685-2630
105	MAXTOR	26-27	800-4MAXTOR
252	MAYER AUTOMATION GROUP	288	800-289-6293
•	MCGRAW HILL NRI (N.A.)	236A-B	
146	MEDIA VISION (N.A.)	30-31	800-845-5870
515	MEGADATA	40IS 24	516-589-6858**
189	MICRO 2000	279	800-864-8008
295-296	MICRO SOLUTIONS COMP PROD	168	800-295-1214
311-312	MICRO SOLUTIONS COMP PROD	271	800-295-1214
313-314	MICRO SOLUTIONS COMP PROD	273	800-295-1214
191-192	MICRO-INTERNATIONAL, INC	278	800-967-5667
106	MICROPOLIS CORP	191	800-395-3748
307	MICROPROSE SOFTWARE	283	800-879-PLAY
•	MICROSOFT CORP	11	
•	MICROSTAR LABORATORIES	290	206-453-2345
•	MICROWAY	214	508-746-7341
516	MINOLTA GMBH (INT'L)	33	+49-511-7404-401
114-115	MINUTEMAN	51	800-238-7272
519-520	MINUTEMAN	40IS 23	214-446-7363
538-539	MITRON COMPUTER (INT'L)	89	+65-2-87-5879
	N		
275-276	NANAO USA CORP (N.A.)	123	310-325-5202
213	NATIONAL INSTRUMENTS	295	800-433-3488
517-518	NATIONAL INSTRUMENTS	40IS 22	800-433-3488
278	NEC ELECTRONICS INC	125	800-366-9782
277	NEC SERVERS	106-107	800-NEC-INFO
•	NETWORK COMP DEVICES (N.A.)	89	800-800-9599
•	NETWORLD+INTEROP 94	220	800-488-2883 ext. 218
184	NEVADA COMPUTER	276	800-654-7762
107	NORTON-LAMBERT	37	805-964-6767
547	NOW ELECTRONICS INC	284PC 3	800-350-2NOW
317	NSTL - PC DIGEST - TRUTH	251	800-257-9402
111-112	NSTL - PC DIGEST / LANBIT	216	610-941-9600
109-110	NSTL - PENTIUM UPGRADES	233	800-220-NSTL
108	NSTL - SALUTE TO CUSTOMERS	202	610-941-9600
	O		
529	OLIVETTI SYS & NETWKS (INT'L)	8-9	
525	ON TIME MARKETING	40IS 12	+49-40-437472
113	OSBORNE MCGRAW-HILL	239	800-822-8158
299	OVERLAND DATA INC	293	800-729-8725
	P		
230	PACIFIC SOFTWORKS	295	800-541-9508
116-117	PC POWER & COOLING	53	800-722-6555
118	PERSOFT INC	91	800-368-5283
119	PHAR LAP SOFTWARE INC	98	617-661-1510
120-121	PINNACLE MICRO	7	714-727-3300
558	PIONEER HIGH FIDELITY (GB) LTD (INT'L)	172	

YOUR DIRECT LINK

ADVERTISER CONTACT INFORMATION

Inquiry No.		Page No.	Phone No.
122	PKWARE INC	78	414-354-8699
279	PKWARE INC	138	414-354-8699
167-168	PLEXTOR	59	800-886-3935
•	POWERSOFT CORP (N.A.)	48A-B	
152	POWERSOFT CORP (N.A.)	48-49	800-395-3525
102	PROGRAMMER'S PARADISE	38-39	800-445-7899
285-286	PROXIMA CORP	118	619-457-5500

Q

Inquiry No.		Page No.	Phone No.
214	QUALSTAR CORP	293	818-882-5822
124	QUARTERDECK OFFICE SYSTEMS	43	310-392-9851
125	QUATECH INC	260	800-553-1170

R

Inquiry No.		Page No.	Phone No.
126-127	RAINBOW TECHNOLOGIES	57	800-852-8569
246-247	RCI	289	908-874-4072 ext. 71
187	RECORTEC INC	267	800-729-7654
310	REFERENCE POINT SOFTWARE	295	800-776-2001
172-173	ROBERTSON-CARUSO & ASSOC	42	404-512-0600
128-129	ROSE ELECTRONICS	250	800-333-9343
297	ROSS TECHNOLOGY, INC	166	800-774-7677

