

# BYTE

**The Macintosh at 10:  
How It Changed Computing**

**Low-Cost Pentiums Reviewed**

**New WfW 3.11 Previews**

**Microsoft's Smart Office** PAGE 181

THE WORLDWIDE COMPUTING AUTHORITY

# COM PRES SION

## Is it safe?

**Data compression can double  
your hard disk space —  
but not without risks.** PAGE 56



**STATE OF THE ART**

## COMPILERS FOR TOMORROW

**PLUS**

- **The Top Communications Software** PAGE 104
- **Genetic Programming with C++** PAGE 171





## 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<sup>95</sup>**

*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. 7852**

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

**Borland**  
Power made easy™

Copyright © 1993 Borland International, Inc. All rights reserved. All Borland product names are trademarks of Borland International, Inc. Offer good in the United States and Canada only. All prices in U.S. dollars. Dealer prices may vary. \*Novell Message Handling Service (MHS and NGM); MCI Mail; cc:Mail; Windows for Workgroups, MS-Mail, and other MAPI-compliant messaging services; Local Area Network (LAN) systems, such as Novell NetWare, Banyan, IBM® LAN Server, MS-LAN Manager, AT&T StarGROUP, and other peer-to-peer networks. BI 6014

Circle 72 on Inquiry Card (RESELLERS: 73).

# 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.

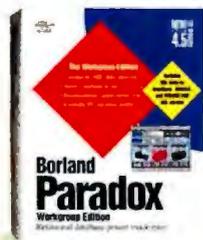
## Share data easily with any workgroup

First we built in support for SQL servers, including Borland's InterBase,™ Sybase/Microsoft,® and Oracle, so you can work with information

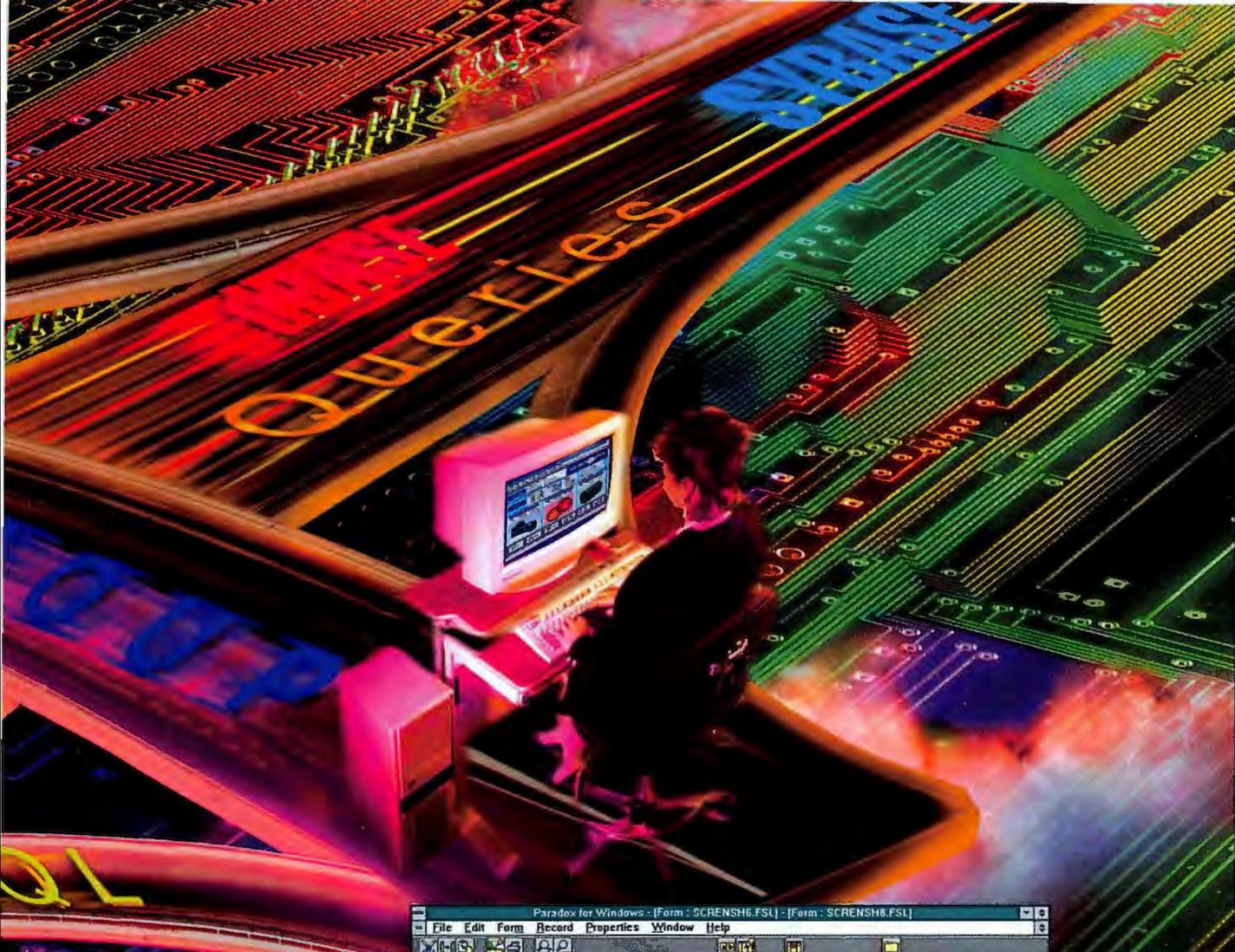
from corporate databases as if it were on your desktop. But we didn't stop there. We added the Workgroup Desktop to distribute the data where it's needed. Now anyone with a Workgroup Edition of Borland Paradox (or Quattro® Pro) can exchange data over local and wide area networks, or via electronic mail.\* 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?**



Paradox for Windows - [Form : SCREENSH6.FSL] - [Form : SCREENSH6.FSL]

File Edit Form Record Properties Window Help

**Customer** Customer No: 201  
Telephone: +44.71.423456  
Company Name: The Camera Shop

**WORLD OPTICS**

Workgroup Desktop Active MCI Outgoing 3

**Order**

Order No	Date	Total Amount	Status	Ship via
2209	1-Jan-92	1,189.00	In Stock	One day
2208	2-Feb-92	1,235.23	Back Ordered	Ordered by: B. Johnson
2350	3-Mar-92	1,913.55	Discontinued	PO No.: M1209

Camera			Filters			Lens		
Qty	Unit Price	Total Price	Qty	Unit Price	Total Price	Qty	Unit Price	Total Price
2	1,195.00	2,390.00	1	19.00	38.00	1	295.00	295.00

New Find Delete Print Orders SQL SQL Orders

▲ 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.

**SQLTool**

- Aliases
- Create Table
- Drop Table
- Add to Table
- Secondary Index
- Ad Hoc Statements

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



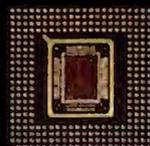


P u t t i n g I m a g i n a t i o n

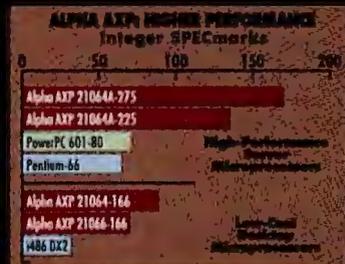
©Digital Equipment Corporation, 1994. The DIGITAL Logo and Alpha AXP are trademarks of Digital Equipment Corporation. Windows and Windows NT are trademarks of Microsoft Corporation. i486 and Pentium are trademarks of Intel Corporation. PowerPC is a trademark of IBM.

# Imagine A Microprocessor That Makes Windows NT Fly.

## Alpha AXP Does It Now.



You're going to blaze some new trails with the mainframe power of Windows NT.™ Don't compromise it. Run it on the fastest vehicle you can get—an Alpha AXP™ microprocessor. Choose from a family of fast server microprocessors with performance as high as 170 SPECint, more than twice that of Pentium™ or PowerPC™ – and priced to compete. Or choose from low-cost desktop PC microprocessors with prices that start below an i486.™ Alpha AXP runs Windows NT with thundering speed, with hundreds of Windows NT applications shipping now and hundreds more on the way. Plus Alpha AXP runs your existing 16-bit



DOS/Windows™ applications. All this power is part of a long-term architecture based on a scalable RISC design and standards like the PCI local bus. And it's available to any PC maker—from us now, and soon from our second source Mitsubishi Electric Corp. The decision with Windows NT is simple. On other microprocessors, it runs. On Alpha AXP, it flies. Which way would you rather cover new ground? Call your PC maker and ask about the Alpha AXP family. Or call us at 1-800-332-2717. And kick start your future.

T O W O R K

digital™

## News & Views

### COMMUNICATIONS

**Just Like Magic?**.....22  
After more than four years in gestation, a suite of technologies designed by General Magic stands poised to alter today's mishmash of wired and wireless networks.

### PROGRAMMING

**Agents on the Loose**.....23  
Telescript, General Magic's communications-oriented programming language, lets developers write tools that permit casual users to create intelligent applications that seek out and retrieve important information.

### NEW PRODUCTS

**Best of Comdex Awards**.....24  
BYTE editors worked morning, noon, and night picking the best products and technologies at Fall Comdex in Las Vegas.

### GRAPHICS/ENTERTAINMENT

**High-Performance 3-D Coming to PCs**.....28  
Applications such as 3-D model animation, stock market visualization, and other high-end programs usually found on expensive workstations should start appearing in 1994 on less expensive 80x86-based PCs.

### PDAS

**Simon Says: Communicate**.....28  
IBM's new personal communication device combines a cellular phone, fax, E-mail, paging, and personal productivity applications.

### APPLICATIONS DEVELOPMENT

**Developers Announce PowerPC Mac Applications**.....38  
Apple has distributed the first software development kits for writing applications for the System 7 operating system on the PowerPC. Numerous developers are now announcing support for the Mac PowerPC platform.

### NEW PRODUCTS

**What's New**.....204  
A cellular device transmits data; an applications development environment lets you create cross-platform workgroups; virtual reality becomes interactive; and more.

## Cover Story

DATA COMPRESSION

# HOW SAFE IS DATA COMPRESSION?

Page 56

BY TOM R. HALFHILL

On-the-fly data compression can double your storage space—but not without some hassles and headaches.

Data Compression on the Macintosh—62

Data Loss: A Cautionary Tale—64

## Feature

DESKTOP SYSTEMS



### The Macintosh at 10

BY TOM THOMPSON

On the Mac's tenth birthday, BYTE looks at its profound influence on computing.

47



## State of the Art

THE NEW COMPILERS

### Today's Compilers 76

BY FRANK HAYES

Challenged by multiple new processors, parallel machines, and operating systems, compiler builders must rework their mainline products to produce faster, leaner code.

Compiler Benchmarks: How Useful?—80



### Optimizing for Today's CPUs 81

BY ALEX LANE

Making code run faster and smaller is an important goal of modern compilers.

Optimizing with Pre- and Post-Compilers—82

Pentium Optimizations—86

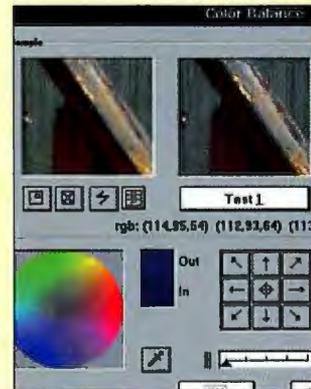
## Reviews



PAGE 125



PAGE 129



PAGE 137



### Developing for Multiple Platforms 91

BY DOUGLAS K. OLSON

Writing applications to run on multiple platforms is an art that software engineers are just beginning to master.

Porting Adobe Photoshop: A Case Study—92

COMMUNICATIONS SOFTWARE

**Advancing Communications 104**

BY HOWARD EGLOWSTEIN  
Data communications programs with scripting languages can automate your on-line sessions. Testing editor Howard Eglowstein looks at seven popular communications packages from four different environments, testing them with new 28.8-Kbps modems.

Life at 28.8—106  
New and Improved—108

APPLICATION-INTEGRATION SOFTWARE

**A New Synergy for Windows 115**

BY STEVE GILLMOR  
With ProdeaSynergy, you can easily automate interapplication Windows tasks. Gillmor builds cross-application projects with off-the-shelf Windows software and the Prodea tools. Doing the same chores without ProdeaSynergy is difficult and sometimes impossible.

GRAPHICS

**HOOPS 4.0: Beyond 3-D 125**

BY JOEL ORR  
The common API to most 2-D and 3-D libraries and hardware now offers a real-time mode and a powerful font engine.

DESKTOP SYSTEMS

**Low-Priced Pentium PCs 129**

BY ED PERRATORE  
General Pentium price wars have started. This review examines three Pentium systems, priced between \$4000 and \$4500, from ALR, Gateway, and Ambra.

IMAGE PROCESSING

**PhotoStyler Fights Back 137**

BY HOWARD EGLOWSTEIN  
Since Aldus's last release of PhotoStyler, the image-editing market has heated up with the introduction of Photoshop on the Windows platform. PhotoStyler 2.0 represents more than a simple face-lift. Aldus pumped up the performance and the features set and comes away with a serious competitor.

NETWORK SOFTWARE

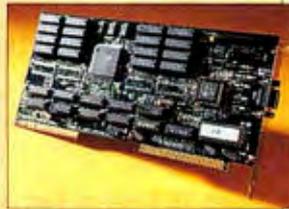
**WinFax Pro Hits the Network 141**

BY STAN MIASKOWSKI  
Delrina's WinFax Pro for Networks lets workgroups share fax modems.

ACCELERATED GRAPHICS CARDS

**Lab Report: 76 Cards for Fast Graphics 146**

Our applications-based tests identify the best PC and Mac accelerator boards for general-purpose and specialized applications.



- Best for VL-Bus Systems—148
- How We Tested—150
- Best for ISA-Bus Systems—154
- Windows NT Drivers: Better Late Than Never?—156
- How to Buy a Graphics Accelerator—156
- Best for Macintosh NuBus Systems—158
- Best for EISA-Bus Systems—162
- How Bus Architecture Affects Graphics—162
- Honorable Mentions—166
- Dubious Achievements—166

**Pournelle: Upgrades from Hell.....185**

BY JERRY POURNELLE  
One assumes Jerry didn't have a great month.

**Books & CD-ROMs: The Genesis of the Mac .....41**

BY TOM THOMPSON, RAYMOND GA CÔTÉ, AND MICHAEL NADEAU  
The birth of a computer, an astronomy CD-ROM, legal requirements in business, and laptop repair.

**Commentary: Layoff Software.....262**

BY STEVE EVANGELOU  
Let's hope this doesn't become a new growth category.

**Editorial .....10**

BY DENNIS ALLEN  
**Letters.....18**  
Readers champion their favorite operating systems.

READER SERVICE

- Editorial Index by Company 260
- Alphabetical Index to Advertisers 256
- Index to Advertisers by Product Category 258
- Inquiry Reply Cards: 256A

BUYER'S GUIDE

- Mail Order 215
- Hardware/Software Showcase
- Buyer's Mart

PROGRAM LISTINGS

- From BIX: Join "listings/frombyte94" and select the appropriate subarea (i.e., "feb94").
- 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.

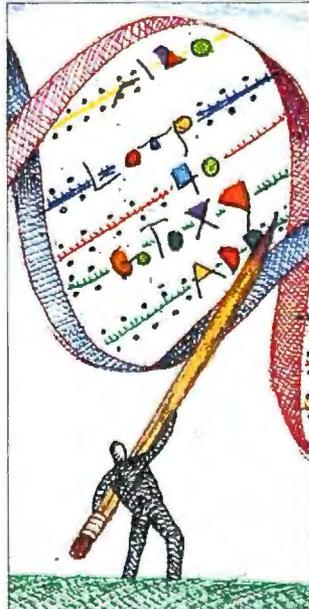
Hands On



**Compilers for Parallel CPUs 97**

BY OLIVER SHARP  
In converting applications for parallel processing, how much of the job can the compiler do without programmer intervention?

- Types of Parallel Machines—98
- Converting an Application for Parallel Processing—100



PROGRAMMING

**Some Assembly Required: Genetic Programming with C++.....171**

BY ANDY SINGLETON  
With an appropriate algorithmic structure, you can develop programs that are self-modifying and evolving.

BUS ARCHITECTURE

**Under the Hood: Inside the PCI Local Bus.....177**

BY GUY W. KENDALL  
This new PC bus provides high throughput and self-configuring add-in cards.

NETWORKING

**Beyond DOS: Windows for Workgroups 3.11.....181**

BY JON UDELL  
This is the most advanced version of DOS-based Windows now available.

## DOS/WINDOWS

### Best of Comdex Awards .....24

Hot new products at computing's annual Vegas exhibition included new Windows software.

### How Safe Is Data Compression? .....56

If you're a Windows user, chances are your hard disk is stuffed to the gills. On-the-fly data compression can double your disk space, but—due sometimes to the hostile environment of DOS-based PCs—you've got to be ready for hassles.

### Today's Compilers .....76

Compilers are changing in order to help software developers write programs for DOS, Windows, NT, and other operating systems—if possible, all at the same time.

### Developing for Multiple Platforms .....91

Adobe's Douglas Olson discusses the daunting task of moving software from one environment to another, including Photoshop from the Mac to Windows.

### Advancing Communications .....104

A review of top communications software for DOS and Windows, including Procomm and Crosstalk.

### A New Synergy for Windows .....115

ProdeaSynergy's graphical tools enable you to build scripts for automating Windows tasks across different applications.

### HOOPS 4.0: Beyond 3-D .....125

This latest release of the platform-independent programming system delivers a rich library of graphics routines for CAD, mapping, visualization, and multimedia software.

### Low-Priced Pentium PCs .....129

ALR, Gateway, and Ambra deliver souped-up Pentium systems for less than \$4500.

### PhotoStyler Fights Back .....137

Aldus pumps up its PhotoStyler image-editing software.

### WinFax Pro Hits the Network .....141

Delrina's fax package lets LAN users share a fax modem.

### Lab Report: 76 Cards for Fast Graphics .....146

Our exclusive tests reveal the best cards for different applications.

### Windows for Workgroups 3.11 .....181

The latest version provides previews of Windows 4 and Microsoft At Work.

## OS/2

### Today's Compilers .....76

OS/2 is one of several platforms that software developers have to consider. Compiler technology is changing to make it easier for programmers to target multiple environments.

### HOOPS 4.0: Beyond 3-D .....125

Besides being "far and away the best tool for almost any kind of graphics programming," the very portable HOOPS also supports OS/2.

### Low-Priced Pentium PCs .....129

Want a little more horsepower without having to sell the farm? Here are three systems from ALR, Gateway, and Ambra—all below \$4500.

### Lab Report: 76 Cards for Fast Graphics .....146

Many accelerators now support OS/2.

## MACINTOSH

### Just Like Magic? .....22

Founded by former Apple engineers, General Magic is coming to market with technologies that could change the way we use computers to communicate.

### Best of Comdex Awards .....24

The P1394 High-Performance Serial Bus (which Apple helped develop) and the DOS-running Quadra 610 were among the best products at the big show.

### Developers Announce PowerPC Mac Applications .....38

With PowerPC Macs coming soon, Apple has shipped kits for developers who want to write programs for System 7 on the PowerPC.

### The Macintosh at 10 .....47

Upon the tenth birthday of Apple's brilliant creation, our resident Mac expert looks back at how his favorite machine has profoundly changed computing.

### Data Compression on the Macintosh .....62

While on-the-fly file squeezing is tricky business on DOS-based PCs, Mac users are in a different situation right now.

### Developing for Multiple Platforms .....91

Douglas Olson's programming team at

Adobe moved Photoshop from the Mac to Windows. Olson discusses the challenges and issues of writing software for different environments.

### Advancing Communications .....104

A review of top communications software for the Mac.

### HOOPS 4.0: Beyond 3-D .....125

Joel Orr looks at this collection of multi-platform graphics programming tools.

### Lab Report: 76 Cards for Fast Graphics .....146

Our applications-based tests help us pick the best accelerators for Mac users.

## UNIX/WORKSTATIONS

### Optimizing for Today's CPUs .....81

Superscalar architectures such as HP's PA-RISC and DEC's Alpha AXP demand new tricks from compilers.

### Compilers for Parallel CPUs..97

Before computers using multiple processors can really deliver higher throughput, a compiler needs to build code for the specific machine.

## NETWORKS

### Just Like Magic? .....22

General Magic's technologies could eventually change the network infrastructure.

### Best of Comdex Awards .....24

Networking and communications products were among the hot spots of this year's big show.

### A New Synergy for Windows .....115

ProdeaSynergy is like a Grand Central Station connecting applications across a network (or on individual machines).

### Low-Priced Pentium PCs .....129

One of these systems from ALR, Gateway, and Ambra could make a good choice for a small file server.

### WinFax Pro Hits the Network .....141

Delrina's fax package offers workgroups easy access to shared modems.

### Windows for Workgroups 3.11 .....181

The new version offers a preview of things to come, including Windows 4 and Microsoft At Work.

<b>Accelerators</b> .....	146
<b>Alpha</b> .....	32, 76, 81
<b>C++</b> .....	76, 91, 171
<b>CAD/CAM</b> .....	149, 155, 165
<b>CD-ROM</b> .....	41
<b>Communications</b> .....	22, 23, 28, 38, 104, 141
<b>Compilers</b> .....	76, 81, 91, 97
<b>Compression</b> .....	56, 62, 64
<b>DOS</b> .....	56, 181
<b>EISA</b> .....	162, 165
<b>E-mail</b> .....	22
<b>Graphics</b> .....	28, 56, 125, 137, 146
<b>Liquid cooling</b> .....	32
<b>Macintosh</b> .....	22, 41, 62, 47, 77, 81, 91, 104, 146
<b>Magic Cap</b> .....	22
<b>Multimedia</b> .....	24, 28
<b>Networks</b> .....	22, 24, 38, 115, 141, 181
<b>NuBus</b> .....	158
<b>OLE</b> .....	115
<b>OpenGL</b> .....	28
<b>OS/2</b> .....	24, 76, 125, 146
<b>Parallel processing</b> .....	97, 98, 101
<b>PCI</b> .....	148, 177
<b>PDA's</b> .....	22, 28
<b>Pentium</b> .....	32, 76, 81, 129
<b>PowerPC</b> .....	38, 76, 81
<b>Programming</b> .....	22, 23, 76, 81, 91, 97, 115, 125, 171
<b>R4000</b> .....	76, 81
<b>RISC</b> .....	81
<b>Scripting</b> .....	22, 104, 115
<b>Sound cards</b> .....	185
<b>Unix</b> .....	76, 97
<b>VL-Bus</b> .....	148, 149
<b>Windows</b> .....	24, 28, 47, 104, 115, 125, 137, 141, 146, 181, 185
<b>Wireless</b> .....	22, 28, 38



# FOR THE RECORD, PRO GRAPHICS 1024 IS THE FASTEST GRAPHICS CARD ON THE PLANET.

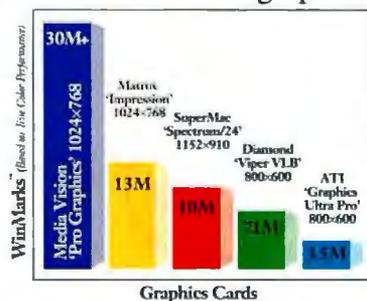
Introducing Pro Graphics 1024 — driving a stunning 16.7 million colors at 1024 x 768 resolution. The Pro Graphics 1024 prevails as the fastest graphics card according to the most recent benchmark test. And it comes from Media Vision, the leader in innovative PC graphics.



16.7 million colors at 1024 x 768 resolution puts a new twist on performance.

Pro Graphics 1024 also offers a refresh rate of 76 Hz for a crisp, flicker-free display and a price that won't blow you away. So why not test drive a Pro Graphics 1024 at your local computer retailer? And see what 16.7 million colors at 1024 x 768 looks like at this speed. Now, that's true color.

For more information on the Media Vision family of Pro Graphics accelerators call **1-800-845-5870 dept. 630.**



**MEDIA VISION**

Tests performed using Ziff Davis Labs' WinBench™ V.3.11 without independent certification by Ziff. Media Vision conducted all tests based on Diamond motherboard with Intel 486DX2/66 CPU, 16MB RAM, 256K cache, 340MB IDE hard drive, MS-DOS Version 5.00. ©1994 Media Vision, Inc., 3185 Laurelview Court, Fremont, CA 94538. (510) 770 9592. Pro Graphics 1024 is a trademark of Media Vision, Inc. Any other trademarks and registered trademarks are owned by their respective holders.

Circle 159 on Inquiry Card.

# A COMPUTE TO USE DESE THIS EASY



1) The Deskpro XE has preinstalled software to get you up and running quickly. 2) It's plug and helps you better organize your work. 4) Enhanced Business Audio lets you operate the PC with your

# FOR THIS EASY UPGRADES AN AD TO READ.

play capable so future upgrades are a snap. 3) An exclusive new software interface called TabWorks  
voice. 5) And starting at \$1,499\*, it's easy on your budget. 6) For details, just call 1-800-345-1518.

**COMPAQ**

Some may be trademarks and/or registered trademarks of their respective companies. \*Estimated selling price, actual price may vary. The Intel Inside logo is a trademark of the Intel Corporation.

Circle 78 on Inquiry Card.

# Beyond the GUI



**The point-and-click paradigm is stale. We need a more human interface.**

In an apparent effort to make computers easier to use, General Magic has developed a new user interface for its Magic Cap operating system. It doesn't look anything like the file folders and program icons you are used to seeing; instead, the new GUI paints an office with a desk that has a telephone, card file, in/out boxes, and so forth. In other words, if you want to check your mail, you simply click on the in-basket on the desk. Need an address? Just click on the Rolodex-like file. You get the idea. You can also go to a file cabinet to take out a file, and a clock on the wall makes office clock watchers feel right at home.

You can even open a door and go down "Main Street" to one of the many office buildings. For example, you might go to the bank building to do electronic banking. It all seems very intuitive—if you've worked with a point-and-click user interface, that is.

This new interface is supposed to make computing more accessible to computer novices, which is a grand and noble idea. And surely every company has some people who would be more productive if computers were less intimidating. Let's face it, Microsoft Windows and the Macintosh interfaces might be a far sight better than a command prompt, but many people don't find either interface to be particularly natural to use.

To these otherwise capable people, ascending the computer learning curve is tantamount to scaling the Matterhorn. The problem is not trivial. Somehow computers must be made easier to use if we expect our enterprise-wide solutions to work. It does no good to restructure an enterprise based on technological solutions (as many large companies are indeed doing), if some people can't use the technology.

For many of us, the problem is sometimes forgotten, because after all, we do not have any problems using computers. For that matter, neither would most of our close associates. But consider the nontechnical workers in your organization; will they be able to navigate through a maze of servers to find that information they need? We may be living in the age of empowerment with information at our fingertips, but so far, the only people who have been empowered are the technically elite.

That has to change. The wave of empowerment that

technology creates must be driven down to everyone in an organization if that organization is to truly benefit from the technology. Information must be easily accessible across the enterprise, and systems must be easy to navigate. That's the idea behind General Magic's new GUI.

Bill Atkinson and Andy Hertzfeld, the inventors of the new GUI, are old hands at creating easy-to-navigate interfaces, and they have deservedly earned respect for their early work on the Macintosh user interface. This time, though, Atkinson's and Hertzfeld's work is not so revolutionary. Their new GUI is still based on a point-and-click paradigm. It not only fails to move beyond that basic point-and-click concept, the new GUI perpetuates point-and-click to a new level of complexity.

For example, say you want to access the services or database of another company using the Magic Cap interface. With point-and-click mouse or pen gestures, you would have to open the office door, walk down the simulated Main Street, and choose the building that represents the other company. If you're an experienced point-and-clicker, the first time you see someone use the Magic Cap GUI that way it will seem logical. But it doesn't really make sense. Neither does opting for pull-down menus or resorting to programming a macro to perform the tasks, both of which nullify the intent of the new GUI.

So why must you open a door and stroll down Main Street to tell a computer what to do? It seems that the Magic Cap GUI is one that force-teaches users how to converse with a computer, when what we really need are computers that better understand what users want.

It's the computer that must be expected to do the work of understanding if we are ever to empower nontechnical workers. The point-and-click paradigm is stale and overworked, and it's time to move up to the next level: We need user interfaces that listen more like humans and accurately—and automatically—anticipate what users want. Despite all the hype and hoopla, the Magic Cap GUI does not significantly improve user interfaces as did that of the Mac 10 years ago. ■

*P.S. With this February issue, I'd like to officially announce the newest member of the BYTE family, BYTE Türkiye, which will publish a version of BYTE in Turkey.*

A stylized, handwritten signature in black ink, consisting of a large, sweeping initial 'D' followed by a series of loops and a long horizontal stroke.

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



## FIRST WE MADE WINDOWS. NOW IT'S TIME TO TALK.



With the new Microsoft® Windows™ Sound System, just tell your computer what you want it to do. You can customize your system to respond to your personal spoken commands. Even our new directional microphone knows exactly who you are.

This full set of audio software has lots of options, too. Spice up presentations with music or quotes.

Or proofread numbers as the computer reads them back.

All for the price of a game.

You can also get this software with the sound board included. So go visit your nearest reseller to see what's creating all the conversation.

**Microsoft**  
Making it easier



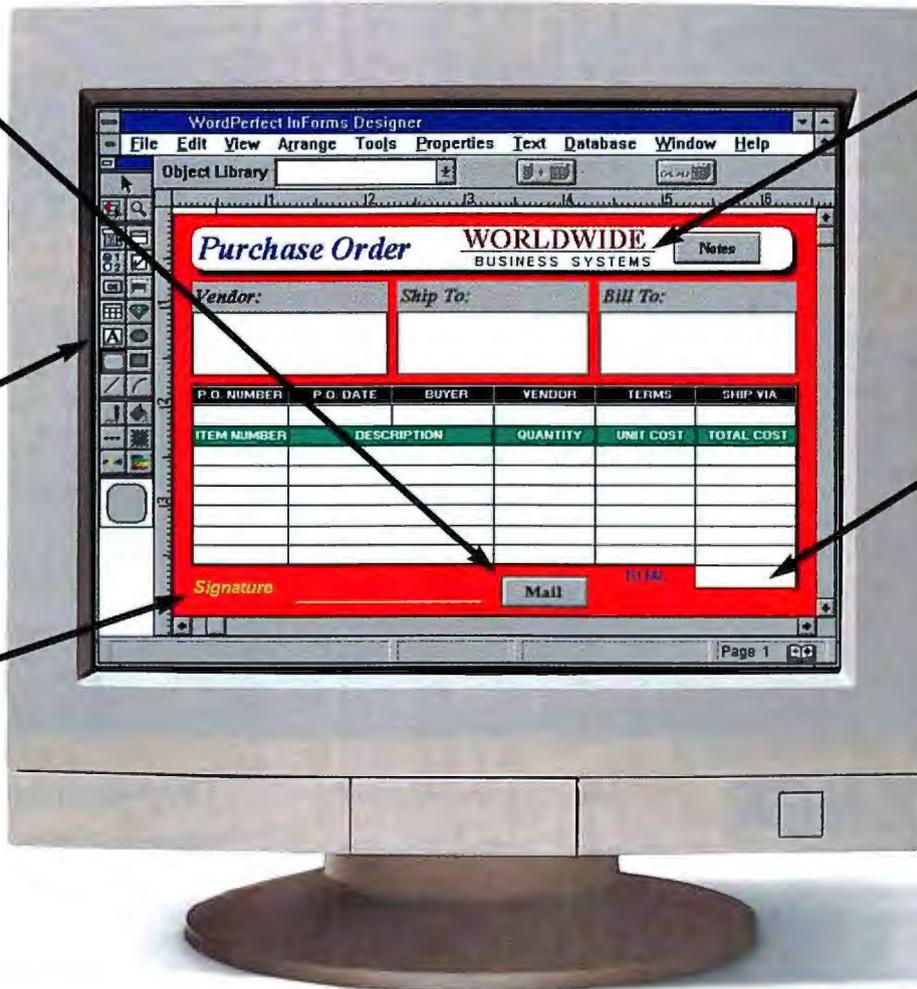
© 1993 Microsoft Corporation. All rights reserved. Microsoft is a registered trademark and Windows and the Windows logo are trademarks of Microsoft Corporation.

# For the best in electronic forms, this choice is easy.

**J**ust click here to let it ride on your e-mail or messaging system.

**U**se any of 22 drawing tools to create your form.

**T**he electronic signature lets you tamperseal the data on your form.



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

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

WORDPERFECT IS A REGISTERED TRADEMARK OF WORDPERFECT CORPORATION WITHIN THE UNITED STATES AND OTHER COUNTRIES. ALL OTHER

You've decided to streamline and cut costs with an electronic forms package. But which package should you choose? • First, look for one that's easy to manage. With graphics and spreadsheet capabilities, to make

your forms look and act exactly the way you want them to. And with design tools that let you get up and running right away. • Second, look for the one that will get you the most out of your databases. That will let

# For the easiest in multiple database access, this choice is best.

**P**ick up your vendor address from dBase, and your billing address from Oracle.

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

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

**A**utomatically update your Sybase SQL inventory database.



BRAND AND PRODUCT NAMES ARE TRADEMARKS OR REGISTERED TRADEMARKS OF THEIR RESPECTIVE COMPANIES. © WORDPERFECT CORPORATION 1993

you access, update or query multiple databases from a single form. • Now that you know what you're looking for, the best choice is easy: WordPerfect® InForms. No electronic forms package is easier to handle and supports

nearly as many databases (19 of the most popular). Take a look at the next generation in electronic forms. Call (800) 526-4806 for a FREE WordPerfect InForms demo disk, or (801) 225-4414 to download from our BBS.

# WordPerfect® INFORMS

**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 Editor: Robert M. Ryan, Russell Kay

**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**  
Jonathan Amsterdam, Nicholas Baran, Mark Clarkson, Don Crabb, Hugh Kenner, Anne Fischer Lent, Laurence H. Loeb, Trevor Marshall, Stan Miaszkowski, Roberta Pournelle, Wayne Rash Jr., Kenneth M. Sheldon, Jane Morill Tazelaar, 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 Services 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 Deguisse  
Data Processing Coordinator: Diane Henry  
Production Assistant/Purchaser: Agnes Perry

**MARKETING AND PLANNING**  
Director: L. Bradley Browne  
Administrative Assl.: Arja Neukam  
Marketing Communications Manager: Rob Mitchell  
Marketing Art Director: Stephanie Wamesky  
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 Russ  
Assistant Manager: Lynn Lagasse  
Subscriptions Assistant: Christine Tourgeon  
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) 643-4782  
Brian Higgins (603) 924-2651

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

**SOUTHWEST, ROCKY MOUNTAIN**  
Jennifer Walker (214) 701-6496  
Brian Higgins (603) 924-2651

**SOUTH PACIFIC**  
Beth Dudas (714) 753-8140  
Alan El Faye (213) 480-5243  
Barry Echavarria (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 x 2)**  
Margot Gnade (603) 924-2656

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

**REGIONAL**  
Ed Ware (603) 924-2664

**BYTE DECK**  
Brad Dixon (603) 924-2596

**EURO-DECK**  
Joseph Mabe (603) 924-2533

**INTERNATIONAL ADVERTISING SALES STAFF**  
See listing on page 257.

**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.  
**WCT:** 250-0135 BYTE Magazine. Many editors also have individual MCI addresses in their own name.  
**OTHERS:** Many editors also are reachable through unet, 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. 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), 27 Congress St., Salem, MA 01970, 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, 27 Congress St., Salem, MA 01970. 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.

Copyright © 1994 by McGraw-Hill, Inc. All rights reserved. BYTE and BIX are registered trademarks of McGraw-Hill, Inc. Trademark registered in the United States Patent and Trademark Office.

 Member Audit Bureau of Circulation

## BIX Interactive On-line Service

**PRODUCT MANAGER**  
Kip Bryan

**DIRECTOR OF COMPUTER-RELATED SERVICES**  
Stephen M. Laliberte

**MEMBER SERVICES MANAGER**  
Kevin Plankey

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

BIX, owned and operated by General Videotex 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 make a data call to our Tymnet address: 310690157800. Then hit the Enter/Return key and enter "BIX" when asked to log in; then enter "BIX.VILLE" when asked for a name. For current fees and more information, call (800) 695-4775 or (617) 354-4137 on voice phone; fax: (617) 491-6642; Internet: bix@genvid.com.

**OFFICERS OF MCGRAW-HILL, INC.:**

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. Bahasi; Senior Vice President, Treasury Operations: Frank D. Penglase; Executive Vice President, Publication Services: Norbert Schumacher; Vice President/Group Publisher, Computer Magazines: Fritz Landmann.

Founder: James H. McGraw (1860-1948).

# The

It's time for a truly objective discussion about application development. IBM's System Object Model (SOM) (currently shipping with OS/2® 2.1) is a language-neutral mechanism for developing object-oriented class libraries. Together with our new IBM SOMobjects™ Developer Toolkit, you can write apps faster and more efficiently than ever before.

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

SOMobjects is available for both OS/2 2.X and IBM AIX/6000™ 3.2 (or higher) operating systems and is planned for the Windows™ environment. It complies with industrywide standards of the Object Management Group's (OMG®) Common Object Request Broker Architecture (CORBA). To find out more or to order the SOMobjects Developer Toolkit, call 1 800 3-IBM-OS2 today. If your object is easier development, it's a more desirable way to work.

Making reuse a reality.

# objects

# of

# your

# desire.

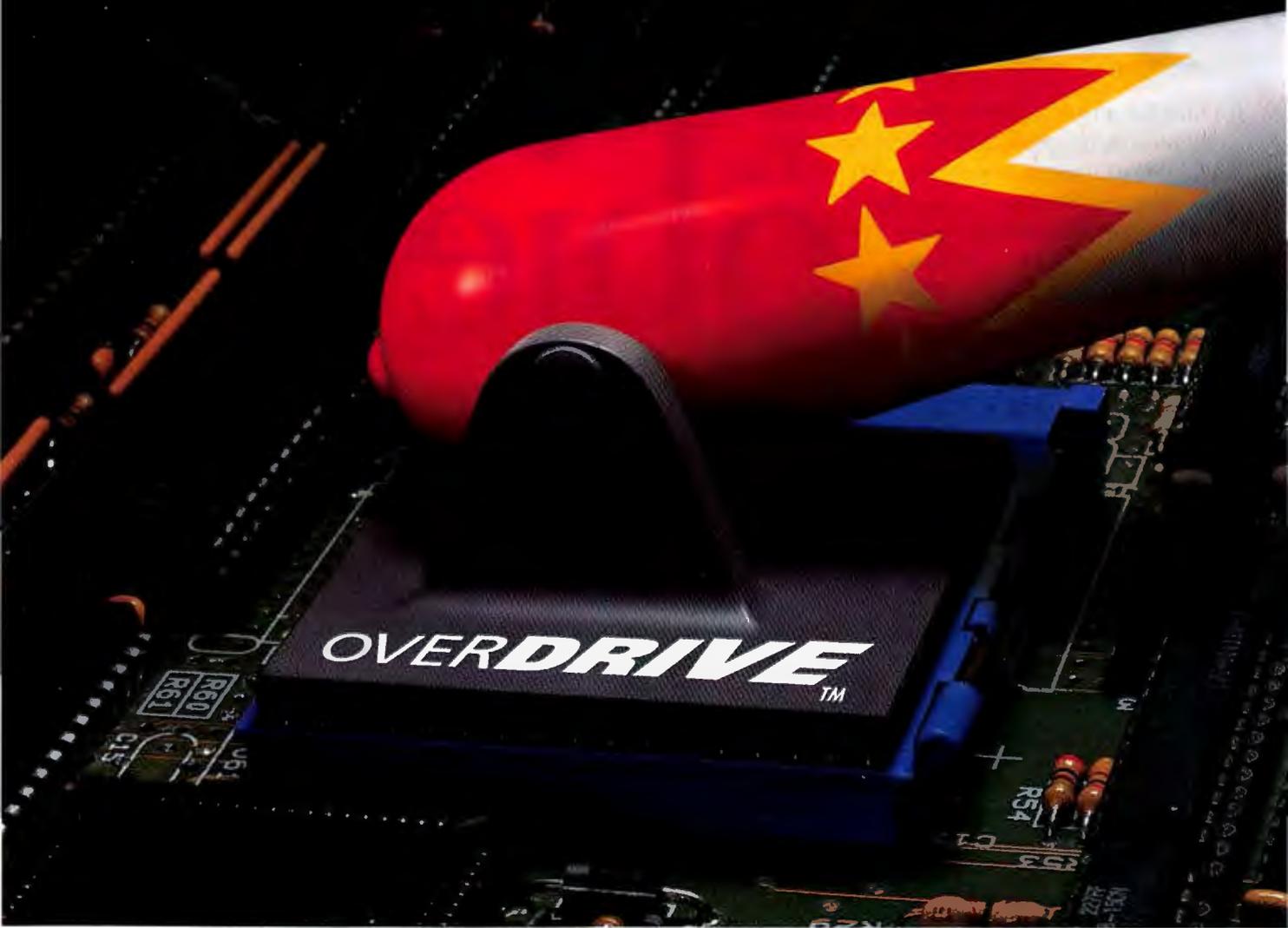
SOMobjects  
Developer Toolkit



## The object of SOMobjects

- Distributed object support**—allows objects to be distributed over entire networks.
- Upward binary compatibility**—object modification without application recompilation.
- Language-neutrality**—IDL compiler allows objects to be used by different programming languages.
- Replication frameworks**—makes copies of a single object available to multiple clients.
- Multiple platforms**—available for OS/2 and AIX/6000.





# 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 i486™ DX2 OverDrive

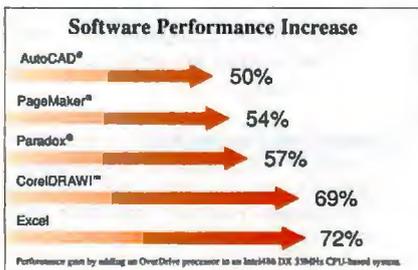
processor to your Intel486™ SX or DX CPU-based system. And watch *all* your power-hungry software take off.

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 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.



# ware up to 70% more ka-boom.



Plus, the OverDrive processor is easy to install. Depending on your system, you can either plug it into the OverDrive socket or swap it with your original microprocessor. No problem.

To get a better idea of how the OverDrive processor boosts perfor-

mance of your software, call 1-800-354-3112, Ext. 5719,\* for a free demo disk. It could be the greatest show on earth.

**intel**®

Circle 107 on Inquiry Card.

## OS/2 Coverage: Excellent or What?

You published the most comprehensive review of OS/2 (November Special Report) I have ever seen. You did an excellent job in pointing out OS/2's strengths and limitations, as well as comparisons to Windows and Windows NT. Your readers now have a clearer understanding of what OS/2 is and is not. Other publications have an unexplainable bias toward Microsoft and against IBM.

John Caprioli  
Worcester, MA



Jon Udell's November article "Is There a Better Windows 3.1 Than Windows 3.1?" sums up the new direction BYTE is taking in its perennial attack on OS/2. The appearance of NT as a white elephant means OS/2 can no longer be dismissed for requiring 8 MB of RAM and lots of disk space. Comparisons must now be sought with Windows 3.1.

Windows 3.1's background processing makes a system jitter like a chicken with its head cut off; OS/2's multitasking capabilities purr like a kitten. As for NT, OS/2's object orientation gives me the power to tailor my environment to my personality, and not to that of Bill Gates.

Mark Heseltine  
London, U.K.

*We don't think we've been attacking OS/2. In fact, we voted OS/2 2.1 a BYTE Award of Excellence (see last month's issue).—Eds.*

It's about time we began to look beyond mighty Microsoft in the operating-system arena. For two years, Microsoft has been telling us everyone needs a multitasking, multithreaded, protected, 32-bit operating system. But when NT went from a desktop operating system to a network server, Microsoft told us we don't need that power "quite yet." When Chicago comes out, suddenly we'll need that power.

I say we have that power now. It's called OS/2, it's here, and it works. Most magazines are so enamored of Microsoft they won't look at anything else.

Todd Louis Green  
Silver Spring, MD

In a nutshell, I don't believe you. Udell's Windows-OS/2-Windows NT comparison claims NT has disk I/O speeds more than

twice those that DOS-based Windows or OS/2 can deliver. Something's wrong here.

Disk I/O is mature in operating systems and approaches the maximum throughput the hardware can deliver. Am I to believe

Microsoft has suddenly developed a manner of handling disk I/O that blows all previous methods out of the water—and then didn't trumpet this new method to the stars? I think not. When something looks too good to be true, it usually is. I think someone needs to substantiate your results, before I start to believe some PR person sent you a case of your favorite wine.

Peter Skye  
Glendale, CA

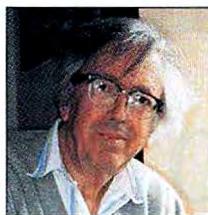
*NT can't make disks transfer data faster, but its unified cache manager—which dynamically allocates memory not claimed by the operating system or by applications to the caching of all local and redirected file systems—does a terrific job. You can statically allocate big chunks of dedicated RAM to the Windows or OS/2 disk caches, but then applications can't share it.—Jon Udell*

## Books on CD

I welcomed Hugh Kenner's Commentary in the November issue. Books are often hard to read on CDs. I also find it annoying that I can't scribble notes in the margins and that CD-ROM publishers often fail to include page numbers or complete bibliographic information. This makes academic citation all but impossible.

On the other hand, cutting and pasting makes quoting large tracks a breeze, and the low cost of CDs is a boon to students like myself.

Wade Riddick  
Austin, TX



I was appalled by Kenner's claim that "most books are better left on paper" (than put on CD-ROM). Is the day far off when the cost of a library on CD is less than a comparable one in text? That day is here for subscribers to periodically updated professional libraries in law and medicine. The issue for "the future" is not printed versus electronic books, but locally stored

(CD-like) versus transmitted (superhighway) books. I have some nice slide-rule company stock for naysayers.

R. I. Feigenblatt  
Arden, NC

## This Office Needs Another Subscription

Here's a game based on Jerry Pournelle's column: When a new issue of BYTE arrives at the office, volunteers each take a turn to find the first instance of *alas*. (As in, "Alas, the computer didn't work.") The player with the shortest time wins and gets priority to the office's lone copy.

Bill Clark  
Sheboygan, WI

## Fixes

We inadvertently omitted mentioning the company (Caere, Los Gatos, CA) in a December 1993 What's New write-up of OmniScan, its 400-dot-per-inch hand-held scanner.

In "Point-and-Click Presentations" (November 1993), the author incorrectly said that Harvard F/X, the bit-map editor in Harvard Graphics 2.0, does not support scaling and cropping of bit-map images; it does.

In "Printers in Transition" (December 1993), we stated that as printer resolution rises, required RAM increases exponentially. The correct mathematical relationship is proportional to the square of the resolution, because as you double resolution, you get four times the data.

The map in the December 1993 Report from Cyprus ("A Market in Transition") was incorrectly identified. According to experts in international relations, the international community recognizes the Republic of Cyprus as a sovereign state and does not recognize two separate states within the island. Most countries (with the exception of Turkey) have not recognized the northern part of Cyprus as a state.

**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.

COLORADO TAPE BACKUP



4 Gigabytes.  
Under \$1,700.

**POWER**TAPE



WHEN YOU CONSIDER THE VALUE of all the data on a network, any backup system is a wise investment. But now you have a choice. PowerTape Series from Colorado Memory Systems. With a native capacity of 2 GB and 4 GB using data compression, PowerTape can handle virtually any backup task.

The PowerTape system includes a backup tape drive, Colorado® Backup software and more. At \$1,695 MSRP why pay more? And, if 4 GB is more than you need, a 2.4 GB model is available with the same high performance features at only \$1,295 MSRP.

A new low-cost 1 GB model is available as well. At, \$799 MSRP, PowerTape 1100 is the most affordable PowerTape ever.

With PowerTape, you get safe and easy restores and backups, plus the reliability of QIC Industry Standard Format. PowerTape offers broad network compatibility including Novell® NetWare®, NetWare Lite™, LANtastic® and IBM® PC-NET and operates under UNIX, OS/2 and Microsoft Windows NT operating environments. And all PowerTape systems are backed by the best support in the industry.

Call **1-800-451-0897** extension. 317 today for a FREE Colorado *Total Backup* catalog.

## Colorado PowerTape Series

*Capacities from 525 MB to 4 GB.*



© 1992 Colorado Memory Systems Inc. All rights reserved. PowerTape and Colorado are trademarks of Colorado Memory Systems, Inc. All other trademarks are property of their respective companies. PTA-BY113093

Circle 76 on Inquiry Card (RESELLERS: 77).

# The Toshiba T4700C Series

## Introducing a notebook so powerful, it breaks the sound barrier.

### T4700CT

- 9.5" TFT-LCD active matrix color display

### T4700CS

- 9.5" Dynamic-STN dual-scan color LCD display

### Both Models

- 50MHz SL Enhanced i486™DX2
- 8MB RAM (expandable to 24MB)
- 200/320MB HDD
- Two PCMCIA slots (16mm and 5mm)
- Integrated graphics accelerator
- VL local-bus video
- Built-in microphone
- Wave™ audio capabilities
- Audio jacks: headphone/speaker and microphone
- NiMH battery for extended life
- QuickCharge battery recharge system
- 3.5" 1.44MB floppy disk drive
- BallPoint™ 2.0 mouse with QuickPort™
- MaxTime™ Power Management system
- LCD status icon bar
- DOS™ 6.0, Windows™ and Microsoft® Sound System™ software pre-installed



**Blazing 50 MHz:** Run with the power of the SL Enhanced i486™DX2 – the fastest microprocessor ever designed specifically for notebook computers.



**Two separate PCMCIA slots:** A 16mm and a 5mm slot are your keys to expansion, now and into the future—for modems, storage and more.

**The only computer you'll ever need:** Slip it into the optional DeskStation IV, and you're instantly connected to your network, printer, VGA monitor, mouse, and full-size keyboard.



**A multimedia roadshow:** Wave audio compatibility, headphone or external speaker port, and microphone jacks make it perfect for presentations.





This is it! The most powerful notebook you've ever heard. The Toshiba T4700C Series can run your most intense applications— or even help you run a presentation.

With its SL Enhanced i486™DX2 50MHz processor, it easily handles graphics-rich programs as well as spreadsheets. The built-in multimedia



capabilities let you create and give breakthrough presentations anywhere. The renowned Toshiba color displays will make all your work shine. And there's even a full 3-year limited warranty so you can carry it with complete confidence.

With so much going for it, buying a T4700C Series notebook is obviously a sound decision.

**For a dealer, call 1-800-457-7777.**

In Touch with Tomorrow  
**TOSHIBA**

# News & Views

## COMMUNICATIONS

# Just Like Magic?

It will likely take years, but General Magic and its partners want to create a ubiquitous communications infrastructure

BY TOM R. HALFHILL AND ANDY REINHARDT

Today's communications infrastructure is a chaotic mishmash of wired and wireless networks that either aren't interconnected or are linked via clumsy gateways. Business users and consumers who could benefit from ubiquitous communications have trouble dealing with all the different platforms, topologies, and protocols. Developers who could provide solutions face formidable obstacles because there's no unifying technology to bridge the gaps. Although users can access a wealth of

on-line information and services, they must know where to look and be willing to master different user interfaces, which tend to be rigidly text-based and command-line-oriented.

After four years in development, a suite of technologies designed to profoundly alter this structure is coming to market. The technologies were de-

veloped by General Magic (Mountain View, CA), a start-up company that counts Apple, AT&T, Matsushita, Motorola, Philips, and Sony among its partners. The pieces include Telescript, a communications-oriented programming language for creating distributed applications and intelligent agents; Magic Cap, an object-oriented operating system designed for PDAs (personal digital assistants); and a new GUI that's a radical departure from the Lisa-Macintosh-Windows model of the 1980s.