S

Inquiry No.		Page No.	Phone No.
280	SAMTRON DISPLAY INC (N.A.)	133	310-802-8425
537	SAMTRON (INT'L)	73	+49-61-96-48-38-29
289-290	SCEPTRE TECHNOLOGIES	155	800-788-2878
215	SEALEVEL SYSTEMS INC	288	803-843-4343
130	SEQUITER SOFTWARE INC	230	403-437-2410
239-240	SHAFFYTALL CORP	294	800-248-3475
233-234	SIGMA TECH SOFTWARE	288	818-368-6132
•	SILICON GRAPHICS (INT'L)	157	415-940-4343 ext. B26**
•	SILICON GRAPHICS (N.A.)	157	800-431-4331 ext. B26
201	SILICON VALLEY COMPUTER	280-281	415-967-1100
154	SOFTARC	76	416-754-1856**
131	SOFTWARE SECURITY	180	203-329-7428**
306	SONY (N.A.)	172	201-476-8199
171	STAMPEDE TECHNOLOGIES	179	800-763-3423
132	STATSOFT	77	918-583-4149
158	SUN PRO (N.A.)	12-13	800-2SUNPRO
•	SUPRA CORP (N.A.)	32A	800-727-8647
522	SYMANTEC (INT'L)	165	408-252-3570
135-136	SYSTAT INC	201	708-864-5670

T

Inquiry No.		Page No.	Phone No.
216	TALKING TECHNOLOGY INC	289	800-685-4884
248-249	TAPEDISK CORP	294	800-827-3372
553	TECHPOWER COMPANY LTD	40IS 24	+886-2-753-1940**
137	TEKTRONIX	55	800-835-6100 ext. 34J
546	THE COMPUTER MUSEUM	284PC 2	
229	TIEPIE ENGINEERING	290	+31-5106-704**
138	TOSHIBA AMERICA INC	2-3	800-457-7777
281-282	TOUCHSTONE SOFTWARE	130	714-969-7746
244	TRANS 2000	290	310-908-6814
228	TRI VALLEY TECHNOLOGY INC	289	510-447-2030
139-140	TRIPP LITE	96	312-755-8741
149	TURTLE BEACH SYSTEMS	218	800-645-5640

U

Inquiry No.		Page No.	Phone No.
222-223	UNICORE SOFTWARE	290	800-800-BIOS
220-221	UNICORE SOFTWARE	295	800-800-BIOS
•	UNIXWORLD	285	800-257-9402 ext. 29

V

Inquiry No.		Page No.	Phone No.
224	VICTORY ENTERPRISES TECH	291	800-727-3475
225	VIDEX, INC	288	503-758-0521
283-284	VIEWSONIC	145	909-869-7976
291-293	VISIONWARE	137	415-325-2113

W

Inquiry No.		Page No.	Phone No.
521	WALKER, RICHER & QUINN	40IS 17	206-324-0407
141	WATCOM	25	519-886-3700
200	WEST COAST MICRO	286	619-581-6040
160-161	WIBU (INT'L)	42	+49-721-377455**
160-161	WIBU (U.S.)	42	301-570-3497
226	WINTEK CORP	294	800-742-6809

Z

Inquiry No.		Page No.	Phone No.
142	ZEOS INTERNATIONAL	212-213	800-554-5226
227	Z-WORLD ENGINEERING	293	916-757-3737

• Correspond directly with company.
*** Indicates FAX Number*

BYTE ADVERTISING SALES STAFF

David B. Egan, Associate Publisher, One Phoenix Mill Lane, Peterborough, NH 03458, Tel. (603) 924-2678, Fax: (603) 924-7620
Diane Lieberman, Director, Inside Advertising Sales, One Phoenix Mill Lane, Peterborough, NH 03458, Tel. (603) 924-2518, Fax: (603) 924-2683

NEW ENGLAND
ME, NH, VT, MA, RI, CT, ONTARIO
CANADA & EASTERN CANADA
Sanford L. Fibish **(617) 860-6344**
Patricia Payne **(603) 924-2654**
McGraw-Hill Publications
24 Hartwell Avenue
Lexington, MA 02173
FAX: (617) 860-6899

EAST COAST
NY, NYC, NJ, DE, PA
Kim Norris **(212) 512-2645**
Jonathan Sawyer **(603) 924-2665**
McGraw-Hill Publications
1221 Avenue of Americas—28th Floor
New York, NY 10020
FAX: (212) 512-2075

SOUTHEAST
NC, SC, GA, FL, AL, TN, MS, AR, LA,
KY, DC, MD, VA, WV
MaryAnn Goulding **(404) 843-4782**
Brian Higgins **(603) 924-2651**
McGraw-Hill Publications
4170 Ashford-Dunwoody Rd., Suite 520
Atlanta, GA 30319
FAX: (404) 252-4056

MIDWEST
IL, MO, KS, IA, ND, SD, MN
WI, NE, IN, MI, OH
Kurt Kelley **(312) 616-3328**
Ed Ware **(603) 924-2664**
McGraw-Hill Publications
Two Prudential Plaza
180 North Stetson Ave.
Chicago, IL 60601
FAX: (312) 616-3370

SOUTHWEST,
ROCKY MOUNTAIN
CO, OK, TX
Jennifer Walker **(214) 701-8496**
Brian Higgins **(603) 924-2651**
McGraw-Hill Publications
14850 Quorum Dr., Suite 380
Dallas, TX 75240
FAX: (214) 991-6208

SOUTH PACIFIC: Los Angeles, CA
LOS ANGELES COUNTY, AZ, NM, NV
Alan El Faye **(213) 480-5243**
Brad Dixon **(603) 924-2574**
McGraw-Hill Publications
3333 Wilshire Boulevard #500
Los Angeles, CA 90010
FAX: (213) 480-5235

NORTH PACIFIC
NORTHERN CA, OR, ID, MT, WY, UT
Roy J. Kops **(415) 513-6861**
James Ball **(603) 924-2662**
SILICON VALLEY, HI, WA, AK,
W. CANADA
Bill McAfee **(415) 513-6862**
James Ball **(603) 924-2662**
McGraw-Hill Publications
1900 O'Farrell Street, Suite 200
San Mateo, CA 94403
FAX: (415) 513-6867

SOUTH PACIFIC: Irvine, CA
ORANGE COUNTY
SAN DIEGO COUNTY
Beth Dudas **(714) 753-8140**
Brad Dixon **603) 924-2574**
McGraw-Hill Publications
15635 Alton Pkwy., Suite 290
Irvine, CA 92718
FAX: (714) 753-8147

Peterborough, NH Office: Inside Sales FAX: **603-924-2683** Advertising FAX: **603-924-7507**

Hardware/Software Showcase
Mark Stone (603) 924-2695
Ellen Perham (603) 924-2598
BYTE Publications
One Phoenix Mill Lane
Peterborough, NH 03458

The Buyer's Mart/Classifieds
Margot L. Swanson (603) 924-2656
BYTE Publications
One Phoenix Mill Lane
Peterborough, NH 03458

BYTE Deck
Susan Rastellini (603) 924-2596
BYTE Publications
One Phoenix Mill Lane
Peterborough, NH 03458

EURO-DECK
Joseph Mabe (603) 924-2533
BYTE Publications
One Phoenix Mill Lane
Peterborough, NH 03458

Regional Advertising Sections
Ed Ware (603) 924-2664
Fax: (603) 924-2683

INTERNATIONAL ADVERTISING SALES STAFF

UNITED KINGDOM,
FRANCE, BENELUX
Gary Lucas **(+44 71 495 6780)**
Jonathan McGowan
(+44 71 495 6781)
McGraw-Hill Publishing Co.
34 Dover St.
London W1X 4BR
England
FAX: +44 71 4956734
TELEX: 892191

GERMANY, SWITZERLAND,
AUSTRIA
Jürgen Heise
McGraw-Hill Publishing Co.
Liebigstrasse 19
D-60323 Frankfurt
Germany
Tel: +49 69 7140 7140
FAX: +49 69 7140 7146