All these technologies will start appearing in the next few months, embedded in devices from General Magic's partners and licensees. At least two firms—Sony and Motorola—plan to introduce their PDAs by midyear. Initially, they will be based on Motorola's 68300 "Dragon" microprocessors, but Magic Cap is being ported to other chips, including Intel's 80x86 and the PowerPC.

These new PDAs probably won't rely as heavily on handwriting recognition as Apple's MessagePad and Tandy/Casio's Zoomer. Instead, they'll be more communications-oriented, with integral wireless and cellular-phone capabilities.

Telescript, a communications-oriented programming

### THE MAGIC CAP INTERFACE

**Library** Wednesday, November 24 9:27 a.m. Hallway

WRITING  
Getting Started

Contact

who Barbara Nelson

call message look up

**Desk** Monday, November 22 Hallway

Stationery

plain postcard plain letter urgent postcard

business letter

**Desk** Monday, November 22 6:56 p.m. Hallway

Magic Cap may resemble a cartoon, but it's simple enough for casual users and is a radical departure from today's GUIs.

**In box** Tuesday, November 23 8:24 p.m. Desk

From When About

In box rules

- 3. When any message arrives, play the Magic sound.
- 4. When a confidential message arrives, file it in the Personal folder
- 5. When a message with an offer stamp arrives, file it in the trash
- 6. When an urgent message arrives, post an announcement saying "Urgent message arrived!"

No matter where you are in Magic Cap, you can call someone, send a message, or look up someone's address.

Magic Cap's desk metaphor lets you file documents in a drawer.

Magic Cap provides you with a set of editable rules for handling incoming messages.

## AGENTS ON THE LOOSE

Telescript, General Magic's communications-oriented programming language, lets developers write tools that permit casual users who know nothing about programming to create intelligent applications that seek out and retrieve important information. What kinds of applications does Telescript enable?

Think how PostScript made it easy for nonprogrammers to enrich documents with new data types—such as graphics, color, fonts, and photos—and then reproduce those documents on a wide variety of output devices without writing—or even seeing—any PostScript code. Telescript hopes to do the same thing for communications. Users could send E-mail enriched with graphics, photos, video clips, voice annotation, encryption, and scheduling information while avoiding the chaotic details of file formats, network protocols, service gateways, and other technical exotica.

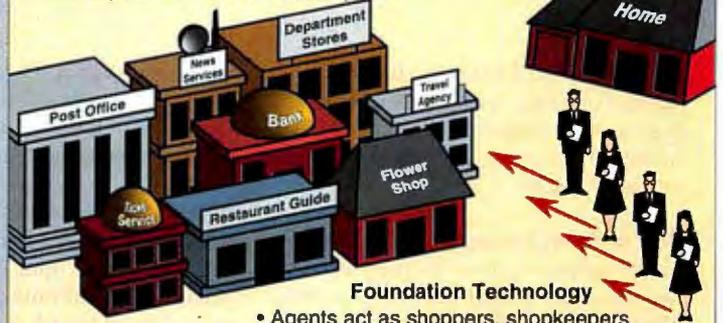
The key breakthrough: Telescript messages are smart objects that know what to do and where to go. Unlike today's E-mail messages, which are merely files of ASCII text and binary attachments that flow through a pipe, Telescript agents are self-contained units. They navigate WANs (wide-area networks) on their own, correctly present themselves when they arrive at their destinations, and support flexible capabilities such as automatic forwarding or return receipts, regardless of the platform.

For example, businesspeople could create or buy custom news-clipping agents ("Fetch me every AP story on oil exploration") and stock-market agents ("Send a buy order to my broker if Intel's stock dips below 100"). Newspapers could sell on-line classified ads and then freely distribute agents to help consumers find what they want.

The open specifications for Telescript may enable a cottage industry of freeware and shareware agents customized to perform a limitless number of specialized tasks.

—Tom R. Halfhill and Andy Reinhardt

### Telescript in the Electronic Marketplace



- Foundation Technology
- Agents act as shoppers, shopkeepers
  - Places function as electronic stores, malls
  - Agents go to places to conduct business on your behalf
  - Developers write agents for end users

language comparable to C or Pascal, will let developers create network-independent intelligent agents and distributed applications. Some of these applications, in turn, may be tools that let ordinary users create intelligent agents without programming. What PostScript did for cross-platform, device-independent documents, Telescript aims to do for cross-platform, network-independent messaging. General Magic hopes Telescript will become a lingua franca for communications.

Because Telescript is a portable language that executes atop a run-time interpreter, applications can run without recompilation on any supported platform or network, not just Magic Cap. Equally important, Telescript shields programmers from many of the underlying complexities of network protocols and directory services, just as the Windows API and Mac Toolbox shield programmers from the complexities of window management, graphics, and device I/O. General Magic is widely licensing Telescript to vendors for many different purposes.

For example, AT&T is now using Telescript to build a new E-mail service that will support rich messaging and data interchange. The new service will offer gateways to existing services, such as CompuServe, America Online, and AT&T's own EasyLink. Because Telescript is also being adopted by other General Magic partners, it has an opportunity to become the standard middleware for all communications-centric applications.

Like Telescript, Magic Cap will appear on PDAs from multiple vendors, including General Magic's partners and licensees. Magic Cap isn't just an operating system for PDAs, however. It could also be used in devices like fax machines, smart phones, or even TV cable boxes.

Magic Cap represents General Magic's bid to take GUIs to the next conceptual level. While today's environments protect users from many details

of the hardware and operating system, Magic Cap goes even further. For instance, no longer must users understand the differences between executable and nonexecutable files, directories and subdirectories, physical and logical drives, or filenames and extensions.

The new GUI was invented by ex-Apple engineers and General Magic cofounders Bill Atkinson and Andy Hertzfeld. It may appear as absurd and cartoon-like to experienced computer users as the Lisa's GUI did in 1983, but it's intended to make personal computing accessible to the millions of people who otherwise might never buy a computer. Although Magic Cap is optimized for the small LCD screens of PDAs, it will also run on desktop computers, either as the primary GUI or atop an existing one (much as Apple's At Ease runs atop System 7), such as the Mac or Windows.

Magic Cap already runs on the Mac, and it can take advantage of the higher resolution and better color available on the screens of desktop computers. It has the potential to become a leading desktop GUI for users who are technically unsophisticated. Even if it fails in this attempt, it will likely influence the future evolution of other user interfaces.

General Magic has many potential competitors. Magic Cap goes up against operating systems like Windows for Pens/Winpad, PenPoint, Newton Intelligence, GeoWorks' GEOS, and DOS running on pocket PCs. Microsoft is promising users and ISVs (independent software vendors) "Windows everywhere," but it remains to be seen how the look and feel of Windows will be preserved across disparate platforms and devices. GEOS does a better job of bridging these differences by decoupling the user interface from the application

code, and it's already showing up on PDAs from Tandy, Casio, and Sony. The fate of the MessagePad is unclear.

The competition for Telescript is not as obvious. Its closest rivals appear to be RPC (remote procedure call) mechanisms like the OSF's (Open Software Foundation's) DCE (Distributed Computing Environment) and Sun's DOE (Distributed Objects Everywhere), as well as store-and-forward architectures like Microsoft's MAPI (Messaging API).

The obstacles to General Magic's success may appear daunting, but General Magic is not your typical start-up company. Its partners include some of the biggest players in the worlds of computing, communications, and consumer electronics, and it's loaded with top-notch engineers who have been given a clean slate to reinvent traditional approaches to ubiquitous worldwide communications.

## NEW PRODUCTS

# Best of Comdex Awards

**A**t last fall's Comdex, BYTE editors worked morning, noon, and night in picking the best products and technologies exhibited at the show. Winners and finalists are listed below.

**Best of Show:** Simon, a personal communications device, took top honors at the show (see the related story on page 28).

**Most Significant Technology:** Top honors went to the P1394 High-Performance Serial Bus draft standard, a new technology that should have a profound effect on computers and peripherals, as well as home electronics and industrial equipment. This bus interface is designed to be an inexpensive, universal interconnection for linking computers with hard drives; CD-ROM drives; printers; scanners; and consumer products like digital VCRs, TVs, and stereos at data transfer rates of up to 400 Mbps. The standard is being developed by a committee within the IEEE. Companies receiving the award that participated in P1394 development included Adaptec, Apple, IBM's PC Company, Maxtor, Texas Instruments, and Western Digital.

Finalists in this category were  $\mu$ Pol (pronounced micropol), from VRex (Hawthorne, NY); and Raven, from Intergraph (Huntsville, AL). The VRex technology includes hardware and software for inexpensively displaying 3-D stereoscopic images. Raven, a software/hardware combination, is designed to bring high-speed audio and video to Windows NT.

**Best Portable:** Simon won this. Finalists included the highly expandable, luggable PAC-586 Pentium system from Dolch (see the related story in this section), and Irvine, California-based Toshiba's Portégé T3400 and T3400CT subnotebooks.

**Best System:** The Quadra 610 with its DOS-compatible card took top honors (see the January News&Views). Finalists were the Express RISC server from NEC Technologies (Boxborough, MA), a dual-processor system that's based on NEC's VR4400MC Mips processor; and DEC (Maynard, MA), which has introduced its DECpc XL series of modular 486- and Pentium-based PCs that will let you upgrade to the company's Alpha AXP CPU technology via a daughtercard.

**Best Connectivity/Hardware:** Largo, Flori-

da-based AT&T Paradyne's DataPort 2001 Multimedia Communicator, a modem-size box with bundled modem/fax software and Data Beam's FarSite shared whiteboard program, lets you simultaneously talk and send and receive still images, graphics, and data on the same regular telephone line. Finalists included Solflower Computer (San Jose, CA), which developed a multihost controller that lets up to 16 Sun workstations share information at 8.3 MBps. Artisoft's (Tucson, AZ) Simply LANtastic, the other finalist, includes a scaled-down, simplified version of LANtastic 5.0 and ingenious self-terminating Ethernet adapters that can be daisy-chained and disconnected without interrupting the network.

**Best Peripheral:** SyQuest's SQ1080 offers the first PCMCIA removable hard disk cartridge drive. Finalists were DSP Solutions' (Palo Alto, CA) portable 16-bit PCMCIA sound card and Philips Consumer Electronics' Brilliance 2130, a 21-inch digital monitor.

**Best Connectivity/Software:** DEC's LinkWorks software lets workgroups share information and collaborate over networks. Finalists were Visual Voice, a Visual Basic custom control from Stylus Innovation (Cambridge, MA), and BW-Server, from Raleigh, North Carolina-based Beame & Whiteside. BW-Server provides NFS (Network File System) functionality to an Intel-based PC without requiring a Unix-based machine to act as an NFS server.

**Best Multimedia Hardware:** Austek Microsystems' A1060 was named the winner (see the related story on page 28). Finalists included Fast Electronic U.S. (Natick, MA), which offers a video overlay, frame grabber, TV tuner, and video-editing system on one card with software for \$549, and Microfield Graphics' (Beaverton, OR) Softboard.

**Best Multimedia Software:** Ultimedia Video IN/2 (\$199) for OS/2 2.1 from IBM Personal Software Products converts video input to Indeo or IBM Ultimotion format. Finalists were Lotus Development's ScreenCam (see the story on page 28), and Tempra Producer Pro, a \$99 Windows-based modeler and rendering program from Mathematica (Lakeland, FL).

**Best Printer:** QMS (Mobile, AL) and its



Microfield Graphics' Softboard is a \$2995 peripheral that looks like an everyday whiteboard but displays information that you write simultaneously to a Mac or PC connected via a modem and phone lines. Softboard can greatly enhance a remote audioconference.



When system manufacturers include the drive in their desktop and notebook computers, SyQuest (Fremont, CA) expects the price for end users to be less than \$1 per megabyte. The drive accepts rugged, removable 60- and 80-MB cartridges.



Kai's Power Tools, which works with any Windows application that supports Adobe Photoshop plug-in extensions, simplifies many of the complex operations in applying special effects to an image. The Texture Explorer lets you generate textures that go far beyond traditional textures like marble or wood.

2001 Knowledge System (\$3999) took the top award in this category. QMS's system is based on Windows 3.1, and it combines a copier, fax, scanner, and laser printer. Finalists were the 360-dpi Canon (Costa Mesa, CA) \$649 BJC-600 color ink-jet and LaserMaster's (Minneapolis, MN) \$19,995 Digital Color Printer.

**Best Software:** Kai's Power Tools from HSC Software (Santa Monica, CA) won. Finalists were WizRule, a program developed by Rational of Tel Aviv that discovers exceptions and unknown rules in a database, and IBM's Personal Dictation System, which can handle up to 70 spoken words per minute.

—Dave Andrews

# WATCOM™ VX•REXX™

## Visual Development Environment For OS/2 REXX

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

**Design Applications Visually** Create rich graphical applications quickly and easily using the visual design environment. With the visual designer, you can graphically create 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.

### Interactive Debugging

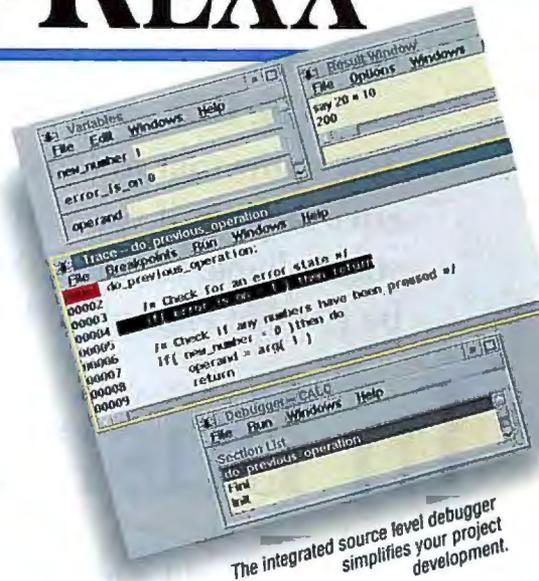
If an error occurs at run-time, VX•REXX will display a traceback pinpointing the source line where the error occurred. A simple click of the mouse will return you to the source edit window to correct the error. The built-in interactive source-level debugger lets you set breakpoints, step through code and watch variables to track down complex problems.

### Build Professional Applications

WATCOM VX•REXX allows you to leverage key OS/2 features to create professional applications. Build applications that dynamically create and modify CUA'91 screen objects at both edit and run-time, and include OS/2 style help and hints.

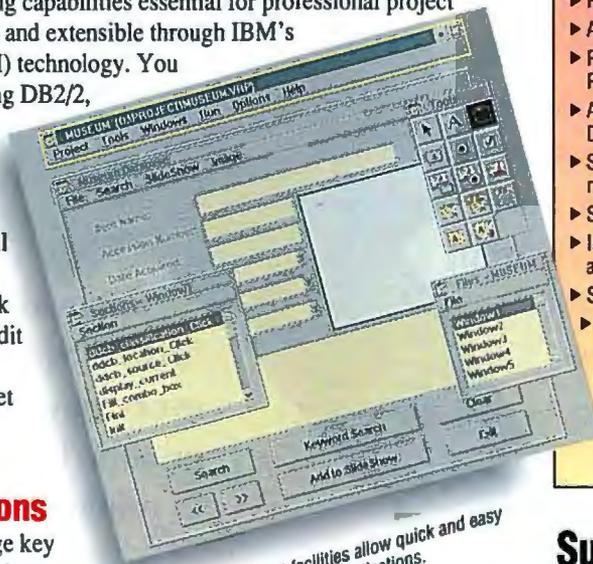
### Create Multi-Threaded Applications

Every VX•REXX application contains multiple threads. One thread remains responsive to user input while others continue processing. In addition, VX•REXX provides the ability for advanced applications to easily use additional threads.



### Highlights

- ▶ Easy to use visual development environment
- ▶ Drag-and-drop programming
- ▶ Create and modify objects dynamically at both edit and run time
- ▶ Powerful project management facility
- ▶ Advanced interactive source-level debugger
- ▶ Package your applications as EXE files or PM macros
- ▶ Access to standard Rexx API's including DB2/2
- ▶ System Object Model (SOM) based object manager
- ▶ Support for multi-threaded applications
- ▶ Include OS/2 style help and hints in your applications
- ▶ Supports SAA CUA'91 objects
- ▶ Integrated console window support for existing Rexx programs
- ▶ Royalty-free run-time
- ▶ Multiple modeless window support
- ▶ Create PM macros for applications supporting Rexx as a macro language



**Suggested Retail: \$199\***

**WATCOM**

Call Toll Free  
**1-800-265-4555**

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

Circle 152 on Inquiry Card.

You need a system flexible enough to handle any application.

The RISC System/6000.

You know that in today's business environment if you can't bend you're liable to break. You have to be flexible enough to handle what-

ages. Applications as far-reaching as fourth-generation languages, warehouse management, job costing, insurance agency management, the most powerful CAD applications, and there's much, much more. In

# In business you need mo

ever the world can throw at you.

So we built the RISC System/6000® to give you more than just speed and power but also an unparalleled flexibility of applications. To run more than 6,500 different applications to fit any industry, any business need. Everything from software development tools to accounts receivable. From payroll to the leading database pack-

fact, our Business Partners are bringing innovative

new applications to the RISC System/6000 every day. All of this greater flexibility is made possible



by AIX/6000™, IBM's industrial-strength version of the UNIX® operating system. AIX/6000 opens up a world of possibilities, without upsetting your existing equipment and network links,

and consulting services. If you need it, we'll bend over backwards to get it to you. In fact, there's only one thing we're inflexible about: the superiority of IBM's service and support. 24 hours a day, 7 days a week, 365 days a

# re than speed and power.

whether they're from IBM or not. And because AIX/6000 complies with all relevant UNIX industry standards, including the new DCE from OSF, you can take advantage of the newest client/server applications.

IBM backs all of this up with total installation support, system customization

year. To get a complete listing of the thousands of applications available to you, call 1 800 IBM-6676, ext. 676 for your copy of the AIX Solutions Catalog.

Or to get information by fax, call 1 800 IBM-4FAX.

We'll give you all the power, speed and flexibility you'll need to go straight to the top.



## BUSINESS MULTIMEDIA

# ScreenCam, Lotus's On-Screen "Tape Recorder"

**T**oo much technobabble and too heavy a reliance on video: Steve Barlow, the product manager for multimedia at Lotus Development (Cambridge, MA), believes that these two obstacles have contributed to the perception by business that multimedia doesn't make you productive and isn't worth the cost. Barlow says if Lotus had originally marketed its flagship

Lotus 1-2-3 in the same way multimedia is being promoted today, the company would have pointed at the spreadsheet program and said, "Look at this great technology...look at this great cell engine."

As part of its strategy to deliver business-practical multimedia into the hands of novice computer users, Lotus has introduced ScreenCam, a program for Windows that lets you capture screen activity, cursor movements, and sound into a file that can be integrated as a stand-alone executable file or with any Windows program that supports OLE.

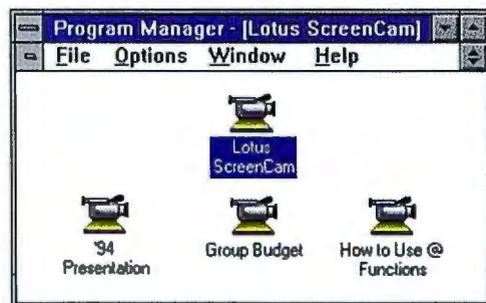
To create a ScreenCam file, you click on a record icon to begin the recording session. As you move the mouse and enter keystrokes, you narrate your screen activity as you speak into a microphone. To play a ScreenCam file, you don't need ScreenCam or the application that created it. ScreenCam does not require a video-capture card (although it does require a sound card). It can create full-screen, full-motion files that can play on a 386-based or higher machine.

Lotus says that ScreenCam is a natural for letting people distribute files that explain a

new feature in a program or annotate a word processing or spreadsheet file. A 1-minute ScreenCam file will typically consume about 1 MB, most of which is due to the sound, Barlow says. Lotus is investigating several compression alternatives.

ScreenCam will be bundled first in Lotus 1-2-3 release 4/ Multimedia Edition, but Barlow says the company plans to release it with future versions of Lotus Notes and SmartSuite. A stand-alone version expected in the first quarter will probably sell for under \$100.

—D. A.



### SIMON SAYS: COMMUNICATE

IBM and partner BellSouth have introduced a personal communication device that combines a cellular phone, fax, E-mail, cellular paging, and several personal productivity applications in a system that weighs just 18 ounces.



BellSouth, which is distributing the product for IBM, will introduce Simon (\$899, call (800) 746-6672) first to the central Florida region and then to other markets in the U.S. Nicole Lipson, manager of media relations at BellSouth Cellular, says the company expects that Simon will be available nationwide by April. IBM is evaluating whether it will release Simon to international markets.

BellSouth quotes a battery life of about 8 hours while in standby mode and about 1 hour during continuous talking or data transmission. A backlit LCD lets you access Simon's communications, calendar, appointment, calculator, paperless notepad, keyboard, and address book applications using a plastic pen or your finger. A built-in 9600-bps fax modem lets you send or receive faxes up to three pages. An optional PCMCIA pager card will let you receive alphanumeric pages.

—D. A.

## GRAPHICS/ENTERTAINMENT

# High-Performance 3-D Coming to PCs

**A**pplications like 3-D model animation, stock-market visualization, and other high-end programs usually found only on expensive workstations should start appearing this year on less expensive 80x86-based PCs. Thanks to board-level OpenGL graphics accelerators coming soon from companies like Austek Microsystems and DuPont Pixel, system vendors will be able to build relatively inexpensive PCs capable of delivering workstation-like performance on applications running atop OpenGL.

Silicon Graphics' OpenGL API makes it easier for developers to program such applications and creates the hooks for hardware accelerators. These inexpensive graphics accelerators, when working side by side with CISC or RISC processors and OpenGL-based applications, will make it possible to deliver a 3-D processing platform at an affordable price.

At Comdex, Austek Microsystems (Fremont, CA) introduced its A1060 graphics accelerator, which the company expects to begin production on in the first quarter and sell for about \$100 each to OEMs in "moderate" volume. The goal of the company, according to Chris Russell, marketing manager of graphics products at Austek, is to provide a low-cost platform that al-

lows the easy porting of high-end applications to higher-volume platforms. Such graphics accelerators can off-load the central CPU from having to write pixels to a frame buffer and shade them and let the main CPU and FPU concentrate on true math operations (e.g., matrix transformations).

DuPont Pixel's Glint chip will accelerate OpenGL 3-D graphics running under Windows NT and Unix. Osman Kent, executive vice president of R&D at DuPont Pixel (San Jose, CA, and Egham, U.K.) says the Glint chip will deliver advanced graphics performance on machines ranging in price from \$3500 up to \$35,000. Glint is not expected to start sampling until the middle of the year.

Austek's Russell cautions that these new 3-D platforms are not restricted to the technical market. "Developers of entertainment and education applications may also see this platform as a very attractive one to write 3-D programs," he says. "As board-level products begin to emerge based on our technology and Silicon Graphics' OpenGL, then the entertainment developers would see this as a very attractive combination to write high-performance, low-cost 3-D games."

—Dave Andrews and Dom Pancucci

Pixels per second

1,600,000

1,400,000

1,200,000

1,000,000

800,000

600,000

400,000

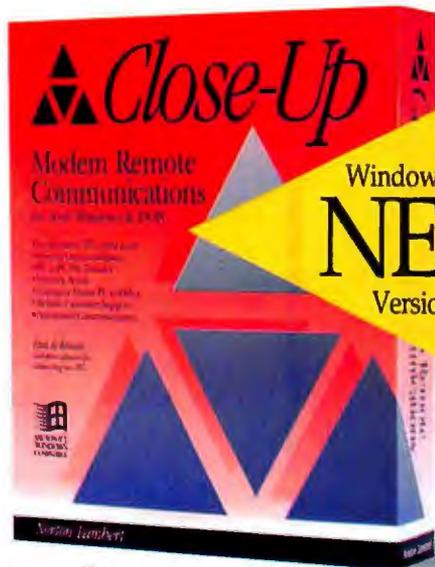
200,000

Close-Up 5.0

## 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.



For Both Windows & DOS

**NEW**  
Version 5.0

# 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!

### Technology Firsts

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

## 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). 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 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.<sup>95</sup>

**Upgrade** your current or competitive remote program to new Close-Up 5.0. Get both sides, Host & Remote, for only \$69.<sup>95</sup>

Order Today 805-964-6767

**Norton-Lambert**

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

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. Modem: 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.  
© 1994 Norton-Lambert Corp., P.O. Box 4085, Santa Barbara, CA 93140 USA Phone (805) 964-6767 Fax (805) 683-5679

# The PowerPC™ is coming soon to a

**B**uckle up and  
hang on tight.

Personal computers  
based on  
PowerPC  
micropro-  
cessors from  
Motorola are  
coming your way.

And when  
they arrive,  
they're going to be the fastest,  
most powerful personal  
computers you've ever seen.

Computers based on PowerPC

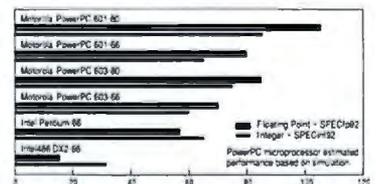


microprocessors will  
run circles around  
machines based on  
the Intel486™  
DX2 micro-  
processor. They'll whip  
those based on  
the Pentium™  
microprocessor,  
too, especially in  
crucial floating  
point performance. And they'll  
cost no more than today's PCs.

Right out of the gate, computers

based on PowerPC microprocessors  
will be able to run the most popular  
software operating systems, including  
AIX, Macintosh® System 7, MS-DOS,®  
Novell® NetWare® 4, OS/2,® the  
PowerOpen™ Environment, Solaris®  
and Windows NT.™

You'll be able to choose application  
software from leading vendors like  
Adobe, Aldus, Autodesk, Banyan,®  
Claris, Frame, Informix, Ingres,®



Computers powered by Motorola's PowerPC microprocessors  
will run new generation software a great deal faster  
than computers powered by Intel's Pentium microprocessors.

## PowerPC microprocessors. Changing

# microprocessor computer near you.



Microsoft, Oracle,  
Sybase, Symantec and



WordPerfect. And with  
the superior floating



point performance of  
computers based on



PowerPC micropro-  
cessors, you'll run that

software faster and  
more efficiently than

will those based on

Intel microprocessors.

Also, you can expect the performance  
advantage of computers based on

PowerPC microprocessors to increase

◀.....▶

*"The PowerPC microprocessor changes the rules of the game. Historically, graphics applications have done as much as possible in integer arithmetic because previous processors have had better performance there. What we're seeing with the PowerPC is a move to floating point for our graphics applications and getting better performance."*

— Jerry Barber,  
Chief Technical Officer, Aldus Corporation

◀.....▶

over time. Because while the Pentium  
microprocessor is bumping the limits  
of its 15-year-old architecture, the  
streamlined PowerPC Architecture<sup>™</sup>  
is just getting started.

As 1994 unfolds, you'll see  
new workstations and desk-  
top computers based on the

PowerPC 601<sup>™</sup> microprocessor as  
well as notebooks and low-cost

desktop computers based on the

PowerPC 603<sup>™</sup> microprocessor.

Now we can't tell you exactly  
when the new computers based on  
PowerPC microprocessors will be  
available, but your computer com-  
pany probably can. So call them.

Or for a copy of our latest PowerPC  
Microprocessor Update, call

1-800-845-MOTO.

PowerPC micro-  
processors from

Motorola. The

fastest computers you can buy  
are fast approaching.



the course of computing. For the better.

is a trademark of the PowerOpen Association. PowerPC, the PowerPC logo, PowerPC Architecture, PowerPC 601 and PowerPC 603 are trademarks and AIX is the registered trademark of IBM Corporation and are used by Motorola under license from IBM Corporation. OS/2 is a registered trademark of International Business Machines Corporation. Novell and NetWare are registered trademarks of Novell, Inc. All brand or product names appearing in this ad are either trademarks or registered trademarks of their respective holders. All rights reserved.

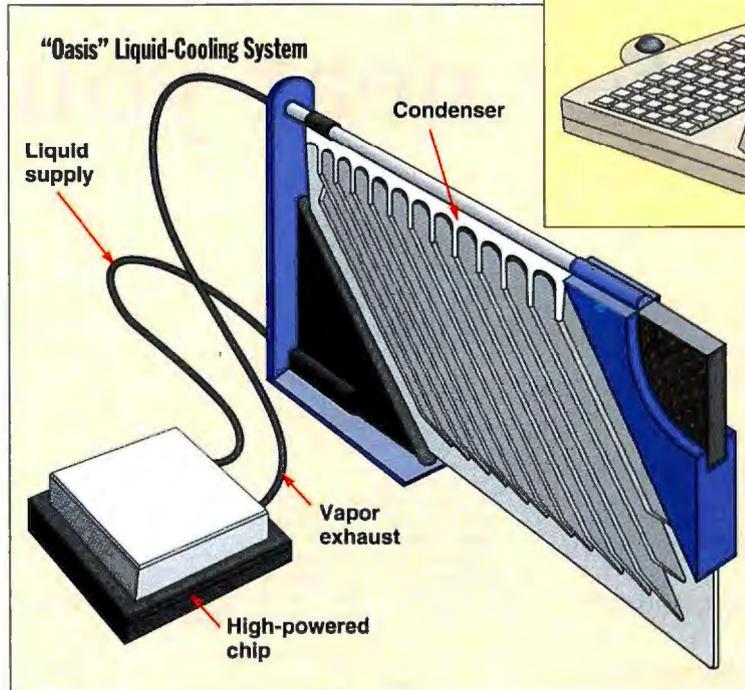
## NEW TECHNOLOGY

# Liquid-Cooled PCs: The Next Hot Thing?

**W**ith chips like the Pentium and DEC's Alpha, the power of the mainframe has indeed arrived on the desktop, but you probably didn't expect the mainframe's cooling system to come along for the ride. However, that's exactly what a New Hampshire company is working on: liquid-cooling systems for desktop PCs and even laptops and notebooks. Unlike the fans currently used to cool desktop PCs, the liquid-cooling system doesn't draw any power and can have a lower profile than a metal heat sink.

The liquid-cooling system developed by Aavid Engineering (Laconia, NH) works much like an air conditioner or a refrigerator and uses a refrigerant fluid called Fluorinert. Unlike Dolch's liquid-cooling technique, Aavid does not use a heat sink. Aavid's system consists of an evaporator, which sits on top of the microprocessor, and a condenser, which can be as small as 6 by 3 inches. The entire system weighs about 75 grams. The fluid in the evaporator draws the heat from the microprocessor and flows to the condenser, where the heat is dissipated.

According to Gary Kuzmin, Aavid's digital product direc-



tor, the first application of the liquid-cooling system will be in desktop machines, because it will be easy to incorporate the system into existing form factors. Laptop and notebook computers would have to be redesigned to accommodate the cooling system, particularly the condenser. Kuzmin says that the condenser can be built into the back of a laptop's display.

Not all CPUs require this much cooling, however. The PowerPC 603, due this year,

will likely offer Pentium performance while drawing just 1 to 1.5 W, compared to the 66-MHz Pentium's 16-W power consumption.

Aavid's goal is to produce

cooling units priced at around \$20 in high-volume quantities. Look for computers using the liquid-cooling system to appear in the second quarter.

—Nicholas Baran

## Superservers Everywhere

**C**ompanies like ALR, AST, Compaq, and Dell, along with IBM, NetFrame, Sequent, and Tricord, are all selling *superservers*, machines that often differ widely in terms of supported operating systems and maximum number of CPUs. What about Cray Research? A company known better for its supercomputers than for scalable servers is actually the company that holds the trademark on the name *superserver*. Yet it wasn't until last fall that Cray's subsidiary, Cray Research Superservers (Beaverton, OR), released a SPARC-based superserver called the CS6400 that will compete with its superserver rivals in commercial markets.

Christopher Willard, manager of high-performance technologies at IDC in Mountain View, California, says that "this system will compete in two areas. One is for technical computers with RISC processors that can run the same software you can run on the desktop. That market includes IBM, Digital, Silicon Graphics, and HP. The other market is the Unix database market, which includes, on the commercial side, Sequent, Pyramid, and others." The new system can have up to 64 CPUs and will be priced starting at \$335,000.

—Anne Fischer Lent

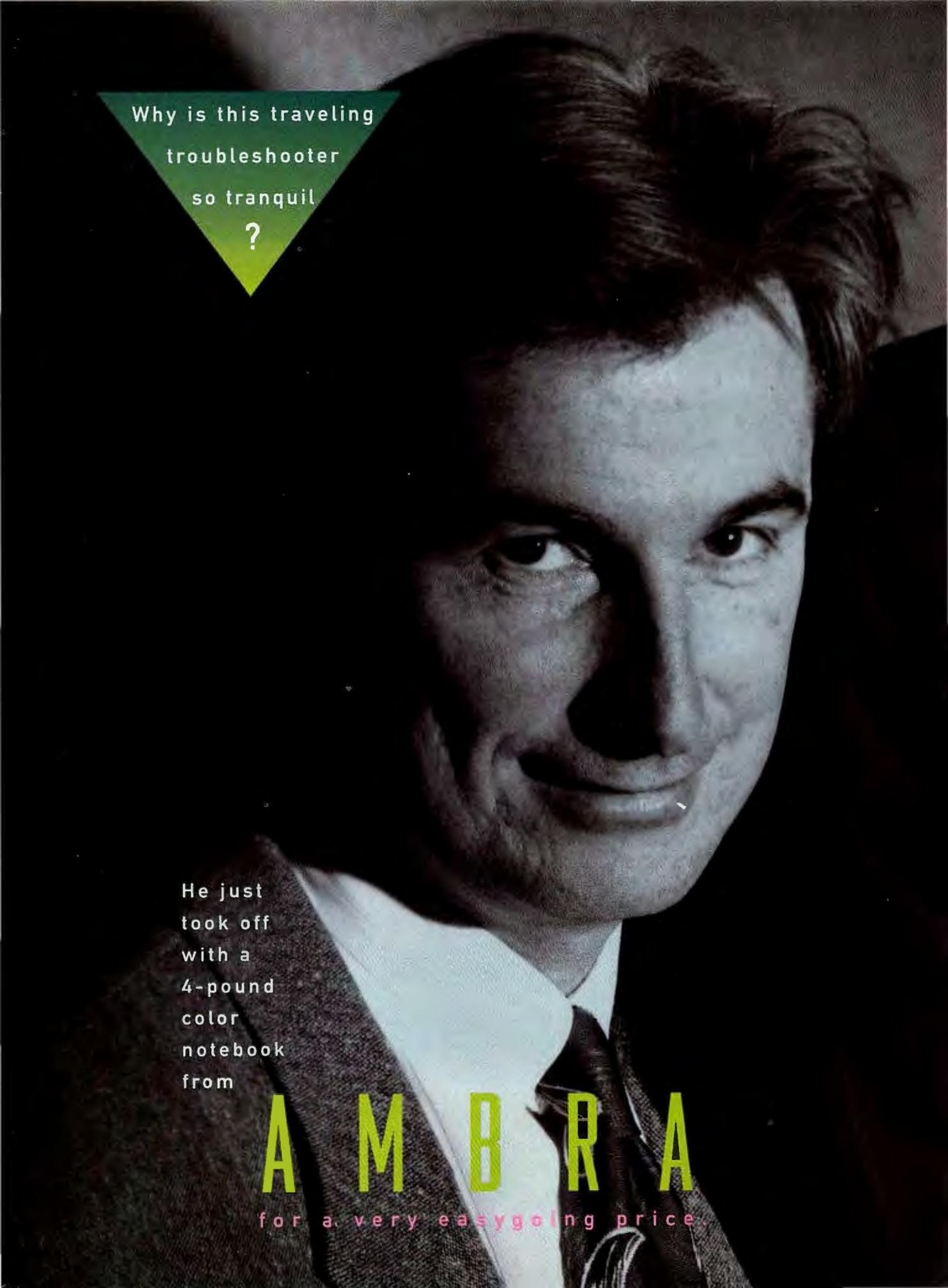
### DOLCH ANNOUNCES LIQUID-COOLED PENTIUM PORTABLE



Dolch Computer Systems' (Milpitas, CA) PAC-586, a Pentium-based portable, uses a liquid-cooling technique to eliminate the need for large cooling fans and big heat sinks. Dolch's liquid-cooling technique, which the company uses in its Mach portable computers, uses a combination of a fluorocarbon gel and a heat sink, according to Steve Fritz, spokesman for the company. As the Pentium chip gets hot, heat is conducted through the gel to a heat sink that transfers the heat throughout the metal skin of the portable's inner chassis. The PAC-586, which starts

at about \$6000, is designed for people who need a highly expandable, lug-gable PC.

—D. A.



Why is this traveling  
troubleshooter  
so tranquil  
?

He just  
took off  
with a  
4-pound  
color  
notebook  
from

**A M B R A**

for a very easygoing price.

Four Pounds of Colorful Computing.



\$ 1,899

**SN-Series**

**FEATHERWEIGHT AND FULL FORCE.**

Frequent flyers and life-on-the-road types take note: New lightweight **486SX** notebooks from AMBRA™ combine **25 MHz** speed with first-class computing



capabilities —  
including **color** —  
yet tip the scales  
at a mere  
**four**  
**pounds!**

**Cool mono**

**Hot color**

From **clean-edged STN** images to easy cursor tracking, AMBRA lightweight notebooks' STN color and mono screens are the picture of **price/performance**. Our larger notebooks' STN color screens offer the added benefits of extra-generous viewing area and **dual-scan technology**.

PC Computing calls **active matrix color** "beautiful to behold."<sup>1</sup> One glance at the uniformly brilliant, fast-refresh, glare-free **TFT** screen of our premium notebook, and you're sure to agree!

**DAUNTLESS POWER**

**N-Series**

**BEYOND OFFICE DOORS.**

With new high-speed, high-performance AMBRA notebooks, no application is too demanding.

You have the power to do it all! At **6.6 pounds**, these machines are as trim as they are fast —

**33 or 50 MHz**. Besides **486SX or DX2**

processing clout, they come with a full array of desktop-level features, and **high-volume hard disk capacity**.



If your  
work keeps you  
on the move,  
call **AMBRA**.  
Our new  
**MOBILE SYSTEMS**  
pack lots of  
**POWER** yet  
travel **LIGHT**.

**Comfortable keyboards, fingertip mouse function.**

Some notebook keyboards feel cramped and shallow, with pointing devices that are unwieldy or easily lost. Not ours. Here's why:

- 86 keys, including 12 function keys
- Standard keyspacing
- 3mm key travel (strike depth)
- Integrated 16mm trackball

**16mm  
trackball**

**SUSPEND RESUME**  
Work steadily through a  
"stop and start" day! AMBRA  
SN-Series notebooks let you  
easily halt mid-application, and  
later pick up in the same place.

**AMBRA**

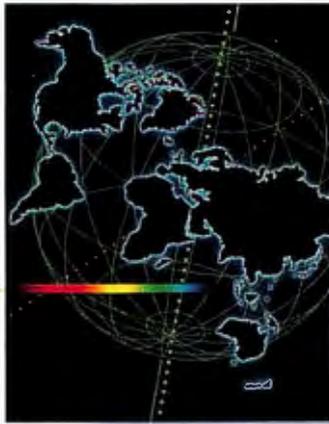
**1-800-239-5739**

**Fax figures to far-away colleagues!**

**Tie into an onsite network!**

**Download data from your host's host!**

**When you return, be instantly at home!**



## SMALL OPTIONS, BIG OPPORTUNITIES— EVERYWHERE YOU GO.

AMBRA mobile systems make room for your pick of credit-card-size PCMCIA options, providing everything from fax/modem function to on-the-spot mainframe connectivity!

- 9.6 kbps fax/modem
- 14.4 kbps fax/modem
- Token-Ring adapter
- Ethernet adapter (10BaseT)
- 3270 adapter

### “ROAD WARRIOR” OPTION BUNDLE: \$386

For SN-Series: Includes PCMCIA 2.4/9.6 kbps fax/modem, extra battery, battery charger, carrying case

### “TRAVELER” OPTION BUNDLE: \$288

For N-Series: Includes PCMCIA 2.4/9.6 kbps fax/modem and extra battery

With **AMBRA**, mobile computing power goes hand-in-hand with capability to **COMMUNICATE** and **CONNECT**.

### “INSTANT OFFICE”

#### OPTION BUNDLE:

**\$927**

For N-Series:

Includes docking station, 15" FST color monitor, full-size keyboard

### “QUICK DOCK”

#### OPTION BUNDLE:

**\$417**

For SN-Series:

Includes port replicator, 14" UVGA color monitor, full-size keyboard

## BACK AT YOUR DESK: CONVENIENT DOCKING.

With an optional docking station, your AMBRA mobile system can be instantly plugged into extra storage, extra peripherals, networks and resources throughout your company!

### ■ N-Series Docking Station

- 4 ISA slots (2 VESA on local bus)
- 2 drive bays (5.25" and 3.5")
- 2 internal speakers
- 2 serial ports
- 1 parallel port
- 1 video port
- 1 keyboard port

**\$499**

### ■ SN-Series Docking Station

- 2 ISA slots
- 2 serial ports
- 1 parallel port
- 1 video port
- 1 keyboard port

**\$249**

### ■ SN-Series Port Replicator

- 2 serial ports
- 1 parallel port
- 1 video port
- 1 keyboard port

**\$89**



### ▼ N-Series

#### N450T

- 486DX2, 50 MHz
- 8MB RAM, max: 12MB
- 3.5" 1.44MB diskette drive
- 200MB hard disk
- 9.5" TFT active matrix color screen
- 1 PCMCIA slot, Type III
- Integrated 16mm trackball
- MS-DOS® Windows™ 3.1
- Carrying case
- 6.6 lbs, including battery

**\$3,999**

#### N450C

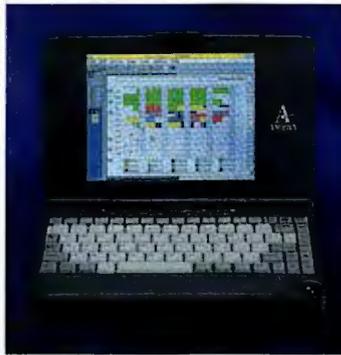
- 486DX2, 50 MHz
- 4MB RAM, max: 12MB
- 3.5" 1.44MB diskette drive
- 200MB hard disk
- 9.5" STN dual-scan color screen
- 1 PCMCIA slot, Type III
- Integrated 16mm trackball
- MS-DOS, Windows 3.1
- Carrying case
- 6.6 lbs, including battery

**\$2,699**

#### N433C

- 486SX, 33 MHz
- 4MB RAM, max: 12MB
- 3.5" 1.44MB diskette drive
- 120MB hard disk
- 9.5" STN dual-scan color screen
- 1 PCMCIA slot, Type III
- Integrated 16mm trackball
- MS-DOS, Windows 3.1
- Carrying case
- 6.6 lbs, including battery

**\$2,299**



### ▼ SN-Series

#### SN425C

- 486SX, 25 MHz, SL-Enhanced
- 4MB RAM, max: 20MB
- 170MB removable hard disk
- 7.8" STN color screen
- 1 PCMCIA slot, Type II
- Integrated 16mm trackball
- Suspend/Resume
- MS-DOS, Windows 3.1
- Slip case
- 4 lbs, including battery

**\$1,899**

*(With external 3.5" 1.44MB diskette drive, add \$99.)*

#### SN425

- 486SX, 25 MHz, SL-Enhanced
- 4MB RAM, max: 20MB
- 80MB removable hard disk
- 8.2" monochrome LCD
- 1 PCMCIA slot, Type II
- Integrated 16mm trackball
- Suspend/Resume
- MS-DOS, Windows 3.1
- Slip case
- 4 lbs, including battery

**\$1,399**

*(With 170MB hard drive, add \$150. With external 3.5" 1.44MB diskette drive, add \$99.)*



### FULL CONVENIENCE.

To place an order or get more information, just call — weekdays 8 am to 11 pm, weekends 10 am to 7 pm (ET). We accept Visa®, MasterCard®, Discover® and American Express® — and purchase orders from qualifying businesses. Pick up the phone today!

**LIGHTWEIGHT  
NOTEBOOKS**

Featherweight.

Fierce **COLOR.**

Friendly price.

### FIRM CONFIDENCE.

AMBRA covers every mobile system with a 30-day money-back guarantee and a one-year limited warranty. For just \$99, an optional Executive warranty is available.<sup>2</sup> With either warranty, you can rely on toll-free technical support around the clock!



In Canada<sup>3</sup> call 1-800-363-0066, Ext. 5739

**1 - 8 0 0 - 2 3 9 - 5 7 3 9**

<sup>1</sup> Ron White, "In Search of the Ultimate Notebook," *PC Computing*, July 1993. <sup>2</sup> Please call for details regarding AMBRA's money-back guarantee, limited warranty and Executive warranty. Return shipping and insurance charges are the responsibility of the customer. <sup>3</sup> Offerings may differ in Canada. ©1994 AMBRA Computer Corporation. AMBRA is a trademark of ICPI Ltd. and used under license therefrom. The AMBRA logo and logotype are trademarks of AMBRA Computer Corporation. Intel is a registered trademark of Intel Corporation. MS-DOS is a registered trademark and Windows is a trademark of Microsoft Corporation. All other product names are trademarks or registered trademarks of their respective suppliers. Offerings, prices and products are subject to change without prior notice. Prices do not include shipping.

# Screen Savers Ad Nauseum

**S**creen savers, those neat little utility programs that pop up flying toasters, sea horses, and bespectacled cows, have become big business for software companies. Currently, the Software Publishers Association (Washington, DC) tracks screen-saver programs with other utility programs, so it's hard to tell how much revenue this category generates. But Berkeley Systems (Berkeley, CA), developer of the popular After Dark screen-saver program, says it has sold over 1 million copies of the program.

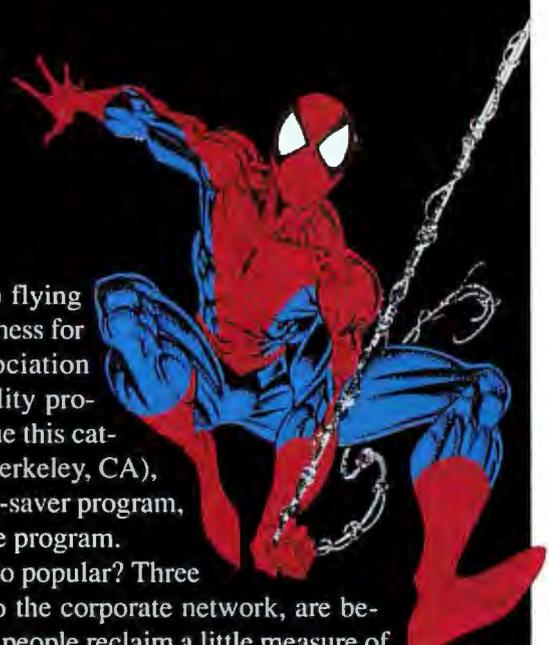


Why has this product category become so popular? Three reasons: PCs, as they become hooked into the corporate network, are becoming less personal, and screen savers let people reclaim a little measure of individuality by letting them put zany characters on their screen. Second, corporations are using programs like Pleasonton, California-based Aristo-Soft's CD-Blaster and Media Blitz 3.0 from Asymetrix, which let them insert their own com-

pany logo with a motivational or informational message along with it. Third, most screen savers offer password protection, which adds a measure of security to all this fun. New entries to this category include (clockwise from top right): Marvel Comics Screen Posters (Berkeley Systems); BYTE's screen-saver program; Jurassic Park (Asymetrix, Bellevue, WA); Opus 'n Bill (Delrina, San Jose, CA); and the Snoopy Screen Saver (Image Smith, Torrance, CA).

One ominous measure of how popular screen-saver programs have become is that this category has even made legal news. Berkeley Systems forced Toronto-based Delrina to modify its Opus 'n Bill screen-saver program because the company believed that one module in which the cartoon penguin Opus shoots a flying toaster infringed on Berkeley's copyrights and trademarks. Delrina reissued Opus 'n Bill with the offending sequence removed.

—D. A.





The *road warrior's* weapon of choice.

Now with 2-MB memory!

**The HP 100LX palmtop PC keeps you in touch wherever you go.**

It packs cutting-edge computing and communications features. All wrapped up in a sleek 11-ounce package. Including one-key access to:



cc: Mail® Mobile, the market-leading e-mail software.

Today's new card modems fit neatly into our PCMCIA 2.0 slot, connecting you to your corporate or office systems.



Take your office with you. Built-in MS DOS® 5.0 means you can run optional PC software.

With the new 2-MB memory, you can add even larger applications, such as Quicken and ACT!.

Use the built-in applications to create custom databases. And sort through a list of customer billing profiles or your favorite restaurants.

**123** Keep running numbers on the run. One touch brings up Lotus® 1-2-3® Rel. 2.4. You're in spreadsheet heaven!

The features keep coming. Like our appointment book to keep you on top of your schedule, with week- and month-at-a-glance. Notetaker to capture ideas. Powerful analysis on the HP financial calculator. Flexible phone book.

All this and much, much more. Now for much less. The 1-MB HP 100LX is just \$549.\* The new 2-MB version only \$749.\*

For more information and the name of your nearest HP 100LX dealer, call us at 1-800-443-1254, Dept. 785.† Then hit the road armed with all the right answers.



**HEWLETT®  
PACKARD**

\*U.S. list price. †In Canada, 1-800-387-3867. cc: Mail Mobile is a trademark of cc: Mail, a wholly owned subsidiary of Lotus Development Corporation. Microsoft and MS-DOS are U.S. registered trademarks of Microsoft Corporation. Lotus and 1-2-3 are U.S. registered trademarks of Lotus Development Corporation.  
©1994 Hewlett-Packard Company PG 12307A



# Programmer's Paradise®

## Doc-To-Help by WexTech Systems

The world's best documentation and help-authoring tool just got better, and now supports all Windows 3.1 features. New features of version 1.5 include an interactive help window editor, an interactive help macro editor, support for segmented hypergraphics and the ability to import existing help source files and convert them into documentation.



List: \$295    Ours: \$236    FAXcetera #: 1000-1901

## TNT DOS-Extender 6.0 by Phar Lap Software

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



List: \$495    Ours: \$420    FAXcetera #: 1490-0009

## WindowsMAKER Professional 5.0 by Blue Sky Software

**NEW VERSION!**



Next generation of the most powerful C/C++ Code Generator and Prototyper for Windows 3.1, NT & Win32s. The fastest way to create full-featured Windows apps. This product stands out, does everything—even a toolbar can be created with

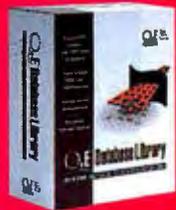
1 click! Test run your design, make changes interactively, generate code for multiple platforms—ANSI C, MFC, OWL, etc.: widest compiler support in industry. TrueCode technology—user code is 100% preserved. Highly recommended!

List: \$1096    Ours: \$875    FAXcetera #: 2602-0003

## PRODUCT OF THE MONTH

## Q+E Database Library by Q+E Software

Q+E Database Library 2.0 streamlines DBMS-independent applications development by providing transparent access to major SQL and PC DBMS from user's desktops with automatic support for ODBC & IDAPI. QELIB2 works with existing development tools and is simply the best way to add complete DBMS access to applications today, and tomorrow!



List: \$699    Ours: \$475    FAXcetera #: 2625-0002

## c-tree Plus® by FairCom

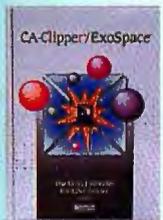
DOS • WINDOWS • NT • UNIX • OS2 • SUN • RS6000 • HP9000 • MAC • QNX • BANYAN • SCO. This well known, highly portable data management package has become established as the tool of choice for commercial development. Offering unprecedented data control, programmers may choose from direct low level access, ISAM level convenience, or SQL access with the FairCom Server. Single User, MultiUser, or Client/Server, ANSI Standard.



List: \$595    Ours: \$505    FAXcetera #: 1381-0008  
Call Programmer's Paradise® Italia for special pricing in Europe.

## CA-Clipper 5.2 and CA-Clipper/Exospace by Computer Associates

Buy CA-Clipper 5.2 or the Competitive Upgrade, the premier Application Development System, and take advantage of CA-Clipper/Exospace, which includes virtual memory manager and allows you to run CA-Clipper Applications in protected mode.



CA-Clipper Comp. Upg.: List: \$199    Ours: \$149\*  
CA-Clipper/Exospace: List: \$ 99    Ours: \$ 85  
FAXcetera #: 1004-0017  
\*While supplies last.

## 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    FAXcetera #: 1004-9201



## Symantec C++ Professional 6.0 by Symantec

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

Competitive Upgrade for Borland or Microsoft customers \$189.

Comp. Upgrade: List: \$499    Ours: \$299  
FAXcetera #: 2132-0038    List: \$199    Ours: \$189

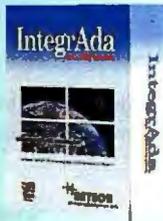
8 0 0 4 4 5 - 7 8 9 9

# Best Sellers



## IntegrAda for Windows by Aetech Inc.

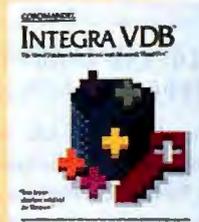
A complete Ada Programming Support Environment (APSE) for Windows, adding a language sensitive editor; automatic code generation & error checking; interactive error correction; pop-up menus to completely customize the environment to the standard Windows features. Allows you to quickly code, correct,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



List: \$995 Ours: \$895 FAX<sub>catena</sub> #: 2358-0003

## Integra VDB Coromandel Industries, Inc.

Integra VDB is a visual database builder for use by Visual C++, Visual Basic, and Borland C++ developers in building ODBC compliant Windows database solutions easily, quickly, and often with virtually no code. It consists of database custom controls, functions and classes that are seamlessly integrated with these tools, a visual query builder, a visual data manager, and an ODBC compliant SQL engine based on ANSI 92 standard.



List: \$499 Ours: \$449 FAX<sub>catena</sub> #: 3004-0003

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

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



List: \$199 Ours: \$99\* FAX<sub>catena</sub> #: 1683-0016  
\*Pricing valid while supplies last.

## RoboHELP® 2.0 by Blue Sky Software

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



List: \$495 Ours: \$439 FAX<sub>catena</sub> #: 2602-0005

## NEW THIS MONTH

### SKRIBE Report Writer "Q+E at Work" by SKRIBE Software, Inc.

SKRIBE Report Writer is a powerful yet simple to use report designer and graph generator for use with your SQL and ODBC compatible databases and Excel or ASCII files. SKRIBE allows you to create simple or complex report designs with Point & Click ease, with absolutely no programming! Easily integrate SKRIBE into your existing application or use it in a Client Server environment.



Windows List: \$695 Ours: \$495  
FAX<sub>catena</sub> #: 1012-2601

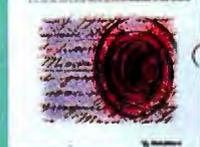
### WATCOM™ C/C++32 v9.5 by WATCOM

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<sub>catena</sub> #: 1683-0003

MetaWare



### MetaWare High C/C++ by MetaWare, Inc.

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

List: \$795 Ours: \$669 FAX<sub>catena</sub> #: 1590-0008

## 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<sub>catena</sub> #: (201) 762-1378

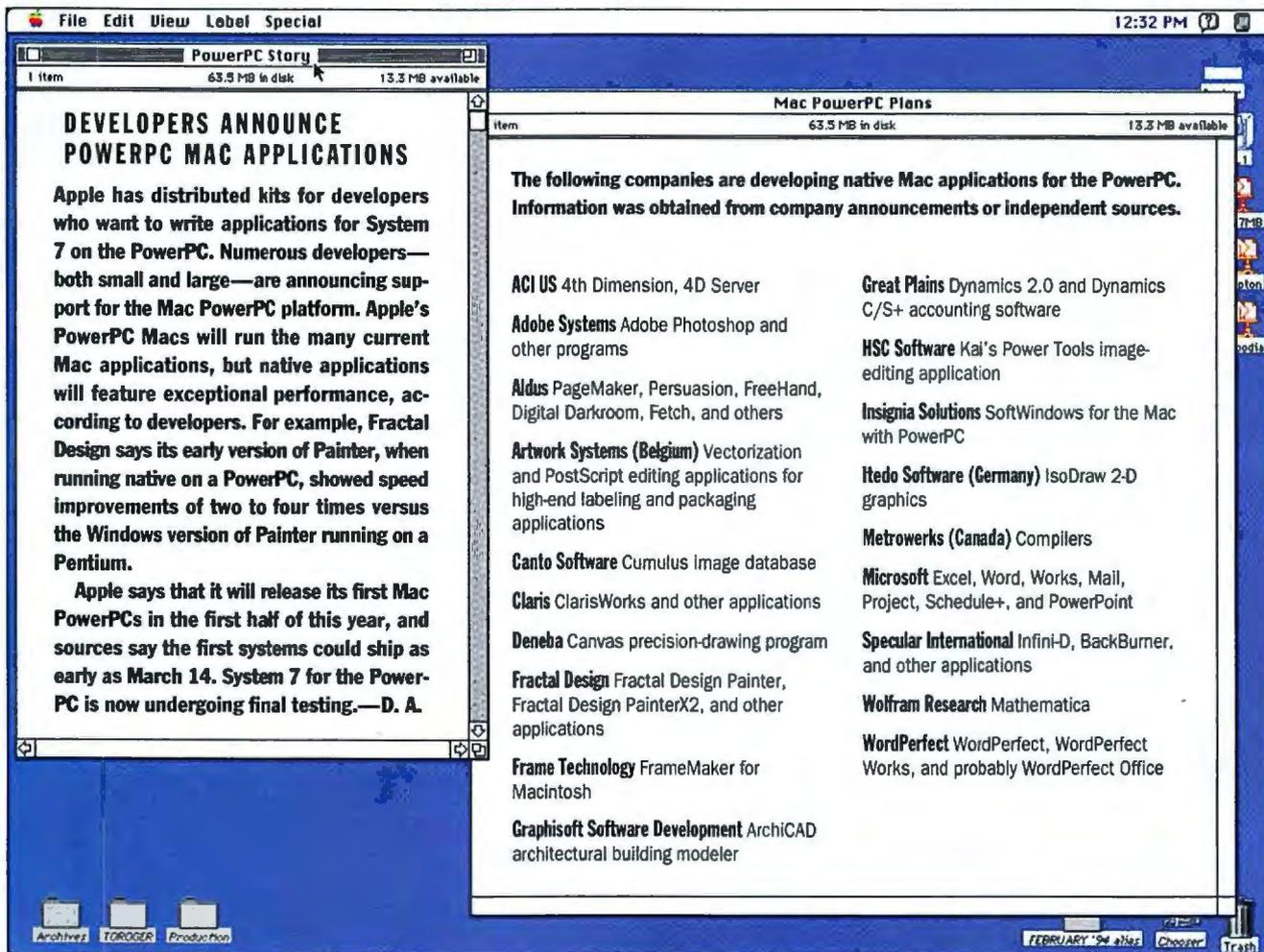
Programmer's Paradise®  
1163 Shrewsbury Avenue  
Shrewsbury, NJ 07702

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

Circle 115 on Inquiry Card.

8  
0  
0  
4  
4  
5  
-  
7  
8  
9  
9





## Wireless Data over the GSM Voice Channel

**M**UNICH—For many users in Europe, mobile wireless modems are still a thing of the future. But an inventive German company called TLK Computer (Munich) has a modem that, in connection with a digital mobile phone, is able to transmit data across Europe over a network that is currently used for voice traffic, no matter what your location. TLK's transmitting system works over the GSM-Network (Groupe Speciale Mobile), which is a digital cellular mobile telecommunications service.

Initially, the D-net, which is the GSM-Network's digital cellular network, was designed for speech transmission only. Both telecommunications companies in Germany, Telekom (i.e., German PTT) and Mannesmann, have stated that it is impossible to transmit data via the voice

channel of the D-net. But thanks to a special error-correction method and modulation scheme, TLK has achieved what those companies said couldn't be done.

Due to TLK's modulation scheme, to transmit data over the D-channel, you need a TLK GSM modem on both ends of the connection. But it makes no difference if the connection is established between a GSM phone and a regular one. The modems will cost about \$1600.

Presently, the modems transmit at approximately 1000 bps. This is because they must share slices of time with other users on the D-net. TLK (+49 89 45 85670; fax +49 89 44 86297) is investigating various compression techniques that it will use in the next version of the modem (due sometime this year).

—Bernhard M. Bradatsch

## CELLULAR DATA MARKET SEGMENTATION

The first CDPD cellular-data networks were slated to begin operating in select cities early this year, and CDPD cellular carriers are currently negotiating agreements that will let users transparently roam from one area to another without dropping their connection. At press time, McCaw Cellular Communications' new AirData CDPD network was slated to begin operating in Las Vegas, while GTE Mobilnet planned to take CDPD commercial in San Francisco and Houston in the second quarter. GTE forecasts that by the end of the year, CDPD will be available in about five dozen metropolitan areas in the U.S.

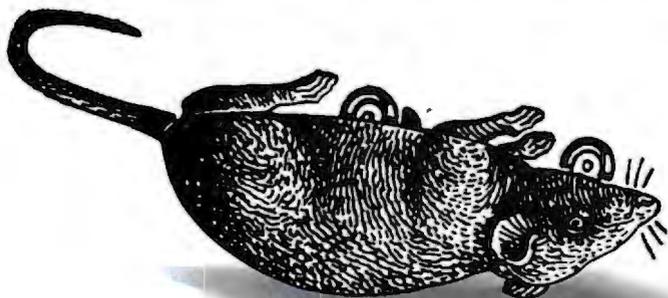
### Emerging Wireless-Data Market Segments



Source: McLaughlin & Associates (Schaumburg, IL), 1993

**ARISTO**

# POOR OLD MOUSE.



Most of the time all mice are nice and fine for pointing around. But when it comes to inputting graphics or logos into any application or any CAD package, they are hopeless. They just can't — and so you can't. No way.

Problem? Yes and no. It depends — you may shrug your shoulders and say "Well, I'll never do CAD and I just never want to input any sketches, logos, or photos into my computer anyway." Or — you feel that isn't good enough after all the money you have invested and all the nice things you know you could do today with your own graphics once they were in the computer.

## PROBLEM SOLVED.

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



**yes**  
It runs with  
NetWare



# ARISTO *College Board \ digital*

North America:  
ARISTO Graphic Systems  
A Division of KOH+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  
Brocknall 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 47-226  
Fax: (040) 547 47-111

## ALL IN ONE.

Mouse, Digitizer Tablet, Drawing Board

Circle 172 on Inquiry Card (RESELLERS: 173).

## SUPERCONDUCTIVITY

# You're Getting Warm if You're Thinking Cool

**Y**ou won't be working at a cryogenic workstation this year or next. But before the turn of the century, you may be. Recent advances in the field of cryoelectronics, which involves computing at very low temperatures, mean scientists can now evaluate superconductivity at the relatively high temperature range of 77 K (i.e., -356°F) to 135 K. Previous experiments in this area involved working at temperatures in the range of 10 K to 15 K, or about -443°F. By the year 2000, systems could be available that use the following types of HTS (high-temperature superconductive) devices: semiconductors; interconnections between processors, chips, and boards; DRAM chips; and even MCMs (multichip modules).

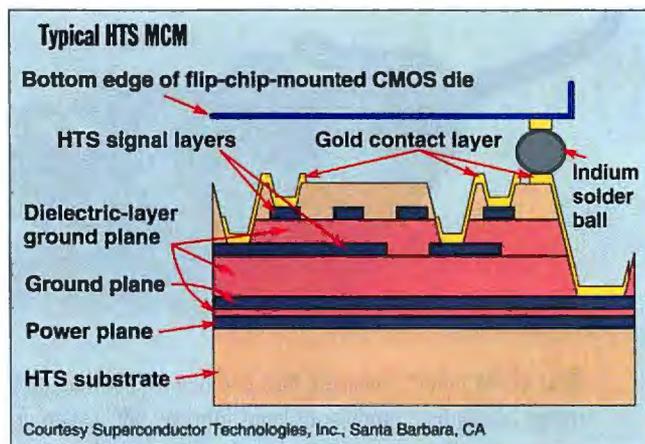
The benefits of these HTS systems include increases in speed (10 to 100 times), reductions in power (90 percent or more) and reliability (due to their operation with little resistance). According to Joseph Warner, materials electronics

engineer at the NASA Lewis Research Center (Cleveland, OH), a refrigerator the size of a Coca-Cola can that can cool these HTS components has already been developed for the space effort.

Scientists have produced successful experimental (and some prototypical) HTS devices for signal processing, ADCs (A/D converters), optical sensors, logic, and memory. Also, analog HTS arrays have been developed for microwave communications and telemetry applications.

The U.S. government's ARPA has a program to develop HTS devices. Among the 20 participating firms are Superconductor Technologies, Inc. (Santa Barbara, CA), Conductus (Sunnyvale, CA), and E-Systems (Dallas, TX). Joseph M. Madden, manager of applications engineering for STI, is one of many who believe that an HTS computing environment is a must.

"HTS interconnects, for example," Madden says, "have



Courtesy Superconductor Technologies, Inc., Santa Barbara, CA

In HTS MCMs, line widths in transmission lines can be very narrow (i.e., 2 microns), allowing a higher packing density and improved signal transmission over conventional MCMs. Shown here is the module that wires multiple chips together while providing their ground plane and power source.

demonstrated the ability to pass signals with much greater speed than normal metal interconnects." Madden says that tests performed at STI on a 10-centimeter, 3-micron copper line and an HTS transmission line showed that the HTS line can operate at least twice as fast as an identical copper line.

Claude Hilbert, a member of the technical staff at Microelectronics and Computer Technology (Austin, TX), believes that the gap between microprocessor and memory is where we need HTS technology. He is close to assembling and testing a second-generation HTS hybrid memory (i.e., fast RAM). The ultimate goal of his project is to create a monolithic hybrid chip—a chip with both HTS and semiconductor devices—to be used in high-performance cryogenic workstations.

As if it were not tough enough to develop HTS chips, a number of researchers are working on an even more challenging undertaking—creating an HTS MCM. A popular packaging technology, an MCM provides shorter interconnections, high chip densi-

ties, and improved IC system performance. HTS MCMs would magnify these benefits.

During the first quarter of 1993, Conductus and STI scientists demonstrated that it is possible to produce a hybrid structure combining active semiconductor and HTS devices on the same substrate. They believe that the successful integration of these disparate yet complementary technologies paves the way for the development of true semiconductor-superconductive hybrid ICs capable of combining the best of both worlds.

Although the benefits of HTS are eagerly awaited by many, not everyone sees HTS devices as tomorrow's technology of choice. The technology has many challenges to overcome. Some computer manufacturers are skeptical that successful solutions will be reached in a timely enough manner to bring relief for some of the difficulties facing the industry. Others have decided to continue using conventional semiconductor devices because of their already outstanding capabilities.

—Janet J. Barron

## GEEK OF THE WEEK ON TAPE



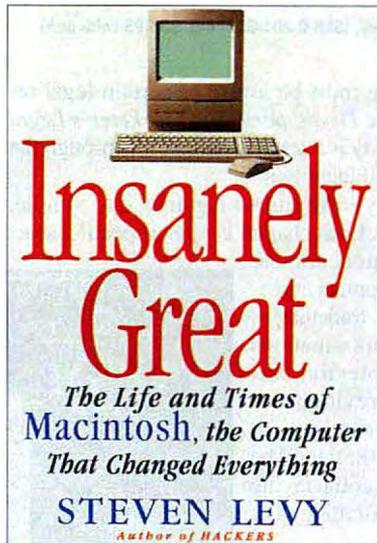
Ever listen to one of those 5-minute-long news pieces being broadcast on National Public Radio's *All Things Considered* and wish they were doing an in-depth story on new technology? Well, your wishes are answered.

Each week, Internet Talk Radio offers a 30-minute audio interview with a notable member of the Internet community under the tongue-in-cheek name of "Geek of the Week." You can download this file and play it at your workstation. But if you

don't want to download the 45 MB or so of data that is associated with each interview, O'Reilly & Associates sells cassette versions of the interview for \$9.95 each. For more information on the radio program over the Internet, send mail to [info@radio.com](mailto:info@radio.com). For information on the tapes, call O'Reilly & Associates at (800) 998-9938 or (707) 829-0515 or send mail to [audio@ora.com](mailto:audio@ora.com).

—D. A.

# The Genesis of the Mac



**TOM THOMPSON**

It seems like only yesterday when I bought my 128-KB Macintosh, early in 1984. Today, it's hard to believe the Mac is 10 years old. *Insanely Great* by Steven Levy both describes and celebrates the Mac's birth.

Levy's book does a good job in two areas. First, it presents a brief history of the Mac's technology roots. Much of what became the Mac evolved out of research by Doug Engelbart and Xerox PARC's (Palo Alto Research Center) work on GUIs. This work was applied by Apple engineers to the now-defunct Lisa computer. Much of what made the Lisa a good machine in turn found its way into the Mac.

Second, *Insanely Great* chronicles the personalities of the design team and the pressure-cooker environment under which all such teams labor. You discover that the Mac's genesis was a tumultuous one. It started out as a skunk-works project by Jef Raskin to build a low-cost computer and was actually canceled several times. We get glimpses of the technical hardware wizardry of Burrell Smith, and of Andy Hertzfeld's and Bill Atkinson's inspired software craftwork. Of course, the book also documents working for the mercurial Steve Jobs, who took the project over after winning the political infighting with Raskin.

While Levy does a commendable job covering the people, he goes astray with the technology. Perhaps in targeting a general audience, some of the technical points he tries to make are muddled at best. Some are downright wrong.

For example, Levy dismisses NASA's space program because its "main benefits seem to have been Teflon, Tang, and a stack of very cool photographs." He credits ARPA funding with promoting the growth of software technologies that evolved into word processors, spreadsheets, and the like. The point he misses is that the space program required contractors to cram lots of electronics and machinery into small spaces. These efforts accelerated—by a decade or more—the fabrication techniques used to produce microelectronics. In turn, this sired microprocessors, RAM, and hard drives much smaller than a washing machine. While ARPA funds might have spawned practical software, NASA funds ultimately created the hardware that runs this software, while fitting it all on a desktop and without requiring a government grant to own it.

Sorry, Steven: The original LaserWriter used a 68000 processor, not a 68020. In documenting the start of desktop publishing, he's correct that Aldus PageMaker was the crucial software component. But his mention of the LaserWriter seems merely coincidental to desktop publishing, not crucial to it (which it was). And he fails to mention the contribution of AppleTalk (now LocalTalk), a plug-and-play network that justified the purchase of the expensive LaserWriter for desktop publishing because it allowed several people to share it. (A serious omission.)

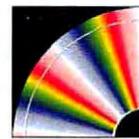
*Insanely Great* makes for great reading and documents the happenstance creation of one of the decade's most innovative computers. However, marred as it is by technical inaccuracies, the book is only decent, not insanely great. ■

*Tom Thompson, a senior technical editor at large, specializes in Macintosh coverage. You can contact him on the Internet or BIX at tom\_thompson@bix.com.*

INSANELY GREAT

Steven Levy  
Viking Press  
ISBN 0-670-85244-9

\$19.95



## PLANETARIUM IN A BOX

**REDSHIFT** Maris Multimedia, Ltd.,  
99 Monsell St., London E1 8AX, U.K.,  
+44 71 488 1566; fax +44 71 702 0534, \$99

Time and again, I'm impressed with the ingenuity of programmers, especially when they're given free reign with the huge amount of storage provided by a CD-ROM. Maris Multimedia has devised a CD-ROM (Mac and Windows versions are available) that functions as a planetarium-cum-sky chart-cum-sky atlas-cum-dictionary. When Redshift starts, it presents you with a realistic map of the night sky, keyed to the computer's clock and date. The program uses a catalog of 250,000 stars to accurately reproduce each one's color and position. Information on 40,000 deep-sky objects is also provided.

Clicking on a star gives you its SAO (Smithsonian Astrophysical Observatory) number, proper name, Bayer name, Flamsteed name, right ascension, declination, and a host of other information. Clicking on a button overlays the view with the constellations. An orbital mechanics engine positions the planets for anytime between 4000 B.C. and A.D. 11,000, using data from the Jet Propulsion Laboratory. A menu choice gives you access to digitized photos of the planets, their moons, and interesting deep-sky objects (e.g., the Pleiades and the Orion nebula). Hypertext links in the photo gallery connect to entries in the *Penguin Dictionary of Astronomy*. A movie gallery has footage of noteworthy events, such as when the Lunar Excursion Module touched down on the moon.

One neat feature is the program's ability to place you in the vicinity of any planet in the solar system. You can zoom in or out, hang out around a planet's equatorial plane, or sweep up for a view over the polar regions. The 3-D planetary images are created from photo images returned by the *Voyager* spacecraft. It's awe-inspiring to watch Jupiter's Great Red Spot crawl across the planet, and abruptly one of the moons—Io—floats across the scene. Redshift is a technical achievement, serving up impressive views of the sky with amazing accuracy. Amateur astronomers will love this program.

—Tom Thompson

# Create a Multimedia Presentation in 60 Minutes... GUARANTEED.



**SST**  
SUPER SHOW & TELL

Now you can create a multimedia presentation in one hour! **SST** maximizes Windows 3.1 and lets you produce dynamic presentations complete with scrolling text, sound effects, narration, graphs, pictures, live motion video - even interactive capabilities. **SST** works like a slide carousel and a VCR player. It features easy-to-learn point & click and drag & drop controls. Plus, it utilizes two revolutionary operating techniques that no longer require you to learn complicated script languages or deal with time-based editing systems. It's the easy way to get into the multimedia action and make your presentations soar! **Satisfaction Guaranteed.** Create a multimedia presentation in sixty minutes or return for a refund. Call for details and limitations.

suggested retail price  
**\$149.95**

**AskMe** Multimedia Center  
1700 Northland Circle, Suite 201  
Minneapolis, MN 55428  
FAX (612) 531-0645



**SOFTWARE RESOURCE**  
FOR SMALL BUSINESS

**NERISE I**

**KENFIL DISTRIBUTION**

**1-800-879-7899**

**1-800-637-4735**

**1-800-745-3634**

## Ever seen a grown pirate cry? Just plug this in ... and watch



### MEMOPLUG™

The amazing Software protection system based on a hardware plug. Contains read-write programmable memory. This system is practical and easy to use for both programmer and end-user. Supports various programming languages, operating systems and types of computers.

### U-PLUG™

The premiere protection plug for UNIX systems that connects the standard serial port of computers and workstations.



### LANPLUG™

Comprehensive network protection starts with a single plug. The LANPlug lets you operate protected software from any workstation on the network, while supervising a number of authorized simultaneous operation applications.



### CLOCKPLUG™

This unique Time-limited software protection system is based on a plug containing a real-time clock. It allows users limited execution times for leasing and demonstration applications.

A password system allows you to rewind the clock by telephone



Design: Zamir studio

**U.S. office:** Tel: 1 (800) 677 1587  
Tel: (407) 682 1587 Fax: (407) 869 1409  
**South Africa:** LionSoft Tel: 011 640 6002  
**Holland:** M.H.P. Tel: (31) 440612916  
**France:** C.T.I. Tel: (1) 47 38 16 17  
**Spain:** Economic Data Tel: (34) 1 442 28 00  
**Czech Republic:** PC Kompas Fax: (42) 2 43 11 88

**EliaShim**  
MICRO COMPUTERS LTD

5 Haganim, P.O. Box 8691  
Haifa 35022 ISRAEL  
Tel: 972-4-516111, Fax: 972-4-528613

**Currently looking for international distributors**

## Books & CD-ROMs

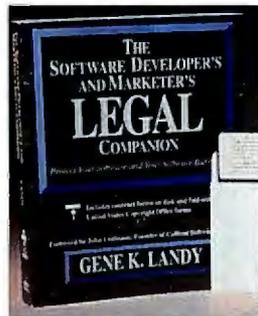
### LEGAL ADVICE

**THE SOFTWARE DEVELOPER'S AND MARKETER'S LEGAL COMPANION: PROTECT YOUR SOFTWARE AND YOUR BUSINESS**  
by Gene K. Landy Addison-Wesley, ISBN 0-201-62276-9, \$34.95 (with disk)

If you're in business, you must be aware of certain legal requirements. *The Software Developer's and Marketer's Legal Companion* by Gene K. Landy is a step-by-step guide through the most frequently encountered legalities.

Landy translates some typically terse legalese into simple, easily readable explanations. Each chapter covers a specific issue: copyrights, trade secrets, noncompete agreements, software development agreements, shrink-wrap licenses, trademarks, and more. Landy even covers situations such as ensuring that a potential employee leaves his or her previous employer properly, so no one can raise issues about stealing company secrets. The last third of the book (and accompanying disk) contains templates for drafting your own legal documents.

Of course, Landy's book will not supplant your own legal adviser. But it will provide you with sufficient background to create your own first-draft documents and to be aware of the legal implications associated with your agreements.

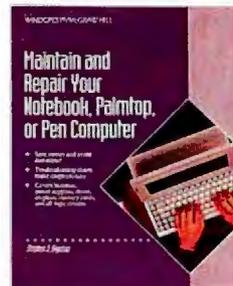


—Raymond GA Côté

### LAPTOP REPAIR

**MAINTAIN AND REPAIR YOUR NOTEBOOK, PALMTOP, OR PEN COMPUTER**  
by Stephen J. Bigelow Windcrest/McGraw-Hill,  
ISBN 0-8306-4455-5, \$18.95

Repairing small computers is not a task for the fainthearted. The electronics are highly integrated and tightly packed within the case. Expensive tools are often required to troubleshoot the problem and perform the repair. Yet, you can easily diagnose and fix many problems yourself with just a few common tools.



*Maintain and Repair Your Notebook, Palmtop, or Pen Computer* covers both the hard and easy problems in a clear, methodical manner. With nerve and a well-stocked workshop, you can avoid calling for help in many cases. The author takes you as far as you want to go and doesn't hesitate to tell you when you should get professional help.

What I found even more valuable than the repair tips, however, was the excellent material on how components of small computers work—everything from batteries to storage devices to mice. As a reference alone, this book is worth the \$18.95 price. ■

—Michael Nadeau

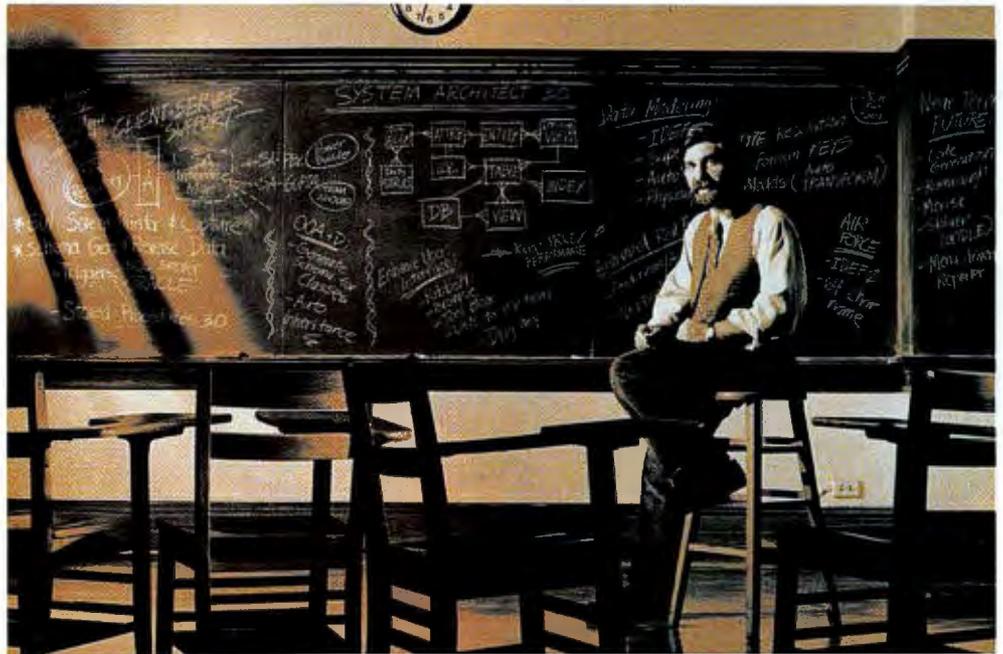
# “You asked for a powerful and affordable tool to develop client/server applications. That’s why I developed System Architect 3.0.”

JAN POPKIN, CHIEF SCIENTIST  
POPKIN SOFTWARE & SYSTEMS, INC.

Developers and project teams looking for a CASE-based tool for client/server application development will find the answer in System Architect™ 3.0. This latest version of the CASE price/performance leader includes the features of expensive tools for a fraction of the cost.

## System Architect 3.0.

SA 3.0 simplifies the development of client/server applications by supporting multiple methodologies including Information Engineering, Gane & Sarson, Yourdon, IDEF, OOA&D, SSADM IV, Shlaer/Mellor, and Ward & Mellor. It also features an integrated data repository you can customize. And it runs under MS Windows® or IBM’s OS/2 PM.®



## Flexibility And Functionality.

The ideal combination of flexibility and functionality has made SA the undisputed price/performance leader. As the needs of developers have changed, so has the scope of SA’s features and options:

**SA Screen Painter:** Allows repository-based development of GUI screens and menus or character-based screens.

**SA Object-Oriented Version:** Supports Booch '91 and Coad/Yourdon.

**SA Reverse Data Engineer:** Reverse engineers SQL databases, including SQL Server, SYBASE, DB2, Informix, and Oracle.

**SA Schema Generator:** Generates DDL and SQL triggers from entity models for Oracle, Informix, Ingres, PROGRESS, Paradox, dBASE III, DB2, SQL Server, SYBASE, and other SQL and 4GL databases.

**SA Project Documentation Facility:** Enables the automatic generation of deliverables with desktop publishing quality from SA Encyclopedia.

Paints GUI screens from data in repository.



## Choose Your Development Environment.

**SA/PowerBuilder Link:** Allows the exchange of design information between SA and PowerBuilder for the development of more robust client/server applications.

**SA/SQL Windows Link:** Works with Gupta’s SQL Windows.



System Architect 3.0 covers your development lifecycle with a complete range of features and options.

## Put Your Project Team In A Class Of Its Own.

System Architect 3.0 makes your project team more productive with a range of capabilities including:

**Network Version:** Allows multiple team members to work concurrently on a project while

sharing the SA Repository by locking diagram and data dictionary records.

**Network Security:** Allows Project Managers to uniquely identify and classify personnel with appropriate levels of authorization.

**Access Control:** Allows team members to check-out, check-in, or freeze encyclopedia objects with defined authorization.

**Version Control:** Allows project encyclopedias, and their related files, to be saved and stored with appropriate version-identifying data. (Available in version 3.1)

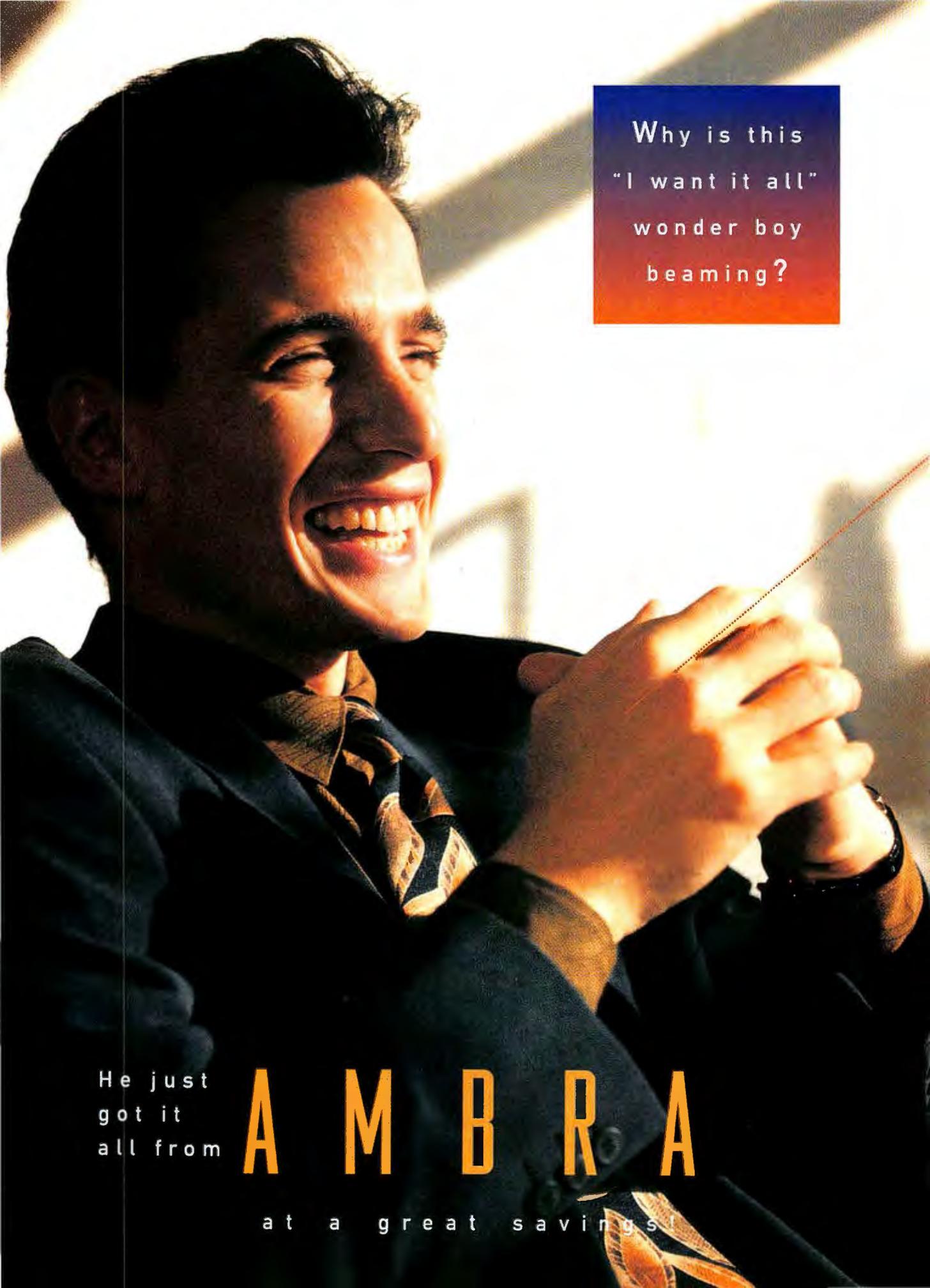
## Call Us Today At 800-REAL-CASE, X138.

To find out how to qualify for your free 30-day evaluation copy, call us today, or fax us at 212-571-3436.

## SYSTEM ARCHITECT

Popkin Software & Systems, Inc.,  
11 Park Place, New York, NY 10007

England 44-926-881186; Benelux 31-3406-65530;  
Germany 49-6151-82077; Italy 39-49-8700366;  
Switzerland 41-61-6922666; Denmark 45-45-823200;  
Australia 61-02-346499; Sweden 46-8-626-8100;  
Elsewhere 1-212-571-3434

A man in a dark suit and patterned tie is smiling broadly, looking off to the side. He is holding a telephone receiver with both hands. The background is bright and out of focus, suggesting an office or indoor setting with large windows. The lighting is warm and dramatic, highlighting the man's face and hands.

Why is this  
"I want it all"  
wonder boy  
beaming?

He just  
got it  
all from

**A M B R A**

at a great savings!

## MOBILE SYSTEMS

### SN425C

- 486SX, 25 MHz, SL-Enhanced
- 4MB RAM
- 170MB hard disk
- 7.8" STN color screen
- 1 PCMCIA slot, Type II
- 86-key keyboard
- Integrated 16mm trackball
- Suspend/Resume
- MS-DOS® 6.0, Windows™ 3.1
- Slip case
- 4 lbs., including battery

**\$1,899**

(Monochrome models available at \$1,399. With external 3.5" 1.44MB diskette drive, add \$99.)

### N450C

- 486DX2, 50 MHz
- 4MB RAM
- 3.5" 1.44MB diskette drive
- 200MB hard disk
- 9.5" STN dual-scan color screen
- 1 PCMCIA slot, Type III
- 86-key keyboard
- Integrated 16mm trackball
- MS-DOS 6.0, Windows 3.1
- Carrying case
- 6.6 lbs., including battery

**\$2,699**

### N450T

- 486DX2, 50 MHz
- 8MB RAM
- 3.5" 1.44MB diskette drive
- 200MB hard disk
- 9.5" TFT active matrix color screen
- 1 PCMCIA slot, Type III
- 86-key keyboard
- Integrated 16mm trackball
- MS-DOS 6.0, Windows 3.1
- Carrying case
- 6.6 lbs., including battery

**\$3,999**

## SLIMLINES

### S450DX

- 486DX2, 50 MHz
- 4MB RAM
- 128KB processor cache
- 3.5" 1.44MB diskette drive
- 340MB hard disk
- 3 ISA slots (2 VESA on local bus)
- 3 drive bays
- Windows accelerator, 1MB video memory
- 14" SVGA color monitor, LR
- MS-DOS 6.0, Windows 3.1
- Mouse

**\$1,699**

For the **LIGHTEST** to the **LATEST**

in computing, call **AMBRA™**

We've got it all for you, for **LESS!**

**4 lbs!**

**Blue Lightning**

### D466BL

- 486 Blue Lightning™, 66 MHz
- Upgradeable to Intel® Pentium™ technology
- 4MB RAM
- 256KB processor cache
- 3.5" 1.44MB diskette drive
- 340MB hard disk
- Onboard SCSI
- 5 16-bit ISA slots (2 VESA on local bus)
- 5 drive bays
- Windows accelerator, 1MB video memory
- 15" Flat Square color monitor, LR, NI
- Network-ready (Ethernet 10BaseT)
- MS-DOS 6.0, Windows 3.1
- Mouse

**\$1,908**

(For 8 x 6 minitower, add \$75.)



## DESKTOPS

### D466DXA

- 486DX2, 66 MHz
- 8MB RAM
- 128KB processor cache
- 3.5" 1.44MB diskette drive
- 440MB hard disk
- 5 ISA slots
- 5 drive bays
- Windows accelerator, 1MB video memory
- 2X CD-ROM drive
- 15" Flat Square color monitor, LR, NI
- MS-DOS 6.0, Windows 3.1
- Mouse

**\$2,439**

**BIG VALUE!**

### D466DXA

- 486DX2, 66 MHz
- 8MB RAM
- 128KB processor cache
- 3.5" 1.44MB diskette drive
- 440MB hard disk
- 5 ISA slots
- 5 drive bays
- Windows accelerator, 1MB video memory
- 2X CD-ROM drive
- 17" Flat Square color monitor, LR, NI
- MS-DOS 6.0, Windows 3.1
- Mouse

**\$2,769**

**BIG VIEW!**

**CD-ROM plus...**

## PENTIUM AND PCI TECHNOLOGY

### DP60/PCI

- Intel Pentium processor, 60 MHz
- 64-bit data path
- 8MB RAM
- 256KB processor cache
- 3.5" 1.44MB diskette drive
- 340MB hard disk
- 4 ISA, 2 PCI, 1 PCI/ISA slot
- 6 drive bays
- PCI graphics accelerator, 2MB DRAM
- 15" Flat Square color monitor, LR, NI
- MS-DOS 6.0, Windows 3.1
- Mouse

**\$2,889**

### DP60/PCI

- Intel Pentium processor, 60 MHz
- 64-bit data path
- 16MB RAM
- 256KB processor cache
- 3.5" 1.44MB diskette drive
- 440MB hard disk
- 4 ISA, 2 PCI, 1 PCI/ISA slot
- 6 drive bays
- PCI graphics accelerator, 2MB DRAM
- 2X CD-ROM drive
- 17" Flat Square color monitor, LR, NI
- MS-DOS 6.0, Windows 3.1
- Mouse

**\$4,140**

### Free customization.

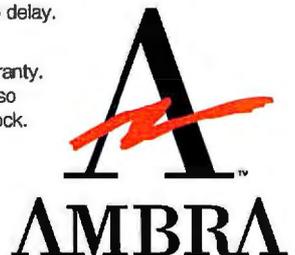
AMBRA custom-configures to your exact specs — with no extra service charge and no delay.

### Firm confidence.

Each AMBRA comes with a 30-day money-back guarantee and a one-year limited warranty. Optional IBM® one-year onsite warranty and Executive warranty (for mobile systems) also available! With every warranty, you can rely on toll-free technical support around the clock.

### Full convenience.

To place an order or get more information, just call — weekdays 8 am to 11 pm, weekends 10 am to 7 pm (ET). We accept Visa®, MasterCard®, Discover® and American Express® — as well as purchase orders from qualifying businesses. Pick up the phone today!



In Canada<sup>2</sup> call 1-800-363-0066, Ext. 5740

1 - 8 0 0 - 2 3 9 - 5 7 4 0

<sup>1</sup> Please call for details regarding AMBRA's money-back guarantee and limited warranty. IBM onsite warranty and Executive warranty. Return shipping and insurance charges are the responsibility of the customer. Onsite service may not be available in certain locations. <sup>2</sup> Offerings may differ in Canada.

© 1994 AMBRA Computer Corporation. AMBRA is a trademark of ICPI Ltd. and used under license therefrom. The AMBRA logo and logotype are trademarks of AMBRA Computer Corporation. IBM is a registered trademark and Blue Lightning is a trademark of International Business Machines Corporation. MS-DOS is a registered trademark and Windows is a trademark of Microsoft Corporation. Intel is a registered trademark and Pentium is a trademark of Intel Corporation. All other product names are trademarks or registered trademarks of their respective suppliers. Offerings, prices and products are subject to change without prior notice. Prices do not include shipping.

Announcing

# COREL SCSI™ NETWORK M A N A G E R

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

## Speed!

### High Performance CD-ROM Server Software

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

## Capacity!

### Advanced Jukebox Support

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

## Security!

### RAID Levels 4 and 5 Software

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



## Compatibility!

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



All logos are trademarks of their respective companies.



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



The Software Solution for Data Security!

For upgrade information or to order, call Corel: ext.28  
**1-800-772-6735**

OEM Sales (613) 728-0826 ext.1051



# The Macintosh at 10

**Regarded initially as a "toy," it's obvious today that the Mac changed the direction of computing for the better**

**TOM THOMPSON**

**T**his month marks the tenth anniversary of the Apple Macintosh line. Although few took it seriously during the early years, in many ways the Mac defined what a desktop computer should be. Apple pioneered many concepts that users now take for granted.

The ideas of cut-and-paste, undo, point-and-shoot menu selection, picking the best typeface for a document, dropping a graphic into a page, and other common operations were first promoted by the Mac 10 years ago. While many of these ideas drew on work done at Xerox PARC (Palo Alto Research Center), Apple refined and popularized them. The Mac also ushered in new technologies and new expectations that go beyond ease of use, such as plug-and-play expansion boards and networks, remote access, and 24-bit color editing and printing.

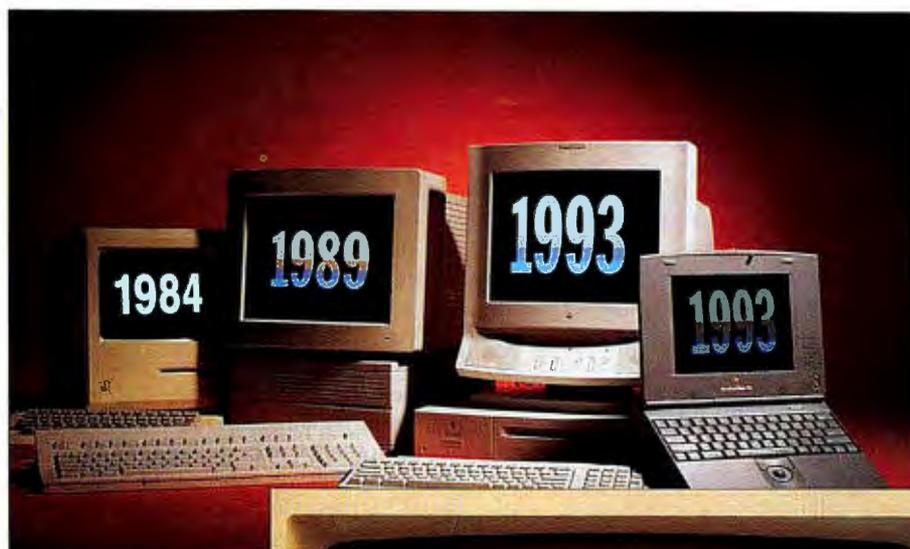
The Mac's trendsetting days are not over. Today, the AV-series Macs are the first mainstream desktop systems to offer video capability and voice control as standard equipment. The PowerBook line of notebooks brings a new level of usability to portable computing. And Apple continues to be a driving innovative force in building systems for the graphic arts.

Today Apple is at a crossroads. It is in the process of moving the Mac from its traditional Motorola 680x0 processor to the new PowerPC that the company codeveloped with IBM and Motorola. Apple is also a pioneer in the emerging PDA (personal digital assistant) category with its Newton line. So now is a good time to look back at the Macintosh milestones and place their significance in perspective.

## Descended from Lisa

In 1983, Apple introduced the Lisa, its successor to the company's aging Apple II line. The Lisa's most innovative aspect was its GUI-based operating system, with windows, icons, and menus. The system's consistent interface with data-as-a-concrete-object metaphor promised ease of use for the office worker. However, its hefty price tag of \$10,000 was hard to handle.

A year later, Apple brought out the Macintosh. It was smaller, faster, and—most important—cost \$2495. It borrowed a lot from the Lisa, including the GUI and mouse. The Lisa was discontinued in 1985, but its influence lives on inside the Mac, which has



SCOTT PARKER / AVIS STUDIO © 1994



The original Macintosh design team. Left to right: Andy Hertzfeld, Chris Espinosa, Joanna Hoffman, George Crowe, Bill Atkinson, and Jerry Manock. The Mac's high-quality WYSIWYG output was possible because everything on-screen—including text—was a bit-mapped graphic.

gone from a small closed system to a variety of forms: tower systems, small desktop units, and notebooks. Most PCs sold today offer a mouse and run Windows—a tacit approval of the concept of a consistent, user-friendly interface that the Lisa and the Mac pioneered.

Compared with other personal computers of its time, the original Mac was a bit anemic in some ways while excelling in others. For example, few personal computers offered even one built-in serial port, yet the Mac had two of them. More significant was how Apple made use of the system ROMs. The Mac's ROMs were downright massive compared to those of other personal computers. While the IBM XT had 48-KB ROMs, they contained mostly BASIC. Much of the Mac ROM code came from



**1984:** The first Macintosh borrows the Lisa's mouse and GUI. Other features included a 7.83-MHz 68000 processor, a single-sided 3½-inch floppy drive that could hold 400 KB of data, 64-KB ROMs, and 128 KB of RAM. Price was \$2495.

the Lisa and was distilled down into tight assembly code by Bill Atkinson (who wrote the Lisa's graphics engine) and Andy Hertzfeld.

These ROMs supplied an array of routines known as the Mac Toolbox. Related Toolbox routines were collected into groups called Managers, such as QuickDraw (the graphics engine), the Device Manager (which dealt with hardware at a high level), the Window Manager, the Menu Manager, and the Font Manager. These Managers supplied hardware-independent functions that programmers used to communicate with devices, create windows, handle a menu selection, change a font, or establish a network session.

In short, the Mac Toolbox defined an API years before the term was coined. Nowadays, programmers are familiar with an army of competing APIs: Windows, NextStep, and Motif. However, the Mac does a better job of integrating the various services, such as memory and printers, and it places most of the API in ROM. There the Mac API makes fewer demands on memory and disk space. However, its entry points are located in RAM, so that RAM patches can fix bugs or enhance certain services in the API.

In retrospect, the 128 KB of RAM was inadequate for the memory-intensive GUI. It was assumed that since Mac applications would be making heavy use of the ROM-based Toolbox, less RAM would be needed for actual user code. To make the best use of the limited memory, a Memory Manager could load or purge sections of program code on demand. This had important consequences for both programmers and users.

For the Mac programmer, it meant that code had to be written using PC-relative addresses. That's because the Memory Manager might reload the code into different areas of RAM. On the 68000 processor, PC-relative displacements were restricted to 15 bits (the 16th bit was a sign bit, used to determine the direction of the jump), so these chunks of code—called *code segments*—were limited to 32 KB.

the Lisa and was distilled down into tight assembly code by Bill Atkinson (who wrote the Lisa's graphics engine) and Andy Hertzfeld. These ROMs supplied an array of routines known as the Mac Toolbox. Related Toolbox routines were collected into groups called Managers, such as QuickDraw (the graphics engine), the Device Manager (which dealt with hardware at a high level), the Window Manager, the Menu Manager, and the Font Manager. These Managers supplied hardware-independent functions that programmers used to communicate with devices, create windows, handle a menu selection, change a font, or establish a network session. In short, the Mac Toolbox defined an API years before the term was coined. Nowadays, programmers are familiar with an army of competing APIs: Windows, NextStep, and Motif. However, the Mac does a better job of integrating the various services, such as memory and printers, and it places most of the API in ROM. There the Mac API makes fewer demands on memory and disk space. However, its entry points are located in RAM, so that RAM patches can fix bugs or enhance certain services in the API. In retrospect, the 128 KB of RAM was inadequate for the memory-intensive GUI. It was assumed that since Mac applications would be making heavy use of the ROM-based Toolbox, less RAM would be needed for actual user code. To make the best use of the limited memory, a Memory Manager could load or purge sections of program code on demand. This had important consequences for both programmers and users. For the Mac programmer, it meant that code had to be written using PC-relative addresses. That's because the Memory Manager might reload the code into different areas of RAM. On the 68000 processor, PC-relative displacements were restricted to 15 bits (the 16th bit was a sign bit, used to determine the direction of the jump), so these chunks of code—called *code segments*—were limited to 32 KB.

these handles just to set up pointers to these data structures got a rude surprise when the Memory Manager, going about its duties, rendered the pointer useless by relocating the data structure elsewhere. For programmers used to the absolute addressing schemes of earlier personal computers, this sort of behavior was maddening. It didn't help that you had to learn about an event-driven interface that let the user do anything in any order, or that you needed a Lisa to develop code.

The use of PC-relative code design was prescient, since it allows applications to function in a multitasking or virtual memory environment. The 15-bit branch displacement limit was expanded to 32 bits in the 680x0 processors; this simplifies code design unless the application has to run on the older 68000 Macs. And the Mac has a wide variety of native development tools, with languages from BASIC to C to Forth. Several vendors offer tools with visual programming interfaces, such as Mainstay's Visual C, Zedcor's Future Basic, and Prograph International's Prograph.

Users eventually saw a silver lining, too. The combination of the Memory Manager and PC-relative code enables the Mac environment to run efficiently in far less memory than Windows needs.