ITALY,
SCANDINAVIAN COUNTRIES
Zena Coupé, Amanda Blaskett
A-Z International Sales Ltd.
70 Chalk Farm Road
London NW1 8AN
England
Tel: +44 71 2843171
FAX: +44 71 2843174

ISRAEL
Dan Ehrlich
Ehrlich Communication Int'l
P.O. Box 99
Herzliya 46101
Israel
Tel: +972 9 586245
Tel: +972 9 586246
FAX: +972 9 585685

TAIWAN
Janet Wang
Third Wave Publishing Corp.
2nd Fl., No. 19-2, Lane 231
Fu Hsing North Road
Taipei 105
Taiwan R.O.C.
Tel: +886 2 7136959
FAX: +886 2 7189467

HONG KONG
Zoe Yen
Third Wave Publishing Corp.
Unit 2, 6F Hing Wah Center
82-84 To Kwa Wan Road
Kowloon, Hong Kong
Tel: +852 764 3830
FAX: +852 764 3857

KOREA
Young-Seoh Chinn
JES Media International
6th Fl., Donghye Bldg.
47-16, Myungil-Dong
Kangdong-Gu
Seoul 134-070, Korea
Tel: +82 2 4813411
FAX: +82 2 4813414

JAPAN
Masaki Mori
Transworld Media Inc.
702, 2-26-3 Nishigotanda
Shinagawa-ku,
Tokyo 141
Japan
Tel: +81 3 33887466
FAX: +81 3 37880674

A. Suzuki
Nexus, Inc.
2-35-8, Unoki, Ota-ku
Tokyo 146
Japan
Tel: +81 3 37573721
FAX: +81 3 37572266

SINGAPORE
Derek Ng
Stephen Tay
Eastern Publishing Assoc. Pte., Ltd.
1123 Serangoon Road, #03-01
Singapore 1232
Tel: +65 296 6166
FAX: +65 296 7551

AUSTRALIA
Phil Bush
National Advertising Services
7-13 Parraween Street
Cremorne NSW 2090,
Australia
Tel: +61 2 908 9329
FAX: +61 2 953 8274

INDIA, INDONESIA, PAKISTAN,
PHILIPPINES, OTHER ASIAN
AND PACIFIC COUNTRIES
K.T. Wu
Third Wave Publishing Corp.
2nd Fl., No. 19-1, Lane 231
Fu Hsing North Road
Taipei 10445, Taiwan
R.O.C.
Tel: +886 2 7136959
FAX: +886 2 7151950

MALAYSIA
H.K. Lin
Servex (Malaysia) Sdn. Bhd.
5th Floor, Bene Tower
160, Jalan Ampang
50450 Kuala Lumpur
Malaysia
Tel: +60 3 2624592
FAX: +60 3 2624591

Subscription Customer Service
U.S. 1-800-232-2983
Outside U.S. +1-609-426-7676

For a New Subscription
U.S. 1-800-257-9402
Outside U.S. +1-609-426-5526

YOUR DIRECT LINK

PRODUCT CATEGORY INDEX

For FREE product information from individual advertisers, circle the corresponding inquiry numbers on Your Direct Link Card!

To receive information for an entire product category, circle the category number on Your Direct Link Card!

YOUR DIRECT LINK

PRODUCT CATEGORY INDEX

For FREE product information from individual advertisers, circle the corresponding inquiry numbers on Your Direct Link Card!

To receive information for an entire product category, circle the category number on Your Direct Link Card!

EDITORIAL INDEX

For more information on any of the companies covered in articles, columns, or news stories in this issue, circle the appropriate inquiry number on Your Direct Link Card. Each page number refers to the first page of the article or section in which the company name appears. IS pages appear only in the International edition.

 Fred R. Shapiro

The First Bug

Exposing the myth behind the first bug reveals a few tales

ALAN S. ORLING © 1994

Etymological folklore is remarkably persistent. Neither lack of documentation, nor lack of plausibility, nor even outright disproof seems to pose much of an obstacle to the career of a colorful word-story. For example, the term *hooker*, meaning "prostitute," is frequently said to be derived from the name of a Civil War general. The fact that the *OED* (*Oxford English Dictionary*) records the use of *hooker* in this sense as early as 1845, long before General Hooker came on the scene, has had little impact on the popularity of this tale.

A spurious account of the origin of the computer terms *bug* ("a defect in hardware or software") and *debug* ("to eliminate such defects") has become the most popular item of etymological folklore of our time. The legend derives the terms from an actual moth found inside an early computer by the pioneer computer scientist Grace Murray Hopper. A typical recital runs as follows:

"One day in the 1940s, Harvard's famed Mark I—the precursor of today's computers—failed. When the Harvard scientists looked inside, they found a moth that had lodged in the Mark I's circuits. They removed the moth with a pair of tweezers, and from then on, whenever there was a problem with the Mark I, the scientists said they were looking for bugs. The term has stuck through the years." (*Dun's Business Month*, February 1983)

In some versions, the moth is said to have inspired the scientists to speak from then on of *debugging* the computer, with *bug* originating as a later derivative of *debug*.

This moth myth has been repeated in countless computer dictionaries, textbooks, guides, and histories. Even an ostensibly scholarly journal, the *Annals of the History of Computing*, has worked hard to promote the story.

I must note that there does appear to have been a moth found in the Mark II (not the Mark I) by Hopper and her colleagues at Harvard. It is preserved at the Naval Museum in Dahlgren, Virginia, taped to Hopper's log of September 9, 1945. However, the claim that computer defects are called bugs *because* the moth was found is easily disproved. The *OED* records such a meaning of *bug* (4b; "a defect or fault in a machine, plan, or the like") as early as 1889. In that year, the *Pall Mall Gazette* (March 11) reported that "Mr. Edison... had been up the two previous nights discovering a 'bug' in his phonograph—an expression for solving a difficulty, and implying that some imaginary insect has secreted itself inside and is causing all the trouble."

On November 18, 1878, Edison wrote to Theodore Puskas, "It has been just so in all my inventions. The first step is an intuition—and comes with a burst, *then* difficulties arise. This thing gives out and then that—"Bugs"—as such little faults and difficulties are called—show themselves and months of anxious watching, study and labor are requisite before commercial success—or failure—is certainly reached" (Matthew Josephson, *Edison: A Biography*, John Wiley & Sons, 1992, page 198).

It is plain from citations in the *OED*, the *Dictionary of Americanisms*, and the 1878 Edison quotation that, moth notwithstanding, the computer term *bug* was merely a specialized application of a general engineering term dating from the 1800s. This meaning was common enough by 1934 to be recognized in *Webster's New International Dictionary*: "bug, n... 3. A defect in apparatus or its operation... *Slang, U.S.*"

Hopper and her colleagues must have thought the discovery of the moth remarkable because mechanical defects were *already* called bugs. Her September 9, 1945, log entry, which reads, "First actual case of bug being found," makes this quite clear. Even the verb *debug* must have predated Mark II, since the *OED* cites a 1945 use in the *Journal of the Royal Aeronautical Society*, which was probably preceded by several years of oral use in engineering slang.

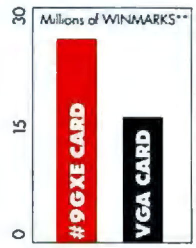
The argument is clinched by remarks made by J. Presper Eckert, the coinventor of ENIAC, the first fully electronic digital computer. In an interview in *Computerworld* (George Harrar, "In the Beginning...," November 3, 1986), Eckert was asked, "Do you know how the term *bug* originated?" He replied, "I know how Grace Hopper thinks it originated. She tells this fanciful story. As far as I know, this was a term in use by engineers, both mechanical and electrical, for difficulties in the equipment long before Grace Hopper ever heard of any of these things. What it amounts to is that it was a new term to Grace. I've never called her up and told her that that's nuts, but it is nuts. That term was in wide use before then." ■

Fred R. Shapiro is associate librarian for public services and lecturer in legal research at Yale Law School. He is also the editor of the Oxford Dictionary of American Legal Quotations *(Oxford University Press, 1993). He can be reached on the Internet at shapiro@yalevm.cis.yale.edu, or on BIX c/o "editors."*

FOR THOSE OF YO
BORN INTO P

Upgrade to a virtual screen monitor by adding our optional 1MB VRAM and 1MB DRAM upgrade. Then you can pan across multiple applications while you work.