One side note on the original design is that Apple used the top 2 bits of the 68000 processor's 24-bit address lines as chip selects for RAM, ROM, I/O, and the floppy drive subsystems. This trick partitioned the Mac's 16-MB address space into four sections: The lower 4 MB was for RAM addresses, the next 4 MB was for ROM addresses, the next 4 MB was for I/O hardware, and so on. Therefore, the ROMs were located just above 4 MB. This location blocked memory expansion beyond 4

The Memory Manager might also shuffle crucial data structures around in memory to make an opening for a code segment.

The proper way to address these structures was through handles. Programmers who, for performance reasons, used

MB in the Mac Plus and Mac SE. However, for roughly the same reasons, the PC design suffered the same problem. The PC's ROM, I/O, and video memory were mapped into the upper 384 KB of the Intel 8088's 1-MB address space, so that available RAM topped out at 640 KB. This created the "640-KB barrier" that plagued PC software design for years.

**Networking**

In January 1985, Apple introduced the Macintosh Office. This consisted of a low-cost LAN and a LaserWriter laser printer. At \$6995, the LaserWriter cost more than several Macs, but its price was a lot better than the \$50,000 commanded by commercial laser printers at the time. The AppleTalk LAN allowed you to justify such a printer because you could easily share it among several Macs.

This 203.4-Kbps LAN was later renamed LocalTalk, and its strength was that it used low-cost components and featured a plug-and-play setup—necessary since the Mac was a closed system. You simply plugged the network connectors into each Mac's printer port and into a LaserWriter, ran cable between the connectors, and you were done. LocalTalk used a CSMA/CA scheme to attach and map the computers into the network. The network connectors were self-terminating, so you could add or remove Macs from the setup

**Famous Mac Firsts**

The Apple Macintosh pioneered the use of many features on desktop and portable computers that people now take for granted.

- **Cut-and-paste**
- **Undo**
- **Point-and-shoot menu selection**
- **Built-in video**
- **Voice control**
- **The API**
- **Built-in networking capability**
- **Built-in SCSI**
- **Plug-and-play design philosophy**
- **Dynamic memory allocation**
- **Hypertext**
- **24-bit color capability**



**Chris Espinosa: "Apple would have been caught in a bruising price war in 1987 instead of in 1992 if we'd have licensed the ROMs freely. We would have had to cut our margins and expenses earlier and wouldn't have been able to fund a lot of development that brought us to where we are today—such as System 7, the Powerbooks, and the AV technology."**

without bringing the network down.

Apple further refined the plug-and-play network concept in 1991 with the introduction of self-terminating Ethernet modules for thick, thin, and 10Base-T cables. In many cases, you could set up a high-speed Ethernet network for an office of Macs in minutes, without getting involved with hardware configuration or IP addresses. Also, System 7's built-in peer-to-peer networking services meant you could create workgroups instantly by setting passwords and access privileges with a few clicks in a Control Panel on each Mac.

While plug-and-play is touted as the Next Big Thing in the PC world, the Mac embraced the concept as its basic design philosophy and has been providing it to users for years. This is evident in the Mac's networking services and in other areas.

### The Genesis of Desktop Publishing

In early 1985, many people considered the Mac a curiosity. It was easy to use, but otherwise it offered no compelling advantage over a faster, if arcane, PC. That attitude changed in the summer with the arrival of Aldus PageMaker. It was the first successful page-layout program, and it let you quickly flow text and add graphics to "virtual pasteboards" for designing a newsletter. Furthermore, it let you do this without rocket science or knowing too much of the conventional production details.

The troika of PageMaker, an easy-to-connect LAN, and a shareable laser printer that could chum out camera-ready copy suitable for newsletters and other low-cost publications gave the Mac a unique capability. There were workstations that could manage the same feat, but not with the Mac's ease of use and penchant for visual fidelity between the screen and output.

The Mac was hardly two years old when it gave birth to desktop publishing. Today, DTP is a huge, multimillion-dollar industry, no longer limited to newsletters. Newspapers rely on it to add late-breaking news to their front pages. Magazines use DTP to

expedite the creation of the magazine, dropping in text, artwork, and scanned images from a medley of sources.

### A SCSI Pioneer

The Mac Plus, introduced in January 1986, was the first personal computer to provide embedded

SCSI. However, Apple goofed in its SCSI driver implementation. In a SCSI transaction, an initiator (usually the computer) issues a request to a target SCSI device. The target then issues subsequent SCSI commands to the initiator, completing the initiator's request. In other words, the target drives the transaction. Apple got it backward, having the initiator drive the transaction. This caused problems with early SCSI peripherals, but Apple can be excused as a pioneer here: SCSI itself wasn't formally adopted as an ANSI standard until June 1986. It didn't help that third-party vendors had different interpretations of the standard.

SCSI's high-speed interface and simple-to-configure design made it a natural fit to Apple's plug-and-play philosophy. Despite initial problems during 1986, the Mac's SCSI capability fostered development of easy-to-connect SCSI peripherals, such as third-party hard drives and scanners. The Mac is responsible for the wide acceptance of SCSI in the computer industry today, in part because it proved SCSI's versatility as a low-cost peripheral expansion bus, but also because other computer vendors wanted to tap into the ready-made market of Mac SCSI peripherals. Today, SCSI pervades the industry, serving as a peripheral bus for PCs and workstations. Many hard drives and CD-ROM

drives use SCSI because it allows them to connect to any hardware platform.

### Bringing Color to the Desktop

In 1987, Apple both boosted the power of the Mac and discarded the closed-system concept with the introduction of the Mac II and Mac SE. The Mac II featured 256-KB ROMs that added more text-handling capabilities, plug-and-play configuration software for the NuBus boards called the Slot Manager, and Color QuickDraw. Suddenly, the Mac became respectable: Storage problems were a nonissue due to internal or external SCSI drives; you could expand the systems easily using plug-in boards; and the Mac II's color capabilities easily blew away those of existing PCs.

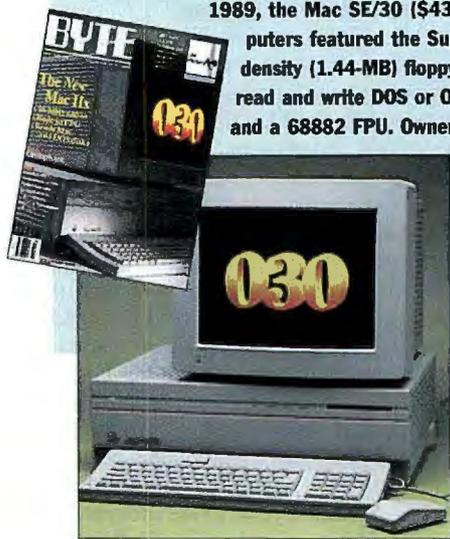
The Mac II fostered the growth of color-output devices, since many users wanted to get on paper what they saw on their screens. Within a year, QMS provided a desktop solution with the ColorScript 100, a PostScript-clone thermal-wax color printer. It was a tad pricey, but for some companies the printer could pay for itself in a year by eliminating the costly errors that occurred when complex color files were sent to a typesetting service.

The stampede of color printers that followed—ranging from high-end PostScript printers to low-cost ink-jets—expanded

**1987: The Mac II used an internal SCSI hard drive, a 16-MHz 68020 processor, and a 68881 FPU as standard equipment. It had eight SIMM sockets that allowed RAM expansion to 128 MB. It also had six NuBus slots for expansion boards. A Mac II with a 40-MB hard drive cost \$5498. The Mac SE kept the compact form of the original Mac but added a SCSI hard drive and an expansion slot called the Processor Direct Slot (PDS). A Mac SE with a 20-MB hard drive cost \$3698.**



**1988:** Apple migrated the Mac to the 68030 processor, by introducing first the Mac IIx (\$7769) and then, in January 1989, the Mac SE/30 (\$4369). These computers featured the SuperDrive, a high-density (1.44-MB) floppy drive that could read and write DOS or OS/2 floppy disks, and a 68882 FPU. Owners of Mac IIs and



SEs could upgrade to the new machines with a floppy drive and main logic board swap.

the Mac's ability to supply color in DTP output and helped make the Mac a serious replacement for the artist's traditional palette and paint. It helped that the Mac's plug-and-play Slot Manager made adding expansion boards a snap. Most professional artists liked the Mac's set-up-and-go design, since they would rather start drawing than try to figure out how to set up a high-resolution board's jumpers for a PC. And if their monitor proved too small for their work, they could expand the total screen size by simply plugging in another display board and monitor.

**Software Strides**

The original Mac could use 128 KB of RAM because as the software engineers moved Lisa software components to the Mac, they stripped out the multitasking features. Only one application ran at a time on the Mac, except for Desk Accessories, small "applets" that ran concurrently because they masqueraded as drivers. However, as memory became more plentiful, the multitasking issue resurfaced.

The answer was MultiFinder, written by Erich Ringwald and Phil Goldman. This ingenious bit of software provided cooperative multitasking by patching certain Toolbox routines in the Mac OS, and the MultiFinder application managed loading and context switching of applications.

The reasons MultiFinder worked at all are several-fold: First, because Mac applications frequently called the Toolbox event handlers, these handlers served as doorways by which the thread of execution could be passed to other applications. Second, as execution moved to another application via the modified event handler,

MultiFinder took notice of this and preserved certain non-reentrant system globals used to maintain the application's environment. These values were restored when control returned to the application. Finally, the same PC-relative code that initially gave programmers fits meant an application could be loaded anywhere in memory and still run.

The icing on the cake was that MultiFinder retrofitted this capability on existing Macs back to the Mac

Plus—no additional hardware was required other than a minimum of 2 MB of RAM. While numerous GUIs for PCs and workstations have appeared since then, none offers the seamless level of integration for copying information between applications

**1989:** The Mac SE/30 was the first high-performance compact Mac design. It had a 16-MHz 68030 processor and a 68882 FPU. Because the screen display used separate VRAM rather than main memory as in the original design, better bus throughput was achieved.



and the easy ability to select system resources such as networked printers.

**HyperCard: GUI Programming for the Masses**

The Mac was hard to program. Bill Atkinson crafted HyperCard, which he called "a software erector set," to eliminate this hurdle. It implemented a card-stack metaphor that enabled users to browse through and manipulate information. HyperCard provided a set of built-in editing tools and

a natural-language programming script called HyperTalk. With these tools and HyperTalk, the average user could collect, organize, and store information in HyperCard stacks in any fashion.

HyperCard and MultiFinder were introduced in August 1987 and were bundled with every Mac shipped. In a demonstration of its robust design, HyperCard was used to operate information kiosks that supplied show information. It introduced ease-of-programming to the average Mac user and promoted to computer users the concept of hypertext links. Nowadays, computer users understand that phrases that stand out in a document (perhaps by being in a different color or underlined) serve as a hypertext link to additional information. HyperCard educated the user on this "intuitive" concept.

**32-Bit QuickDraw Arrives**

For folks doing serious image and graphics work, the 256 colors displayed by Color QuickDraw's 8-bit color were simply inadequate. Clever display-board vendors such as SuperMac Technologies managed to coerce 24-bit data onto the screen by successively assembling an image's three-color components in a display board's frame buffer.

Apple came out with a revised version of Color QuickDraw in April 1989. Called 32-Bit QuickDraw, it was a patch file that retroactively implemented 24-bit color capabilities on existing color Macs. (The 32-Bit term in the name came about because pixel data was stored as 32 bits even though only 24 of them actually contained color information.) It also let you switch on the fly between 24-bit color (millions of hues), which is suitable for photo-realistic editing, to 16-bit color (thousands of hues), suitable for handling digital video for multimedia. This lets you pick the screen depth

**1989:** The Mac IIcx, Apple's first 25-MHz 68030-based computer, featured built-in video. It cost \$6969 with a 40-MB hard drive and used 512-KB ROMs that were "32-bit clean" (i.e., the code was designed to operate in a new 32-bit address space, although it could also operate in the old 24-bit address mode for software compatibility). This ROM code has become the "universal ROM" code used in every 68030-/68040-based Mac since then.



# 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

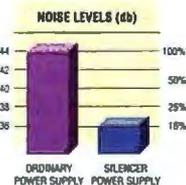
### STANDARD UNITS

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
  - 100X more reliable than a single-unit
  - load-sharing design
  - hot-swap capability
  - 5-year warranty
  - monster-case compatible
- TWIN-POWER 900 ..... \$995



## OVER-TEMP ALARM

Don't wait for the acrid smell of burnt components! With our new 110 Alert, you'll know if your PC is overheating before damage occurs. Should the computer's temperature reach 110°F, a loud 1" x 1.5" 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.



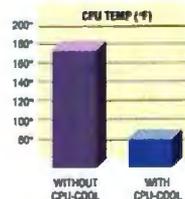
110 ALERT ..... \$29

## 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. ©1993 PC Power & Cooling, Inc.

**1990:** Apple changed its direction and introduced the “cheap Macs”: the Mac Classic (basically a revised Mac SE), the Mac LC (a Mac II in a svelte housing), and the 20-MHz 68030-based Mac IIs. These machines represented Apple’s intent to expand market share by producing systems priced competitively with PCs. The Mac Classic cost \$999, the Mac LC cost \$2499 with a 40-MB hard drive, and a similarly equipped Mac IIs cost \$3769.



that is suitable for the job at hand.

This support of high-resolution color accelerated the Mac’s use as a digital-image editor. Now, not only could the Mac lay out the text of magazine pages, it could also edit the high-quality images that went into them. It also let the Mac function as a data visualization tool in scientific and engineering applications.

Again, 24-bit color manipulation wasn’t a new concept, but the custom high-end workstations with similar capabilities cost \$30,000 or more. The Mac’s new capability raised expectations in the PC world: At that time, you typically had only 15 or possibly 256 colors on the screen; today, you can shop for a PC display board that supports thousands or millions of colors.

**Portable Lessons and Power**

One of the glaring deficiencies in the Mac product line was the lack of a notebook computer. In September 1989, the company introduced the Mac Portable to plug this gap. Unfortunately, the computer barely earned the label “portable,” weighing 17 pounds and being the size of a small briefcase. Three things in its favor were the sharp active-matrix display, an integrated trackball, and an 8-hour battery life, thanks to the heavy lead-acid battery.

The Mac Portable turned out to be a

dud, sales-wise. However, Apple learned a valuable lesson from it. Two years later, in October 1990, the PowerBooks showed that Apple could pack a Mac into a light, 7-pound notebook form factor. These systems came equipped with a practical set of features, such as a 25-MHz 68030 processor (in the PowerBook 170) and fax and remote-access software.

Nor was the Mac Portable’s design effort a total waste: Much of its power conservation software, and hardware tricks such as slowing the processor clock and switching off idle subsystems, found their way into the PowerBook designs. The Apple Remote Access software bundled with PowerBooks let users connect as a remote node to the AppleTalk network in their office. This let them transfer files, print documents, and access databases or schedules the same way they did in the office. The PowerBooks let the on-the-go office worker contact anyone by E-mail, fax, or remote access.

Today, many PC notebook computers imitate the PowerBooks’ physical layout, including the integrated trackball. Still, most of them can’t match the PowerBooks in the level of software integration.

**New Software, New Processors**

At the May 1988 Developer’s Conference, Apple talked about System 7, the successor to System 6.0.x. It would be a 32-bit operating system offering significant features, such as a new SCSI driver, drag-and-drop printing, a new graphics engine, and built-in cooperative multitasking.

Apple had hoped to introduce System 7 about two years after its announcement in 1988. It didn’t turn out that way; it arrived in May 1991—a year late. System 7 improved the user interface in several subtle and effective ways, such as by providing a built-in find function that locates a file on your hard drive or on a network. And while multitasking under System 6.0.x was something of a kludge, a Process Manager in System 7 managed the multitasking environment by handling the creation of memory partitions and loading the applications.

A 7.1 revision of the operating system consolidated fonts into a separate folder, where you installed or removed them by simply clicking on and dragging files. System 7.1 also introduced the concept of a System Enabler—a small file of hardware-

specific code—that at boot time sets up the low-level environment so System 7.1 can operate. This lets System 7.1 function without modification even if the hardware changes. This seems like a minor point unless you’ve tried to install Windows on different machines with different hardware. Whereas a new Mac simply requires a new System Enabler, a Windows user can spend hours trying to massage Windows and DOS drivers to get a combination that works.

**Video Killed the Radio Star**

Introduced with System 7 was QuickTime, which gave the Mac the ability to control time-based data. For example, QuickTime handled the display of digital video clips and sound, ensuring that both the pixels and sound were synchronized and delivered to the screen at the constant rate demanded by such media. An important point is that QuickTime is a cross-platform technology: A Windows version is available, and Silicon Graphics has adopted QuickTime as a digital format. This lets multimedia applications developers store digital video and sound as QuickTime movies and count on them to function as expected on any platform.

**1991:** Along with the PowerBooks, Apple also presented its first 68040-based Macs—the Quadra line. The Quadoras started out as 25-MHz 68040-based systems with 1-MB ROMs, 24-bit on-board video, and built-in Ethernet capabilities. The Quadra 700 used a IIfx-style form factor, and the Quadra 900 used a tower design. A Quadra 700 with 4 MB of RAM and an 80-MB hard drive cost \$6399, while a Quadra 900 with 4 MB of RAM and a 160-MB hard drive was priced at \$8499. The latest offering is the 25-MHz Quadra 605, which comes in a slim pizza-box housing and costs up to \$1269.



# QEMM 7 finds room nobody else can.

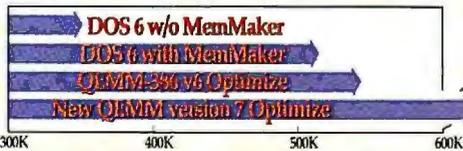
Sooner or later, you'll get an "Out of Memory" message. Whether you have 1 megabyte or 16.

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

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

**Have your cake and eat it, too.**

The more memory you have, the more flexibility and reliability you can enjoy. Thanks to



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.

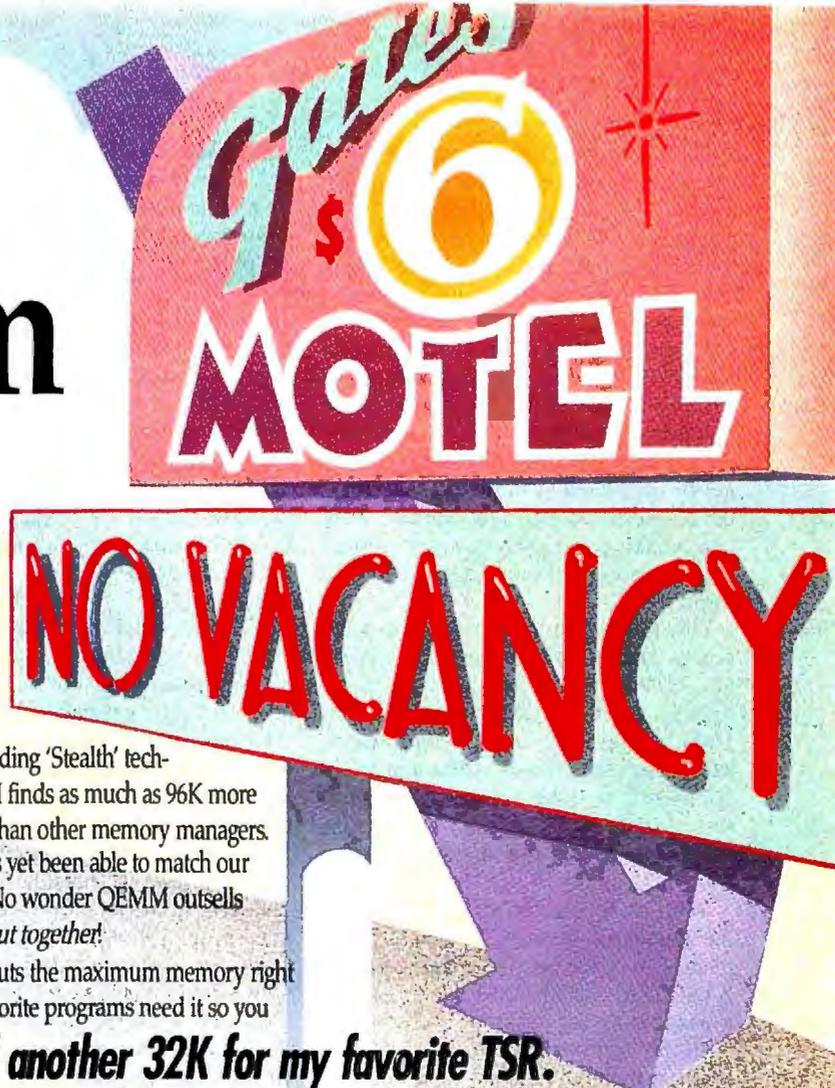


# Quarterdeck

Circle 132 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—86/33 ALR Power/business VESA 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=20 MYSOUND.SYS, SNDISK12.SYS, SLED.SYS, DOS SHELL—statement in the AUTOEXEC.BAT file: VSATF, MSCDEX, UNDELETFE, LSL.COM, NEZ000.COM, IPXQDL.COM, NETX or DMS-NETX, MOUSE.COM, SMARTDRV.COM, PRYSOCCAP.COM. ©1993 Quarterdeck Office Systems. Trademarks are property of their respective owners.



## NO VACANCY

our patent-pending 'Stealth' technology, QEMM finds as much as 96K more high memory than other memory managers.

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

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

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

can run them and TSRs without 'out of memory' problems or conflicts. That keeps your PC running smoothly and performance at its best.

**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

Digital movies, however, require tons of storage. In anticipation of these storage demands, Apple has heavily promoted the adoption of CD-ROM as a storage medium by offering built-in CD-ROM drives in many of its systems. These drives are dual-speed, multisession drives, unlike the single-speed, single-session drives found in most MPC systems. Apple also supports Kodak's Photo CD digital-image standard and provides a driver that transparently reads Photo CD files. Consumers might not be enamored of digital photography, but businesses that do a lot of image work (e.g., making and printing catalogs) find Photo CDs to be the ideal storage/retrieval format.

Due to the Mac's push on color technology and the availability of dual-speed CD-ROM drives, today you have a choice of interactive CD-ROM titles that can play 16-bit digital video clips. With low-cost MPEG encoders from C-Cube and others appearing, you can expect to see full-screen (640 by 480 pixels), full-motion (30 frames per second) digital movies on CD-ROM soon.

With its AV line of Macs, Apple blurs the boundaries between TV and the computer. Out of the box, AV Macs can drop NTSC, PAL, or SECAM live video into a window on the desktop. Furthermore, with the appropriate software you can snatch a frame of video, or capture video

into a QuickTime clip. You can also easily "print" a screen or a running demonstration to a VCR tape. While these capabilities don't come close to those offered by professional equipment, it's the start of the Mac breaking traditional boundaries, transforming itself from a simple personal computer into a communications device. This will accelerate the integration of TV and information services into the desktop computer.

While the original Mac was touted as an "information appliance," after a decade it's clear that the Mac has yet to reach that lofty goal. However, it's well on its way.

**The Future**

Where does Apple go in the future? It continues to push the boundary on technical innovation. In 1991 it forged strategic alliances with Motorola and IBM to share various hardware and software technologies. The first result of this alliance is the PowerPC RISC processor. RISC systems, though powerful, were simply too expensive for the personal computer market until the PowerPC arrived. The PowerPC bucks this trend with low fabrication costs combined with RISC's high performance.

Apple is basing a line of Macs on the processor. A low-cost PowerPC Mac, combined with IBM PowerPC offerings, could push RISC into the mainstream of personal computing. With the proper System Enabler and a 680x0 emulator, System 7.1 actually runs on a PowerPC-based system.

Apple also continues to work toward replacing its low-level single-threaded operating-system services with a microkernel. The microkernel would provide memory protection, multiple threads, reentrant drivers, and preemptive multitasking.

This makes for a more robust environment and lets the operating system manage its resources more effectively. Apple is attempting to do this while simultaneously preserving the existing

software base by adding portions of the microkernel piecemeal.

For example, the Quadra 840AV uses a new SCSI Manager 4.3 that not only implements SCSI correctly but is a reentrant driver. Likewise, the ROMs in the PowerPC Mac implement Toolbox routines as DLLs; this will allow multiple threads. Will

Mac users be able to use such an operating system on existing hardware? It's possible: Since the Mac SE/30, all 68030-/68040-based Macs have a SIMM ROM socket at the ready. Although most of these Macs have 1 MB of ROM or less, they can address 8 MB (except for the Mac SE/30, which can address only 2 MB). Apple isn't talking about its plans in this area.

Apple has also attempted to jump-start the PDA industry with the MessagePad, the first implementation of its Newton Technology. Newton Technology is a multitasking, object-based operating system. Apple has licensed it to a number of vendors for use in different products, dispelling the technology's proprietary label.

More important, Newton Technology is an information-centric, not document-centric, operating system. Put another way, with Newton Technology you simply deal with information; you don't get caught in the mechanics of handling the information. For example, with the proper application on a MessagePad, you can jot, "Cab \$10." The Newton operating system interprets the command, starts an Expense Report application, and drops the value of \$10 into a travel expense cell dated for today. On a desktop system, you'd have to launch the appropriate application, locate the proper cell, enter the value, and then attach a date to the value.

Whether or not the MessagePad succeeds, Newton Technology will be a success because it shows us an even better way to work with our computers. That's something that the Mac did only 10 years before. ■

*Tom Thompson is a BYTE senior technical editor at large, a long-time Mac user, and a certified Apple developer. You can reach him on the Internet or on BIX at tom\_thompson@bix.com.*

**"We used HyperCard to design the Newton interface. We'd sit down with HyperCard and use the drawing tools to sketch out something. We'd tinker with it until we got what we wanted."**

**— Steve Capps, Distinguished Engineer**



**1993: The video Macs arrive. The Quadra 840AV comes in a short tower design and has 2-MB ROMs and a 68040 processor clocked at 40 MHz. A Quadra 840AV with 8 MB of RAM and a 230-MB hard drive costs \$4069. It has built-in live video capture and presentation hardware, and a DSP (digital signal processor) that handles voice recognition and CD-quality stereo sound, plus fax and modem functions.**



reentrant drivers, and preemptive multitasking.

# It SHOWS.

Watch A Mac Compatible Monitor From CTX



Shown: CTX1785GM



**CTX INTERNATIONAL, INC.**

USA Headquarters  
20530 Earlgate Street  
Walnut, CA 91789  
909/595-6146  
Fax 909/595-6293

Southern Region  
6090-F Northbelt Parkway  
Norcross, GA 30071  
404/729-8909  
Fax 404/729-8805

Eastern Region  
146 Division Place  
Hackensack, NJ 07601  
201/646-0707  
Fax 201/646-1998

Midwestern Region  
500 Park Blvd., Ste 295C  
Itasca, IL 60143  
708/285-0202  
Fax 708/285-0212

Southwestern Region  
1225 E. Crosby Rd., Ste. A21  
Carrollton, TX 75006  
214/416-9610  
Fax 214/245-7447

**As** a prominent leader in today's display technology, CTX proudly introduces its new GM Series of Macintosh compatible products that may change the way you think of monitors.

In sizes from 14" to 17", the GM Series provide features and capabilities that meet virtually any user's requirements for performance, resolution and price. Low Radiation (MPR II) and Power Saving Management are standard. As you may know, CTX monitors are built through stringent internationally recognized quality standards, such as ISO-9000. They offer crisp, steady and brilliant images as well as advanced features, while maintaining superb reliability and affordability.

To get a closer look at these true quality world-standard monitors, contact your nearest CTX dealer today.

MODEL	1462GM	1562GM	1565GM	1765GM	1785GM
CRT	14"	15"	15"	17"	17"
Dot Pitch	0.28mm	0.28mm	0.28mm	0.27mm	0.26mm
Scan Frequency	H:30-62KHz V:50-90Hz	H:30-62KHz V:50-90Hz	H:30-65KHz V:50-90Hz	H:30-65KHz V:50-90Hz	H:30-85KHz V:40-100Hz
Macintosh Compatibility	640x480/67Hz 832x624/75Hz	640x480/67Hz 832x624/75Hz	640x480/67Hz 832x624/75Hz	640x480/67Hz 832x624/75Hz	640x480/67Hz 1152x870/75Hz
Full Screen	Yes	Yes	Yes	Yes	Yes
Low Radiation	Yes	Yes	Yes	Yes	Yes
Digital Control	-	-	Yes	Yes	Yes
Power Saving	Yes	Yes	Yes	Yes	Yes

**CTX**

Committed To Excellence



**Technical Support**  
1-800-888-2012  
BBS: (909) 594-8973

Copyright © 1993 CTX International, Inc. All rights reserved. All brand and product names are trade marks or registered trademarks of their original owners. The ENERGY STAR™ emblem does not represent EPA endorsement of any product or service. Macintosh is a registered trademark of Apple Computer, Inc.

Circle 84 on Inquiry Card (RESELLERS: 85).

# HOW SAFE IS DATA COMPRESSION?



**TOM R. HALFHILL**

**T**o paraphrase Aesop, necessity is the mother of compression. If it weren't for the explosive growth in the size of operating systems, applications software, and data files, today's hard disks would be cavernous warehouses with acres of megabytes to spare. In just a few short years, desktop PCs with 40-MB hard drives have given way to systems that rival network servers: 200-, 400-, and even 1-GB hard drives aren't uncommon.

Yet despite the rapidly rising capacities and falling prices of hard disks, not everyone can afford the latest hardware, and some systems can't be upgraded. So it's no surprise that millions of PC users who bought MS-DOS 6.0 last year quickly embraced a new feature called DoubleSpace. Merely by installing some free compression software that ran invisibly in the background, they could virtually double the size of their existing hard disks.

But it wasn't that simple. Almost immediately, Microsoft was besieged by complaints about a myriad of problems, and some users reported catastrophic losses of data. Other people had no trouble at all and enthusiastically endorsed DoubleSpace. The controversy raged on BBSes and on-line services for months, while Mi-

crosoft steadfastly denied that DoubleSpace was buggy. Finally, last November, Microsoft released DOS 6.2 with several new safeguards.

Nevertheless, many users remain spooked about real-time data compression. Their fear is fed by persistent horror stories of users who have trashed megabytes of valuable files while using DoubleSpace and other on-the-fly disk compressors. Although in many cases the compression software is an incidental player, the association has been made: Compression is unreliable.

The real problem isn't data compression, though; it's how well the technology is implemented in the operating environment. And no environment is more hostile than that of DOS-based PCs.

PCs are plagued by dozens of "standards" covering everything from video cards to I/O buses. The memory layout resembles a map of the Balkans. TSRs and device drivers fight territorial battles over disputed memory blocks and interrupts. Applications think nothing of bypassing the ROM BIOS to save a few microseconds, and there are a number of versions of the BIOS from different vendors. Software installation programs automatically rewrite critical configuration files such as AUTO-EXEC.BAT and CONFIG.SYS, often without notifying

**MS-DOS 6.0 with DoubleSpace raised real-time data compression to a new level of visibility. As controversy raged over its reliability, some concerned users retreated from the technology. But the real issue isn't data compression at all; it's how compression is integrated into the operating environment. New approaches promise to make this technology much more foolproof.**



the oblivious user. Windows 3.1 layers a multitasking GUI atop a single-tasking, character-based operating system and contributes additional configuration files: SYSTEM.INI, WIN.INI, CONTROL.INI, and more. Different versions of DOS are available from three major companies. Most important, the DOS file system was simply not designed with real-time compression in mind.

Nearly all the troubles that users experienced can be traced to confusion or to odd interactions between the compression software and other parts of the system. That doesn't make the complaints any less serious, of course, but it does mean that the future of data compression is tightly bound to the continuing evolution of PCs. As PCs mature, become easier to use, and consolidate around better standards, data compression will steadily gain in popularity.

Transparency is the key: Data compression works best when it's completely transparent to both users and software. Today's compression software tries to keep a low

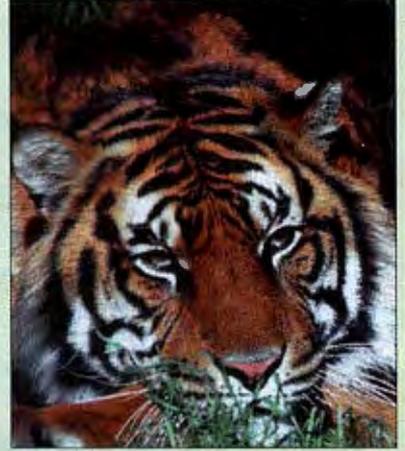
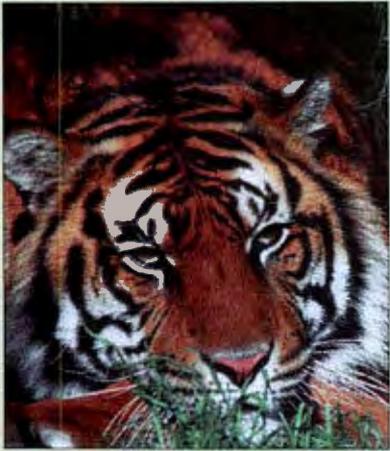
profile, but it is frequently shoved into the open by forces beyond its control.

One lasting effect of the DoubleSpace debate is that all makers of compression software are paying even closer attention to safety issues. Current products will continue to improve, and new approaches are being explored.

For instance, some companies are working to move compression into hardware. By integrating the technology with the CPU's I/O bus—and, perhaps, even in the CPU itself—data compression could become as transparent as floating-point math. The goal is not only to conserve hard disk space but also to significantly improve system performance by keeping the data compressed while it moves over the bus to peripherals and networks, and maybe even to main memory.

#### **Compression Goes Prime-Time**

The basic concept of data compression is at least as ancient as the Romans, who figured out that the Roman



With lossy compression techniques such as JPEG, image quality declines as the compression ratio goes up. This is because files are compressed by throwing out data. The first image is uncompressed. Maximum compression was used for the last image. The remaining image represents the middle ground between the two.

numeral *V* required less space on a stone tablet than did *IIIII*. Modern compression techniques are widely used to shrink huge graphics, video, and sound files down to manageable size.

But those types of compression—JPEG, MPEG, Indeo, and the compressors included with QuickTime and Video for Windows—are so-called *lossy* methods; some data is irretrievably discarded when the files are compressed. Lossy compression is unacceptable for critical data, such as spreadsheets, databases, and text. For those types of files, only *lossless* compression will do: Not a single bit of valuable information can be lost during compression or decompression.

Before DoubleSpace, the most popular lossless compression products were the file-level utilities for archiving data on floppy disks and saving time during downloads. One of the leading file compressors for PCs is Phil Katz's PKZip, a shareware program so effective, it can squeeze the complete text of NAFTA (North American Free Trade Agreement) from its normal bureaucratic bulk of 3.3 MB down to a mere 568 KB—an impressive compression ratio of nearly 6 to 1. The resulting file is small enough to fit on a floppy disk or to download from a BBS. Similar utilities are available for Unix and the Macintosh (see the text box "Data Compression on the Macintosh").

But file-level utilities require users to run a program to compress and decompress the file. Some utilities can make self-extracting archives—a single executable file that encapsulates both the compressed data and the decompression program—but it's still not simple enough for casual users. For them, real-time, on-the-fly data compression is a better solution.

Real-time compressors run in the back-

ground, automatically shrinking files when they're saved on disk and expanding them when they're loaded. Most real-time compressors set up a compressed virtual drive on the uncompressed host drive, so compressing a file is as easy as saving or copying a file onto the new virtual drive.

For PCs, examples include DoubleSpace from Microsoft; Stacker from Stac Electronics (Carlsbad, CA); XtraDrive from Integrated Information Technology (IIT) (Santa Clara, CA); SuperStor Pro from AddStor (Menlo Park, CA); and DoubleDisk Gold from Vertisoft Systems (San Francisco, CA), which supplied Microsoft with compression technology for DoubleSpace.

In 1991, DR-DOS 6.0 from Digital Research was bundled with SuperStor, thus becoming the first version of DOS to include real-time data compression. Until DoubleSpace came along, however, real-time compressors were mainly confined to a relatively small market of power users. With the release of MS-DOS 6.0, millions of casual users who barely knew the difference between a physical drive and a logical drive were suddenly creating compressed volumes on their hard disks with nary a second thought—some with disastrous results.

#### Trouble with DoubleSpace?

Data-loss problems are always difficult to trace, and the natural tendency is to blame the last thing installed. With DoubleSpace, most problems seemed to fall into three categories: (1) file corruption caused by bad sectors on the hard disk; (2) puzzling disk-full errors caused by badly fragmented compressed drives or lower-than-expected compression ratios; and (3) subtle interactions with other software, including the SmartDrive disk caching in DOS 6.0.

Microsoft responded by adding several

safeguards to DOS 6.2 and DoubleSpace. ScanDisk, a new diagnostic/repair utility, fixes damaged files and automatically scans the hard disk for surface errors before DoubleSpace is installed. DoubleGuard, a new protection option, alerts users if another program or TSR corrupts the RAM-resident portions of DoubleSpace. SmartDrive no longer turns on writeback caching by default. And Microsoft also made it easier to remove DoubleSpace altogether—a paradoxical but popular feature in other compression products.

Despite the safeguarding efforts of Microsoft and others, some users have simply reached the end of their ropes. Steven Polinsky, a lawyer in Ridgefield, New Jersey, says he removed Stacker from the 40-MB hard drive of his desktop PC after experiencing mysterious errors, even though he's not sure Stacker was to blame. Next, he installed DoubleSpace on his laptop computer's 60-MB hard drive but immediately ran into video initialization trouble with Windows. Now, he's reluctant to put either Stacker or DoubleSpace on his desktop PC.

"Overall, I'm a believer in DoubleSpace and in data compression in general," says Polinsky. "But this is my mission-critical computer. It's my billing, my accounting, my research tool, my everything. I can't live without it."

However, most users are so hungry for hard disk space that they're willing to take a little misfortune in stride. Chris Cooper, a software engineer working in Pforzheim, Germany, was not deterred even after CHKDSK failed to fix an error on his DoubleSpace drive: "I backed up, reformatted, and reinstalled everything, and that certainly fixed the problem."

The irony is that data compression is a rock-solid technology. There's no magic



## Modem.

Do you feel the need, the need for speed? You're why there's the new standard of high speed modems

called V.32terbo. Unlike ordinary V.32 bis modems, which run at 14.4 Kbps, V.32terbo runs at 19.2 Kbps, one

third faster. (Think of the difference between a regular sportscar and a turbo sportscar.)

But, best of all, V.32terbo is an open standard. Which means that it's the fastest modem standard there is that can talk to other nonproprietary brands. It can also talk to less speedy modems like V.32bis via Automode.

## V.32terbo modem.

Is V.32terbo the wave of the future? Over forty manufacturers seem to think so. Which is important if you want to make a 19.2 Kbps connection.

So look for the V.32terbo symbol at the left. It doesn't cost a whole lot more.

So why would you even think of buying anything else?

---

**V.32terbo modems.**  
**The open standard of fast.**

---

Call 1-800-372-2447, extension 920.  
We'll tell you more.



**AT&T**  
Microelectronics

# TRAPPED IN THE BODY OF THIS TINY SER

*This is a story about a small computer engineered to be so dependable, you won'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 an enterprise-critical platform before, we invite you to grab your bifocals and begin. (We'll be cramming a lot of information into this ad, which, given how much we managed to fit into our new servers, only makes sense.)*



*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 makes the introduction of the new Compaq ProLiant Server even more timely.*

*The ProLiant is a new family of affordable, high-performance, 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.*



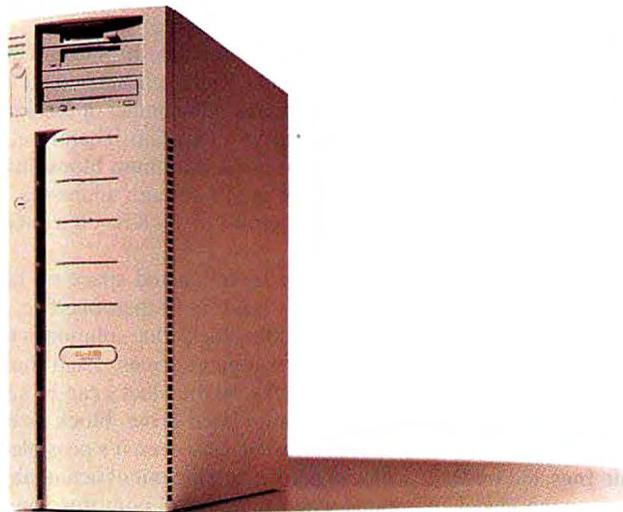
*Still, no network's perfect. In the unlikely event problems occur, our server exhibits remarkable tolerance. Every ProLiant includes Compaq-designed hot-pluggable drives. ProLiant Models 2000 and 4000 come standard with advanced error-correcting memory and off-line backup processor features (whereby 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.*



© 1993 Compaq Computer Corporation. All rights reserved. Compaq Registered U.S. Patent and Trademark Office. ProLiant, Insight Manager and SmartStart are trademarks of Compaq Computer Corporation. Product names mentioned herein may be trademarks and/or registered trademarks of their respective companies. CompaqCare is a servicemark of Compaq Computer Corporation.  
\*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

# SERVER 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. Introducing SmartStart, 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‡.

All of which may help to explain the look your boss gives you when he hears about how much money you saved: stunned admiration. But don't worry, you'll get used to that. It goes with the territory. For more information on the new Compaq ProLiant servers, or for the location of an authorized Compaq reseller that's near you, just give us a call toll-free at 1-800-345-1518. If you'd like to receive model, feature and specification information immediately via fax, select the PaqFax option.



## COMPAQ

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. The Intel Inside logo is a registered trademark of the Intel Corporation. \*For QuickSpecs information, order document numbers 4005, 5003, and 4001.

Circle 79 on Inquiry Card.

or voodoo; it's as straightforward and reliable as  $2+2=4$ . The comparison is apt because virtually all lossless data-compression products are derived from principles of information theory that were formulated in the 1940s and later refined in the 1970s and 1980s. At its roots, the basic technology of data compression may

be the levellest playing field in the computer industry. It is how various companies use compression that makes the difference.

#### Not Rocket Science

Typically, lossless data compression is based on some variation of the LZ (Lem-

pel-Ziv) or LZW (Lempel-Ziv-Welch) methods, named after Abraham Lempel, Jacob Ziv, and Terry Welch. When adapted for real-time compression, LZ/LZW strikes a reasonable compromise between efficiency and speed. On average, it achieves a compression ratio of about 2 to 1. Compare that to lossy methods such

## Data Compression on the Macintosh

**M**acintosh users have thus far escaped most of the controversy over disk compression that haunts PC users. For one thing, disk compression isn't a standard feature of the Mac operating system as it is with the latest versions of DOS. It's like the PC world before DoubleSpace: You have to buy a third-party product to get compression, so it tends to attract users who are more aware of the trade-offs.

Also, for various reasons, Mac software doesn't require as much disk space as Windows software. Many Macs are still sold with 80-MB hard drives—woefully small by today's PC standards but plenty large for the average Mac user.

Nevertheless, data compression is very much in demand. High-end Mac users tend to be graphic artist professionals who handle truly huge files: A single scanned photograph might easily require 50 MB. File-level compressors have been popular for years, and the Mac counterparts of PKZip include StuffIt Deluxe and StuffIt SpaceSaver from Aladdin Systems (Watsonville, CA); DiskDoubler and AutoDoubler from Symantec (Cupertino, CA); More Disk Space from Alysis Software (San Francisco, CA); Now Compress from Now Software (Portland, OR); and Compact Pro, a shareware program by Bill Goodman from Cyclos (San Francisco, CA).

Unlike PKZip, however, most file-level compressors on the Macintosh can work transparently, automatically compressing and decompressing files as they're opened and closed. In fact, some of these programs constantly scan the disk for uncompressed files and automatically compress them during idle times. Control panels let you decide whether all files on a disk should be compressed or only certain files and folders.

Real-time disk compressors are fairly new on the Mac. Unlike file-level compressors, they install themselves at the device-driver level, similar to disk compressors on the PC. There's one important difference, however: On the Mac, device drivers automatically load into memory from all storage media on the SCSI chain during startup or when a removable disk is mounted. In other words, the compression software is tied to the media, not to the machine. So a service bureau, for example, can read a compressed Syquest disk without installing the compression software on its system.

There are three driver-level products available for the Macintosh: eDisk from Alysis Software; Stacker from Stac Electronics (Carlsbad, CA); and TimesTwo from Golden Triangle Computers (San Diego, CA). TimesTwo replaces the disk's existing SCSI driver with a custom driver that handles compression. Both Stacker and eDisk work with the existing SCSI driver, wedging themselves between the driver and the operating system.

The main advantages of driver-level compressors are that they're less likely to conflict with system extensions (also called INITs), and they're capable of compressing more kinds of files—even the non-ROM portions of the Mac operating system in the System Folder. On the downside, driver-level compressors may be incompatible with other SCSI device drivers.

Macintosh compressors use the same basic compression methods as those on the PC, achieving the same average compression ratio of about 2 to 1. However, the Mac file system shares a limitation of DOS that prevents either platform from exceeding that ratio on large hard drives, even with files that are highly compressible.

The problem is that both DOS and the Mac address their allocation blocks (called clusters on the PC) with a 16-bit number, so the maximum number of blocks on a drive—regardless of its capacity—is 65,536. Therefore, drives larger than 512 MB cannot use a minimum block size of 8 KB or less, because there aren't enough addresses. On a 1-GB drive, the block size grows to 16 KB; on a 2-GB drive, it expands to 32 KB.

This results in wasted space on large drives, because a block can't hold more than one file, so even a tiny file requires a whole block. One solution is to partition large drives into smaller logical drives. Each logical drive can address 65,536 blocks, so the blocks can be smaller.

On a compressed drive, block sizes are variable, so less space is wasted. However, it's possible to run out of allocation blocks before running out of actual physical space. This happens when the overall compression ratio on a large drive exceeds 2 to 1. Individual files can be compressed at much higher ratios, of course, but the average compression ratio across the entire disk cannot exceed that limit.

For example, let's say you compress a 512-MB drive. Its virtual size (based on an average 2-to-1 compression ratio) is 1024 MB, or 1 GB, with 16-KB blocks. Now you start filling the drive with highly compressible files that achieve a ratio of 4 to 1. There's enough physical space on the drive to store 2-GB worth of those files, but you'll get a surprising disk-full error after 1 GB. Why? Because the drive is limited to 65,536 allocation blocks, and it would need 131,072 of those 16 KB blocks to store 2 GB.

In practice, this barrier is not a serious problem because the average compression ratio for a typical mix of files rarely exceeds 2 to 1. But as drive capacities continue to climb and compression software keeps improving, this limitation is sure to be removed in future versions of DOS and the Mac OS.

# You're In Control



## With OnView™

**Introducing the ViewSonic 17G** — the first in our "Graphics" line of monitors. It's unique! It's powerful! And it's affordable!

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

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

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

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

### COMPARITIVE CHART

	ViewSonic 17G	NEC 5FGe	NEC 5FGp
Screen Size	17"	17"	17"
Dot Pitch (mm)	0.28	0.28	0.28
Maximum Resolution	1280 x 1024	1024 x 768	1280 x 1024
Maximum Refresh Rate (Hz) Non-Interlaced	160	90	90
OnView Control	Yes	No	No
Color Matching	Yes	No	Yes
Power Saving	Yes	No	Yes
Non-Glare Screen	Yes	Additional Cost	Yes
Price	\$999	\$1,155	\$1,455

**ViewSonic®**  
*See The Difference!™*

20480 Business Parkway Walnut, CA 91789  
Tel: (800) 888-8583 or (909) 869-7976 Fax: (909) 869-7958

All products and brand names are registered trademarks of their respective companies.  
The EPA only promotes energy efficiency and does not endorse any particular company or product.  
Image courtesy of Autodesk Image Development Lab.



OnView™ Menu



ViewMatch™



ViewMeter™

Circle 150 on Inquiry Card (RESELLERS: 151).

as JPEG, which deliver compression ratios as high as 100 to 1, if you aren't too picky about quality.

Compression works better on some types of files than on others, and some files cannot be compressed at all. Compression algorithms depend on repeating patterns of data, so they don't work on files consisting of random data. Typical examples include encrypted files (the better the encryption, the more random the data) and files that have already been compressed (because randomization is a byproduct of compression; otherwise, you could repeatedly compress a file until it was squeezed down to a single byte).

Compression algorithms can be optimized for different data types. One method, RLE (run length encoding), works well on files with long strings of repeating

bytes. For example, if a portion of a graphics file has 100 white pixels in a row, an RLE compressor might save 1 byte that indicates "white" and another byte that indicates "100." The decompressor knows that the first byte represents the color and that the second byte tells how many pixels of that color will follow. Even though RLE is a good choice for compressing a graphics file, it would be a poor choice for a text file.

For that reason, some compressors analyze the uncompressed data to choose the optimal compression method. However, none of the real-time disk compressors, such as DoubleSpace, does this. Analysis takes time, and the extra compression isn't worth the performance hit.

Instead, DoubleSpace and other real-time disk compressors use a *sliding dic-*

*tionary* form of LZ compression, no matter what kind of data the file contains. To shrink a file, the compressor looks for repeating patterns. It then replaces each pattern with a pointer that refers back to an earlier occurrence of the same pattern, as well as a token that specifies the length of the pattern. Later, when the file is decompressed, the pointers and tokens are replaced with the original patterns.

Microsoft cites this example: "the rain in Spain falls mainly on the plain." Counting spaces and the period, this phrase normally requires 44 bytes. But it contains several repeating patterns, including *ain* and *the*. DoubleSpace would encode the phrase as follows:

```
the rain [3,3]Sp[9,4]falls
m[11,3]ly on [34,4]pl[15,3].
```

*continued*

## Data Loss: A Cautionary Tale

HOWARD EGLOWSTEIN

**C**atastrophic data losses caused by disk compression are rare, but definitely happen. Usually, it's not directly the fault of the compression software, but rather is caused by an unexpected interaction between various components of the system. A typical example is my recent experience with Microsoft's DoubleSpace and AddStor's DoubleTools running on a Toshiba T4600C laptop computer.

DoubleTools seemed like an interesting product—it provides finer control over the internal workings of DOS 6's compressed volumes and promises better disk repair capability than the standard utilities included with DOS. I'm not a fan of disk compression in general, but I make regular backups of my data and had nothing to lose.

I installed DoubleSpace on the Toshiba T4600C's 200-MB hard drive, then proceeded to install DoubleTools. As part of the installation procedure, you're given the option of sticking with the standard Microsoft DBLSPACE.BIN driver or replacing it with AddStor's enhanced driver. The enhanced driver gives DoubleTools better access to the internal guts of the compressed volume and allows it to analyze things more thoroughly. The AddStor manual recom-

mends using it, so I did. After installation, you must reboot to load the new driver.

Until this point, everything had gone well. As the Toshiba rebooted, however, the AddStor driver tried to examine my hard drives. It found drive C and then looked at drive D, which was actually Toshiba's PCMCIA driver for a fax modem card. Because the Toshiba driver also supports PCMCIA hard drives, it has to load as if it were a disk drive. I didn't have the PCMCIA drive installed, so accessing drive D caused a "Not ready reading drive D:" error. The DoubleSpace driver paused for quite a while during bootup as it dealt with this nonexistent drive.

I started Windows and loaded the DoubleTools configuration utility to tell it not to bother dealing with drive D. The utility's pick list recognized the two removable drives on the Toshiba (the floppy at drive A and the PCMCIA drive D). I selected drive D from the list. The screen went blank, but then displayed the following message: "Serious error occurred reading drive H:. Press any key to continue." The machine froze, and cycling the power was the only way to get it back.

When the machine rebooted, the DoubleSpace compressed volume was badly corrupted; no standard recovery tools could read it. The only fix was to refor-

mat the drive and reload everything. Just to make sure this wasn't a fluke, I tried the whole exercise again and got the same failure.

What happened? It's not exactly DoubleSpace's fault, and it is not really AddStor's fault, either. (DoubleTools did not expect to find a valid yet nonexistent drive.) Is Toshiba to blame? That depends on whether the problem was caused by the driver or the application's inability to handle a serious error. At press time, this issue was still uncertain.

Any way you look at it, the failure was catastrophic. If this hadn't been a review machine (and backed up at that), I could have lost a great deal of work simply by installing a tool designed to make using my disk safer. That's pretty scary.

There were at least three ways to resolve the problem: remove the fax modem and PCMCIA device driver; uninstall DoubleTools; or just give up on DoubleSpace altogether. Because the modem is handy, and using DoubleSpace without decent recovery tools seemed foolhardy, I decided to uninstall both DoubleSpace and DoubleTools.

*Howard Eglowstein is a testing editor for the BYTE Lab. You can reach him on the Internet or BIX at heglowstein@bix.com.*

# Why do they call it a dongle?



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

Sitting in front of his computer, drinking pots of coffee and smoking cartons of cigarettes, he'd write pages of code.

It took time. Years in fact. But he did it. He wrote the most powerful computer program in the world. Now came the hard part. Selling it.

## The Most Powerful Program in the World

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

So he sold a few. Only a few.

Back in Boston he waited. After a long year

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

 country and flew around the world he discovered everyone knew about his program. Everyone had it too.

## The Global Marketplace

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

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

## Call It What You Like

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

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

"Name it after you, Don!", urged his peers. So he did. Soon everyone was calling the key a dongle, after Don Gall — the lonely software developer who did what he had to do.

## You've Come A Long Way, Baby

Today, dongles are different. Fact is, they've come a long way. Leading the industry with security solutions, Rainbow Technologies has changed the face of hardware keys. They work with multiple applications, are programmable and network versions control concurrent usage. And they're always transparent to the end-user.

## Sentinel Family from Rainbow

Truth is, more and more developers are using keys. And the Sentinel Family is the most widely used in the world. In fact, over 6,000

developers use Sentinel from Rainbow. Why? They are simply the most effective, reliable and easy to implement keys on the market.

Learn more about securing

your software and how keys provide developers with extra value. Call for a free copy of "The Sentinel Guide to Securing Software." And see just how easy it is to

install a hardware key into your application in just minutes. Try it with our low cost Sentinel Evaluation Kit. Order one for your DOS, OS/2, Windows, Macintosh or UNIX based application.

And remember, when you need a dongle, you need Sentinel — the only dongle Don Gall would use.



CALL  
**800/ 852-8569**

FOR YOUR FREE GUIDE  
TO SECURING SOFTWARE

**SENTINEL**  
Securing the future of software

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

**RAINBOW**  
TECHNOLOGIES

9292 JERONIMO ROAD, IRVINE, CALIFORNIA 92718 • 714/ 454-2100 • fax 714/ 454-8557  
International offices are located in the United Kingdom, Germany and France.

Circle 134 on Inquiry Card (RESELLERS: 135).

Bracketed numbers represent pointers and tokens, so [9,4] tells DoubleSpace to replace the pointer (9) and token (4) with the four-character pattern that begins nine characters before the pointer.

The result: The compressed version requires 37 bytes instead of 44. That's not an enormous saving, but the method works much better on database files, whose fields are padded with lots of spaces, and on graphics files that have large areas of solid color. (The algorithm does not care whether the patterns of bytes represent ASCII characters or any other kind of data.)

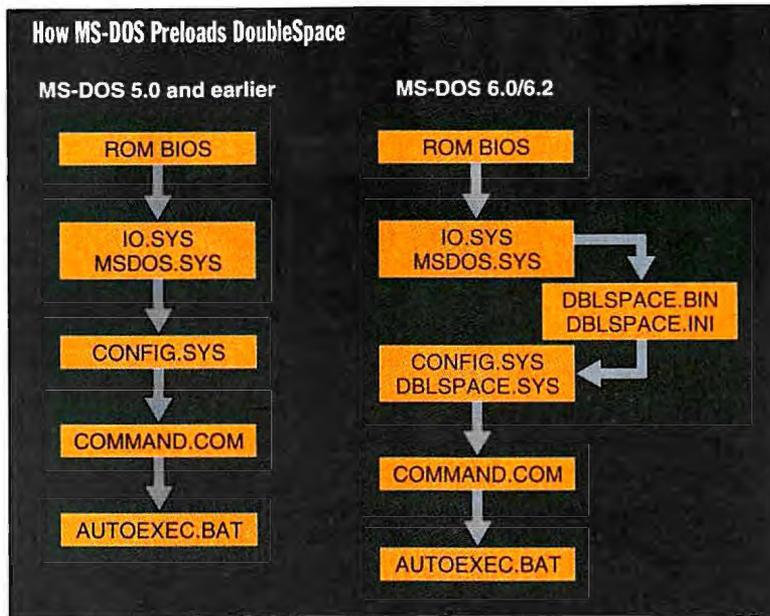
This method is known as sliding dictionary because the compressed data itself contains the "dictionary" of patterns that's later

used to reconstruct the file and because the compressor works its way through the file using a fixed-size sliding window. In other words, the compressor will not scan backward through the entire file to locate a matching pattern; it searches only a window of bytes that slides through the file during compression. The size of that window usually ranges from 2 to 8 KB. (DoubleSpace's sliding window is about 4 KB.)

These and other variables allow for some product differentiation, but in truth, no lossless disk compressor enjoys a knockout advantage in terms of compression efficiency or speed. Much more important is how the compression software interfaces with the operating system, how the compressed volumes are structured, and the quality of their diagnostic and repair utilities.

## Implementing Compression

To keep data compression as transparent as possible to the user (and to applications), it's best implemented as a background process that hooks into the normal file system and automatically compresses and decompresses files as they're saved on disk. If the compression software installs itself as a virtual drive on the system (similar to a logical partition), it can recede even further into the background. On PCs, however, that requires finding room in memory for yet another device driver and then protecting it from other drivers, rogue pro-



Before the release of version 6.0, MS-DOS loaded all device drivers from CONFIG.SYS. But DOS 6.0 has a modified IO.SYS file that automatically loads a device driver called DBLSPACE.BIN, which, in turn, calls a new configuration file named DBLSPACE.INI. Only then does CONFIG.SYS execute, loading any other device drivers, as well as a short program called DBLSPACE.SYS that relocates the DoubleSpace driver into upper memory. Stacker 3.1 is the only other real-time disk compressor that preloads in this fashion under MS-DOS.

grams, and territorial TSRs.

File-level compressors (e.g., PKZip) don't test the fragility of the DOS environment because they don't run in the background, and their compressed files don't appear any different to the system than do ordinary files. But real-time compressors must rely on a device driver to reroute all file I/O through their compression routines.

Before MS-DOS 6.0, most third-party compressors used the same method employed for years by RAM disks, which are also virtual drives: They loaded the device driver from the CONFIG.SYS file during bootup. However, this approach has a few disadvantages. To swap drive letters so that the compressed drive appears as drive C, both the virtual drive and the physical drive need duplicate copies of CONFIG.SYS, AUTOEXEC.BAT, and all files they reference. This, in turn, leads to synchronization problems when you make any changes to the files.

Another potential problem is the competition for memory. If too many device drivers and TSRs load into conventional memory (i.e., the first 640 KB of RAM), some MS-DOS programs—particularly games—will not have enough memory to run. If you modify the CONFIG.SYS file to load the compressed drive's device driver into upper memory (i.e., the area above 640 KB and below 1024 KB), it may conflict with other device drivers or

TSRs competing for the same territory.

## Preloaded Drivers

Digital Research's DR-DOS 6.0 offered a novel solution: A new system file called DCONFIG.SYS that booted before CONFIG.SYS. SuperStor's device driver could load from DCONFIG.SYS immediately after the memory manager, mount the compressed drive, and then chain to CONFIG.SYS on the compressed drive before any other TSRs or drivers tried to grab memory. In other words, the compression software got a head start.

With the release of MS-DOS 6.0, Microsoft achieved basically the same result with a somewhat different approach. Previous versions of MS-DOS couldn't load a device

driver before CONFIG.SYS, but MS-DOS 6 has a modified IO.SYS boot file that automatically preloads a device driver called DBLSPACE.BIN before CONFIG.SYS executes.

DBLSPACE.BIN reads a new configuration file called DBLSPACE.INI, mounts any compressed drives it finds listed there, assigns the appropriate drive letters, and only then passes control to CONFIG.SYS. This happens before any other device drivers or TSRs get a chance to load from CONFIG.SYS or AUTOEXEC.BAT. The CONFIG.SYS file still needs to run a program called DBLSPACE.SYS that relocates DBLSPACE.BIN from conventional memory to upper memory. Even if DBLSPACE.SYS doesn't run, or if the entire CONFIG.SYS file is trashed, DBLSPACE.BIN still preloads and mounts the DoubleSpace drive.

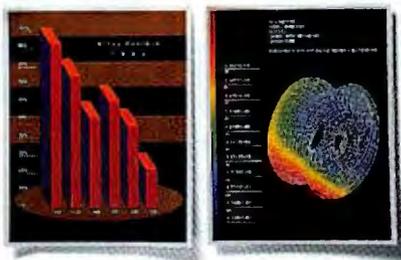
Once the compressed drive is mounted, it appears to the system as a virtual drive. All file I/O happens normally, except the device driver intercepts the I/O to compress and decompress files as they're saved and loaded from the new drive.

Besides DoubleSpace, Stacker 3.1 is the only other compressed-drive product for MS-DOS that preloads its driver before CONFIG.SYS. Earlier versions of Stacker used the former method of loading the device driver within CONFIG.SYS. SuperStor and Vertisoft System's DoubleDisk Gold still load their drivers from



# *After all these years, isn't it time you got the big box of crayons?*

There comes a time in your life when you just have to stop and say, I want all the colors and I want them now. If you have reached that point, congratulations: you're ready for the new Tektronix® Phaser™ 300. We've taken the top-selling printer in its market and made it better. For starters, we've improved the Phaser 300's image quality. So what was once great color is now really great color. Crisper, richer and more detailed. And because we know you don't like sitting around watching paint dry, we've made it faster. Now you can spit out up to an 11"x 17" full bleed image on nearly any kind of paper in two minutes.



*The new Phaser 300 can print a full bleed 11"x 17" page on nearly any kind of paper in two minutes. Think fast.*

Which is twice as quick as its award-winning predecessor. On top of all this, the Phaser 300 gives you PANTONE® approved color matching and connects to any Mac, PC or workstation. Color me flexible. For a free Phaser 300 print sample or the name of your nearest Tektronix dealer, call 800/835-6100, Department 33J. For faxed information, call 503/682-7450 and ask for document #5002. You'll be amazed at what the big box of crayons can do. Of course, the Phaser 300 may not come with its own built-in sharpener, but, hey, with color that looks this good, you can forget about things ever getting dull.

**Tektronix**

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

Circle 144 on Inquiry Card.

CONFIG.SYS when running under DOS.

However, SuperStor/DS—a new DoubleSpace-compatible version of SuperStor included with IBM's PC-DOS 6.1 (which will soon be the only version of SuperStor available)—preloads its driver before CONFIG.SYS when running under IBM's PC-DOS 6.1, which has the same preload capability as MS-DOS 6.0. And the latest version of DR-DOS—now called Novell DOS 7 after Novell's acquisition of Digital Research—comes with Stacker 3.1 instead of SuperStor and also adopts the preload technology.

IIT's XtraDrive adds still another twist. Although XtraDrive loads a device driver from CONFIG.SYS like SuperStor and DoubleDisk Gold, it handles file I/O a bit differently. When you install XtraDrive on a hard disk, it relocates the DOS boot files elsewhere on the drive and substitutes its own custom boot files in the boot sector. As a result, XtraDrive boots first when you switch on the machine, and DOS boots immediately afterward. That allows XtraDrive to intercept calls to BIOS INT 13 (disk I/O) and redirect the I/O to its own compression routines.

Because XtraDrive still relies on CONFIG.SYS to load its device driver, it is as vulnerable as SuperStor and DoubleDisk Gold to CONFIG.SYS problems. If the critical command in CONFIG.SYS is accidentally deleted or the CONFIG.SYS file is trashed or the device driver is somehow corrupted, the compressed drive won't mount. Users have not lost any data at that point, but they will probably be alarmed that their compressed drive seems to have vanished.

The compressed drive is still there, of course, but it's not recognized by DOS until the problem is corrected. In a worst-case scenario, an unsuspecting user might panic and do something that actually destroys the data (e.g., assume the data is already lost, reformat the hard disk, and re-install the compression software). For these reasons, the ability to preload a device driver independently of CONFIG.SYS is considered an important safety feature of real-time disk compressors.

### Data Integrity

Other safety factors come into play after the device

driver loads into memory, and DOS mounts the compressed drive. Compression products take significantly different approaches in the way they simulate a virtual drive and organize their internal structures.

For example, DoubleSpace, Stacker, SuperStor, and DoubleDisk Gold all simulate a virtual drive by creating a single, large file on the uncompressed host drive. (Microsoft calls it a compressed volume file, or CVF.) In other words, the hundreds of files stored on your compressed drive actually appear on the physical drive as a single file.

It is not just an enormous jumble of data, of course—the file mapping is handled internally by the compression software. (XtraDrive, again, is the exception; it stores compressed files in the normal fashion.)

Some people fear that storing everything in one massive file compromises data integrity. However, a number of safeguards and cross-checks are built into the compression architectures to prevent you from losing information even if the CVF is corrupted. What's most important is not whether compressed data is stored in a CVF or in discrete files, but rather the integrity of the compression architecture and how readily you can diagnose and repair common problems with disk utilities.

This is the main battleground on which compression vendors are waging warfare. It also accounts for much of the controversy over DoubleSpace.

### Cluster Bombs

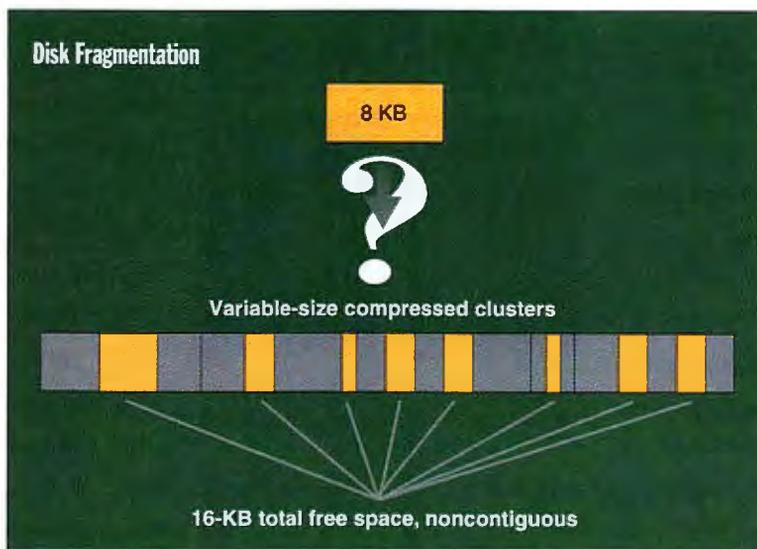
For instance, a significant difference among DoubleSpace, SuperStor, DoubleDisk Gold, and Stacker 3.1 is how they store compressed data. All handle data in 8-KB chunks that are compressed to fit variable-size clusters. A cluster may contain 1 to 16 sectors, each 512 bytes long. But only Stacker can subdivide a cluster and store the pieces in scattered locations on the disk. The others must store a cluster in sectors that are contiguous.

This can lead to problems if the compressed drive becomes badly fragmented. Fragmentation inevitably happens over time as you save, delete, and resave files on a disk. It happens faster under certain conditions, but gradually all disks become fragmented, especially if they're nearly full. Eventually, there's not enough contiguous free space to save an entire file, so DOS has to split up the file and store the clusters in various places around the disk.

Other than slowing down disk I/O, fragmentation isn't a serious problem on an uncompressed drive, because the clusters are always a fixed size. As long as DOS can find enough free clusters, no matter where they're located, it can save the file. If there aren't enough free clusters, DOS returns a disk-full error.

On a compressed drive, however, things are a little more complicated. (Well, a lot more complicated.) To begin with, the actual size of a cluster varies in direct proportion to the compression ratio. The goal is to more efficiently use the disk space that DOS often wastes.

Because uncompressed DOS disks have fixed-size clusters (usually 8 KB), a tiny five-line batch file would still occupy a whole cluster. On a compressed drive, that file could be stored in a one-sector cluster (512 bytes), thus saving 7.5 KB of disk space. If you save an 8-KB file on a compressed drive and if the compressor achieves a 2-to-1 compression ratio, the resulting file needs only 4 KB and occupies a cluster of eight sectors (8 times 512 bytes equals 4 KB). The best possible case is a 16-to-1 compression ratio (yielding a one-sector cluster, 512 bytes). The worst case is a 1-to-1 ratio—no compression (yielding a 16-



When a compressed drive becomes badly fragmented, it may cause puzzling disk-full errors, even when there is enough free space to store the file. This happens when a piece of data won't fit into any of the free but noncontiguous variable-size clusters. In this case, an 8-KB chunk of uncompressible data can't be saved on the drive, even though there's 16 KB of space available. The PC version of Stacker can avoid this dilemma by subdividing the cluster and storing the pieces in noncontiguous locations.

IBM TCP/IP for  
DOS/Windows or OS/2.  
Offer expires Feb. 17, 1994!  
1 800 IBM-CALL, ext. S83



# This offer really stacks up.

IBM TCP/IP is a robust implementation of this standard protocol stack. And it's the perfect building block for creating client/server environments linking a wide number of both IBM and non-IBM platforms. Now if you order before Feb. 17, 1994, you'll get the IBM TCP/IP 2.0 Base Kit for OS/2® or the IBM TCP/IP 2.1 Base Kit for DOS/Windows™ for just \$150 (regular price is \$230) and additional copies for \$130.

The DOS/Windows Base Kit incorporates all standard applications (Telnet, Mail, FTP, LPR, SNMP) with easy-to-use GUIs. Other kits include NFS,® NETBIOS and program development support including the Windows Sockets API. The OS/2 Base Kit also offers all the standard applications as well as new

features like Network News, CID support for remote installation, and Workplace Shell™ Integration. Additional kits are available for X Window System,™ DOS/Windows Sockets applications support, NFS, NETBIOS and program development support.

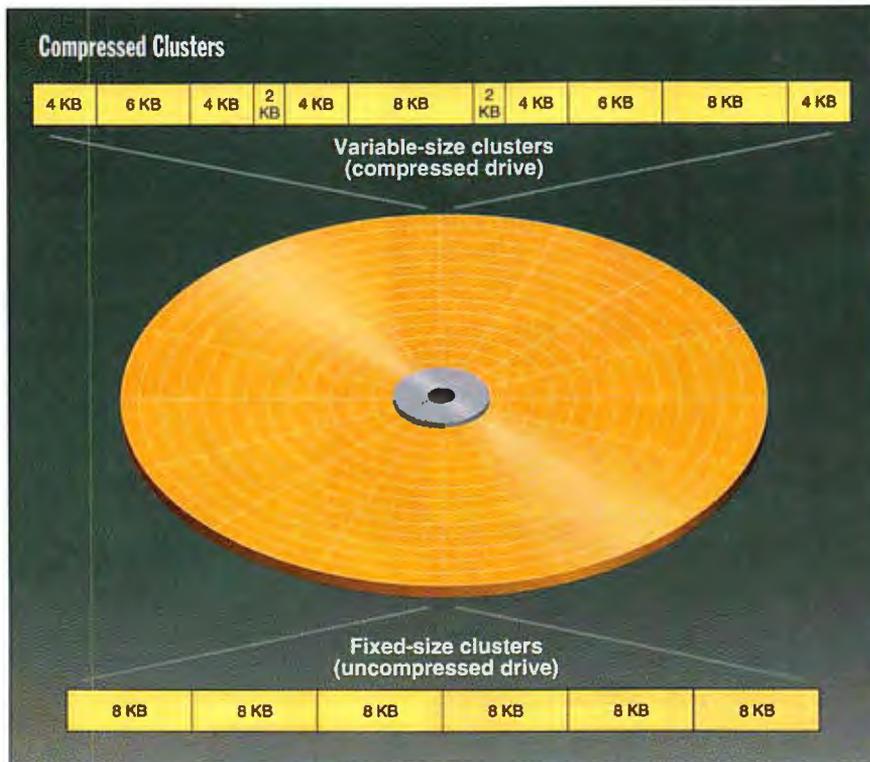
Power, flexibility and value. The reasons for buying IBM TCP/IP keep stacking up. So call 1 800 IBM-CALL, ext. S83, and order today! It's a smart way to spell interoperability.

*Making networks work*

**IBM®**

IBM and OS/2 are registered trademarks and Workplace Shell is a trademark of International Business Machines Corporation. NFS is a registered trademark of Sun Microsystems, Inc. Windows is a trademark of Microsoft Corporation. X Window System is a trademark of Massachusetts Institute of Technology. ©1993 IBM Corp.

Circle 103 on Inquiry Card.



**Uncompressed DOS drives** normally store data in fixed-size clusters of 8 KB. (Macintosh clusters are also fixed size, but the size varies depending on the drive capacity.) Compressed drives store data in clusters that vary in size according to the compression ratio. A cluster may be as small as 512 bytes (assuming a 16-to-1 compression ratio) or as large as 8 KB (if the data is uncompressed). The average is about 4 KB (2-to-1 compression).

sector cluster, 8 KB).

OK, so far. But what if the compressed drive is badly fragmented and DOS can't find enough contiguous sectors to store a cluster? Stacker 3.1 will break up the cluster into smaller pieces (known as *extents*) and fill in the holes. DoubleSpace, SuperStor, and DoubleDisk Gold can't do this. Instead, they return a disk-full error—even if there's actually enough free space on disk to save the file.

The problem gets worse if you're trying to save data that can't be compressed. Perhaps the file is encrypted or has already been compressed with PKZip or is being downloaded as a GIF (CompuServe's compressed file format for graphics). The 8-KB cluster can't be compressed any further, so it needs 16 contiguous sectors (16 times 512 bytes equals 8 KB). Even if the compressed drive has megabytes to spare, DoubleSpace, SuperStor, and DoubleDisk Gold can't save the file if they can't find 8 KB of contiguous free sectors.

In theory, the compressed drive could have hundreds of megabytes free and still return a disk-full error because of a single cluster that won't fit in the holes. In reality, could a drive actually become that severely fragmented? Not likely, in normal use. But Blossom Software (Cam-

bridge, MA), which sells a diagnostic utility called DoubleCheck, gives away a small program called Bust that demonstrates the problem.

Bust deliberately fragments a DoubleSpace drive and then attempts to save a file that won't fit within the clusters. (Don't try this on a drive with important data.) According to Alan Feuer, director of software development at Blossom, DOS 6 sometimes won't return a disk-full error but, instead, reports that the file was successfully saved. Result: a trashed file. Feuer says Microsoft fixed the problem in DOS 6.2.

Microsoft denies such a bug exists, but those who are curious can find Bust in the IBM Forum on CompuServe. (Microsoft removed it from the MSDOS Forum.)

Of course, you can avoid all these problems by defragmenting the compressed drive (e.g., using either DOS's DEFRAG or a third-party utility) on a regular basis; however, some users are not very attentive to system maintenance. What they need is some kind of background defragmenting that functions as transparently as background compression. AddStor sells a product called DoubleTools for DoubleSpace that—among other things—provides this important function.

## FAT Structures

Stacker drives get fragmented just as easily as other compressed drives, but since they can subdivide clusters, there's less chance you'll encounter a mysterious disk-full error. The PC version of Stacker (but not the Macintosh version) can do this because it has an additional mapping table that keeps track of the scattered extents. The extra table is an extension of the FAT (file allocation table), which DOS uses to allocate clusters.

Here's yet another area where compression products differ. They each take a slightly different approach to how they organize and verify the integrity of the FAT and related mapping structures. Naturally, each vendor claims its approach is the most reliable.

If a disk's FAT gets corrupted, DOS won't know which clusters of data belong to which files. If you can't repair the damage, the result could be lost data. For safety, therefore, DOS normally keeps two copies of the FAT on an uncompressed disk. Stacker and XtraDrive also keep two FATs on their compressed disks. DoubleSpace, SuperStor, and DoubleDisk Gold keep only one FAT.

The argument for keeping two FATs is redundancy: If one FAT gets trashed, a repair utility can try to restore it with information from the second FAT. The argument for keeping one FAT is simplicity: If two FATs somehow get out of synchronization, which one is correct?

This could happen if your computer crashes or the power fails while saving a file on a compressed drive. The disk I/O might be interrupted after DOS has updated only one copy of the FAT. It's even more likely if you're using writeback disk caching, because the FAT update could be delayed a few seconds. (One of the changes between MS-DOS 6.0 and 6.2 is that SmartDrive's writeback caching is now turned off by default.)

Microsoft contends that not only are two FATs unnecessary, but that the extra mapping table Stacker uses to subdivide clusters adds yet another layer of complexity to an already complex scheme. In fact, compressed drives from all vendors have internal mapping structures that are much more complex than ordinary drives because they have to keep track of such things as variable-size clusters and compression ratios. DoubleSpace, for example, supplements the normal FAT with a BitFAT and an MDFAT. Stacker's mapping table for extents adds a third level of indirection beyond the FAT and the variable-size cluster mapping.

That's too complicated, says Benjamin

# SO ADVANCED IT EVEN TURNS ITSELF OFF.

**N**anao, the technical leader in monitors has done it again. In addition to being the top choice of today's CAD/CAM, DTP and Windows users, Nanao's award-winning FlexScan monitors now have a remarkable energy-saving system – PowerManager.

PowerManager works with all green computer systems including VESA DPMS (Display Power Management Signaling). But users don't have to own a new green computer in order to take advantage of the PowerManager to save energy. Our PowerManager works with any existing PCs with a screen saver software, including Windows 3.1 and After Dark. Activating when the blank screen of the screen saver appears, PowerManager cuts operating power to less than 8% of total consumption. It also automatically powers the monitor down

to a stand-by mode when the computer is turned off. The PowerManager can save users as much as \$63 per year on utility bills (Source: E Source). PowerManager has placed Nanao at the forefront of the Environmental Protection Agency's Energy Star Program.

PowerManager is now the standard feature of our 15", 17", 20" and 21" monitors. All Nanao energy-saving monitors feature superior Invar Shadow Mask and Trinitron CRTs with non-flicker ultra-high resolution. Their ergonomic features include compliance with MPR-II/TCO low radiation emission standards and anti-reflective treatments. Best of all, they can power down. So when you're not working, neither are they.

Nanao FlexScan monitors. Intelligently designed. Incredibly useful. And now, built to help protect our environment by reducing energy consumption.

\*The Energy Star emblem does not represent EPA endorsement of any product or service.



September 14, 1993  
FlexScan F550i-W



FlexScan F550i

NANAO USA CORPORATION  
23535 Telo Avenue, Torrance, CA 90505  
(310) 325-5202

## NANAO®

Superior In Every Detail

Circle 119 on Inquiry Card (RESELLERS: 120).

1-800-800-5202

## PC DISK-COMPRESSION SOFTWARE COMPARISON

PRODUCT	PRELOADED DRIVER <sup>1</sup>	COMPRESSED VOLUME FILE <sup>2</sup>	DIVISIBLE CLUSTERS <sup>3</sup>	COMPRESSED FATS <sup>4</sup>
Vertisoft DoubleDisk Gold	No	Yes	No	1
Microsoft DoubleSpace	Yes	Yes	No	1
Stac Electronics Stacker	Yes	Yes	Yes	2
AddStor SuperStor DS	Yes <sup>5</sup>	Yes	No	1
AddStor SuperStor Pro	No	Yes	No	1
IIT XtraDrive	No	No	No	2

<sup>1</sup> The device driver for the compressed drive loads during bootup before CONFIG.SYS

<sup>2</sup> The compressed virtual drive appears on uncompressed host drive as a large, single file

<sup>3</sup> Compression software can subdivide a cluster to store data in noncontiguous sectors

<sup>4</sup> Number of file allocation tables on the compressed drive

<sup>5</sup> PC-DOS 6.1 only

W. Slivka, development leader for MS-DOS. Slivka says third-party tool vendors complain that Stacker's architecture is more difficult to support. While true, that hasn't stopped the tool vendors. Most of the major diagnostic and repair utilities support both DoubleSpace and Stacker, although there's less support for SuperStor, DoubleDisk Gold, and XtraDrive, which don't command as much market share.

All disk compressors also come with their own utilities, and these tools are tailored for their unique compression architectures. Often, they try to turn complexity into an advantage by performing extensive cross-checks between the various mapping structures. XtraDrive, for example, compares both copies of the compressed drive's FAT during bootup. If they don't match, the user is advised to run a program called VMU (Volume Maintenance Utility). VMU tries to figure out which FAT is correct by checking file links, mapping tables, and free clusters.

### Strange Interactions

Anytime something as complex as real-time disk compression is introduced into an environment as unruly as DOS, there are bound to be unforeseen consequences. When a mysterious problem can be traced at all, often it's not directly caused by the compression software itself, but rather by interactions among various elements of the system (see the text box "Data Loss: A Cautionary Tale" on page 64).

Microsoft has compiled a list of software that may not work on a DoubleSpace drive, including protected copies of Lotus 1-2-3 release 2.01, Informix relational database, MultiMate 3.3/4.0, the DOS version of Quicken, Movie Master 4.0, Tony La Russa Baseball II, Empire Deluxe, Links, Ultima, and others. Some of these programs won't run on any compressed drive, and the reasons vary widely, ranging from

tricky copy-protection schemes to their handling of temporary files.

Different versions of the ROM BIOS are known to cause problems, too. Some BIOS chip sets don't properly handle an interrupt call made by DBLSPACE.BIN during bootup, resulting in stack corruption. The DOS 6.2 version of DBLSPACE.BIN doesn't call this interrupt.

Writeback disk caching has also been singled out for blame. Some users are in the habit of switching off their computers immediately after quitting an application or even without quitting. If the disk cache isn't flushed before the power goes down, open files may not be closed properly, and the FAT may not be updated. It's a small problem that can snowball, eventually corrupting multiple files. DOS 6.2 now makes sure the cache is flushed before redisplaying the DOS prompt on the screen, but what DOS really needs is a controlled shutdown procedure like that of Windows NT, Unix, and the Mac.

Another interaction is possible with the MS-DOS FORMAT command. Many users scan their hard disks with utilities that check the media for surface errors and then mark those bad sectors so that they'll never be allocated to files. The bad sectors are deallocated in the FAT. But what most people don't know is that FORMAT rewrites the FAT and may reset the bad-sector flags, thus freeing those sectors for allocation to files.

This little detail stumped some users who backed up and reformatted their hard drives before installing MS-DOS 6 and DoubleSpace. Their idea was to clean off the disk and reduce the considerable amount of time it can take to compress a crowded drive. Ironically, it's the kind of thing only a power user would think of; it probably wouldn't occur to a casual user.

But if they didn't immediately follow the reformat with another disk scan, there's a chance at least one file would end up in

a sector previously marked as bad. Sometimes that file happened to be the DoubleSpace CVF. And what happened next depended on the kind of data stored in that sector. If it was part of an executable file, the program would probably crash. If it was part of a data file, information could be lost. Either way, the hapless user was in the dark.

Why wasn't this problem discovered before MS-DOS 6 and DoubleSpace? After all, the FORMAT command has worked the same for years. But apparently, it wasn't noticed or considered important until data compression made the environment more precarious.

Fortunately, Microsoft says it has changed the FORMAT command in DOS 6.2 so it doesn't reallocate bad sectors marked in the FAT. Also, a new utility in DOS 6.2 (ScanDisk) automatically checks the drive for bad sectors before installing DoubleSpace.

Only a tiny minority of users would be affected by something like this, but that's potentially a lot of people when multiplied across the huge installed base of MS-DOS. In fact, MS-DOS 6.0 and DoubleSpace have inspired a whole cottage industry of diagnostic programs, fix-it tools, and free advice on public networks.

Touchstone Software (Huntington Beach, CA), which sells a disk utility called CheckIt Pro, inadvertently upset Microsoft by posting a free program on CompuServe last summer that scans a hard disk for bad sectors. Touchstone was among the first to identify the FORMAT problem. Company president Shannon Jenkins says her small company got in hot water with Microsoft, but she added, "I think the release of DOS 6.2 has borne us out...the things we talked about back in June have now shown up in DOS 6.2."

Microsoft was the first company to encourage users to install data compression without taking security measures. "Just press Return, and you'll get data compression and writeback caching and lots of other stuff," says Jenkins. "Microsoft should have encouraged users to take a more cautious approach."

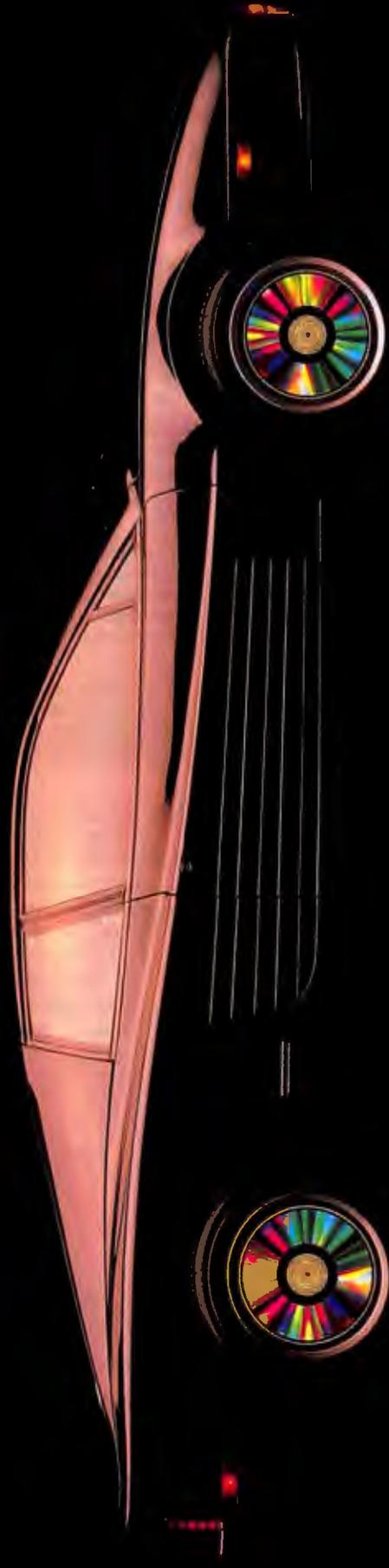
### Hardware Compression: Full Circle?

Microsoft has a golden opportunity to clean house with the upcoming release of Windows 4.0 (code-named *Chicago*). As a major revamping of the PC environment, Windows 4.0 could sweep away years of old code and build a new foundation that's designed from the ground up to accommodate such features as data compression.

However, there's another possibility: By submerging compression even deeper

P I N N A C L E

Drive the Best.



T H E O P T I C A L S T O R A G E C O M P A N Y

19 TECHNOLOGY • IRVINE, CA 92718 • USA • (800) 553-7070 • INT'L (714) 727-3300 • FAX (714) 727-1913

Circle 128 on Inquiry Card (RESELLERS: 129).

than the operating system, it could be made even more transparent and foolproof. What's deeper than the operating system? The hardware.

Once again, hardware-based data compression is an old idea. Back in the days when 8086- and 286-based PCs were the norm, there was a market for plug-in ISA boards that sat on the I/O bus, compressing and decompressing data on its way to and from the hard drive. The compression algorithms were hard-wired into high-speed chips. Real-time compression couldn't be done in software back then because CPUs weren't fast enough. Not until speedy 386 microprocessors became available could software-based compressors work in real time without noticeably affecting system performance. And the plug-in boards became obsolete because they were constrained by the slow speed of the ISA bus.

Hardware-based compression still survives in tape backup units, where it's so reliable and transparent that users scarcely know it's there. In fact, the widespread QIC (quarter-inch cartridge) compression standard for tape backup originated at Stac in the mid-1980s.

Now Stac and other companies are taking another look at hardware compression. The potential advantages are many: Better integration with the system; more transparency to users; greater compression ratios; improved system performance; and, perhaps, faster networking.

Speedy local buses such as VL-Bus and PCI (Peripheral Component Interconnect) are appearing in more new PCs, thus solving the ISA constraint. Hardware compression would require little or no installation or intervention by the user. Greater compression ratios are possible because high-speed compression chips can use more complex algorithms. They also free the CPU for other tasks and don't occupy memory, as software-based compressors do. Finally, by keeping the data compressed as it moves through the computer and over networks, hardware-based solutions can dramatically improve overall system performance.

### The Future of Compression

What kinds of performance gains are possible? Stac says it already has a prototype VL-Bus card that compresses data 20 percent to 50 percent faster than software-based compressors and uncompresses 10 percent to 30 percent faster. But that's just a start.

Software compressors currently work at about 1 MBps on a 66-MHz 486, and about 2 MBps on a Pentium. By next year, Stac says it will have compression chips capable

### Safety Tips for Disk Compression

- If you're using MS-DOS 6.0, you should upgrade to 6.2.
- Before installing compression, prepare your hard disk by cleaning off all unwanted files and then running a defragmenter and a thorough surface test. (This may take a few hours.)
- Back up the hard disk, just in case.
- Read the installation instructions carefully, especially any warnings about disabling incompatible TSRs or other programs.
- After installing compression, be conscientious about system maintenance. Regularly run a defragger and any diagnostic utilities that came with the product.
- Consider buying a good third-party diagnostic/repair utility to supplement the standard utilities.
- Try to avoid completely filling the compressed drive.
- Avoid saving encrypted files or files that are already compressed (e.g., ZIP, ARC, and GIF) on the compressed drive. They can't be compressed any further, and they'll load faster from an uncompressed drive.
- Hard disk space currently costs about a dollar per megabyte; if you can afford to upgrade and your system has room to expand, it's still the best solution.

of 10 to 20 MBps; in two or three years, 50 to 60 MBps. Of course, CPUs will get faster, too, but not anywhere near that pace.

The compression chips could be built right onto the motherboard and would add about \$100 to the street price of a computer, according to Stac. They'll probably show up first in high-end systems.

Last year, Stac made a deal with Novell to license the Stacker compression technology for use in Novell DOS 7 and all networking software. "Stac's vision is that data should need to be compressed only once," says John Bromhead, Stac's vice president for marketing. "After it's compressed, it should stay compressed whether it's transferred to disk or tape or across a network or through the system or whatever."

That's also IBM's vision. IBM Microelectronics is introducing a series of compression chips that couple directly to the CPU. According to Ted Lattrell, development manager, the first chip already compresses data at 40 MBps, and future versions could hit 100 MBps. Lattrell says the chips have already attracted interest from PC and workstation vendors, who are planning to introduce systems later this year or in early 1995.

"Once it happens—once compression

is hard-wired into the first system—there's no going back," says Lattrell. "A system without built-in compression would be at a disadvantage in the marketplace. I think hardware compression will alter the way data is represented inside computers for years to come."

Indeed, IBM is researching the possibility of putting ultraspeed compression chips on the CPU's memory bus. That would do for RAM what disk compressors do for hard drives—effectively double the computer's main memory.

Beyond that, it's possible that compression chips will eventually be integrated within the CPU itself, just as math coprocessors migrated to CPUs on the 486DX and 68040. Today's 0.8-micron process technology makes about 625,000 gates available on a chip, and IBM's compression engine requires only 75,000 gates. Soon, 0.5-micron processes will enable about 1.3 million gates, and IBM hopes to shrink the compression engine down to only 40,000 gates. That makes built-in compression a real possibility for high-end microprocessors, such as the PowerPC 620 under development by IBM, Motorola, and Apple.

One drawback to hardware compression is that it creates a problem when you transfer files over a network or by removable disks to systems that don't have the same compression hardware. A similar problem exists with software compression, and it's usually solved by including a decompression driver with the file or the media.

A more important consideration is that hardware compression, although an old idea, will nevertheless be as new to most of today's users as software compression was before DoubleSpace.

"When you stick this hardware compression into the system, people are going to wonder how it affects their software-based compression," says Phil Devin, vice president of storage technologies for Dataquest (San Jose, CA). "Do their compressed files get compressed again? Is there a conflict? Here comes one more level of uncertainty that's going to be an inhibiting factor at first."

Devin recently wrote a newsletter debunking the idea that data compression of any kind is a free lunch—an idea that particularly caught hold when Microsoft started bundling DoubleSpace with DOS 6. "It's not something for nothing," he says. "It's something that takes work." ■

*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.*

# Some Magic Words to Help Software Developers Increase Their Revenues

**"Aladdin's HASP gives our customers the key to protect their investment in software development."**

David Asia, CEO of Magic Software Enterprises Inc., a world leader in Application Generation software. Listed by *Forbes* as one of the 50 fastest growing companies under \$500 Million.

In every successful software product there is a spark of magic. That magic brings together the ingenuity, skill and years of hard work you've invested in developing something unique and valuable.

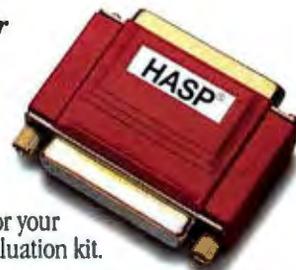
Trouble is, the worldwide epidemic of software piracy threatens your investment. By draining potential revenues, the illegal use of software dramatically reduces your profit margins.

Aladdin's business is helping software companies protect their products – and their profits.

Since 1984, over 8,000 developers in more than 60 countries have chosen **HASP®** – the Professional Software Protection System – to increase their revenues.

**HASP®** delivers the highest level of security for developers, without inconveniencing legitimate users. Experts recognize its design as the most technologically advanced software protection product on the market.

That's *our* magic.



Call now for your HASP® evaluation kit.

## ALADDIN SOFTWARE SECURITY INC

**North America**  
The Empire State Building  
350 Fifth Avenue, Suite 7204  
New York, NY 10118, USA  
Tel: (800) 223 4277  
212-564 5678  
Fax: 212-564 3377

**International Office**  
**Aladdin Knowledge Systems Ltd.**  
15 Beit Oved St., Tel Aviv, Israel  
P.O.Box 11141, Tel Aviv 61110  
Tel: 972-3-5375795  
Fax: 972-3-5375796  
AppleLink: ALADDIN.KNOW  
CompuServe: 100274,434

**France**  
**Aladdin France SA**  
Tel: 33 1 40 85 98 85  
Fax: 33 1 41 21 90 56

© Aladdin Knowledge Systems Ltd. 1985-1994 (1.94)

**SEE US AT:**

IT Forum, Booth K84, Hall 1, Paris France, February 1994  
Software Development, Booth 1131, San Jose CA., March 1994  
CeBIT, Booth B55, Hall 18, Hannover Germany, March 1994



- Australia Conlab 3 8985685 ■ Belgium Akkermans 3 2338826 ■ Czech ATLAS 2 766085 ■ Chile Micrologica 2 222 1388
- Denmark SC Metric 42 804200 ■ Finland ID-Systems 0 870 3520 ■ Germany CSS 201 7498640 ■ Greece Unibrain 1 6856320
- Holland Akkermans 45 241444 ■ Italy Partner Data 2 26147380 ■ Japan Athena, 3 58 213284 ■ Korea Dae-A 2 848 4481
- New Zealand Training, 4 5666014 ■ Poland System 61 475065 ■ Portugal Futurmatica 1 4116269 ■ South Africa D Le Roux, 11 886 4704
- Spain PC Hardware. 3 4493193 ■ Switzerland Opag 61 7112245 ■ Taiwan Teco 2-555 9676 ■ Turkey Mikrobeta 4-4677504

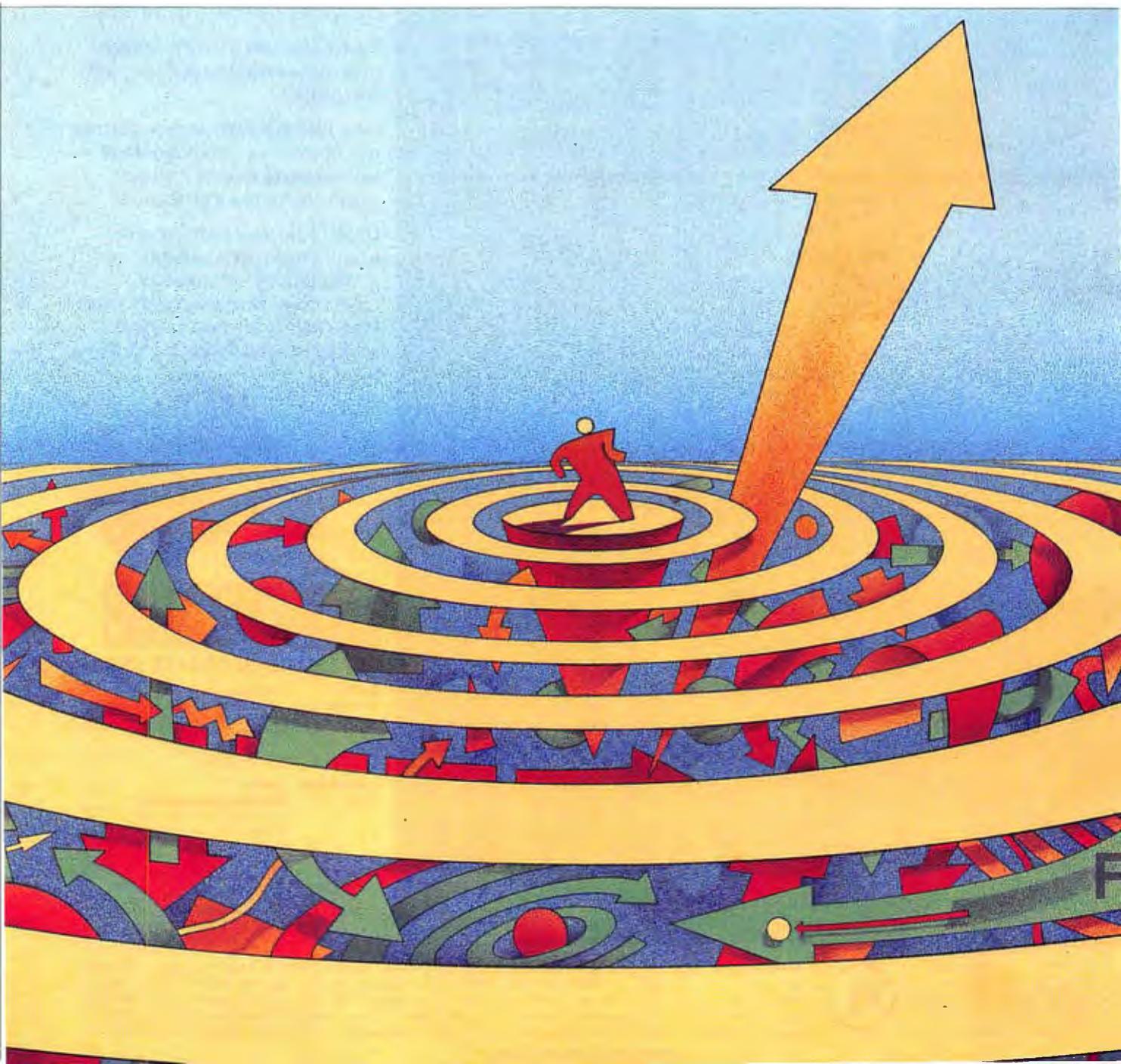
Circle 65 on Inquiry Card.

**State of the Art**

# TODAY'S COMPILERS

**It's a brave new world for compiler makers. New CPUs, new operating systems, and demands for programmer productivity call for compilers that produce faster code—and produce code faster.**

**FRANK HAYES**



A few years ago, compilers seemed simple enough. Steadily improving optimization techniques meant that each year's compilers would generate code just a little bit faster than last year's models. Most companies making compilers, and most programmers using them, focused on a single computing platform—PCs, Macs, Unix workstations, or IBM mainframes. And to a large degree, a compiler was just a compiler.

Those days are now gone. New CPUs including the Intel Pentium, the IBM/Apple/Motorola PowerPC, and the DEC Alpha are suddenly major targets for software development. Software developers now need easier ways to write for DOS, Windows, Mac, OS/2, Windows NT, Unix, and other operating systems—if possible, all at the same time.

And the compiler is now just one part of a complete development environment designed to help create clean, fast code. "Managing the sheer complexity of the development process is a big problem," says Michael Hyman, business unit manager for languages at Borland International. Management today must coordinate the efforts of multiple, large, perhaps geographically dispersed project teams, when one group may be working on a feature upgrade and another doing a cross-platform port of the same application. Code testing, source code control, and limitations of development tools must be addressed head-on.

Compiler vendors say they're up to the challenge. They have sophisticated products today and even more complex plans for the future, all aimed at improving programmer productivity on an ever-widening selection of platforms. In the world of software development, programming demands are becoming more complicated and programming schedules shorter. Programmers need all the help they can get.

### Shock Wave

The biggest shock for most programmers is the sudden requirement that they support a wave of new processors. For nearly a decade, two CPUs dominated mass-market software: the Intel 80x86 family for the PC and the Motorola 680x0 for the Mac. Expert programmers could fine-tune code at the assembler level to optimize code.

No more. Apple's next generation of Macs will use the IBM/Apple/Motorola PowerPC CPU, but Apple will still offer 680x0-based Macs. Microsoft has already provided its NT operating system with compiler support for the Alpha and Silicon Graphics' Mips R4000 CPUs. NT is also reportedly being ported to other processors, including SPARC (by Intergraph) and PowerPC (by Motorola).

It's not just the CPU population that's exploding, either. Where once DOS, Windows, and the Mac reigned supreme, there is currently a dizzying array of systems to write to, including OS/2, NextStep, Win16, Win32s, Win32c, a more unified Unix, and forthcoming systems such as Taligent and IBM's Workplace OS. Most developers will eventually need to support them all.

Personality emulators that run off-the-shelf software handle only part of this new multiplatform requirement. Most new applications will have to be recompiled for several different platforms. The choice of tools and procedures is critical, for it may be necessary to provide capabilities that are not native to the target platform.

Major compiler makers have already leaped to fill the cross-platform gap—each with a different strategy. For example, Microsoft no longer supports OS/2 with its compilers. But Microsoft fully supports Windows on multiple CPUs, and it plans to support Mac development from the same code base on both 680x0 and PowerPC-based Macs, starting sometime this year.

In contrast, Borland supports OS/2, DOS, and several varieties of Windows—but only on 80x86-based PCs. However, Borland also claims better compliance with industry language standards. Its C++ development system includes class libraries from Rogue Wave Software that allow much easier porting of code to Unix workstations.

Symantec supports PC and Mac development with separate compiler products, although the company claims that both products use its common-core compiler technology, which makes porting easier. Symantec licenses class libraries from Microsoft and is Apple's official partner in creating compilers for the PowerPC Macs.

Watcom International supports DOS, OS/2, and 80x86-based Windows platforms, as well as NLMs (NetWare loadable modules) for Novell networks. Other vendors, such as MetaWare and Liant, span the PC and Unix worlds. And even Unix-only compiler makers (e.g., SunPro) are targeting SPARC, 80x86, and PowerPCs (see "Developing for Multiple Platforms" on page 91).

### To C or Not to C

To support such a wide range of platforms, C++ has emerged as the programming language of choice. "C++ brings the benefits of OOP together with the power and flexibility of C, which gives you explicit control over what the machine's doing," explains Dave Boswell, vice president of marketing and sales at Watcom.