Our multi-session, double-spin CD ROM drives come with a special edition of Aldus PhotoStyler and are Kodak Photo CD compatible.



*By adding the #9GXE card, the new Dell Dimension XPS WINMARK performance is up to 1.6 times faster than standard VGA.**

DELL DIMENSION XPS P60 PENTIUM SYSTEM
(Other systems featured are not pictured.)

There are plenty of ways to attain it.

Our Dell Dimension XPS P60 systems are all Pentium processor based, and our i486 systems can easily be upgraded to Pentium Overdrive. Every Dell Dimension system on this page features accelerated local bus video. The rest of the specs read like a power user's wish list of the latest technological innovations.

Take the CD ROM drive for example. Its double-spin technology delivers nearly twice the data transfer rate of single-spin drives. It's multi-session, which means it's Photo CD compatible and you can have your CDs printed on up to four separate occasions. Even its motorized loading tray is state-of-the-art.

Video on this XPS system is supplied by a #9GXE video card that delivers 26 million WINMARKS,**

OU WHO WEREN'T OWER, BUY IT.

Pictured System
DELL DIMENSION XPS P60 PENTIUM 60MHz SYSTEM
$3,499
Business Lease: $129/Mo.

- 16MB RAM • 128MB Max RAM
- 256KB External Cache
- 528MB Hard Drive
- Multi-session, Double-spin CD ROM Drive
- 7 Expansion Slots Total (3 ISA, 1 PCI, 1 PCI/ISA Available)
- PCI #9GXE Video Accelerator Card with Video Control Panel Software
- 1MB Video RAM
- VS15 Color Monitor (15" CRT, 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.2/Microsoft Windows 3.1/Mouse

Order Code #5000651

DELL DIMENSION XPS 450V i486 DX2 50MHz SYSTEM
$2,199
Business Lease: $81/Mo.

- 8MB RAM • 64MB Max RAM
- 450MB Hard Drive
- Upgradeable to Pentium Overdrive
- 7 Expansion Slots Total (5 ISA, 1 VL/ISA Available)
- VL #9GXE Video Accelerator Card with Video Control Panel Software
- VS15 Color Monitor (15" CRT, 1024 x 768, .28mm, NI)
- 1MB Video RAM
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.2/Microsoft Windows 3.1/Mouse

Order Code #5000655

DELL DIMENSION 433SV i486 SX 33MHz SYSTEM
$1,399
Business Lease: $52/Mo.

- 4MB RAM • 64MB Max RAM
- 270MB Hard Drive
- Upgradeable to Pentium Overdrive™
- 5 Expansion Slots Total (3 ISA, 2 VL/ISA Available)
- Accelerated Local Bus Video
- VS14 Color Monitor (14" CRT, 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.2/Microsoft Windows 3.1/Mouse

Order Code #5000652

DELL DIMENSION XPS 466V i486 DX2 66MHz SYSTEM
$2,599
Business Lease: $96/Mo.

- 8MB RAM • 64MB Max RAM
- 450MB Hard Drive
- Multi-session, Double-spin CD ROM Drive
- Upgradeable to Pentium Overdrive
- 7 Expansion Slots Total (4 ISA, 1 VL/ISA Available)
- VL #9GXE Video Accelerator Card with Video Control Panel Software
- VS15 Color Monitor (15" CRT, 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.2/Microsoft Windows 3.1/Mouse

Order Code #5000656

DELL DIMENSION 433V i486 DX 33MHz SYSTEM
$1,699
Business Lease: $63/Mo.

- 4MB RAM • 64MB Max RAM
- 340MB Hard Drive
- Upgradeable to Pentium Overdrive
- 5 Expansion Slots Total (3 ISA, 2 VL/ISA Available)
- Accelerated Local Bus Video
- VS14 Color Monitor (14" CRT, 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.2/Microsoft Windows 3.1/Mouse

Order Code #5000653

DELL DIMENSION XPS P60 PENTIUM 60MHz SYSTEM
$2,599
Business Lease: $96/Mo.