Although C++ supports C programming constructs, it is decidedly a different language that requires its own techniques and supporting tools. But C++'s object-oriented nature, along with its ability to use class libraries that simplify portability to different CPUs and operating systems, put it at the center of the compiler strategies of Microsoft, Borland, and other vendors.

Still, C++ isn't alone as a development

### Today's Compilers

Compilers have to support new CPUs and operating systems..... **76**



### Optimizing for Today's CPUs

Form doesn't always follow function..... **81**



### Developing for Multiple Platforms

Designing applications for portability..... **91**



### Compilers for Parallel CPUs

Tailoring tools to machine architecture..... **97**



# State of the Art Today's Compilers

language. FORTRAN is still in demand for scientific applications. Ada, after nearly a decade of development in primarily military environments, has come into its own for applications requiring high reliability and code reuse. And older languages such as Pascal and especially COBOL are still in wide use. Indeed, COBOL remains the most widely used programming language for mainframe and other transaction-oriented business applications.

To meet the demand for multiple languages, compiler vendors increasingly use the same core compiler for several languages. Even fully integrated compilers first parse the source code into an internal code that can then be used to generate optimized code for the target platform. By changing only the source code parser, compiler vendors can get several compiler products from a single code-generating "back end." For programmers, a common back end means it's easier to combine modules written in different programming languages into a single final application.

## The Productivity Challenge

There's also a renewed demand for faster development. ISVs (independent software vendors) and programmers in corporate MIS departments are under increasing pressure to turn out better programs faster.

For ISVs, the issue is simple competition. Time-to-market and software quality have become crucial; a few months' delay or serious flaws in a product can cost a major vendor millions of dollars in sales—or even its existence. One-time software giants (e.g., Ashton-Tate, whose dBase IV was first delayed and then buggy) are testimony to what can happen when software

products are late or less than perfect.

Corporate MIS departments face different business demands, but the goal is the same: They, too, need to complete applications faster and without bugs to gain an edge over the competition. Although the newest compilers often come with tools for generating GUIs, many corporate developers are opting for 4GLs (fourth-generation languages) and other rapid, high-level applications development tools for simple applications. In many cases, corporate developers may use traditional compilers only for their most demanding projects.

## For Professionals Only

Because of the challenges of graphical environments and multiple platforms, professional developers—not casual or occasional programmers—are the chief market for top-flight development tools. As a result, both compilers and the tools programmers use with them are more sophisticated.

The goal is improved productivity. One solution will always be faster compilers that produce reliable, efficient code. Delivering this requires ever more sophisticated optimization and scheduling strategies. Another emerging key to programmer productivity is improved links between the compiler and other development tools, including debuggers, profilers, browsers, and even editors. "The days are gone when people would just buy stand-alone command-line compilers," says Gene Wang, executive vice president for applications and development tools at Symantec.

Development tools generate information about the code they process. Past tools were independent, unaware of one another, and they discarded much of the informa-

tion they generated. As a result, compilers duplicated the work of syntax-checking editors and couldn't use the information that profilers and debuggers produced to optimize the code. Tools that continually re-created information about code cost programmers time—and productivity.

Today, sets of completely independent tools are rarer. Instead, an IDE (Integrated Development Environment) links compilers, editors, class browsers, and source-level debuggers. Borland, which popularized integrated development in the 1980s with Turbo Pascal, is still a leader, but Microsoft and Symantec have joined it with Visual C++ and Integrated Development and Debugging Environment, respectively, as have other compiler makers.

Tools that communicate with each other can dramatically reduce the time it takes to create and debug code. Once, such integrated tool sets would have been called CASE systems; today, they're just state-of-the-art compiler products. But there's still room for progress.

Compiler-generated information is routinely available to other tools, but the information produced by those tools is rarely available to the compiler. For example, compilers still cannot automatically use test results to further optimize code. That requires full-scale development databases that store everything from symbol tables to profile and test results, giving the compiler a wide range of information to improve optimization.

## Putting It all Together

Improving programmer productivity is not just in the hands of programmers or compiler makers. Modern operating systems

## MAJOR C++ COMPILERS

A roundup of C++ compilers used for desktop development.

VENDOR	COMPILER	CLASS LIBRARIES	DEVELOPMENT ENVIRONMENT	PLATFORMS SUPPORTED								SINGLE COMPILER/SOURCE BASE?	NOTES	
				DOS	Windows	OS/2	Windows NT/Win32	Mac	PowerPC	NetWare	UNIX			
Borland International	Borland C++, Turbo C++	Object Windows Library	Integrated Development Environment	●	●	●	●	○	○	○	○	○	No	
Microsoft	Visual C++	Microsoft Foundation Class	Visual C++	●	●	○	●	●	●	○	○	○	Yes	Mac and PowerPC support based on MFC and Win32 libraries for the Mac
Symantec	Symantec C++	Microsoft Foundation Class	Integrated Development and Debugging Environment	●	●	○	●	●	●	○	○	●	No	Symantec and Apple to codevelop compilers for the PowerPC Mac
Watcom International	C/C++-32	Available but not included	Yes	●	●	●	●	○	○	○	●	○	Yes	Recently merged with Powersoft

● = supported      ○ = not supported      ● = future      ● = some

# STATISTICA/w

Windows,  
DOS, Macintosh

**STATISTICA/w™** (for Windows) Complete Statistical System with thousands of on-screen customizable, presentation-quality graphs fully integrated with all procedures ■ Complete Windows 3.1 support, DDE, OLE, TT-fonts, multiple toolbars, right mouse button support ■ Unlimited numbers of data-, results-, and graph-windows ■ Inter-window integration: data, results, and graphs can be treated as objects and converted into one another in a number of ways ■ The largest selection of statistics and graphs in a single system; comprehensive implementations of: Exploratory techniques; multi-way tables with banners (presentation-quality reports); nonparametrics; distribution fitting; multiple regression; general nonlinear estimation; stepwise logit/probit; general ANCOVA/MANCOVA; stepwise discriminant analysis; log-linear analysis; factor analysis; cluster analysis; multidimensional scaling; canonical correlation; item analysis/reliability; survival analysis; time series modeling; forecasting; lags analysis; quality control; process analysis; experimental design (with Taguchi); and much more ■ Manuals with comprehensive introductions to each procedure and examples ■ Hypertext-based Stats Advisor expert system ■ Extensive data management facilities (spreadsheet with long formulas, block operations, advanced Clipboard support, DDE hot links, relational merge, data verification, powerful programming language) ■ Batch command language and macros also supported, "turn-key system" options ■ All output displayed in Scrollsheets™ (dynamic, customizable, presentation-quality tables with toolbars, pop-up windows, and instant 2D, 3D and multiple graphs) ■ Extremely large analysis designs (e.g., correlation matrices up to 32,000x32,000, unlimited ANOVA designs) ■ Megafile Manager with up to 32,000 variables (8 Mb) per record ■ Unlimited size of files; extended ("quadruple") precision; unmatched speed ■ Exchanges data and graphs with other applications via DDE or an extensive selection of file import/export facilities ■ Hundreds of types of graphs, including categorized multiple 2D and 3D graphs, matrix plots, icons, and unique multivariate (e.g., 4D) graphs ■ Facilities to custom design new graphs and add them permanently to menu ■ On-screen graph customization with advanced drawing tools, interactive stretching and resizing of complex objects, interactive embedding of graphs and artwork, special effects, icons, maps, multi-graphics management, page layout control for slides and printouts; unmatched speed of graph redraw ■ Interactive rotation, perspective and cross-sections of all 3D and 4D graphs ■ Extensive selection of tools for graphical exploration of data: fitting, smoothing, overlaying, spectral planes, projections, layered compressions, marked subsets ■ Price \$995.

**Quick STATISTICA/w™** (for Windows) A comprehensive selection of basic statistics and the full graphics capabilities of STATISTICA/w ■ Price \$495.

**STATISTICA/dos™** (for DOS) A STATISTICA/w-compatible data analysis system ■ Price \$795.

**Quick STATISTICA/dos™** (for DOS) A subset of STATISTICA/dos statistics and graphics ■ Price \$295.

Domestic sh/h \$10 per product; 14-day money back guarantee.

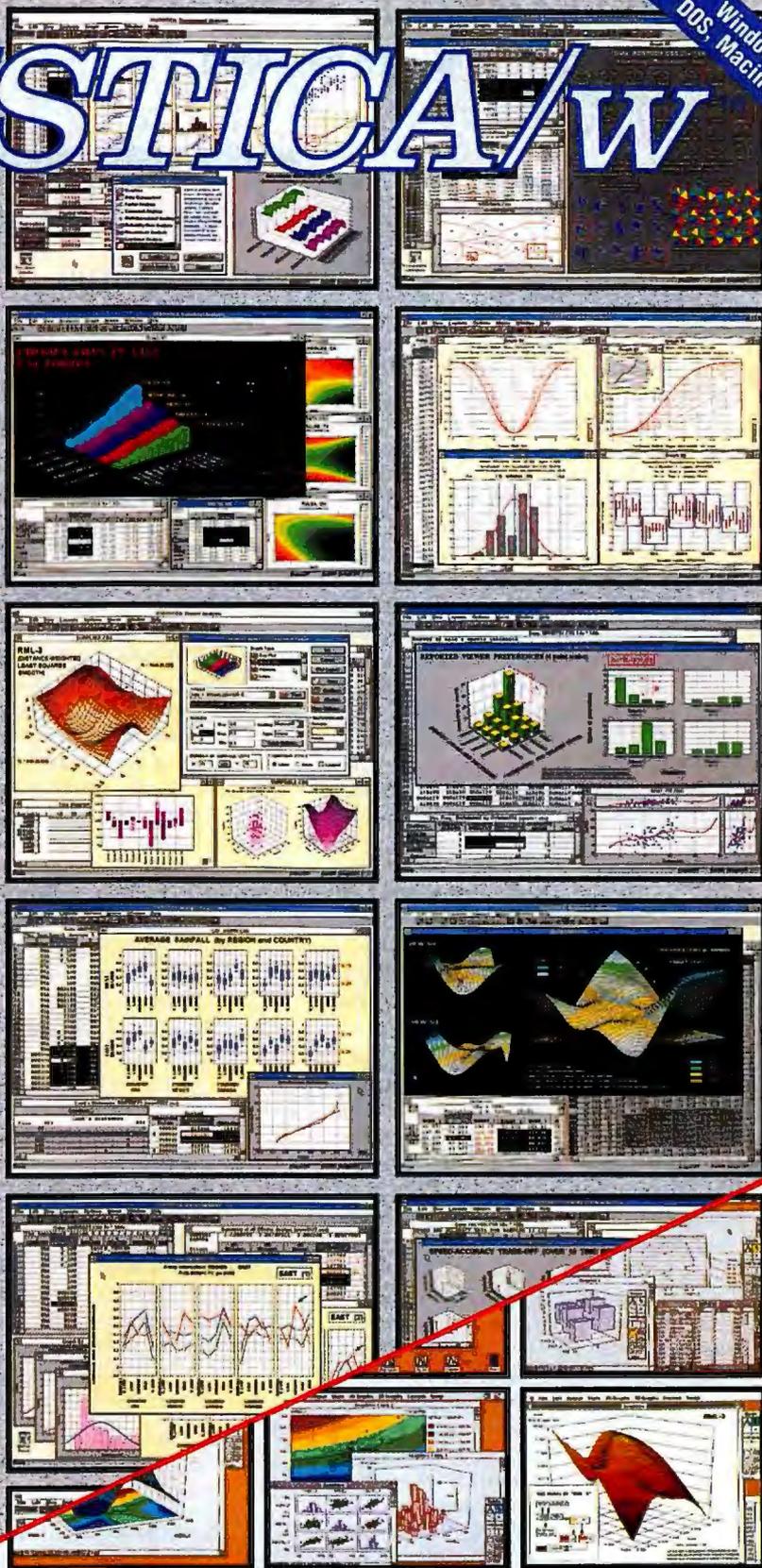
Circle 141 on Inquiry Card.

 **StatSoft™**

2325 E. 13th St. • Tulsa, OK 74104 • (918) 583-4149  
Fax: (918) 583-4376

Overseas Offices: Statsoft of Europe (Hamburg, FRG), ph: 040/4200347, fax: 040/4911310; StatSoft UK (London, UK), ph: 0462/482822, fax: 0462/482855; StatSoft Pacific (Melbourne, Australia), ph: (03) 663 6580, fax: (03) 663 6117; StatSoft Canada-CCO (Ontario), ph: 416-849-0737, fax: 416-849-0918. Available From: CORPORATE SOFTWARE and other Authorized Representatives Worldwide: Holland: MAB Julsing, 071-230410; France: Version US (1) 40590913; Sweden: AkademiData 018-240035; Hungary: Dagent Kft 186-5782; Belgium: TEXMA 10 61 16 28; South Africa: Osiris 12 663-4500; Japan (Macintosh): Three's Company, Inc., 03-3770-7600; Japan (DOS and Windows): Design Technologies, Inc., 03-3567-1110.

StatSoft, STATISTICA/w, Quick STATISTICA/w, STATISTICA/Mac, Quick STATISTICA/Mac, STATISTICA/DOS, Quick STATISTICA/DOS, and Scrollsheet are trademarks of StatSoft, Inc.



**STATISTICA/Mac™** (for Macintosh) A STATISTICA/w-compatible, comprehensive data analysis and graphics system designed for the Macintosh ■ Large selection of statistical methods fully integrated with presentation-quality graphics (incl. EDA, multiplots, a wide selection of interactively rotatable 3D graphs; MacDraw-style tools) ■ Unlimited size of files ■ Full support for System 7, incl. "Publish and Subscribe" ■ Price \$695.

**Quick STATISTICA/Mac™** (for Macintosh) A subset of STATISTICA/Mac: a comprehensive selection of basic statistics and the full graphics capabilities of STATISTICA/Mac ■ Price \$395.



are doing more for the programmer than ever before. Progressively more functionality is being built into operating systems like Unix, OS/2, and NT—not just GUIs but also networking, security, and object management.

Operating-system vendors estimate that anywhere from 50 percent to 90 percent of a typical application's time is spent within the operating system, rather than executing application-specific code. Of course, as programmers let the operating system do more of the work, there's less opportunity for the compiler to improve speed by optimizing raw code. But a sophisticated compiler can also optimize in terms of the operating-system programming interfaces.

Two programming approaches are helping to lift programmers' workloads. One is the use of class libraries—a step made possible by the popularity of C++. Class libraries such as MFC (Microsoft Foundation Class) and Borland's Object Windows Library are more than the object-oriented equivalent of function libraries. Instead, they insulate the programmer almost completely from the operating-system dependencies that make it difficult to port software from one platform to another. In fact, Microsoft plans to use the MFC libraries to let programs written for the Win32s programming interface be recompiled, without change, to run on the Mac.

The other approach that's helping programmers is the dynamic shared library—better known in the Windows environment as a DLL. In the past, when applications were compiled, all library function code had to be incorporated into the application. But in modern operating systems, ranging from Windows to Unix versions (e.g., Sun's Solaris), it's possible to call shared libraries instead. What's the advantage? Shared libraries can be upgraded independently. And since several applications may share the library, they're all improved at once—in theory. But one problem with shared libraries rears its head among Windows DLLs—the case where a DLL is “improved” in such a way that it benefits one particular application but can break other software that uses the DLL.

Class libraries, DLLs, integrated tool sets, and other features of the latest generation of compilers make them far more complex than past compilers—both for the vendors who make them and the programmers who use them. But strange as it sounds, these complex approaches actually make it easier, not harder, for programmers to do the things they need to do

## Compiler Benchmarks: How Useful?

ALLEN I. HOLUB



Benchmarks offer an easy way to quantify compiler performance, making lots of spiffy tables. Unfortunately, those tables are often not the best way to evaluate a compiler's performance. Here are a few issues you should consider when looking at a benchmark-based compiler comparison.

Do run-time benchmarks say anything useful about a real application? For example, Dhrystone is a collection of small code fragments that exercise various language features. There's probably no relationship between the frequency of a fragment in the benchmark and the frequency of similar code in one of your programs.

A test that uses array indexing is not helpful if you use pointers. For a run-time benchmark to be meaningful, you'd have to do a statistical analysis of your own code and adjust the benchmark to match your coding style. A benchmark developed in this way will have no meaning when applied to a different coding style. The only way to really judge is to compile several real applications, not arbitrary benchmarks. Even then, compilers that perform better with some applications will perform worse with others.

Match the benchmark to the language. For C++ compilers, for example, test the efficiency of the in-lining process, the mechanisms that a binary-operator overload function uses for return statements, the way that virtual-function dispatching and virtual-base classes are handled. These concerns often outweigh the efficiency of a switch statement.

The range in efficiency of various compilers is usually insignificant when compared to the speed and size improvements that you can get by editing your code and reworking your algorithms. Most programs are 50 percent larger and 30 percent slower than necessary. Algorithmic changes (e.g., using a shell sort instead of a bubble sort) can improve performance by a factor of two or more. Even small code improvements (e.g., using pointers to go through arrays) can give you a measurable benefit.

Compile-time benchmarks are worthless. You're really interested in the development time of a large project over the complete development cycle. Time staring at the screen while the compiler works is indeed a factor, but so is the quality of the run-time library (a well-written library can save you months), the development environment, and the documentation (10 hours spent searching for critical information in badly written documentation is not offset by saving 2 or even 20 seconds in a compile). To evaluate productivity, you need many teams of qualified programmers developing identical projects over many months but with different compilers.

Even when a compile-time benchmark is meaningful, you must evaluate the complete build system. Saving 2 seconds in a compile doesn't help if the make utility spends an extra 10 seconds doing its work. Also remember to look at the numbers as percentages when comparing two compilers. A 2-second difference between two compile times doesn't much matter if the overall compile takes 10 minutes.

Yes, quantitative benchmarks can be useful, but it's the quality of the overall compiler package that is most important. ■

---

*Allen I. Holub teaches C++ and compiler design at the University of California—Berkeley Extension. You can reach him on the Internet at [holub@violet.berkeley.edu](mailto:holub@violet.berkeley.edu) or on BIX c/o "editors."*

today. Thanks to the increasing sophistication of the available tools, the programmer can focus on what the application is supposed to do, leaving to the compiler the thorny issues of how to optimize the code and how to support an ever-growing variety of CPUs and operating systems.

Ironically, there's no end in sight to the sophistication of compilers. Vendors have just begun to support full-scale client/serv-

er applications and distributed objects. Tool sets are becoming more tightly integrated. And every year, compilers generate code that's a lot faster than the year before. ■

---

*Frank Hayes is a former BYTE West Coast news editor and a contributing editor for the Client/Server ToolWatch newsletter. You can reach him on the Internet or BIX at [frankhayes@bix.com](mailto:frankhayes@bix.com).*

# OPTIMIZING FOR TODAY'S CPUs

Modern compilers employ a full bag of tricks to make programs execute efficiently and to take full advantage of the special abilities of the new superscalar processors

ALEX LANE



**T**raditionally, optimizing code has been straightforward. Compilers improved software efficiency by reducing the number of instructions executed, making better use of the CPU's instruction set, maximizing the use of registers, minimizing memory references, and eliminating unused or redundant code. Currently, developers are creating optimization techniques to take maximum advantage of new processor features, such as on-chip caches, pipelining, and superscalar chip architecture.

The newest round of advanced microprocessors presents special challenges to compiler developers. For processor architectures built around two integer pipelines—such as Intel's Pentium, DEC's Alpha AXP, and Hewlett-Packard's PA-RISC—the compiler must schedule instructions to keep both pipelines full. Mips Technologies' Mips III (as implemented on the R4000 and R4400 chips) uses a number of greater parallel operations, so compilers for it must keep the superpipelines from stalling. With the IBM/Apple/Motorola PowerPC, the principal challenge is to get the maximum number of free instructions per clock cycle, and with the PowerPC 601 in particular, to give branch-prediction hints.

## Goals of Optimization

Compilers generate code in a fairly mechanical way; a specific syntax generates a specific series of instructions. Unfortunately, this mechanical mapping process frequently generates sequences of assembly language instructions that contain redundant instructions or that perform simple operations in an efficient and time-consuming way.

Enterprising writers of early compilers incorporated so-called peephole routines that examined generated code as it was written to an output file, replacing awkward sequences with more efficient instructions. These techniques are known as

# Optimizing with Pre- and Post-Compilers

KEVIN DOWD

People talk about compilation as if it were a single process. In fact, every programming environment has other forms of preprocessors and postprocessors—programs that do something to your code before and after compilation, respectively.

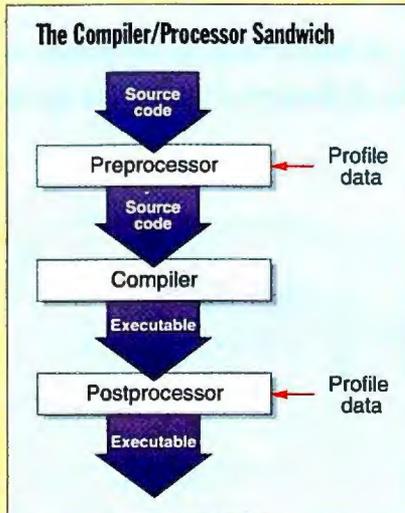
The preprocessor may set compile-time variables, expand other code inline, or conditionally delete sections of the input program. One well-known example is the C preprocessor (or `cpp`), which is part of all C programming environments. The `cpp` can process `#include`, `#define`, and `#ifdef` statements before passing C source code on to the compiler.

Other kinds of preprocessors translate macro languages (e.g., `m4`, `ratfor`, and `FLECS`), check for correctness (e.g., `lint` and `fncheck`), modify source programs so that they can be profiled, translate between languages (e.g., `f2c` and `FORTRAN 90` preprocessors), or place error-checking code inline.

Likewise, postprocessors are programs that do something to a piece of code after compilation—perhaps even after it has been linked into an executable file. Again, the goal may be to collect profiling statistics (e.g., Silicon Graphics' `pixie`); monitor memory activity for illegal references, as Pure Software's (Sunnyvale, CA) `Purify` does; or translate binaries from one brand of processor/operating-system combination to another, like Quorum Software System's (Menlo Park, CA) `Equal Applications Adapter`, DEC's `VEST` (VAX Executable Software Translator), and Echo Logic's (Holmdel, NJ) `FlashPort`. Also, each class of tools—preprocessors and postprocessors—includes programs that can help optimize performance both before and after compilation.

## Optimizing Preprocessors

Preprocessors are usually targeted at a particular application area or pro-



Pre- and postprocessors aid optimization.

gramming language. For numerically intensive applications, there are varieties of optimizing preprocessors that can either restructure loop constructs into more efficient forms or match them to optimized subroutine library routines. The dot product or inner product is an example of a common vector arithmetic construct:

```
do i=1,n
  s=s+a(i)*b(i)
enddo
```

A vectorizing preprocessor such as Kuck and Associates' (Champaign, IL) `KAP/C`, Pacific-Sierra Research's (Los Angeles, CA) `Vast`, or Numerical Algorithms Group's (Downers Grove, IL) `Vecpar` can recognize the dot product and

replace it with a subroutine call or perhaps modify it inline for more efficiency. As a simple example, the following loop produces the same result as above, except it exposes more parallelism:

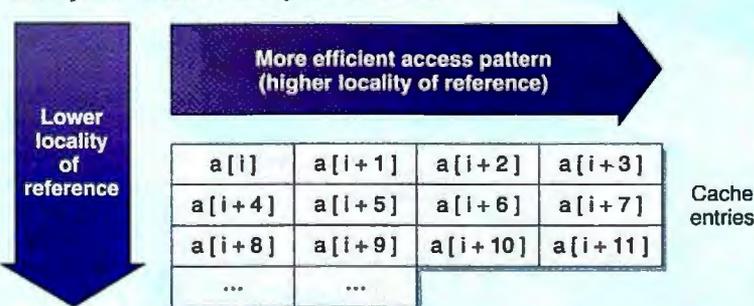
```
s0=0
s1=0
do i=1,n,2
  s0=s0+a(i)*b(i)
  s1=s1+a(i+1)*b(i+1)
enddo
s=s0+s1
```

Two loop iterations are visible at a time, thereby reducing loop overhead and improving opportunities for instruction overlap. Larger constructs, such as matrix multiplies, may be replaced with more efficient forms as well. In some cases, a preprocessor can use information that a profiler utility provides to help it choose where optimizations should be applied.

Exposing more parallelism is important, but perhaps a more important feature of vectorizing preprocessors is the ability to reduce certain types of memory system activity, particularly data-cache misses.

All caches are designed with the assumption that programs will exhibit some degree of locality of reference—that programs will ask for pieces of data that are "near" already-requested data, in space and in time. But a program that accesses memory without regard to locality of reference may perform poorly due to a high degree of cache misses. A vectorizing preprocessor can often reduce data-cache misses by interchanging loops or by tiling

## Locality of Reference in Memory-Access Patterns



A vectorizing preprocessor can increase cache hit rates.

or blocking loop nests so that data is consumed more efficiently, in neighborhoods.

## Optimizing Postprocessors

Because they work on compiled output, object-code postprocessors are generally not specific to particular types of applications. As you can imagine, however, an object-

code postprocessor is usually closely tied to the architecture of its target computers. For performance, a common use of postprocessing is instruction-cache optimization (e.g., *cord*, which is part of the Mips software development tools); an executable file can be rewritten so that its subroutines share the instruction cache more efficiently. Often, this means reordering the relationships of heavily traveled sections of code so that they map side by side in the executable file's address space, reducing contention for particular portions of the cache. A postprocessor determines the best subroutine ordering by examining the results of an execution profile (e.g., those produced by *pixie*, *gprof*, *prof*, and Sun's SparcWorks Analyzer).

Another potential target for postprocessing is branch optimization. Many RISC processors use static branch prediction; the compiler guesses which way a conditional branch is likely to go at compile time, using some simple heuristics. In some cases, static prediction is backed by branch-target buffers—hardware that holds a few instructions from most recently executed branch instructions. To improve the performance of newly encountered branches, a postprocessor (with the help of a profiler) can rewrite the branch instructions in executable files so that they reflect the actual measured run-time behavior of the branches in question.

Postprocessors may also be written to tweak previously compiled programs for better performance or to make it possible to port binaries to other platforms. A vendor providing a new generation of processor, for instance, may wish to take advantage of additional instructions, changes in pipeline restrictions, or an expanded register set. In these cases, a postprocessor provides a path to increased performance without the need to re-port old programs. ■

*Kevin Dowd of Wethersfield, Connecticut, is the author of High Performance Computing (O'Reilly and Associates, 1993). He can be reached on the Internet as dowd@atlantic.com or on BIX c/o "editors."*

*optimizations.*

While the goal of optimization is to make code more compact, run faster, or both, optimization techniques can do only so much in the face of poorly organized programs or inherently slow algorithms. To address these problems, you can use a profiler utility that shows which parts of the code the CPU spends the most time executing. This identifies coding bottlenecks that you can often fix by using a different task organization, coding approach, or algorithm. Beginning developers often wonder why they need to use a profiler utility if they use a code optimizer, and vice versa. In fact, the two tools perform different and complementary functions.

A beneficial side effect of optimization is the ability to write more readable code. Before the widespread use of optimizing compilers, experienced programmers often adopted coding styles that favored better machine code generation over source code readability and maintainability. For example, multiplying a variable by a power of 2 in C might be coded as `var <<= 3` instead of `var * 8`. Alternatively, you could manually insert values for constants and expressions containing constants or use additional temporary variables to take calculations out of loops. Optimizers make such tactics unnecessary, freeing the developer to write more natural, readable code.

Optimization is an analytical process. After being parsed and analyzed, code is examined to extract the maximum amount of information, which can then be used to improve the code while preserving the programmer's original intent. Analysis answers the following questions: Does an expression inside a loop ever change during the loop's lifetime? Are there particular sections of code that will never be executed? Does this variable's value ever change? Is it ever used?

## Optimization Techniques

### Machine-dependent

- Global register allocation
- Register parameter passing
- Loop compaction
- Statement reordering
- Strip mining
- Instruction scheduling

### Machine-independent

- Constant propagation (also known as copy propagation)
- Common subexpression elimination
- Invariant code motion
- Dead code elimination
- Dead store elimination
- Redundant load suppression
- Variable induction
- Loop jamming (often called loop fusion)
- Loop unrolling
- Loop rerolling
- Inlining
- Loop peeling

In typical cases, the greater the scope of optimization, the longer a compiler will take to generate code. Peephole optimizations use relatively little information and operate on a statement-by-statement level. You can get more information by examining blocks of code and identifying relationships between variables and expressions, although this takes longer. Global optimization looks at procedures and loops, and takes even more time.

The complexity of the optimization also affects overall code-generation speed. In any particular situation, it takes far less time to determine where to use arithmetic simplification—a technique in which certain expressions are replaced by simpler equivalents—than to analyze whether advanced optimizations, such as interchanging nested loops or reordering statements, can be used.

Some optimizations can be used with any processor, while others are tailored to specific chips. Machine-independent optimizations focus on generic code improvements, such as eliminating common subexpressions, making loops more efficient, and getting rid of dead code and unneeded variables. These generic optimization techniques need no knowledge of the hardware. Nearly all industrial-strength compilers today offer a full suite of such optimizations.

### Machine-Dependent Optimizations

Unlike the optimizations discussed so far, machine-dependent optimizations take advantage of processor-specific knowledge to improve execution time and reduce overhead. They are particularly important for the new generation of processors, where new architectures require specific new approaches for optimization. For the most part, these kinds of optimizations represent improvements that are beyond the control of a developer who codes in a high-level language.

*continued*



# Finally, an X rated product you can use anywhere.

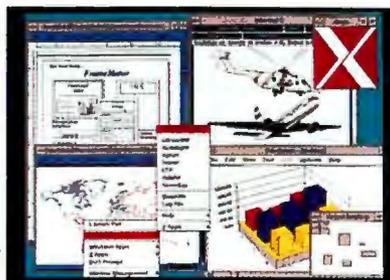
eXceed/Xpress PC X connectivity software from Hummingbird.

Now that home and mobile computing are firmly established, there is a strong demand for access to corporate networks from remote locations.

Until now, remote connection to graphics oriented, X Windows based applications posed a serious challenge: The existing on-line protocols (SLIP, CSLIP, PPP) have not provided acceptable performance for effective use of these graphical applications from remote sites.

Hummingbird Communications Ltd., the PC X Windows connectivity specialist, has addressed this issue with eXceed/Xpress, a PC X server for serial connection, based on eXceed/W, the world's best selling X server for PCs running MS-Windows.

Utilizing an innovative combination of compression and decompression



techniques inherent in the Xpress protocol, eXceed/Xpress gives you unprecedented performance. While accessing X applications running on UNIX or VMS hosts, you may also run local MS-Windows applications at the same time. And, since you can easily copy and paste text and graphics between remote X environments and local MS-Windows applications, eXceed/Xpress becomes a powerful integration tool.

So, wherever you go, go with eXceed/Xpress. Hummingbird's products are sold and supported in over 40 countries around the world.

Other Hummingbird PC X servers:

eXceed/W for MS-Windows  
eXceed/NT for Windows NT  
eXceed/OS2 for IBM OS/2  
eXceed/DOS for DOS

Other Hummingbird Products:

eXceed/NT-XDK to port and develop X applications  
eXceed/W-MDK OSF/Motif toolkit for MS-Windows  
eXtend Host-based PC to UNIX file management system.

Contact us for more information, or for the Hummingbird reseller nearest you.



2900 John Street, Markham, Ontario, Canada L3R 5G3  
Telephone: (905) 470-1203 Fax: (905) 470-1207  
e-mail: sales@hcl.com

All trademarks and registered trademarks are the property of their respective companies.

In Europe:  
37 rue de Vermont, 1202 Geneva Switzerland  
Telephone: 41 (22) 733 18 58 Fax: 41 (22) 733 64 03

Circle 101 on Inquiry Card.

## State of the Art Optimizing for Today's CPUs

One key to generating good code is keeping CPU registers filled with needed values, as opposed to shuttling the values between memory and the CPU. This is the idea behind *global register allocation*, which is a size and speed optimization that figures out what values should be stored in registers. The longer you can keep values in registers and prevent them from being written out to on-chip cache memory or, worse, to external memory, the better performance you get.

Register optimizations are particularly valuable in RISC architectures, which typically provide a large number of registers in the CPU. A similar optimization technique is *register parameter passing*, which bypasses the need to push function parameters onto the stack before the function call is made, by making sure that all needed parameters are preloaded into CPU registers.

Unfortunately, these techniques are of limited value in processors that have only a few registers. In the case of register parameter passing, if the function call does not result in direct execution of the function (a typical situation in environments like Windows), the technique cannot be used.

*Loop compaction* on most 80x86 processors is a machine-dependent optimiza-

important. For example, consider a loop in C written as

```
int x[ROW][COL];
for (j=0; j<ROW; j++)
    for (i=0; i<COL; i++)
        x[i][j]=foo(bar);
```

For sufficiently large values of ROW and COL, this suffers from widely separated addresses—called a *stride* in some circles—for successive values of  $x[i][j]$ . Running this code will likely result in a lot of memory paging. However, just by interchanging these nested loops, successive values of  $x[i][j]$  will be near one another and will reduce the number of paging operations necessary to run the code.

Another commonly used optimization is *statement reordering*. Here, computations are done in a different sequence than specified in the source code. When applied to floating-point calculations, this optimization is likely to produce slightly different results than the originally specified code. This is due to the accumulation of round-off errors that differ from those you would obtain using the original code.

An interesting technique called *strip mining* isn't an optimization in itself, but it can be used with other techniques to boost performance. The term is taken from a technique used with supercomputers.

Strip mining is particularly useful for optimizing matrix multiplication on cache-based, superscalar processors such as the Alpha, Pentium, PowerPC, or PA-RISC chips. The key lies in transforming the ponderous row-column algorithm,

which (if matrix C is an  $n \times n$  product of matrices) looks like this:

```
for (i=0; i<n; i++)
    for (j=0; j<n; j++)
        for (k=0; k<n; k++)
            C[i][j] += A[i][k]*B[k][j];
```

into one that effectively multiplies square subblocks of the matrices. The listing "Strip Mining" shows what the optimized code might look like.

In the sample code, `blk_factor` is a

### Loop Compaction

```
; for (i=0; i<10; i++)
; x[i]=j+k;
;
mov cx, 10                ;load cx w/ no. of iterations
lea di, word ptr [bp-108] ;load di with adr of x[0]
push ds
pop es                    ;load es with data segment
mov ax, word ptr [bp-6]   ;get value of n
add ax, word ptr [bp-8]   ;add value of m
rep stosw                 ;ZOOM!
mov word ptr [bp-2], 10   ;set i to 10
```

tion that takes advantage of highly efficient string-move instructions. A typical example with both C source code and the resulting assembly language instructions is shown in the listing "Loop Compaction." Surprisingly, the `stosw` instruction that improves 386 code will execute significantly more slowly on 486 and Pentium processors.

In pipelined and superscalar processors, techniques that keep instructions executing while minimizing memory paging and register swapping operations are

# WHY'S ANGRY?

processor-dependent number selected to make best use of the CPU's cache that, in effect, causes the matrices to be multiplied in blocks of `blk_factor` size. (The variable `init_strip_sz` is used to multiply a smaller block if the size of the matrices being multiplied is not evenly divisible by `blk_factor`.)

In creating this code, the optimizer strip-mined each of the original loops to create *block loops* and *strip loops*. The block loops, which cause blocks of memory to be paged into and out of the cache, were interchanged to move them to the "outside" of the nest of loops. The strip loops, which perform calculations within each block, were moved to the inside of the nested loops.

Arranged in this way, the computation makes best use of the processor and memory system, since you can use cached matrix blocks repeatedly before discarding them and intermediate results can be enregistered longer than otherwise possible. The result is nearly an order of magnitude improvement in performance for  $n > 150$ .

However, the optimized code is obviously much more complicated than the

## PENTIUM OPTIMIZATIONS

**When Watcom International revamped its C/C++ compilers to take advantage of the Pentium's superscalar architecture, the company got an unintended bonus: integer code that executes substantially faster on 486s. Even though the 486 doesn't have a true superscalar architecture like the Pentium, its pipeline stages can overlap a lot more than Watcom's 486 code could achieve. "Two years ago, we introduced 486 optimizations, and I think the performance benefit was about 5 percent," says Dave Boswell, Watcom's vice president of marketing and sales. "We thought we were really doing something swell. But with Pentium optimizations, we got an average of 30 percent to 40 percent improvement on a 486."**

original. Further, the size of `blk_factor` and the ordering of the loops can vary from processor to processor. (In this example, the transformed code was generated for an IBM RS/6000, which has a 64-KB cache and four-way set associativity, using KAP/C from Kuck and Associates of Champaign, Illinois.) For this reason—and from a readability standpoint—devel-

opers should write code as shown in the original and let the optimizer take care of the details.

Another important optimization for pipelined architectures is *instruction scheduling*. This helps prevent processor pipelines from stalling. In Pentium and 486 processors, for example, if an address or register needed by a particular instruction is not available because a previous instruction has not finished processing, an AGI (Address Generation Interlock) occurs. In the following code example, an AGI occurs after the second instruction because the first has not completed execution:

```
inc eax
mov ebx, [eax] ; stalled owing
                ; to AGI
```

```
inc ecx
```

A good instruction scheduler would rearrange the instructions as follows, to allow uninterrupted execution:

```
inc eax
inc ecx
mov ebx, [eax]
```

AGIs are particularly troublesome for Pentium processors, since two instructions can execute in parallel in the final three stages of the integer pipeline, in separate U- and V-pipes, creating more stalling opportunities in longer instruction sequences. In the following example,

```
;U-pipe      V-pipe
inc ebx      inc ecx
inc edx      mov  eax, [ebx]
```

### Strip Mining

```
int init_strip_sz = (n-1)%blk_factor + 1;
int i_blk, i_strip_sz, i_strip_lb, i_strip_ub;
int j_blk, j_strip_sz, j_strip_lb, j_strip_ub;
int k_blk, k_strip_sz, k_strip_lb, k_strip_ub;

i_strip_lb = 0;
i_strip_sz = init_strip_sz;

for (i_blk = 1; i_blk <= n; i_blk += blk_factor) {
    i_strip_ub = i_strip_ub + i_strip_sz - 1;
    k_strip_lb = 0;
    k_strip_sz = init_strip_sz;
    for (k_blk = 1; k_blk <= n; k_blk += blk_factor) {
        k_strip_ub = k_strip_ub + k_strip_sz - 1;
        j_strip_lb = 0;
        j_strip_sz = init_strip_sz;
        for (j_blk = 1; j_blk <= n; j_blk += blk_factor) {
            j_strip_ub = j_strip_ub + j_strip_sz - 1;
            for (i = i_strip_lb; i <= i_strip_ub; i++)
                for (j = j_strip_lb; j <= j_strip_ub; j++)
                    for (k = k_strip_lb; k <= k_strip_ub; k++)
                        C[i][j] += A[i][k] * B[k][j];
            j_strip_lb += j_strip_sz;
            j_strip_sz = blk_factor;
        }
        k_strip_lb += k_strip_sz;
        k_strip_sz = blk_factor;
    }
    i_strip_lb += i_strip_sz;
    i_strip_sz = blk_factor;
}
```

Introducing C Set ++ FirstStep for OS/2.

IBM C Set ++  
FirstStep for OS/2.  
Starting at \$ 85 (U.S.) - CD-ROM Version.

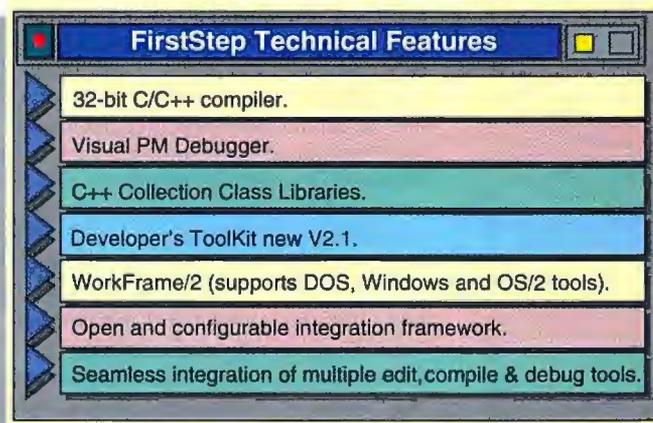
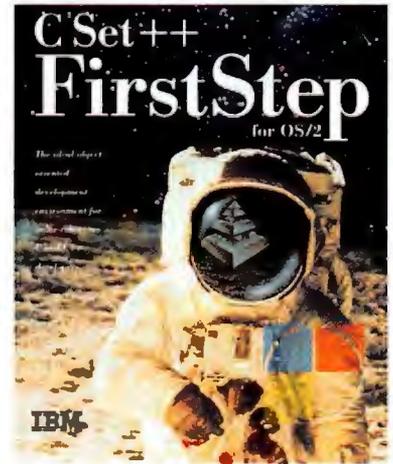


# Object oriented applications

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

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

# start right here.



*Professional developers may require the additional features of C Set ++ V2.1, our professional developer's package including high-end tools, optimization and full support and service.*

To order C Set ++ FirstStep for OS/2, or for further information call 1-800-342-6672 (U.S.A.) or



**C Set ++**

1-800-465-7999, ext. 670 (Canada).

Or contact your local IBM software dealer.



*All long last! A new champion has emerged! Let the  
Some Need Just One  
mighty warriors of DesignCAD assist you in your  
Some Need All Three!  
fight against overpriced CAD.*

**All for one**

**and**

**one for all!**



**DesignCAD 2D for Windows**

**NEW!** Powerful, yet affordable, DesignCAD 2D for Windows is terrific for your drafting and design applications. Plus, with this Windows version, you will be designing within minutes!

- Full Clipboard support
- IntelliCursor
- TrueType Font Support
- Quick-Change Edit Boxes
- Print Preview

Also available is our award-winning DOS version of DesignCAD 2D!

**\$349 (or less)**



**DesignCAD 3D**

The best in 3D CAD will handle all of your solid-modeling and conceptual designs. The special screen allows for 4 different views at the same time! You get all this and more for one low price!

- Solid Modeling
- Rendering with Textures
- BasicCAD
- Supports 10 File Formats
- Volume and Surface Area Calculations

All of this plus a complete set of modeling tools makes designing easy!

**\$499 (or less)**



**VinylCAD**

Create your own business! VinylCAD is capable of producing professional quality signs in a fraction of the time it would take a traditional sign-painter. Here are just a few of its advantages:

- Hold-Text to Any Shape
- Scan Generators are Simple
- Kerning
- Auto Sign creates a Sign for You!
- 400 FREE Symbols

Plus, VinylCAD comes complete with over 600 fonts for any sign you can imagine.

**\$799 (or less)**

**To order call (918) 825-7555 or fax (918) 825-6350!**

Need more information? Call and we will send you FREE color brochures and Demo Disks.

American Small Business Computers • One American Way • Pryor • OK • 74361



## State of the Art

;stalled owing to AGI  
mov esi, [mem]

an AGI occurs after the second instruction is encountered in the V-pipe. This halts execution in both pipes for one clock cycle until the first instruction completes. Properly scheduled, the code would look as follows:

```
;U-pipe      V-pipe
inc ebx      inc ecx
inc edx      mov esi, [mem]
mov eax, [ebx]
```

### To Optimize or Not to Optimize?

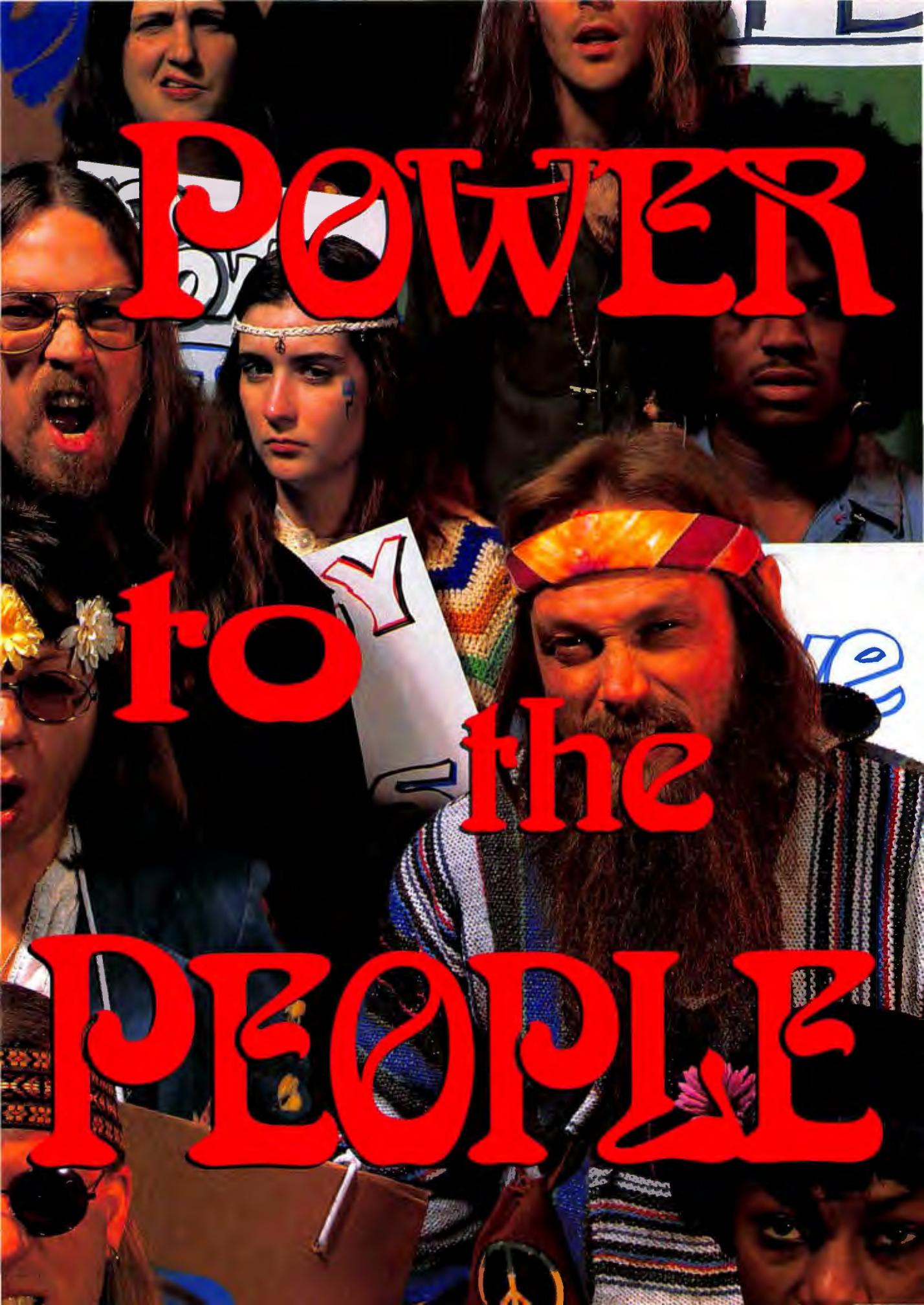
There are two good reasons why you might not want to always run the optimizer when compiling code. The first is time. It's not unusual for compilers with aggressive optimizers to increase code generation time by 200 percent to 300 percent, and this figure may rise for compilers that implement advanced, machine-dependent optimizations.

The second reason concerns debugging. Traditional source-level debuggers rely on a correspondence between the source code and the object code. When you introduce moved code, compacted (or worse, interchanged) loops, eliminated variables, inlining, and so on, optimized code often bears little resemblance to the source code from which it came. This makes debugging optimized code nearly impossible, except at the assembly language level.

Various approaches to debugging optimized code have been tried, such as noting what line of original source code generated particular instructions, and others are under development. Currently, though, the standard approach to software development is to debug using unoptimized code, and only then to run the optimizer to generate the final executable. Any bugs that are introduced during optimization must be chased down at the assembly language level.

As the complexity of processors increases, today's optimizing compilers are becoming more complex. In addition to providing the traditional machine-independent optimizations that mimic what a determined developer might do to make code faster or smaller, the compilers are beginning to perform machine-dependent optimizations that promise quantum boosts in performance. ■

Alex Lane is a Colorado-based writer, speaker, and consultant. He can be reached on the Internet or BIX at a.lane@bix.com.



POWER

to the

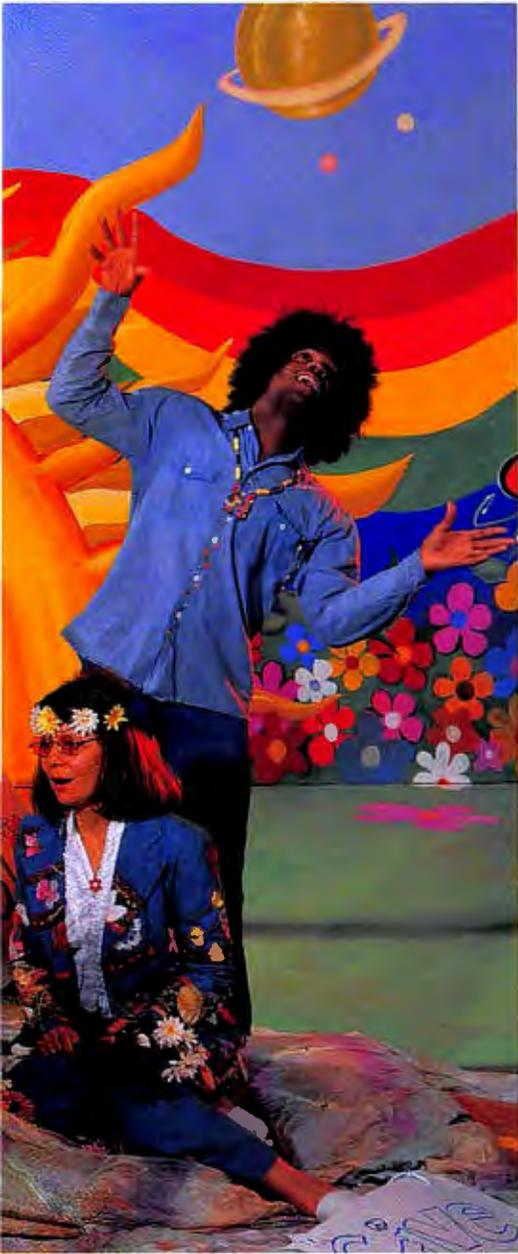
PEOPLE



*Now more than ever, we're giving power to the people. Our Pentium-based PCI systems are priced hundreds, sometimes thousands of dollars less than competitors' comparably configured Pentium systems. That's PC power everyone can afford!*



# You Got It, Baby!

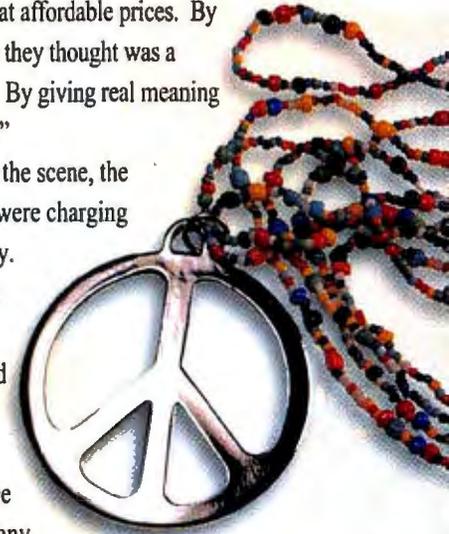


## By the Time We Get to Woodstock

When historians write the history of the personal computer industry years from now, they'll remember Gateway 2000™ as the radical PC manufacturer that gave power to the people by selling the highest-quality, latest-technology computers at affordable prices. By showing PC buyers a level of service they thought was a throwback to the peace and love era. By giving real meaning to the tattered, worn-out term "value."

When Gateway 2000 came onto the scene, the establishment computer companies were charging whatever they wanted for technology. Gateway was a real downer to them because we began selling the same technology for a whole lot less. And the buyers were very smart. They shouted, "Hell no, we won't go," to the big companies, and took a chance on the revolutionary Midwest company called Gateway 2000. Soon a great legion of people — even more than Woodstock attracted — was buying Gateway PCs.

Today, Gateway 2000 is bigger than many of the companies for which it was an alternative. So why should you buy a Gateway computer today? Same reasons as in the beginning. You still get the best price, quality and service from us.



## Demonstrations

That's why, for the third consecutive year, we swept *Computer Shopper's* Best Buy Awards, winning every product award we were eligible for and being chosen as the Best Overall Systems Supplier. (Thanks, *Shopper* readers!) That's why we took five top honors in *PC World's* World Class Awards, including Best Mail Order Company and Best Service and Support. (Thanks, *PC World* readers!) And even though we're now a Fortune 500 company, we still champion anti-establishment thinking. Check it out. You'll find GW2K is far-out, groovy and totally unreal!

*We dedicate this ad to the memory of Sol Pessin, one of our special customers who believed in us during the early days. We'll miss you, Sol.*



8 0 0 - 8 4 6 - 2 0 5 8

# Gateway Gives You Performance

## The Eagle has Landed

When Gateway introduced a Pentium™-based system — loaded — for under \$4,000, everybody in the industry knew the Eagle had landed. The best PC value on the planet had arrived! The editors of *PC/Computing* heralded the accomplishment by naming it Best Desktop of 1993.

Then we topped our achievement by offering *four* Pentium processor-based systems, including a *new 66MHz model*, priced from \$2,495 to \$3,995. Now that's a giant leap in value for one of the highest-performance PCs on earth. These systems are tomorrow's technology available today at affordable prices — only from Gateway.

Our P5 systems include Intel's 64-bit Pentium processor, which moves instructions and data twice as fast as a 486 system. The P5 PCs get another performance boost from a PCI local bus. The PCI bus can operate 10 to 15% faster than a VESA® local bus. The PCI bus' "plug and play" feature makes your PC easier to use, too, by automatically configuring peripherals.

## Space-Age Video

The PCI bus is coupled with a space-age video system, with 2MB standard video memory giving you 64,000 colors at 1024 x 768 resolutions. The PCI-based video system uses a high-performance 64-bit interface to video memory that achieves 16 million colors, true 24-bit, in VGA and SVGA resolutions. Our standard video system gives you the best overall performance on the market.

The net effect of the PCI local bus and this video system is performance that will send you into orbit. It's definitely far-out!

## 486 PCI Local Bus System is A-OK

The PCI local bus and PCI video system are also available in a 66MHz 486DX2 system, Intel® verified to be Pentium upgradable. Another A-OK value in a high-performance system from Gateway!



Photo courtesy of NASA. Thanks!



8 0 0 - 8 4 6 - 2 0 5 8

# That's Out Of This World!



*Our P5-60 was named Best Desktop of 1993 by the editors of PC/Computing. "(It) is nearly twice as fast as its nearest competitor at Windows operations. When it comes to top-of-the-line desktop systems, you can't beat high performance for a low price," states the editorial.*



*New this month is our 66MHz Pentium-based system for only \$3,995.*



# Be A Trend-Setter With A



*Our 4DX2-66V model has to be one of the most highly decorated PCs in the history of the industry. For good reason! Like other Gateway VESA and integrated systems, it's a very attractive value.*



# Gateway VESA Or Integrated PC



*Our Family PC comes with CD-ROM, sound card, speakers, joystick, fax/modem and multimedia software. You choose one software option from five great Family PC multi-title packages. Some of the outstanding titles you can get are: Microsoft Works™, Dinosaurs and Encarta™, Cinemania™, Time Almanac, Links Golf Collection, The Animals, MicroProse™ Game Pack, MECC Elementary Education Pack — and more!*

You'll be a trend-setter in your office or neighborhood if you choose a Gateway VESA® or integrated system because there's nothing more fashionable than a great buy. Everybody wants one!

## VESA a Go-Go

Our VESA local bus machines give you go-go performance at a fab price. VESA, which stands for Video Electronics Standards Association, assures you of compatibility with any VESA peripheral. These systems are also upgradable to a Pentium™ OverDrive™ Processor if you need more processor power in the future.



## Integrated PCs Sock it to 'Em

Our integrated systems definitely sock it to the competition. Offered in space-saving mini desktop cases, our local-bus integrated PCs give you twice the video performance available in many standard desktop machines. In fact, video performance in our integrated systems is similar to, or better than, that found in many of our competitors' high-end systems.

Of course these machines are also upgradable to a Pentium OverDrive Processor.

Our special Family PC, with full multimedia capabilities and some exciting software choices, is priced at only \$1,995. Ask us for details.

If you want a mod PC for the fewest dollars possible, you want an integrated system from Gateway. You can bet your bippy on that!

## Energy Stardom

All Gateway 2000™ VESA local bus and integrated systems wear the Energy Star seal to show they comply with energy-saving guidelines established by the EPA. Our commitment to the Energy Star program is just one of the ways we're working to help the environment — and to help you save money!



"You've got a friend in the business."®

8 0 0 - 8 4 6 - 2 0 5 8

# For The Rolling Stone In You.

Whether you travel constantly from continent to continent or occasionally from office to home, Gateway has the perfect portable PC to keep you rollin' on down the highway.

## Easy Rider

The revolutionary HandBook® 486 gives you more MIPS per pound than any other PC! Plus, the HandBook is the answer to the most common question seasoned portable users ask themselves: should I take my portable or not? Is it worth the hassle? With a HandBook, you'll never ask yourself that question again. It's so small and light, it's effortless to carry. The decision is automatic: of course you'll take your HandBook. You'll never want to be without it! The HandBook is a truly extraordinary product that will forever change the way you use a PC.

The HandBook has all the features that matter to you, too, including: ideal weight and size (less than 3 pounds, about the size of a day-planner); plenty of power (genuine Intel SL Enhanced 486 processor); great screen (bright, 7.9-inch backlit VGA display); comfortable 78-key keyboard; EZ Point integrated pointer (no need to carry a clumsy mouse); excellent battery life (up to four hours); suspend/resume (a handy feature that allows you to stop work any time and resume later without losing data or restarting the system).

## Psychedelic Day-Tripper

Psychedelic color for flower children of all ages. That's the Gateway 2000™ ColorBook™. The ColorBook includes: a brilliant, 9.4-inch VGA color screen (dual-scan STN color is the latest technology in color displays); 486 performance (genuine Intel SL Enhanced 486 processor); excellent portability (weighs less than 5.7 pounds and is ultra-thin — just 1.77 inches); simultaneous video up to 1024 x 768 resolution; a built-in trackball (very easy to use); two PCMCIA Type II slots (can also be used for one Type III PCMCIA card); great battery life (up to four hours); suspend/resume feature.

If you want dazzling color at a mono price, look no further than the ColorBook.



8 0 0 - 8 4 6 - 2 0 5 8



# Gateway Has Groovy Portables.



On your next trip, be sure to take along a good book.  
That's a HandBook or a ColorBook from Gateway 2000!



HandBook  
Best Subnotebook



HandBook  
Best Subnotebook



HandBook  
Best Hand-Held/Palmtop



# Add A Twist



*Shown here is our 4DX2-66V model loaded with options including a 17-inch CrystalScan monitor, combo floppy drive, multimedia kit with optional Yamaha speakers, Colorado Memory Systems tape backup unit, FlightStick and Epson Stylus 800 printer. With multimedia, the sights and sounds of any era are available to you with a click of your mouse. Right on!*

## PORTABLES

### HANDBOOK® 486

- Weight: 2.94 Lbs.
- Dimensions: 9.75" x 5.9" x 1.6"
- SL Enhanced Intel® 486 Processor
- 4MB RAM (expands to 8MB or 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-DOS®, Windows™ & Serial Transfer Cable

#### HANDBOOK 486SX-25

With 25MHz 486SX CPU and 80MB Hard Drive

**\$1495**

#### HANDBOOK 486DX2-40

With 40MHz 486DX2 CPU and 130MB Hard Drive

**\$1995**

### HANDBOOK PACKS

#### Traveler's Packs:

- Microsoft Works for Windows, case, extra battery & PCMCIA 9600/2400 fax/modem. **\$369**
- Microsoft Works for Windows, case, extra battery & PCMCIA TelePath™ fax/modem. **\$489**

#### Presenter's Pack:

- PCMCIA VGA adapter, Asymetrix® Compel & case. **\$319**

### PORTABLE OPTIONS

#### PCMCIA Cards:

- TelePath 14400/14400 fax/modem. **\$319**
- 9600/2400 fax/modem. **\$199**
- Ethernet adapter. **\$189**
- 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 Processor
- 4MB RAM (expands to 8, 12 or 20MB)
- 3.5" 1.44MB Diskette Drive
- Removable 80 to 250MB IDE Drive
- 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™
- MS-DOS and Windows

#### COLORBOOK 486SX-25

With 25MHz 486SX CPU and 80MB Hard Drive

**\$1995**

#### COLORBOOK 486SX-33

With 33MHz 486SX CPU and 170MB Hard Drive

**\$2395**

#### COLORBOOK 486DX-33

With 33MHz 486DX CPU and 250MB Hard Drive

**\$2795**

### COLORBOOK PACKS

#### Traveler's Packs:

- Case, extra battery & PCMCIA 9600/2400 fax/modem. **\$329**
- Case, extra battery & PCMCIA TelePath fax/modem. **\$449**

### NOMAD 450DXC

- Weight: 6.2 Lbs.
- Dimensions: 8.5" x 11" x 2.2"
- 50MHz Intel 486DX2 CPU
- 8MB RAM
- 3.5" 1.44MB Diskette Drive
- 200MB IDE Hard Drive
- 8.4" Color ActiveMatrix Screen
- NiMH Battery & AC Pack
- Simultaneous Video with 1MB
- 79-Key Keyboard & Mouse
- 9600/2400 Fax/Modem
- 1 Parallel, 1 Serial Port
- MS-DOS, Windows & Works **\$3995**

### MULTIMEDIA KIT

Here's everything you need to add multimedia to any Gateway desktop PC. You won't find a better holiday price anywhere!

- Gateway 2000 16-Bit Sound Card, Sound Blaster™ Compatible
- Double-Speed CD-ROM
- 2 Labtec® Speakers
- Microsoft Encarta & Corel Photo CD Software
- Gateway System CD **\$299**

For system configurations that include a CD-ROM drive: **\$132**  
Only with system purchase.

### 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 '92® CD-ROM Edition
- Microsoft PowerPoint for Windows™
- Microsoft Project for Windows™
- The Entrepreneur Pack (Works™ Publisher,™ Money™ & games)
- Borland Paradox® database and Quattro® Pro for Windows spreadsheet
- Microsoft Access™ for Windows

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)
  - Kiplinger's™ CA-Simply™ Money
  - QAPLUS Diagnostics
  - Gateway Computer Glossary
  - Gateway Mouse Pad
- Systems with CDs also include:
- Gateway System CD with Microsoft Multimedia Pack™
  - Multimedia On-Line User's Guide
  - Gateway Mail 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.



# To Your Gateway PC!



When you've picked the PC you want, take a look at the options listed here to make your system as productive and fun as possible. Sorry, the peripherals listed here are sold only with the purchase of a system. For details on our complete line of extras for Gateway customers, ask for our special add-on components division when you call.

## 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 attach to your PC monitor
  - Microsoft® Encarta & Corel Photo CD software
  - Gateway 2000 System CD with Microsoft Multimedia Pack™
- \$299**

For system configurations that include a CD-ROM drive, get the multimedia kit without CD-ROM drive for: **\$132**

### Yamaha®YST-M10 Multimedia Speakers

New! 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 Multimedia Speakers

Get superior stereo sound with these top-rated Altec Lansing ACS-300 speakers with separate powered subwoofer. **\$219**

### CH FlightStick

The joystick that's recommended by our kids! With a sensational "feel" and rugged construction, this is the last joystick you'll ever have to buy! **\$35**

## 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. **\$159**

### Cardinal® 2400 Fax/Modem

Internal fax/modem, 2,400bps modem, V.22bis, with 9,600bps fax capability. Package includes data and fax communication software. **\$49**

### Colorado Memory Systems® TBU

250MB internal automatic tape backup unit copies up to 9.5MB per minute. Comes with 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 Kit (BNC kit includes cable, connector, terminator and card).

### Ethernet Adapter from 3Com®

Manufactured by 3Com for Gateway. Features parallel tasking architecture with a high level of integration. **\$105** Twisted Pair. **\$125** BNC Kit (includes cable, connector, terminator and card).

## Monitors

### CrystalScan® 17-Inch Monitor



Non-interlaced color monitor, .26mm dot pitch. If your system comes with a 14-inch monitor, you can upgrade to this monitor for **\$430**. If your system comes with a 15-inch monitor, you can upgrade for **\$350**. (Prices good only for upgrades at the time of system purchase.)

## Printers

### Epson® 1070+ Printer

Here's a value-priced, wide-carriage dot matrix printer that gives you 225cpi in draft mode, 10 letter-quality fonts and 4 scalable fonts. Quiet, too (46.5db)! **\$359**

### Panasonic Color-Capable Printer

Add color to your documents with this 24-pin dot matrix printer. Includes Adobe Type Manager® KX-P2123 **\$259**; Color Option **\$50**

### Epson Stylus 800 Ink Jet Printer

Great laser quality at an even 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 with crisp, sharp images, black blacks and smooth, "jag-free" lines. It also features a fast six-page per minute print speed, 14 resident fonts, 300 x 300dpi, and 1MB memory expandable to 5MB. Parallel cable included. **\$669**

## TI MicroLaser™ Pro 600

This Texas Instruments laser printer redefines value in high-performance printing with 6MB RAM standard, a fast eight pages-per-minute print rate, 500-sheet capacity and true 600dpi quality.

With 23 PostScript® Fonts: **\$1,449**

With 65 PostScript Fonts: **\$1,629**



## Lexmark 4039 10R

The printer for tomorrow's technology! Featuring a fast, RISC processor it switches between PostScript and PCL5 printer languages automatically and prints at a remarkable 10 pages per minute at true 600dpi. **\$1,399**

## Easy Payment Options

We make it easy for you to buy a Gateway PC, too! We accept most major credits 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.*



8 0 0 - 8 4 6 - 2 0 5 8

*Our '60s models are all Gateway 2000 employees and their children who relived the flower-power era for this ad.*

## INTEGRATED & VESA SYSTEMS

### 4SX-33/4DX-33

- Intel 33MHz 486SX or DX CPU
- 4MB RAM
- 212MB 13ms IDE Hard Drive
- Local Bus Graphics with 512KB
- 3.5" Diskette Drive
- 14" Color CrystalScan® 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- 101-Key Keyboard & MS Mouse
- MS-DOS® 6.2 & WFW™ 3.11
- MS Works for Windows™
- EPA Energy Star Compliant

**4SX-33 - \$1295**

**4DX-33 - \$1495**

### 4DX2-50/4DX2-66

- Intel 50 or 66MHz 486DX2 CPU
- 4MB RAM, 128KB Cache
- 424MB 13ms IDE Hard Drive
- Local Bus Graphics with 1MB
- 3.5" Diskette Drive
- 14" Color CrystalScan 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- AnyKey® Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software
- EPA Energy Star Compliant

**4DX2-50 - \$1795**

**4DX2-66 - \$1995**

### 4SX-33V

- Intel® 33MHz 486SX CPU
- 4MB RAM
- 212MB 13ms IDE Hard Drive
- VLB™ Graphics with 1MB
- Local Bus IDE Interface
- 5.25" & 3.5" Combo Drive
- 14" Color CrystalScan® 1024NI
- Baby AT Case
- 5 ISA & 2 VESA®/ISA Slots
- AnyKey® Keyboard & MS Mouse
- MS-DOS® 6.2 & WFW™ 3.11
- Choice of Application Software
- EPA Energy Star Compliant

**\$1495**

### 4DX2-50 FAMILY PC

- Intel 50MHz 486DX2 CPU
- 8MB RAM, 128KB Cache
- 212MB 13ms IDE Hard Drive
- Local Bus Graphics with 1MB
- Double-Speed CD-ROM, 16-Bit Sound Card & Speakers
- 2400/9600 Data/Fax Modem
- 3.5" Diskette Drive
- 14" Color CrystalScan 1024NI
- Mini Desktop Case
- 5 16-Bit ISA Slots
- 101-Key Keyboard, MS Mouse & Joystick
- Choice of Family PC Software
- EPA Energy Star Compliant

**\$1995**

## VESA & PCI SYSTEMS

### 4DX-33V/4DX2-50V

- Intel 33MHz 486DX or 50MHz DX2 CPU
- 8MB RAM, 128KB Cache
- 424MB 13ms IDE Hard Drive
- VLB Graphics with 1MB
- Local Bus IDE Interface
- 5.25" & 3.5" Combo Drive
- 14" Color CrystalScan 1024NI
- Baby AT Case
- 5 ISA & 2 VESA/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software
- EPA Energy Star Compliant

**4DX-33V - \$1975**

**4DX2-50V - \$1995**

### 4DX2-66V BEST BUY

- Intel 66MHz 486DX2 CPU
- 8MB RAM, 128KB Cache
- 424MB 13ms IDE Hard Drive
- VLB Graphics with 1MB
- Double-Speed CD-ROM
- Local Bus IDE Interface
- 3.5" Diskette Drive
- 15" Color CrystalScan 1572FS
- Baby AT Case
- 5 ISA & 2 VESA/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software
- EPA Energy Star Compliant

**\$2295**

### P4D-66

- Intel 66MHz 486DX2 CPU
- 8MB RAM, 256KB Cache
- 424MB 13ms IDE Hard Drive
- PCI Local Bus Graphics with 2MB
- Double-Speed CD-ROM
- 3.5" Diskette Drive
- 15" Color CrystalScan 1572FS
- Baby AT Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software

**\$2495**

### 4DX2-66V

- Intel 66MHz 486DX2 CPU
- 16MB RAM, 128KB Cache
- 424MB 13ms IDE Hard Drive
- VLB Graphics with 2MB
- Double-Speed CD-ROM
- Local Bus IDE Interface
- 3.5" Diskette Drive
- 15" Color CrystalScan 1572FS
- Baby AT Case
- 5 ISA & 2 VESA/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software
- EPA Energy Star Compliant

**\$2795**

## PENTIUM SYSTEMS

### P5-60

- Intel 60MHz Pentium™ CPU
- 8MB RAM, 256KB Cache
- 424MB 13ms IDE Hard Drive
- PCI Local Bus Graphics with 2MB
- 3.5" Diskette Drive
- 14" Color CrystalScan 1024NI
- Baby AT Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- MS Works for Windows

**\$2495**

### P5-60 BEST BUY

- Intel 60MHz Pentium CPU
- 8MB RAM, 256KB Cache
- 424MB 13ms IDE Hard Drive
- PCI Local Bus Graphics with 2MB
- Double-Speed CD-ROM
- 3.5" Diskette Drive
- 15" Color CrystalScan 1572FS
- Baby AT Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software

**\$2795**

### P5-60

- Intel 60MHz Pentium CPU
- 16MB RAM, 256KB Cache
- 540MB 13ms IDE Hard Drive
- PCI Local Bus Graphics with 2MB
- Double-Speed CD-ROM
- 3.5" Diskette Drive
- 15" Color CrystalScan 1572FS
- Baby AT Case
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software

**\$3295**

### P5-66

- Intel 66MHz Pentium CPU
- 16MB RAM, 256KB Cache
- 540MB 13ms IDE Hard Drive
- PCI Local Bus Graphics with 2MB
- Double-Speed CD-ROM
- 16-Bit Sound Card & Speakers
- 3.5" Diskette Drive
- 17" Color CrystalScan 1776LE
- Tower Case, 300W Power Supply
- 4 ISA, 2 PCI & 1 PCI/ISA Slots
- AnyKey Keyboard & MS Mouse
- MS-DOS 6.2 & WFW 3.11
- Choice of Application Software

**\$3995**



8 0 0 - 8 4 6 - 2 0 5 8



Phone 605-232-2000 • TDD 800-846-1778 • Fax 605-232-2023 • FaxBack 605-232-2561 • Add-On Sales 800-846-2080  
Toll free from Canada and Puerto Rico 800-846-3609 • Sales Hours: 7am-10pm Weekdays, 9am-4pm Saturdays(CST)



# Thank You

Thank you, Gateway customers everywhere, for your support in 1993. As you can see by the number of major industry awards we received, it was another banner year for Gateway 2000. And we owe this success to you. Our most treasured honors are the "Readers' Choice" awards that come from PC users. The majority of our awards are this variety, which is why we feel so fortunate this year.

Thanks again for these groovy tributes. We'll do everything in our power to live up to the confidence you've shown in us. You're the best!

Your Friends at



**GATEWAY2000**



January 1994  
Desktops — #1 in Overall Reliability & Likelihood of Buying Again  
Portables — #1 in Overall Reliability, Repair Service & in Likelihood of Buying Again



Best Service and Support  
Best Mail Order Company



Best Desktop  
of 1993

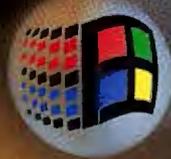
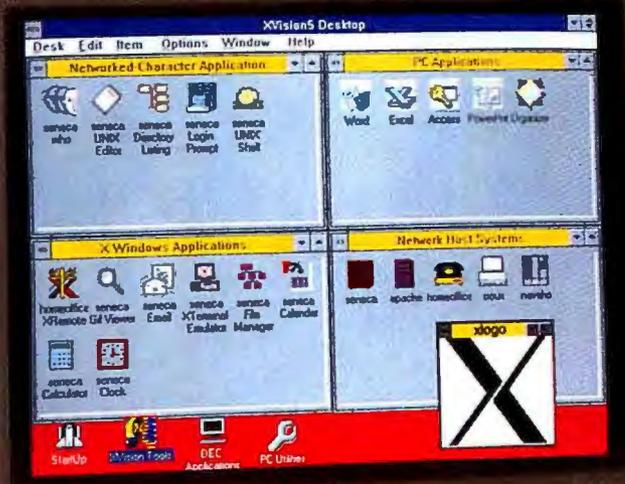


Best Overall Systems Vendor  
Best 486 Desktop  
Best 486 Notebook  
Best Subnotebook



Company That  
Provides the Best  
Service

# XVision 5™ Your Ultimate Connectivity Solution



## XVision 5™

The market-leading Microsoft® Windows™ PC X Server, is packed with smart features that make it your best connectivity solution for running and displaying X Window and VT320 applications.

### Desktop Command Center

Navigate through the whole range of enterprise-wide operating environments. Networked host connections, log-on procedures and application launching are quick and simple icon movements.

### Smart Installation and Configuration

Installation is automatic with XVision 5. Built-in system intelligence detects underlying network transports and configures itself accordingly.

### Automatic Graphics Speed Optimization

XVision 5 dynamically adjusts to take best advantage of your graphics hardware.

### Automatic Font Substitution

Expert system technology locates the "best match" whenever a font requested by an application is unavailable on your PC.

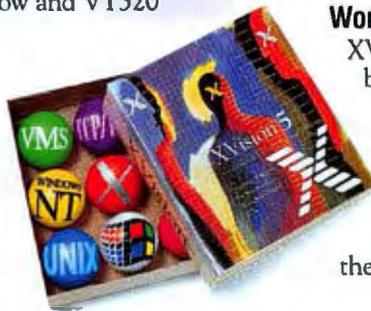
### Workstation Functionality

XVision 5 adds to X Server capability by including bi-directional file transfer, local PC printing of UNIX files, keyboard mapping and VT320 terminal emulation.

### Easy-to-Use

Extensive on-line help and new smart interactive diagnostics make XVision 5 the easiest PC X Server to use.

**XVision 5™**  
The Smart PC X Server  
from VisionWare®.



VisionWare® and the VisionWare logo are registered trademarks and XVision and XVision 5 are trademarks of VisionWare Ltd. XRemote is a registered trademark of Network Computing Devices, Inc. All other trademarks are recognized as property of their respective companies.



US Headquarters

1-800-949-8474

4500 Bohannon Drive, #280 • Menlo Park, CA 94025-1029  
Tel: (415) 325-2113 • FAX: (415) 325-8710

Corporate Headquarters

57 Cardigan Lane • Leeds LS4 2LE • United Kingdom  
Tel: +44 532 788858 • FAX: +44 532 304676

Circle 170: Call me, I'm interested; Circle 169: Send literature; Circle 171: Resellers circle on Inquiry Card.

# DEVELOPING FOR MULTIPLE PLATFORMS

Businesses expect software to run on Macintosh, DOS, Windows, and Unix. Moving an application to another platform is a daunting task that can change a developer's approach to writing software.

DOUGLAS K. OLSON



**B**usinesses today expect the same applications to be available for Windows, DOS, and Macintosh computers. Consequently, engineers are finding ways to sustain and codify cross-platform development efforts. Their strategies are varied, and the process remains highly subjective, but new tools and techniques are gradually beginning to speed and simplify cross-platform development.

One simplification has come with ANSI C and C++, which freed developers from compiler-specific design. By adhering to ANSI C syntax, for example, developers can create code that comes closer than ever before to being compatible with compilers for multiple platforms. In effect, applications are moving toward real portability.

## Toward Compiler Independence

Many issues still stand in the way of compiler independence. For one thing, despite the ANSI standard, various compilers interpret C syntax differently. The reality is that developers must still write C code for specific, individual compilers.

For example, ANSI C does not define the size of all data types. Integer size can be either 16 or 32 bits—whichever is optimal for a given platform. Developers often make the mistake of depending on the size of this variable in their code. And compilers on the same platform implement this data type differently.

Developers also need to be aware of processor-based restrictions. For example, compilers must align data structures on short- or long-word boundaries, according to the memory-addressing rules of various processors. Trouble can result when code makes different assumptions about such alignment.

Platform conventions also define compilers. For example, the Mac environment groups and identifies resources by four-character constants, such as ICON for an icon resource or PICT for a picture resource. Most Mac compilers let you assign these four-character constants to 32-bit

## Porting Adobe Photoshop: A Case Study

In the course of developing and porting Adobe Photoshop, a package for editing images, Adobe engineers have learned a number of lessons.

When Photoshop was conceived in 1988, the Mac was the only affordable desktop system with the needed horsepower. Adobe developed the application in MacApp, an object-oriented framework using Object Pascal. At that time, Windows was not a significant factor for graphics applications, and the Mac was clearly the platform of choice for graphics and desktop publishing.

By late 1990, it was clear that the Windows platform would become a major market, and Adobe began planning its first Windows port. The company faced a difficult task. Understandably, it had not taken enough of the precautionary and preparatory steps that are routine today. Adobe had created a base of source code for which there were very few tools. Windows compilers existed for C, C++, and Pascal, but not for Object Pascal, which was little known outside of Apple.

MacApp itself presented a serious porting challenge. To port Photoshop, not only the application code would have to move but also the entire MacApp framework.

While planning this first Windows port, Adobe was also mapping out new features for the next major upgrade. Clearly, if Adobe engineers opted to take a "snapshot" of the existing Photoshop code and then embark on a complex port to Windows while simultaneously bringing major new features to the Mac side, the two versions would be hopelessly out of sync.

Still, market conditions favored the snapshot approach. No one was certain that Windows would become a popular, viable platform for

graphics and desktop publishing software. And it seemed unwise to tie up the highly successful Mac version of Photoshop while engineers reworked the application to sustain future cross-platform development efforts.

### EMULATING MACAPP

In the end, Adobe opted for a sustained approach, hoping to avoid an endless pattern of releasing different platform versions with leapfrogging feature sets. Adobe decided to do a bulk translation of Photoshop from Object Pascal to C++ and to restructure the application into separate core and edge code. It would also create its own framework for Windows that emulated MacApp.



Doug Olson (lower left) with Adobe Photoshop team members.

The first step was to form separate Mac and Windows development teams. Engineers on the Mac side would restructure the product to separate core code and API-related code. They would use MacApp 3.0, written in C++. Their goal was not to port code but to structure it properly. At the same time, the

Mac team was working on new features for the next major revision.

Meanwhile, the Windows team began building an emulation of MacApp. They looked at the existing Photoshop and emulated only the required portions of MacApp—those relating to the user interface. Their goal was to bring MacApp functionality to Windows and thus ensure that Mac code would compile under Windows.

At that time, it was unclear whether the Windows team would be licensed to use MacApp source code, so they worked without it, using headers that described the MacApp API and building their own analogs. As a result of their efforts, it is possible, using emulated portions of

MacApp, to translate the Mac GUI into a Windows GUI. Adobe developed its own tool that converts Mac *view resources*—which describe interface elements such as dialog boxes and buttons—for use by the emulated MacApp.

This effort was so successful that, to this day, as Adobe's developers continue to improve Photoshop, their code for new features usually compiles without modification under either platform. Aside from the usual compiler independence issues, little hampers this process. Now, when developers complete new Photoshop features for either platform, the same features can be running on the other platform in short order. Mac and Windows versions of Photoshop ship within weeks of each other.

**NEW PLATFORMS—UNIX, POWERPC, AND NT**  
Encouraged by the successful Windows port and market forces, Adobe decided to develop Unix versions of Photoshop, including Sun Microsystems and Silicon Graphics. By leveraging fast I/O bandwidth and RISC processors, Photoshop will get a big performance boost.

To bring Photoshop to Unix platforms, Adobe is using Latitude, an emulated API system from Quorum Software Systems. Because the Quorum system emulates the Macintosh API, MacApp ported directly. A high percentage of Photoshop's Mac source code, running against Latitude's Unix libraries, has compiled without change.

Adobe is currently porting Photoshop to the PowerPC Mac and Windows NT. While it is too early to discuss either port in much detail, the basic approaches are clear.

In porting Photoshop to the PowerPC, the quirks of MacApp proved to be the major obstacle. Apple's compilers for the PowerPC, which were written by IBM, were not geared to certain

variables. But this is not strictly legal ANSI C behavior and will fail on platforms that don't observe this convention.

The ANSI standard offers a mechanism for deviating from its imposed uniformity. For example, to tell a compiler to generate code for a specific processor, developers use `#pragmas`, C words that govern platform- and compiler-specific directives.

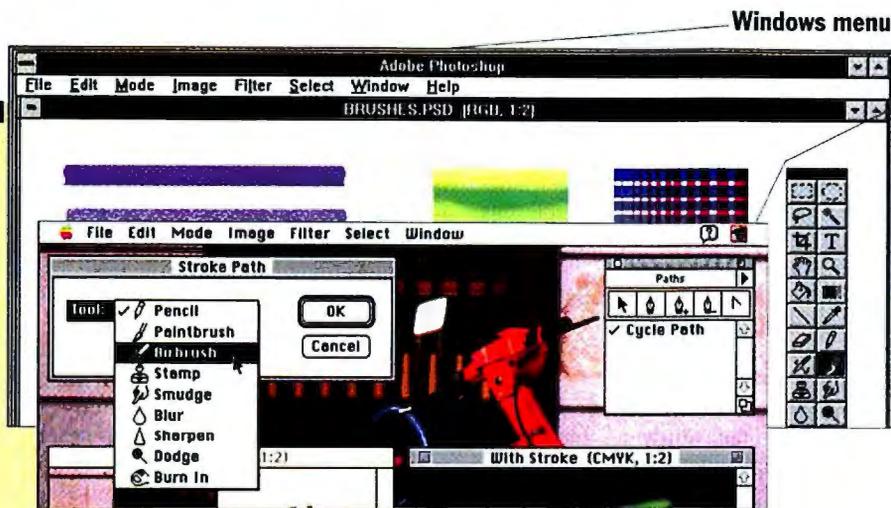
When groups of people program together, source code management tools are essential. The danger is that two people will modify the same code at the same

time, destroying each other's changes. Also, it is often necessary to track code changes and store iterations. Unfortunately, until recently, most vendors of version-control software built their products for one line of platforms.

One common solution is to establish a system that acts as a neutral third party. For example, teams targeting Windows and the Mac could choose a source code control package on a Unix machine. Another strategy is to standardize on a version-control system for a given platform,

such as Projector, part of the MPW. Here, the entire cross-platform team would have access to Mac machines and would check their code in and out of the Mac.

This picture is changing as vendors design source code management products for multiple platforms. One Tree Software's (Raleigh, NC) SourceSafe maintains compatible tools and source code database files that run on the Mac, Windows, and Unix. Intersolv's (Rockville, MD) PVCS Version Manager is a version-control product for Windows, NT, DOS, OS/2, and Unix.



The screens show how well the Windows and Mac versions of Photoshop correspond.

peculiarities of Object Pascal. For example, one involves the use of objects based on handles rather than pointers—a distinctive aspect of Macintosh memory management. Supporting such Object Pascal-based objects and calling sequences was too much for the PowerPC compiler. To get around this, Adobe and Apple jointly developed a new version of MacApp that compiles under PowerPC.

PowerPC and NT bring important changes to APIs and raise the usual issues of compiler independence. With NT, for example, the target machine may be using any of a number of different processors from Intel, Mips, and DEC.

NT brings important benefits to applications like Photoshop. For example, image-processing applications need large data structures. To run under Windows, these had to be broken into 64-KB units—a requirement that NT eliminates because it relies on a 32-bit flat-memory model, just like the Mac. Thus, NT removes the performance constraints that compromise the performance of Photoshop under Windows.

It turns out that, with the MacApp emulation well established on the Windows side, the Photoshop Windows source code contains no attributes that do not easily compile. Therefore, the Adobe team was able to move Photoshop easily to NT.

Debugging is an inherently low-level, platform-dependent task. Now, no debuggers work the same way or present the same interface from platform to platform. The idiosyncratic nature of debuggers makes it a challenge for developers to acquire expertise in more than one platform.

Object-oriented frameworks, such as Apple's MacApp and Microsoft's Foundation Classes, provide a generic application to which developers need only add specific behavior. For example, MacApp has a class library that implements a stan-

dard Mac application—it handles menu commands, updates windows, dispatches events, deals with the Clipboard, and so on. The class library handles all the general items, and the developer provides the application-specific behavior.

Such frameworks can be a boon to development but, unless they target multiple platforms, can seriously hamper future ports. For example, Adobe originally developed Photoshop for the Mac using the MacApp framework and then decided to port the product to Windows. There was no abstracted, portable API into MacApp—and certainly no corresponding Windows version—so developers faced an unusual challenge (see the text box "Porting Adobe Photoshop: A Case Study").

#### Code Issues

To gain performance, virtually all commercial developers write key portions of application code in assembly language. By hand-assembling performance-sensitive components, the developer will generate more efficient code than the compiler and selectively give a boost to important operations. For example, painting with a mouse in a Photoshop document is a well-defined, highly performance-sensitive task. Because Adobe didn't want to compromise performance here, it wrote the inner loops of that function in assembly language.

The problem is that processor-specific assembly code is inherently not portable; to facilitate the porting process, developers have learned to maintain high-level language analogs of assembly language components. Now, when developers rewrite critical C code in assembly, they retain the original C code as well. With these C analogs, engineers can quickly move a package from one platform to the next. They can get a C version running on the new platform and only then decide whether to again rewrite specific sections of code in the new platform's assembler.

As RISC-based systems account for a larger share of the desktop market, future applications will use less assembly language. With RISC, assembling code by hand is dauntingly complex, and a compiler can almost always do a better job.

The move to RISC processors will present other challenges as well. Because it relies on a small and relatively simple instruction set, a RISC machine needs many more instructions than a CISC processor to represent a high-level function. For example, some Mac applications may double in size as they move from 680x0- to PowerPC-based platforms.

#### Like a Family Reunion

Historically, porting strategies can be compared to certain aspects of a family reunion. A defining moment of either is a family portrait—a snapshot documenting the state of application code for a particular platform at a given moment. In a real family, once the photo has been taken, members begin to move around; similarly, having recorded the code at an instant in time, developers begin changing it.

On the one hand, the application code for the original platform is modified as it is maintained and upgraded. At the same time, another team of developers is migrating the code, as recorded in the snapshot, to a new platform. So at a definable instant in time, one set of code begins heading in two directions, changing in various ways for different reasons.

Typically, once the port is completed, developers return to the first platform and begin planning the next major revision. But what should they upgrade? The original snapshot version has changed a lot, and in porting to the second platform, developers invariably add new features and functions. So where do developers start?

The usual answer lies in the family reunion. The latest versions for both platforms must somehow be reunited and reconciled to provide a basis for the revision. Like family members who have not seen one another for many years, the two sets of code do not easily recombine. Developers do their best to re-create a common code base that incorporates desirable features from both versions. But this process can become so difficult that it is often easier to port just the application in reverse order, from the second platform to the first.

#### Virtual APIs

One improvement over the family-snapshot approach is to emulate the original

# State of the Art **Developing for Multiple Platforms**

platform's API on the new platform. This is the next logical evolutionary step in development strategy.

Products are offering these emulated APIs and cross-platform code libraries. Examples are Quorum Software Systems' (Menlo Park, CA) Latitude, a Mac-to-Unix product, and Altura Software's (Pacific Grove, CA) Mac2Win, a Mac-to-Windows product. In theory, about 80 percent of the source code in a standard high-level language should compile.

However, emulated APIs and their libraries invariably trade performance for speed of development. One problem is that different APIs do not map precisely to one another. The extra code required to compile disparate operations from one graphics model to another can significantly slow application performance. One answer is to write platform-specific code here, reaching through the emulation and writing directly to the target API. This effectively trades portability for efficiency.

One way around fundamental differences is to create a virtual API that represents no single platform but embraces stan-

dard functions of many. This generic API runs on many platform APIs. When a developer builds a window, for example, this virtual API would call `NewWindow()` on the Mac side and `CreateWindow()` on the Windows side. One commercial product of this type is XVT (Extendable Virtual Toolkit) from XVT Software (Boulder, CO).

Unfortunately, these generic APIs often produce bland software. Such applications are unlikely to consistently leverage Windows or Mac GUIs in ways that users like. For this reason, virtual APIs are less attractive to commercial developers. These APIs are more practical for, say, vertical-market software developers or MIS departments that need to target an in-house application to multiple systems.

### Successful Approaches

Today, one popular way to speed the porting process is to separate *core* code from *edge* code. Core code includes the basic operations that are common across all platforms. A spreadsheet performs calculations and manages data in cells; a word

processor formats text; and image-processing software blurs and sharpens—these operations run more or less the same on all platforms. Edge code includes those parts of a program that deal with platform-specific issues, such as human-interface functions.

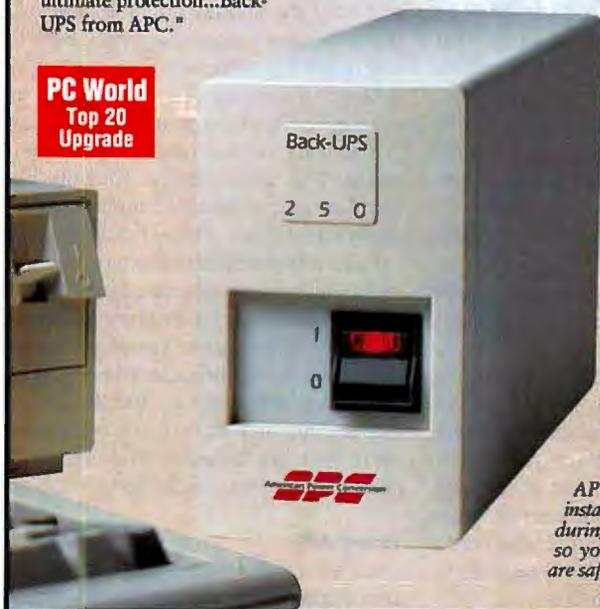
Engineering platform-independent code in one large effort and optimizing platform specifics in parallel, smaller efforts produces major efficiencies. This approach is popular with many commercial developers because it does not compromise the product's "platform flavor." Microsoft estimated that 90 percent of the then-unreleased Microsoft Word 6.0 would be based on common code.

Today's most widely used object-oriented development environments take advantage of core-/edge-code separation. One new cross-platform development framework from Borland is OWL (Object Windows Library). Another object-oriented framework, Bedrock, is being developed by Apple and Symantec. Bedrock will give developers a somewhat abstracted API that controls two separate frameworks:

## Introducing the \$139 investment no computer user can afford to be without...

"Don't take chances...Get the ultimate protection...Back-UPS from APC."

**PC World**  
Top 20  
Upgrade



Blackouts, brownouts, sags... if you use computers, your bottom line is directly linked to your power line. The fact is, your data and hardware are vulnerable to problems that surge suppressors and power directors just aren't equipped to handle.

Now there's an Uninterruptible Power Supply (UPS) to suit any budget. Back-UPS® are perfect protection for LAN servers, personal computers, phone/fax systems, POS equipment, or any other device that can go down when the power does. If lightning is a concern, Back-UPS are even backed by a \$25,000 insurance policy against surge damage to your equipment (see details).

So don't wait for the inevitable power problem to rob your business. Protect your productivity with Back-UPS, available where quality computer products are sold.

APC Back-UPS provide instantaneous battery power during power disturbances, so your data and hardware are safe!

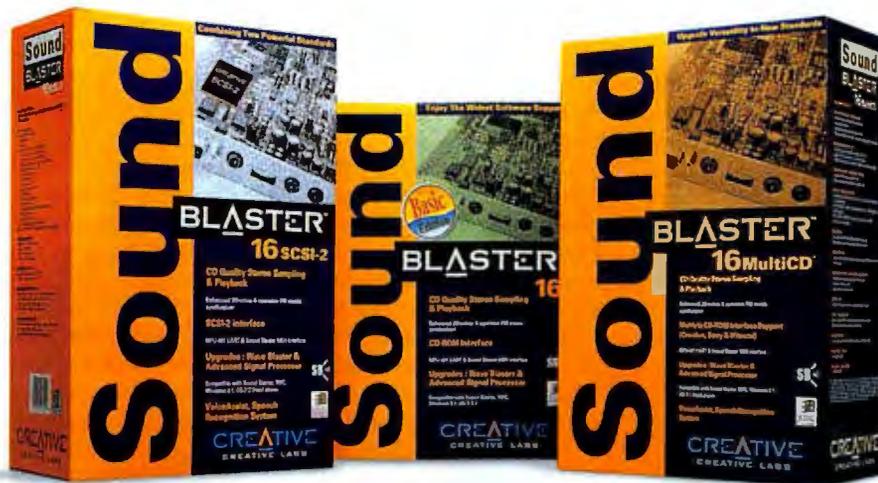
Call for your  
**FREE 60 page**  
PC power  
protection  
handbook!

# APC

AMERICAN POWER CONVERSION

800-800-4APC, dept. A2

Businessweek's #1 Hot Growth Company!(NASDAQ:APCC)



# NO MORE EXCUSES.

NOW THERE'S A 16-BIT SOUND BLASTER FOR EVERY APPLICATION AND BUDGET.

Every day, more people buy Sound Blasters than any other PC audio card. Except for a few of you. You know who you are.

But now there's a 16-bit Sound Blaster™ for every application and budget... and no more excuses for owning anything less.

### SOUND BLASTER™ 16 BASIC EDITION: MORE VALUE.

16-bit performance at an 8-bit price. Same great hardware as our premium models, but in a no-frills \$199.95\* package.

*Creative VoiceAssist™ software and microphone provide hands-free Windows control for Sound Blaster MultiCD and SCSI-2 packages.*



Same Wave Blaster™ Sampled Wave Synthesis and Advanced Signal Processing options, too.

### SOUND BLASTER 16 MULTICD: MORE CD-ROM OPTIONS.

If you've got another manufacturer's CD-ROM drive, take heart. Here's a Sound Blaster 16 that's 100% compatible with best-selling drives from Sony, Mitsumi, and Panasonic.

\*All prices listed are manufacturer's suggested retail



*Boosts CPU efficiency by up to 65% with an Advanced Signal Processing upgrade.*

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

### SOUND BLASTER 16 SCSI-2™ MORE SCSI COMPATIBILITY.

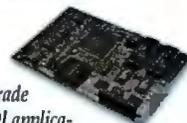
Waiting for full SCSI compatibility in a Sound Blaster? Wait no longer.

Sound Blaster 16 SCSI-2 meets the new, more comprehensive SCSI standards that other cards don't. And runs the complete battery of SCSI peripherals, not just CD-ROM.

Best of all, it's got a dynamite software bundle and a remarkable \$279.95\* price.

### JUST WHEN YOU THOUGHT YOU'D HEARD EVERYTHING...

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



*Upgrade MIDI applications and soundtracks to Sampled Wave Synthesis with a Wave Blaster daughter board.*



THE 16-BIT SOUND STANDARD.

**CREATIVE**  
CREATIVE LABS, INC.



U.S. inquiries: Creative Labs 1-800-998-5227 or 1-408-428-6600. International inquiries: Creative Technology Ltd., Singapore TEL 65-773-0233 FAX 65-773-0353. Sound Blaster, Creative VoiceAssist, Wave Blaster and the Sound Blaster and Creative logos are trademarks of Creative Technology Ltd. All other trademarks are the property of their respective holders. © Copyright 1993 Creative Technology Ltd. All rights reserved. \*SRP. Note: Sound Blaster 16 MultiCD works with Sony CDU31A; Mitsumi CRMC-LU005 and -FX001; and Creative Labs/Panasonic CR-523 and -563.

Circle 158 on Inquiry Card.

# State of the Art **Developing for Multiple Platforms**

one for Windows and one for the Mac. This provides some of the benefits of a virtual API while letting developers separately refine edge code for each platform.

## Trade-Offs

Today, market realities dictate that major applications must run on all mainstream platforms. Developers are reluctant to invest in technologies and feature sets that exist on only one platform. This is why

Microsoft is eager to introduce the newest version of OLE to the Mac, and why Apple has made its QuickTime video technology available to Windows. Developers want to know about a feature's cross-platform potential before they incorporate it.

On the other hand, if developers decide not to target single-platform technologies, their applications tend to reflect the lowest common denominator. Such software may be workgroup-friendly, but if it lacks plat-

form flavor, it can disappoint individual customers. Developers face an ongoing challenge to maintain a balance of features between platforms without compromising the unique flavor of each.

Developers must also decide just how much alike the same application should look on different platforms. They know that users tend to have a favorite platform and expect applications to reflect certain platform characteristics. Again, in striving for middle-of-the-road commonality, an application can fail to leverage the best attributes of either platform.

A related issue is the timing of releases. However methodical and even-handed engineers try to be in cross-platform development, they usually favor one platform over another, so the second version tends to lag. A company determined to release versions for different platforms at the same time invariably compromises performance, features, or time-to-market in one version.

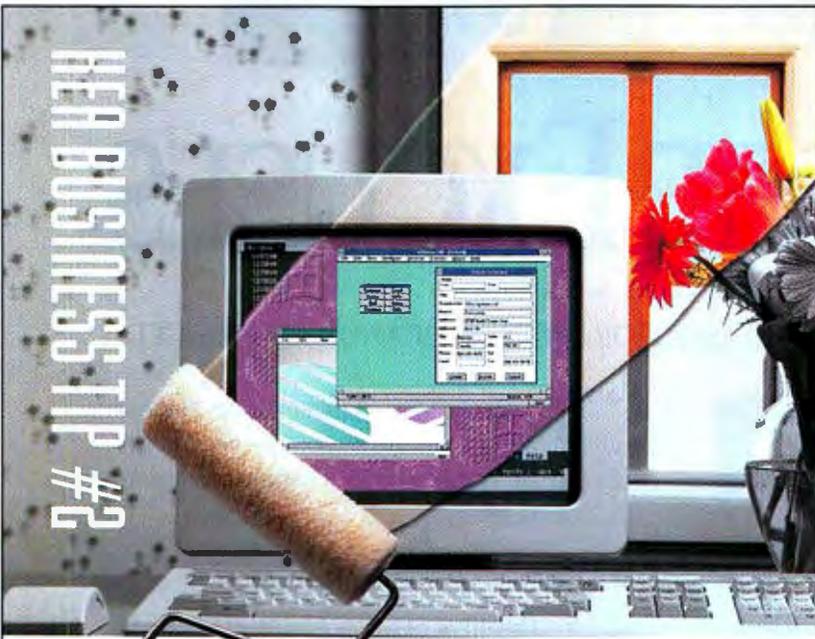
Managing cross-platform development teams involves different trade-offs. The challenge is to sustain work on two platforms, while challenging the imaginations of all developers. It's important to ensure that no one team gets stuck with too much drudgery for too long. One solution is to assign platform experts to developing edge code and put generalists to work on core code. Another is to have one team working on new features for one platform, while a different team ports a "snapshot" from that first platform to a second.

This latter approach can be effective in bringing software to market, but it really isn't sustainable for long, because it fails to efficiently leverage the teams' overall effort. This means products will be slow to market, and companies will incur high engineering expenses.

## Here to Stay

New operating systems are becoming increasingly portable. Users will soon be able to choose hardware and system software independently of each other. As a consequence, cross-platform development is here to stay. For developers, the ability to write portable code using techniques such as core-/edge-code segregation and object-oriented methodologies is becoming a key competitive advantage. ■

*Douglas K. Olson is manager of engineering for imaging and video applications, Application Products Division, Adobe Systems. You can reach him on the Internet at [dolson@mv.us.adobe.com](mailto:dolson@mv.us.adobe.com) or on BIX c/o "editors."*



**HEA BUSINESS TIP #2**

## PUT A NEW FACE ON YOUR HOST DATA...

**KEAterm VT EMULATION GIVES YOUR HOST DATA A FACELIFT—THE WINDOWS INTERFACE!**

Before KEAterm, host data was dull, colorless, and limited by aging host applications. KEAterm transforms your host data—making it better looking, and more useable.

Apply the power and ease of Windows tools, like Excel, 1-2-3, WordPerfect, Visual Basic... to your host data using KEAterm's DDE, hot links, file transfer, and user-defined menus and dialog boxes. And you'll get more done faster with multiple KEAterm sessions.

Advanced features include a powerful macro language and definable on-screen button pads, to make your work even easier. KEAterm speeds your work with high throughput over your serial port or installed TCP/IP or LAT network. ■

**KEAterm 420**—a powerful link to your VAX and UNIX text applications.

**KEAterm 340**—for applications requiring ReGIS, Tektronix, or sixel graphics.

**KEAterm**—for Windows NT available soon!

**Empower your desktop now!**

**Call 1-800-663-8702**

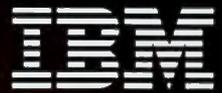
**KEA Systems Ltd.**  
3738 North Fraser Way, Unit 101  
Burnaby, B.C. Canada V5J 5G1  
Phone: (604) 431-0727  
Fax: (604) 431-0818



KEAterm 340



KEAterm, KEAterm, ZSTEM, PowerStation, KEA and their respective logos are trademarks of KEA Systems Ltd. All other brand and product names are trademarks or registered trademarks of their respective holders. Copyright © KEA SYSTEMS LTD. 1992. All rights reserved.



**\$1,999\***

# Multimedia without the mumbo jumbo. And we'll deliver it loaded, tested and ready to run.

*John Craig  
PC Consultant*

*Get the right answers.  
Right away.  
When you call IBM PC  
Direct™, you'll get  
expert advice to help  
you put together exactly  
the right multimedia  
system, whether it's for  
business presentations,  
your home office or  
your family.*



You've heard enough cyberspeak. You want straight answers, from an expert, about putting multimedia to work right away. That's why you should call us about this eye-popping offer.

It's our Reference Package, a warehouse of information to help you work smarter and more productively. Interactive sight and sound are built in and ready to go.