- 8MB RAM • 128MB Max RAM
- 256KB External Cache
- 450MB Hard Drive
- 7 Expansion Slots Total (4 ISA, 1 PCI, 1 PCI/ISA Available)
- PCI Video Card
- 1MB Video RAM
- VS14 Color Monitor (14" CRT, 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.2/Microsoft Windows 3.1/Mouse

Order Code #5000657

DELL DIMENSION 466V i486 DX2 66MHz SYSTEM
$1,999
Business Lease: $74/Mo.

- 4MB RAM • 64MB Max RAM
- 450MB Hard Drive
- Upgradeable to Pentium Overdrive
- 5 Expansion Slots Total (3 ISA, 2 VL/ISA Available)
- Accelerated Local Bus Video
- VS14 Color Monitor (14" CRT, 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.2/Microsoft Windows 3.1/Mouse

Order Code #5000654

DELL DIMENSION XPS P60 PENTIUM 60MHz SYSTEM
$2,999
Business Lease: $111/Mo.

- 8MB RAM • 128MB Max RAM
- 256KB External Cache
- 450MB Hard Drive
- Multi-session, Double-spin CD ROM Drive
- 7 Expansion Slots Total (3 ISA, 1 PCI, 1 PCI/ISA Available)
- PCI Video Card
- 1MB Video RAM
- VS15 Color Monitor (15" CRT, 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.2/Microsoft Windows 3.1/Mouse

Order Code #5000658

3 levels of magnification and on-the-fly resolution switching.

And you have the security of knowing your system is backed by the computer company that ranks highest in customer satisfaction — according to the 1993 J.D. Power and Associates Desktop Personal Computer Customer Satisfaction Study among business users.†

So get your hands on all the power you ever wanted. Even if you weren't born into money.

DELL™

TO ORDER, CALL
800-284-1150

HOURS: MON-FRI 7AM-9PM CT SAT 10AM-6PM CT SUN 12PM-5PM CT
IN CANADA,* CALL 800-668-3021. KEYCODE **#11EBC**

Some products and promotions not available in Canada or Mexico. °Business leasing arranged by Leasing Group, Inc. The Intel Inside and Pentium Processor logos, i486, Pentium and Overdrive are trademarks of Intel
MARKS test results obtained by running WINBENCH version 3.11 at 1024x2048, 256 colors. Parrot screen image source: Kodak Photo CD Photo Sampler. ©1991 Eastman Kodak Company. Photographer: Steve Kelly.

KICKBUTT.²

60MHz Pentium microprocessor. Wow.

8MB RAM

450MB hard drive

256KB external cache

PCI video card

1MB video RAM

MS-DOS® 6.2, Microsoft® Windows™ 3.1, and a mouse

VS15 Color Monitor (15"CRT, 1024 x 768, .28mm, NI)

intel inside pentium PROCESSOR

Multi-session, double-spin CD ROM drive

One 3.5" diskette drive

This system comes from the company that ranked highest in the 1993 J.D. Power Desktop Personal Computer Customer Satisfaction Study among business users.†

$2,999

Business Lease®: $111/month

Multimedia Sound upgrade including Sound Blaster 16 and Peavey® Speakers available for an additional $199.

DELL DIMENSION™ XPS P60 PENTIUM™ SYSTEM

You might think you've been clippin' right along with your i486.™ Well, sit down in front of one of these babies and find out what speed is all about.

Take a minute to read the features up there by the monitor – starting with that sweet little 60MHz Pentium chip that's nearly twice as fast as any i486 chip. Then call the 800 number below and find out how simple it is to finance a new Dell® Pentium System. You won't find anything in the same league. Not with all that power. And not for $2,999. Yeah, $2,999. That's the kicker.

DELL™

TO ORDER, CALL

800-948-3355

HOURS: MON-FRI 7AM-9PM CT SAT 10AM-6PM CT SUN 12PM-5PM CT

IN CANADA,* CALL 800-668-3021 KEYCODE #11ED4

Order Code #5000638

†1993 J.D. Power and Associates Desktop Personal Computer Satisfaction Study conducted among 1,956 user respondents.