It's a multimedia – and business – PC you can use today. It's preconfigured at a price that's hard to beat. And it's only a phone call away.

### The IBM Multimedia Reference Package

- i486™SX/25MHz Processor
- NEW IBM 14V borderless, energy-efficient Color Monitor
- 170 MB Hard Drive
- 4MB RAM
- 1MB Video Memory
- 1.44MB Diskette Drive
- Double-speed, multi-session-compatible CD-ROM drive
- Sound Blaster™ 16-bit audio card
- External speakers and microphone
- IBM 101-Key Basic Keyboard and IBM Mouse
- Conforms with Multimedia PC Marketing Council's Level 2 specification for maximum compatibility
- Kodak® Photo CD™ Access Software and Photo Sampler
- Software Toolworks™ Encyclopedia
- Microsoft® Bookshelf™
- HSC InterActive Presentation Tool™
- Microsoft Works™ for Windows
- IBM DOS 6.1 and Microsoft Windows™

**Call 1 800 426-7731**

8am-midnight M-F, EST  
8am-7pm 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 make priced right and

What's new? The "V" series borderless, energy-saving monitors.<sup>1</sup> 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.<sup>2</sup>

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.

## IBM PC Direct

*We're putting the personal  
in personal computing.*

### ValuePoint Si.

Conserve space and money.

- 3 expansion slots, 3 bays
- VESA Local Bus Video
- Pentium<sup>3</sup>-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: \$50/mo.\*\*\*) \$1,369\*

#### 433DX/Si

486DX/33MHz,<sup>1</sup> 120MB HD, 4MB RAM  
14L8 (IBM Credit Lease: \$62/mo.) \$1,719\*

#### 433DX/Si

486DX/33MHz,<sup>1</sup> 212MB HD, 4MB RAM  
14L8 (IBM Credit Lease: \$66/mo.) \$1,829\*

#### 466DX2/Si

i486DX2/66MHz, 212MB HD, 4MB RAM  
14L8 (IBM Credit Lease: \$80/mo.) \$2,229\*

### ValuePoint DeskTop.

The modern-day workhorse.

- 5 expansion slots, 5 bays
- VESA Local Bus Video
- Pentium<sup>3</sup>-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,<sup>1</sup> 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\*



It's easy to get the PC you want,  
ready to go to work.

**ValuePoint Mini-Tower®**

With room to grow.

- 8 expansion slots, 6 bays
- VESA Local Bus Video
- Pentium<sup>1</sup>-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**

i486DX/33MHz<sup>†</sup> 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.<sup>4</sup> 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.<sup>5</sup>

**Call 1 800 426-7731**

8am-midnight M-F, EST  
8am-7pm Sat., EST

Purchase order available for qualifying customers.





Don Williams, Jr.  
PC Consultant



When Don Williams, Jr. saw the new IBM monitors, he couldn't believe his eyes. He or any of our other PC consultants can't wait to give you the details. These monitors are available separately, or as part of an IBM ValuePoint we'll custom build for you. At a price that's easy on the eyes, too. Call today!

# Our newest monitors are even easier on your eyes. Not to mention your electric bill.



Who says you can't have it both ways? These advanced high-resolution monitors deliver a brighter, bolder, crisper, borderless image that's flicker free.

But when you're not using them, they'll automatically power down<sup>2</sup> to miserly energy consumption levels. When you resume work, just touch a key or the mouse and they'll power up instantly, right where you left off.

Add a CD-ROM drive and find out what you've been missing. Practically all multimedia applications – and more and more regular software titles – are available in CD-ROM format. This internal ISA interface version has a 300KB/Sec maximum sustained data transfer rate with

The "V" series: for new systems and upgrades, too. Cross-platform compatibility is built in. You can plug it right into almost any IBM-compatible system and run most popular software. These monitors are available in 14", 15" and 17" screen sizes.

So, see the light. And save energy. Call IBM PC Direct today.

multi-session CD-ROM technology, including full Kodak CD compatibility. We can install it for you at the factory so it's ready to go when your IBM ValuePoint arrives.

ISA Internal CD-ROM Drive (32G2961)..... \$245\*



**Complimentary!**  
It's the latest edition of the IBM PC Direct catalog. ValuePoints, ThinkPads®, printers, monitors, multimedia, software, and more. To get your copy, call IBM PC DIRECT today.



\*IBM PC DIRECT prices only. The offerings, prices and products are subject to change or withdrawal without prior notice. Products you acquire may not be counted under any existing Volume Purchase Agreement. The same offerings and products may be available through IBM Authorized Remarketers. Remarketer prices may vary. Shipping and handling charges are extra. \*\*IBM Credit Lease prices are quoted for 36-month terms. Lease rates quoted are good through 2/28/94, after which time rates are subject to change without notice. Lease available to qualified commercial customers only. <sup>1</sup>Some 486DX/33MHz processors may be manufactured by IBM. 1. Not all V-series monitors are compatible with all ValuePoint PCs. Please call your IBM PC DIRECT sales rep for further information. 2. Requires VESA-DPMMS compatible system hardware and software to engage. 3. Upgradable with Intel's future OverDrive™ processor based on Pentium technology. 4. Copies of warranty and 30-day moneyback guarantee information available through IBM and IBM Authorized Dealers. Please call 1 800 426-2968 for details regarding IBM's moneyback guarantee and limited warranty. 5. At no additional charge during warranty period. Onsite service available Monday-Friday 8am-5pm in your time zone. IBM, ThinkPad, Mini-Tower, HelpCenter and HelpWare are registered trademarks, and ValuePoint and Soft Select are trademarks of International Business Machines Corporation. All other brands and product names are registered trademarks, trademarks or service marks of their respective holders. PC Direct is a trademark of Ziff Communications Company and is used by IBM under license. ©1994 International Business Machines Corporation

**Call 1 800 426-7731**

8am-midnight M-F, EST  
8am-7pm Sat., EST



Purchase order available for qualifying customers.

## IBM PC Direct

*We're putting the personal in personal computing.*

# COMPILERS FOR PARALLEL CPUs

New computers using multiple CPUs may increase throughput considerably—providing the compiler understands how to build code for the specific machine

OLIVER SHARP



**T**wo heads are better than one—or at least they can be. With this in mind, computer designers and programmers have long sought to harness processors together so that time-consuming applications will execute faster. During the past few decades, researchers and manufacturers have created wildly different parallel-processing architectures. This has kept life interesting for applications developers, who must learn how to use the new machines. The primary burden, however, falls on systems developers and compiler makers to create tools that exploit the new capabilities.

Four main types of parallel machines are VLIW (very long instruction word), distributed-memory, shared-memory, and data-parallel (see the text box “Types of Parallel Machines”). Each type has its own set of implications for compiler design and use.

A variety of programming models have been proposed for building parallel applications. In some cases, the programmer does all the hard work, while in others, the compiler is responsible. Some models leave the parallelism exposed and obvious, some force the programmer to express it manually, and others require the compiler to dig it out. The same holds for scheduling onto the available processors.

## Dusty Deck Model

The simplest solution is the dusty deck model, the one programmers like best. It provides a parallel option on the compiler. If you feed an existing program through the compiler, efficient code pops out for your parallel machine. This idea is the holy grail of parallel compilation and has been enthusiastically pursued by the research community. Unfortunately, the results have not been encouraging. (The term *dusty deck* is a rueful homage to the thousands of huge, time-consuming applications, written on punched cards in



## Types of Parallel Machines

### DISTRIBUTED-MEMORY ARCHITECTURE

A computer network is one form of distributed-memory machine. A better approach uses a single box for up to 1000 processors, with hardware for fast communication. Key issues include bandwidth, latency, topology, network interface, and communications/computation overlap.

This is the most popular approach. Thinking Machines' CM5 Connection Machine has a network of SPARC processors that can theoretically yield 100-plus MFLOPS performance. Others include the Cray T3D, with DEC Alpha processors, and the Intel Paragon, with 860s.

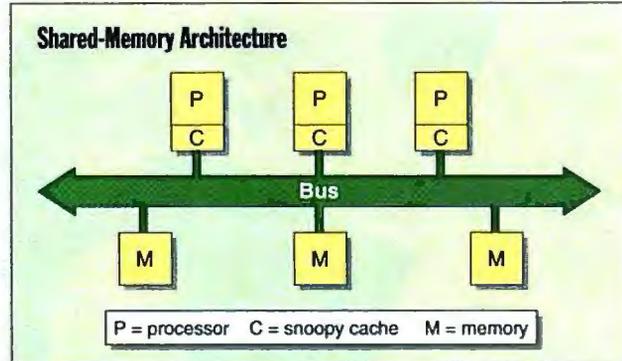
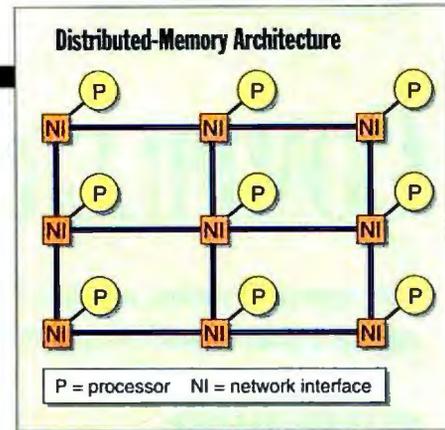
### VLIW MACHINES

VLIW (very long instruction word) machines have many functional units (e.g., floating-point adders and multipliers). Where superscalar chips have a couple of these units, VLIW machines have

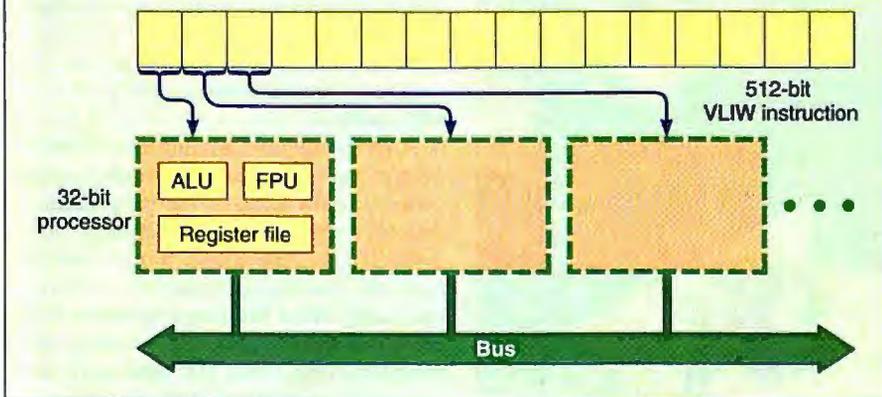
dozens. Each instruction can have up to 1024 bits, with many small subfields that tell a unit what to do. It's up to the compiler to keep all the units busy. Multiflow Computer built and marketed a major VLIW design in 1988. The company developed many interesting compiler techniques, but it went out of business in 1991.

### SHARED-MEMORY ARCHITECTURE

Attaching all processors and memory to a shared bus creates a single address space. Memory location 1000 on each CPU refers to the same piece of storage. Programmers don't need to send data between CPUs.



### Very Simple VLIW



languages such as FORTRAN, which have been running for decades.)

Recompiling these dusty decks is hard because it is difficult to figure out what they do, how to transform them, and how to decompose them for good parallel performance. Before the compiler can exploit parallelism, it needs to know how the existing code behaves. This is a major problem with most languages now in use. It's easy to translate array operations into correct executable code but much harder to summarize array behavior at a higher level.

In a complicated loop, for example, the compiler is faced with dozens of lines of code that invoke procedures, walk over arrays, and jump around unpredictably. What

languages such as FORTRAN, which have been running for decades.)

languages such as FORTRAN, which have been running for decades.)

languages such as FORTRAN, which have been running for decades.)

Caching is required for performance, but intelligent caches are needed to work correctly. Consider the following example: Processor A reads a memory location and caches the data; processor B writes a new value to that same location. "Snoopy" caches, which monitor the bus, keep A from using the outdated value.

Adding processors means you eventually run

the executable file (see the text box "Converting an Application for Parallel Processing"). The conversion requires the programmer, the compiler, or both to make a lot of nontrivial decisions about how to break up the problem.

Although the fully automatic approach hasn't worked well, researchers have developed many systems for interactively analyzing, transforming, and decomposing sequential applications. These make the task less onerous but are far from being turnkey solutions that shield the programmer from the complexities of parallelism.

### Message-Passing Libraries

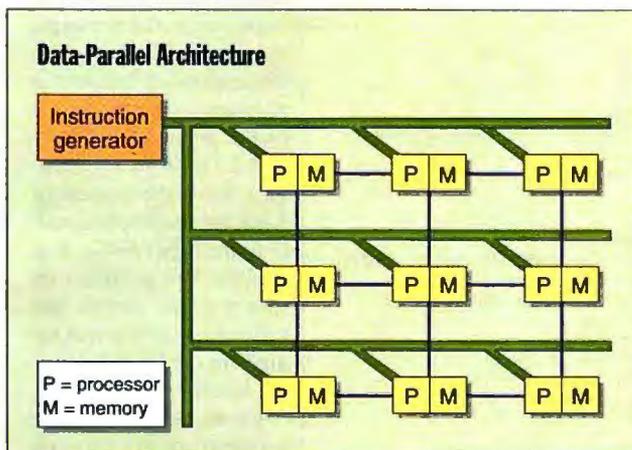
Message-passing libraries move you from one extreme to the other. With them, you forget the compiler and manage the parallelism yourself. Most applications that run on distributed-memory machines today use message-



out of bandwidth, so shared memory has lost popularity except for speedy desktop machines. Newer operating systems—including OS/2 and Windows NT—are being extended to support a few processors. Most shared-memory machines to date (e.g., the Sequent) run Unix.

#### DATA-PARALLEL ARCHITECTURE

This unusual machine has many small, limited processors that work together in lockstep. A central unit broadcasts a command to each, and they all execute together. The best-known data-parallel machine is the 1987-vintage, 64,000-processor CM2 from Thinking Machines.



passing libraries that give the programmer full control over decomposition and scheduling. These libraries provide routines to distribute tasks to processors and send data back and forth across the machine. Some libraries support features such as asynchronous communication; you hand them a callback routine that will be invoked the next time a message arrives.

The compiler doesn't do much with these kinds of applications; they are treated like ordinary sequential programs. Writing an application using message passing is like programming in assembly language; you get control of the system whether or not you want it. You also spend much time manually shipping data around the system.

Debugging becomes a terrible job. A program's behavior can change every time it runs. Worse, many bugs depend on timing. If a message arrived in time, the program reads correct data; if not, you get garbage. Also, the bug may occur on some runs but not others. Adding debugging

code can change the timing enough to mask it. If you take the test code out, the bug reappears; this can be maddening.

#### The Shared-Memory Model

The shared-memory model is the usual way to program a shared-memory machine. A copy of your executable file runs on each processor; all share the same data. They communicate with one another the same way multiple threads do; they can set or release locks or use semaphores.



A "bag of tasks" is a simple strategy that's easy to code with the shared-memory model. Divide the work into separate tasks and put the tasks into a bag, or a list. The different processors draw work from the list; when one processor finishes a task, it picks up another from the list. To access the list safely, you must use a semaphore to request exclusive access. When the request returns, you own the list and can remove the first item on it. You release the lock and start on the task.

The advantage to this model is that the programmer doesn't have to move data. Just by referring to a memory location, you arrange for the data to be available to your processor. But don't ignore locality; even on a shared-memory architecture, there is a cost to data transfer, and you get poor performance if you don't pay attention to it.

Debugging is easier on a shared-memory model, because data is immediately accessible, and programs are less cluttered with explicit communication routines. Still, timing-dependent behavior is a serious problem.

As with message-passing libraries, the compiler usually doesn't help much. The programmer has to assign work to processors and manage the interactions, although the code is more compact than for a distributed-memory application. Some researchers have looked at using compiler transformations to improve performance; the problem is related to cache management on a sequential machine.

While this model is most commonly available on shared-memory machines, an ambitious goal is to supply it on other ar-

chitectures. Here, the compiler becomes an integral player because a simple-minded implementation would yield dismal performance.

#### Hints from the Programmer

This method lets the programmer help the compiler. That's the idea behind a number of recent languages, including FORTRAN D, which provides keywords that let the programmer specify how to allocate data across a parallel machine.

Every processor gets a copy of the program and execute it together. Based on the programmer's directives, a processor *owns* some of the data. On a four-processor machine, for example, each CPU might own every fourth column of a large matrix.

As the program executes, the system decides which processor performs each computation according to the "owner-computes" rule. When the value of a computation is assigned to a specific memory location, that location's owner performs the operation. Other processors must send any required data to the location's owner.



Now under construction, the FORTRAN D compiler faces the hard task of minimizing communications overhead. A modern processor can execute a floating-point operation in a tenth of a microsecond, but a message between processors takes much longer—tens or hundreds of microseconds. It is impractical for each instruction to wait for a message to provide data. The solution is for the compiler to look at a block of code (typically a loop) and know beforehand what data each owner will require. Before the application starts executing that code block, it arranges for each processor to make a bundle of data and send it to the owners that need it. Each owner can perform its computations without further communication. Because the programmer can easily produce code that is hard to analyze, the FORTRAN D user must learn to write programs the compiler can handle effectively.

#### Data-Parallel Programming Model

The data-parallel programming model provides the programmer with primitive operations that can be applied to an entire set of data at once. By composing these operations, you can perform complex and powerful manipulations of large



# Converting an Application for Parallel Processing

Imagine that you are trying to implement a simple climate model on a distributed-memory parallel machine. There is no need to describe climate modeling in detail here; you can look at parallelization without understanding much about the physics being modeled. This example outlines a simple-minded approach to the problem and explains why it may or may not perform well.

## Creating the Model

First, divide up the earth's surface using a 2-D grid. Each grid "square" represents, say, 5 degrees of latitude and 9 degrees of longitude, giving a total of 1440 grid locations covering the earth. (They aren't actually squares, of course.) The model will track various parameters for each square: water vapor, temperature, radiation absorption, and the amount of sunlight reflected by the surface. (This simplified model might bother a real climate researcher, because their 2-D models usually divide the earth into latitudinal bands and the atmosphere into vertical layers.)

In this model, each iteration corresponds to a given amount of simulated time—say one hour—and consists of two steps. First, neighboring grid squares exchange information. A hot square might leak some of its heat to a cooler neighbor, or perhaps wind currents lead to the movement of water vapor between squares. Then, after each square gets the information it needs from its neighbors, you have the system figure out what happens within the square and update its local state. To keep track of what the model is doing, various summary results for each

iteration are computed and stored; you can view those results after the program finishes to find out what happened.

## Analyzing the Parallel Possibilities

The first step in parallelizing the model is to figure out how to decompose the problem. This application, like many physical models, has good locality—a grid square directly influences its neigh-

costs are about equal for communicating between any pair of processors. The listing "Master/Slave Parallel Processing" shows how the application might be structured on such a machine. So how much faster will this application run on 16 processors rather than on just one? That depends.

Your biggest ally is locality; the "area-perimeter" rule says that if you only com-

municate at the edges of a rectangle, the ratio of communication to computation improves as the rectangle gets bigger. That's because the amount of data sent is proportional to the length of the perimeter ( $2*A + 2*B$  for an A by B rectangle), while the amount of work grows proportionally to the area ( $A*B$ ). You divided the problem up into a single region per processor, so the rectangles are the largest possible size for your machine.

On the other hand, three problems might trip you up. The first is the cost of communicating between processors. Suppose it takes 1 second for every processor to exchange data with the processors handling neighboring grid points. Ideally, the cost of computing a timestep will be much more than a second. If it were exactly 1 second, you spend only

half your time doing useful work. If it takes one-fifteenth of a second, then even if all host-slave communication is free, the 16 processors working together won't go any faster than just one processor acting alone.

The second potential problem is that control is centralized at the host processor. The slave processors have to wait until the host tells them what to do, and all global processing between timesteps happens on the host while the slaves re-

## Master/Slave Parallel Processing

```
master_code()
{
  /* setup */
  start up one slave per slave processor
  broadcast to each slave processor the grid squares it will
  handle
  distribute initial data to each slave

  /* start modeling */
  for i = 1 to max_timesteps
    call slave_code() ;tell each slave to compute one timestep
    wait until slaves finish and report results
    compute and store summary information from the results

  tell each slave to die
}
slave_code()
{
  /* setup */
  wait for master to say which grid squares to handle
  wait for initial data

  /* start modeling */
  do forever:
    get message from host
    if asked to die, commit suicide
    compute_timestep()
    send local-state info to host
}
compute_timestep() {
  send interaction information to each neighbor
  wait until each neighbor's information arrives
  model physics in each grid square, using neighbor info
}
```

bors, not squares on the other side of the world. To take advantage of that property when decomposing the application onto different processors, you allocate contiguous blocks of grid squares. If you chose instead to allocate individual squares randomly, this would introduce much more communication when the squares tried to talk to their neighbors.

This example uses a simple parallel architecture with a master host processor that controls 16 slave processors. The

main idle. Even if the host is fast enough to keep 16 slaves busy most of the time, that may not remain true when more slave processors are available.

### Balancing the Workload

Finally, load-balancing problems can easily cut overall performance in half, or worse. You have allocated an equal number of grid squares to each processor; if each square takes the same amount of time to compute, that was a good decision. Even if they vary a bit, you have many grid squares per processor so that will help even things out. But suppose you have an elaborate strategy for modeling ice; when the temperature is low enough, you spend a lot of time figuring out ice formation, thickness, and the fraction of land covered. Since ice doesn't cover much of the Sahara, a few parts of the world will require a lot of processing for the ice model while others will not need any. The processors that cover the Pacific Ocean or Africa will finish their processing quickly and sit around waiting while the processors handling the poles work on the ice model. This unbalanced load hurts performance.

There are two ways to improve load balance: Do a better static decomposition of the problem, or move to dynamic scheduling. Static means that you divide the problem once at the beginning and never change your mind. You might be able to finesse the problem with ice, because the parts of the world that are covered with it are fairly predictable. Rather than giving each processor the same number of grid squares, you could give the ones managing land near the poles fewer squares. That evens out the load so that there won't be as much variance in the time it takes each processor to finish.

A more elaborate strategy for balancing load requires a much more complicated way to manage parallelism. Dynamic scheduling shuffles grid squares between processors as the application runs; when one processor is getting its squares done much faster than another, some of the work is shifted, so the load evens out. Dynamic scheduling is tricky to implement well, though, and it can lead to a lot of overhead if you are not careful.

amounts of data in a few lines of code. If you are familiar with APL, you have a good idea of what data-parallel programs can look like.

Data parallelism is appealing for many reasons. Since all the parallelism comes from the operations, the application has only one thread of control and is much simpler to debug. Programming languages look similar to their sequential cousins, although they need special features for defining data structures and parallel operations. There is one fly in the ointment, however: You must make sure that your program does most of its computation using data-parallel operations, because the rest of the time, you are just executing sequentially. Most existing applications must be completely redesigned, and many will not adapt well to a data-parallel style.

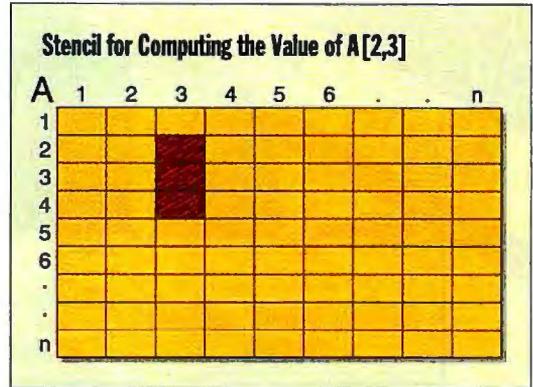
Compiling data-parallel languages can be easy or challenging. If your target machine is data parallel, you can design the language to provide the same primitives as the architecture. Compilation is a snap; you simply translate each data-parallel operation in the program into the corresponding machine-language instruction.

On the other hand, compiling a data-parallel program for a different architecture can be difficult. The figure "Stencil for Computing the Value of A[2,3]" shows a simple data-parallel operation in which each array element is computed based on the value of itself and of the two elements below it. The equivalent in a conventional language would be as follows:

```
for i = 1 to n-2
  for j = 1 to n
    A[i,j]=f(A[i,j], A[i+1,j],
            A[i+2,j])
```

The figure also shows a shaded area representing the data used to compute A[2,3]. This data-parallel operation is very regular; the shape of the shaded area will be the same regardless of the array element being computed. The most important task in compiling a data-parallel computation is to figure out that shape, which is called the *stencil*.

Here, the stencil includes no neighbors to the left or right, showing that columns are independent of each other. There is no advantage to allocating two neighboring columns to the same processor. Rows are a different story, however; assigning rows randomly to processors would be an ex-



An example of a simple data-parallel operation.

tremely bad allocation strategy.

The stencil tells the compiler how much communication will be required by any data decomposition. The compiler must minimize communication overhead and balance load. However, compilers can deal with data-parallel models much more easily than conventional programs because the stencil can usually be determined automatically with good accuracy. Languages like FORTRAN often make it very hard (and sometimes impossible) to determine the stencil.

### Other Language Models

Conventional languages are hard to analyze for parallelism, and their storage model is mathematically inelegant. Why not toss them out entirely and start over? Many language designers feel that way. One school favors functional languages like Haskell and ML; it is easy to find parallelism in them. Others rely on unification with logic-programming languages inspired by Prolog. So far, none of these alternatives has become widely adopted for parallel programming, but improved implementations in the future may gain converts.

### The Future of Parallel Compilation

It isn't easy to produce a program that runs efficiently on a parallel machine. If programming continues unchanged, compilers are unlikely to solve the problem automatically. Researchers will try to help by offering tools that ease the transition; they will also do their best to offer effective new programming models. There's nothing computer scientists like better than designing languages; they won't give up. ■

*Oliver Sharp works for Heuristic Research in Berkeley, California. He is completing his Ph.D. at the University of California at Berkeley, investigating compilation for parallel architectures. You can reach him on the Internet at [oliver@heuristic.com](mailto:oliver@heuristic.com) or on BIX c/o "editors."*

CADVANCE,  
Claris CAD, VersaCAD,  
MacBravo! users ...  
**TRADE UP to MicroStation**  
Trade requires proof of purchase. \$1,500 until June 30, 1994. 1/price good in U.S. only.

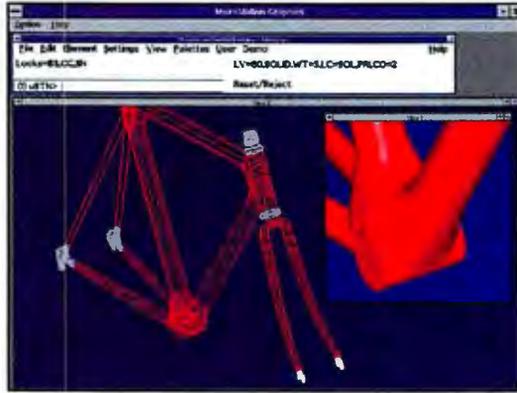


**Rendering.** Visualization and flythroughs – at your fingertips! MicroStation offers photo-realistic rendering to every designer, right in the software. It's easy to make your image reflect your imagination.



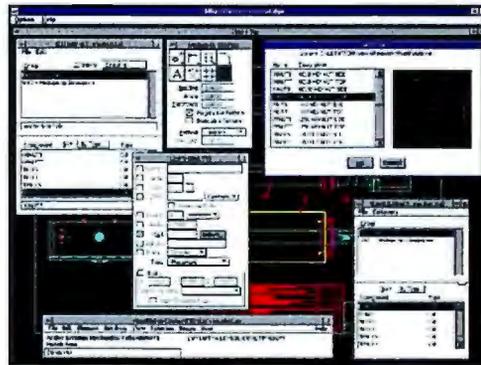
**Windows.** It walks and talks Windows. Behind MicroStation lies the user-responsive programming you look for in good Windows software. Version 5 gives you the ultimate in integration of CAD, engineering, and business applications.

# MORE POWER TO YOU.



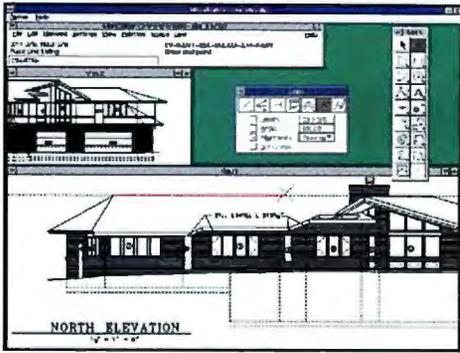
**Modeling.** Model any surface you can imagine in MicroStation. NURBS surface modeling combined with 3D Boolean operations gives you astounding flexibility in creating and modifying freeform models.

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 power – without the limitations of old technology. Enjoy the advantages of contemporary features like associative patterning/batching, plot preview, standard text editing and fonts, and context-sensitive Hypertext help.



**Usability.** What does computer-aided drafting have to do with the way you think? Everything. MicroStation software works for you. It understands the drafting process so well that it infers what you'll do next.

### Graphical User Interface.

MicroStation's easy-to-use interface includes pull-down menus, dialog boxes, tear-

off tool palettes, and tool settings window. Choose your interface –

Windows or Motif – on any platform. **Transparent Modeless**

**Operation.** The software supports the way you naturally work, maintain-

ing command execution while you fine tune: change element attributes or com-

mand parameters, manipulate views, change the dimensioning system, and more.

**Powerful View Manipulation.** MicroStation supports up to eight

active views that can be moved, sized, and overlapped to fit your design. Zoom and area at

any scale. Move around your design fast with built-in dynamic panning.

**Workspace Editor.** Tailor pull-down menus, dialog boxes, and tool palettes –

even disable commands – with a graphically oriented toolset for customizing your chosen

interface. **Text Capabilities.** A convenient text editor lets you easily edit single-

line or paragraph text. Choose from TrueType, PostScript, AutoCAD SHX, and

MicroStation fonts. ASCII text files can be imported and exported. **Multiple**

**Undo/Redo Commands.** Undo mistakes and perform “what-if”

designs in a flash with unlimited undo and redo. **Plotting.** Plot raster and vector

information by view or defined areas, at any scale. Visually preview the plot before

plotting, saving time and materials. **Online HELP.** MicroStation's

HELP remains active, tracking the command you're currently using,

so there's no searching through manuals for assistance.

**Associative Patterning and Hatching.**

Associate patterning with graphics. Change graphics and the

patterning updates. Flood-fill hatching/patterning

intelligently fills an area, detecting boundaries

and holes with a single pick. **Associative**

**Dimensioning.** Dimensions are associated

with the geometry. not with a point in space, so that when you change

the geometry, the dimensions automatically update. **Custom Line Styles.**

Create space-saving custom line styles and place railroad tracks, trees, isobars – anything – just as you would place a line.

**Multi-lines.** Define line string elements comprising up to 16 parallel lines of varying symbology and store them in a style library

for easy recall. Architects can use multi-lines for fast and easy placement and intersection cleanup of walls and partitions. **2D Boolean**

**Operations.** Quickly modify, measure, and hatch multiple 2D shapes with integrated Boolean operations. **Mass Properties.** Calculate area and

properties of your model: surface area, volume, mass, centroid, moments and products of inertia, principal moments and directions, and radii of gyration.

**Associative Dimensioning.** Define relationships among graphic entities with intuitive drawing modes such as tangent, parallel, perpendicular, midpoint, intersection, and end

point. **Dimension-driven Symbols.** Based on established relationships, you can assign variables to dimensioned graphics and save the graphics as cells

for easy placement. Changes in dimensions automatically drive changes to graphics. Dimension-driven design saves valuable time in the design of families of



**Power.** Take your pick of popular environments: DOS, Mac, Windows, Windows NT, or UNIX. Have a look at MicroStation on Intergraph's Technical Desktop Series personal workstations.

## MicroStation V5. CAD software that puts you in charge.

Call 800-345-4856 for a free brochure on MicroStation Version 5 and the name of an Intergraph representative in your area.



# MicroStation INTERGRAPH

Circle 109 on Inquiry Card (RESELLERS: 110).

# Advancing Communications

Today's telecommunications software offers high speed, scripting, and even ease of use

HOWARD EGLOWSTEIN

**M**odern data communications software does lots more than just read E-mail messages. If your current communications package is more than a few years old, you're missing out on all the fun.

Today's advanced communications programs promise speed, features, ease of use, and programmability. The one feature that marks an advanced communications package is, in fact, a strong programming language. That language should be easy to program, yet capable. While it may not make coffee and put out the cat while transferring your files, it should be able to automate many of your communications activities.

In this review I look at seven of the communications packages you're most likely to see on a software store shelf or hear about around the office. There are literally dozens of full-featured communications packages available; I picked these seven because of their overwhelming market presence. According to the sales charts, folks who use MS-DOS communications software are most likely to run Procomm Plus from Datastorm. Due to Procomm's start as a well-liked shareware package, Procomm Plus is far and away the most popular commercial package. Second place belongs to Telix, a shareware application from deltaComm Development.

If you use a Macintosh, you're sure to have heard of MicroPhone Pro from Software Ventures and White Knight from Freesoft. Both of these packages enjoy fierce loyalty from their respective user bases, and rightfully so. Running close behind these two commercial packages is ZTerm, a popular shareware application. I don't look at ZTerm here, but it's available through most Macintosh shareware sources, and it's well worth a test drive.

Given Procomm's popularity on DOS

Procomm Plus's dialing directory lets you pick from 200 prestored numbers. Each number has an associated COM port setting, script file, and usage statistics.

Telix's dialing directory is functionally similar to Procomm's even though it's laid out differently. Like the rest of Telix, the dialing directory clearly shows some heavy Procomm influence.

Crosstalk for Windows supports more file transfer protocols than most other packages. Besides those shown here, Crosstalk supports DART, CompuServe B, and Crosstalk.

MicroPhone Pro comes complete with a handy script editor. You can select functions from a pick list instead of typing them from memory. After you finish writing your script, the editor can check it for errors, saving you lots of debugging time.

Term's Spartan Interface leaves most of the screen available for your communications session. This screen is from the DOS version 6.3.4, functionally and cosmetically similar to the upcoming Unix version 6.3.

Procomm Plus for Windows is one package that provides a modem status window while making a connection. It's very handy for figuring out why a connection won't go through.

When White Knight sees an incoming Zmodem transfer, it automatically starts up the file transfer. The efficiency is calculated based on the DTE modem speed (in this case, 38.4 Kbps), not on the carrier speed.



machines, it's not surprising that Procomm Plus for Windows is one of the two big sellers for the Windows environment. The other is Crosstalk for Windows from Digital Communications Associates. DCA used to dominate in the DOS environment as well, but now it appears to have focused more on its Windows product, with good results.

As far as communications is concerned, the Unix crowd doesn't need much more than it already has. Unix installations come with excellent mail systems built in, and many Unix users are content to send mail directly from their machines via the Internet. For transferring files from system to system, Unix is again years ahead of the other platforms with FTP. So how do Unix people access their BIX accounts or dial into a BBS? Usually through public domain implementations of Kermit, but also with Term, a commercial package from Century Software. Term is also available for DOS, Windows, and the Mac. I look at the Unix version here.



#### Procomm Plus

Procomm Plus is the commercial version of a package that grew up as shareware.

The shareware version practically owned the entire DOS market; copies were included free with just about every modem sold. Many users happily upgraded to the commercial version when it became available. Procomm Plus 1.0 had a better scripting language than the shareware version and a much prettier interface. Procomm Plus 2.01 goes it one better.

The Procomm interface is largely based on control-key combinations to implement functions, which makes sense for a keyboard-oriented DOS environment. You can choose to activate Procomm's menu and use it with a mouse, but most users stick with the keyboard.

Procomm's functions are grouped into several primary menus. The setup menu, for example, gives you control over modem settings, file transfer options, and environment features such as "file done" alerts. Other menus include dialing, macros, and hardware setup. Procomm supports serial port speeds of up to 115.2 Kbps on serial ports COM1 through COM8; the I/O addresses and IRQ (interrupt request) settings for all ports are fully configurable.

Like all the other communications software programming languages, Procomm Plus's Aspect is a procedural language. You specify a series of events that must

occur in a particular order. The sample Aspect script listing shows a simple script for logging on to the BIX on-line service. Aspect has about 240 commands to do everything from watching a service for specific strings to painting custom dialog boxes on your screen.

However, a communications session often has unpredictable events that can disrupt the flow of a purely procedural language. The ability to handle so-called interrupt events is one feature that separates the good packages from the average. Aspect provides a WHEN statement that lets you define up to three interrupt events for a program to watch for and handle while doing other things.

For example, your on-line service might put out a "...more.." prompt at the end of each page and then wait for you to press the return key. Adding the line WHEN 0 "...more.." transmit "^M" anywhere in your script will handle this common situation, sending a carriage return in response to the prompt to provide continuous scrolling.

Surprisingly, Procomm Plus doesn't support devices other than standard 8250/16450 and 16550 UARTs and modems. If you have a networked communication device that works through INT 14 emulation, you'll either have to buy the networked version of Procomm or look elsewhere. Being a DOS package may give Procomm Plus the edge when it comes to performance, but it also means that you can't do background file transfers. If you need this ability, you'll want to either run the package under Windows or some other multitasker, use a Windows program

instead, or keep some creaky old 286 system around for doing file transfers.



#### Telix

Telix grew up at about the same time as the shareware version of Procomm, and it shows: Telix has a look and feel remarkably similar to Procomm's (see the screens on page 104), and many of the function keys do precisely the same things they do in Procomm. I've included Telix here because every DOS communications software user I spoke with either has tried or is currently using Telix. Why? Largely because it's still shareware and it costs only \$39 to register.

Telix offers two distinct programming languages, Script Application Language for Telix, or SALT, and Salt Implementation, or SIMPLE. SALT programs look very much like C code. A typical program is a series of IF statements nested within a large WHILE loop. Perhaps I might have gotten into SALT programming more if I was a C programmer, but I found the C syntax unnecessary and the lack of event support (such as Procomm's WHEN statement provides) frustrating.

SIMPLE is a higher-level language that uses an English-like sentence structure to represent many of the SALT functions. The SIMPLE compiler generates SALT code that you can either run directly or modify and compile with the SALT compiler. deltaComm expects you to use SIMPLE largely as a tool to learn SALT; I expect that most Telix users could just use SIMPLE as their primary scripting language. *continued*

#### A sample Aspect script from Procomm Plus that logs onto BIX.

```

proc main
clear                               ; clear screen
locate 0 0                           ; locate cursor at 0,0
box 0 0 4 22 14                       ; draw box
atsay 2 2 14 "Logging onto BIX..." ; put message in box
locate 6 0                             ; cursor to row 6

if not fromddir                       ; if not a linked dial directory script
dial TYMNET_ENTRY                     ; dial TYMNET
endif
transmit "^M"                         ; send a carriage return
waitfor "identifier"                 ; wait for TYMNET prompt
transmit "A"                         ; send an A
waitfor "log in: "                   ; wait for TYMNET prompt
transmit "bix^M"                     ; say you want BIX
waitfor "Name? "                     ; wait for BIX name prompt
transmit NAME                         ; send your name
transmit "^M"                         ; followed by a carriage return
waitfor "Password: "                 ; wait for password prompt
transmit PASSWORD                     ; send your password
transmit "^M"                         ; followed by a carriage return
endproc

```

# Life at 28.8

Testing performance of sophisticated communications software on fast computers requires fast modems. As luck would have it, Microcom sent two of its DeskPorte Fast 28.8-Kbps modems as I was putting this review together. With V.42bis data compression (up to fourfold under ideal circumstances for compression), these modems are supposed to handle throughput up to 115.2 Kbps.

If you've never worked with a truly high-speed modem before (and I don't mean a 9600-bps model), you're in for a shock the first time you dial into a system and get 80- or 90-Kbps throughput on a standard voice line. Not only is that much faster than most modems can handle, it's faster than many computers can handle. The serial port on a Mac is only set to do RS-232 asynchronous communications at up to 57.6 Kbps. A PC can handle 115.2 Kbps in theory, but most systems can't because of software overload. If you plan to do high-speed communications, you'll need one of the special communications boards like Hayes's ESP, or at least a serial port with a 16550 buffered UART to ease the load on the communications software.

If you're a Windows user, the problem is much more serious. Windows can't handle incoming serial streams at much over 9600 bps on most systems because of outdated 16450-type UARTs used to control the serial ports. With a newer 16550 UART you might get 19.2 Kbps, but nowhere near the speeds faster modems provide with V.42bis compression.

Microcom's solution is to put a parallel port on the modem and provide a driver that tricks your Windows communications software into thinking it's talking to a serial port. I installed the driver as COM3 on my notebook machine, and it worked exactly as advertised. Not only does the software run at full speed, but it frees up a serial port in case you're out of IRQs (interrupt request lines) on your Windows machine.

Many communications programs were written before anyone even conceived of a mo-

dem running at a DTE rate of 115.2 Kbps. Procomm Plus, for example, supports only standard Hayes connect messages. When the Microcom modem reported a 28.8-Kbps connection, Procomm didn't recognize it. I had to make that connection by dialing manually or through a script I wrote in Aspect.

As another example, the BBS software we use for distributing listings is an older version of Opus running on the Fossil serial driver. Fossil had no trouble handling the high data rates, but Opus was written to expect connect speeds of up to only 38.4 Kbps. When Fossil told Opus that it had connected at a serial rate of 115.2 Kbps, Opus got hopelessly confused and assumed a 300-bps connection. The data stream was fine, but Opus overestimated transfer times by many hours. As a consequence, I wasn't able to download files much bigger than a megabyte or two without exceeding my default time limit of 1000 minutes.

When V.34, the final V.Fast standard, is approved next spring or summer (or so people expect), don't think that you can simply buy a shiny new modem and connect it up. Your software may not understand the high-speed connect messages. You may have to replace your old nonbuffered serial ports with something better. Or perhaps you'll have to start over from scratch, as we'll have to do with our BBS. The 25-MHz 386 we normally use will barely keep up with that data rate; the serial ports certainly won't, and neither will the current software.

Should you buy a modem now? If you're equipping both ends of your data connection, there's no reason not to. All the modems available are based on the Rockwell chip set. Even though this set won't be compatible with the final standard, all the modems you can buy today are supposed to be able to talk to each other. Both Hayes and Microcom have committed to an upgrade program as well. For \$39, Microcom will take back your DeskPorte and upgrade it to V.34, or send you the parts to do it yourself.



## White Knight

White Knight from Freesoft is another package that started as shareware. Up through version 10, it was known as Red Ryder. Now in version 11, White Knight does just about everything you'd expect a world-class communications package to do. Mac software in general does a good job of adhering to Apple's Macintosh interface standards, and White Knight is no exception (see the screen).

I've used Red Ryder/White Knight for years on my old Macs (a 512K and an SE). In all this time, I can't remember ever opening the manual, and I'm sorry now that I didn't. Not only is the manual easy to understand, the foreword is downright fun to read. After reading that, I skipped over the user stuff and started reading through the scripting language specification. (In all this time, I've never found the need to work with White Knight scripts.)

White Knight's scripting language supports about 170 different functions. With them you can build scripts (or procedures) that add functions to the menu bar, for example, or that define macros triggered by on-screen buttons and icons. White Knight can also access external programs written as RCMDs (special plug-in code resources) that will do just about anything you like. One provided sample RCMD lets your procedures access MacInTalk (available separately from Apple) to give you spoken messages.

A White Knight script is a straight-line procedural program that starts at the top and executes to the end. The functions mostly mimic those available from the menus, but a few conditional statements let you compare strings and branch around in your program. Unexpected events are referred to as ALERTs, and White Knight can handle three of them at any time.

A typical procedure establishes a connection, sends some preliminary log-in strings to a host computer, sets ALERT conditions to handle an unexpected line drop, gathers up your mail, and then logs you off the host. Compared to some of the other scripting languages in this review, I found White Knight's procedures somewhat primitive but still functional.



## MicroPhone Pro

Software Venture's MicroPhone Pro is available in both Macintosh and Windows versions. I looked at only the Mac version here. Like White Knight, MicroPhone Pro manages to be a full-featured

communications package behind a user interface that conforms well to Apple's interface standard. I had no trouble learning all MicroPhone Pro's main features simply by examining the menus. I won't dwell on the user interface here because I'd be describing just about every Mac package you've ever seen.

MicroPhone supports fewer script commands than White Knight (only about 70), but it includes support for Apple Events and external programs (including Mac-InTalk support). Through Apple Events,

you could have an Excel spreadsheet start up MicroPhone Pro, run a script to log into an on-line service, and grab current stock prices into Excel, for example.

MicroPhone Pro handles interrupt conditions through an elaborate WHEN statement. It doesn't set a resident condition handler like White Knight's ALERT, but rather suspends the script execution until the conditions match one of those specified in your WHEN statement. Possible conditions include specified incoming strings, some amount of wait time, a specified pe-

riod of silence, a button press, or some expression coming true.

In theory, this should work just as well as the resident ALERT. In reality, I found it difficult to get some of my MicroPhone Pro scripts working the way I wanted, despite the excellent documentation. Developing scripts to access on-line services can be tricky, and I expect that getting MicroPhone Pro to handle unusual conditions will become easier as I spend more time with it.

### COMMUNICATIONS SOFTWARE PERFORMANCE

Transfer rate between each software product and a BBS running on a 50-MHz 486 with a Microcom DeskPorte Fast modem, connected at 115.2 Kbps. The rate shown is the effective character rate in bits per second, allowing for Zmodem file transfer overhead, connect speed, and telecommunication software overhead. The uncompressed data rate is for a selection of text files. The compressed data rate is based on transferring files already compressed with PKZip. The faster transfer rates are the result of the modem's data compression and will vary according to the different programs' ability to handle fast data streams. Higher numbers indicate faster throughput. However, comparisons between platforms are meaningless because of hardware differences. (N/A = not applicable.)

PRODUCT	UNCOMPRESSED DATA	COMPRESSED DATA	UNCOMPRESSED (PARALLEL)	COMPRESSED (PARALLEL)
<b>DOS software<sup>1</sup></b>				
Procomm Plus 2.01	59000	30000	N/A	N/A
Telix 3.21	64000	30000	N/A	N/A
<b>Macintosh software<sup>2</sup></b>				
Microphone Pro 1.0	53000	29985	N/A	N/A
White Knight 11.14	57600	30520	N/A	N/A
<b>Windows software<sup>3</sup></b>				
Procomm Plus 1.02 for Windows	18740	18300	48500	29750
Crosstalk for Windows 2.0	18900	18340	40900	32900
<b>Unix software<sup>4</sup></b>				
Term 8.2	8800	5890	N/A	N/A

<sup>1</sup>Connection was made to a Microcom modem at 115.2-Kbps DTE speed; the modem-to-modem speed was 28.8 Kbps with MNP 10.

<sup>2</sup>Connection was made to a Microcom modem at 57.6-Kbps DTE speed; the modem-to-modem speed was 28.8 Kbps with MNP 10.

<sup>3</sup>Connection was made to a Microcom modem at 19.2-Kbps DTE speed; the modem-to-modem speed was 19.2 Kbps with MNP 10.

<sup>4</sup>Connection was made to an ATI V.32bis modem at 9600-bps DTE speed; the modem-to-modem speed was 9600 Kbps. File transfer protocol was Ymodem.

### A sample CASL script from Crosstalk for Windows that logs onto MCI Mail.

```
label LOGIN
/* Try to log in to MCI Mail for 50 seconds. If not successful, then
hang up and exit. */
trys = 1
while online and trys < 5
  watch 10 seconds for
    quiet 2 seconds      : reply
    "name:"              : wait 5 ticks : reply UserID
    "password:"          : wait 5 ticks : reply Password
    "sorry, inc"         : wait 5 ticks : reply : bye : bye
    "COM"                : alarm 1 : message "MCI logon complete" : end
    "call Customer Service" : ALERT "Connection refused", OK : end
  endwatch
  trys = trys + 1
wend
```



### Crosstalk for Windows

Crosstalk for Windows may not be the most popular Windows communications package, but the people who use it defend it passionately. During this review, it quickly became obvious why so many people (including a number here at BYTE) like it so much.

Crosstalk emulates most standard terminal types, handles a number of file transfer protocols (including a few that no other package handles), supports DDE functions, and allows connections through a network. The network support includes redirected BIOS access through INT 14, NASI (NetWare Asynchronous Services Interface), NCSI (Network Communications Services Interface), and the ACS (Asynchronous Communications Server) interface. The ability to access shared resources over a network is quickly becoming a required feature in most software packages. A few other Windows packages permit this, including the new version of Procomm Plus for Windows.

Configuring Crosstalk for a variety of communications sessions is simple because of the straightforward way DCA designed the setup interface. One menu choice brings up the settings dialog box, which has a number of subfunctions. Each of these is accessed through an icon button that—unlike most Windows icons—is clearly marked with text describing its function.

The toolbar (or Crosstalk's QuickBar) has a number of icons that are supposed to make using the package more convenient (see the screen). I found that few of them made any sense, and on a notebook display they were practically unreadable. If you like toolbars in other Windows programs, however, you may find them useful. I ended up turning them off and using the menus.

Besides strong network support, the other standout feature that makes Crosstalk worth consideration is its programming

language, CASL (Crosstalk Application Scripting Language). CASL is an extension of the language used in earlier versions of Crosstalk. Programming in CASL is straightforward, and I found that programs generally work the way you expect them to. The sample CASL script listing is a routine for logging into a system. The CASL documentation is fat and daunting, but don't let that scare you.

## New and Improved

Three of the packages reviewed here—MicroPhone Pro for the Mac, Procomm Plus for Windows, and Term—will be shipping in new versions by the time you read this. According to the vendors, here is what you can expect from the upgraded products:

According to Software Ventures, MicroPhone Pro 2.0 for the Mac adds support for simultaneous ongoing sessions, more terminal emulations, more and faster transfer protocols such as CompuServe B+, easier hardware configuration, keyboard mapping (handy for PowerBook users), and scriptable custom windows. For information junkies, Software Ventures has added a rich set of tools for navigating the Internet. The upgrade price is \$59.95.

DataStorm has added fax support to Procomm Plus for Windows 2.0. You'll be able to load up to five Action Bars at the same time with the new version, and the Aspect language has been enhanced. Configuring your modem should be easier, with automatic detection of 500 different modems—Procomm will figure out which modem you have and configure itself automatically. Improvements to Procomm's host mode include fax capability that lets callers dial into your system to request faxes. Support for NASI/NCSS network connections is scheduled, and you'll be able to arrange your dialing directory into groups for easier access.

Century Software is updating the Unix version of Term to 6.3, adding in Zmodem, CompuServe B, and FTP file transfer protocols. The vendor will also add more terminal emulations and improve Term's capability for unattended automated file transfers. The upgrade price for current Term users will be \$189, directly from Century Software.



**Procomm Plus for Windows**  
Procomm Plus for Windows came onto the scene riding the coattails of its popular

DOS cousin, Procomm Plus. The Windows version is more than a Windows interface glued onto the DOS program, however. DataStorm enhanced the Aspect programming language, for example, to support windows, bit-mapped graphics, and other Windows features. Procomm's Action Bar is one of the few comprehensible toolbars I've seen on a Windows package. It has only 10 icons, and about half of them actually make sense.

From the menus and dialog boxes (see the screen), you can manage your dialing lists, write and compile scripts, transfer files, and configure the program for any combination of modems and serial connections. I found both strong and weak points to the interface. The setup menu, for example, brings up a dialog box with a series of buttons. When you click on the Connection button, you can select from the predefined connections; double-click on it, and you can define new ones. While the double-click trick is convenient, it's not obvious; you must read the documentation. It would be nice if the selection menu also offered a New option.

If you often find yourself downloading GIF files, you may like Procomm's automatic GIF viewer. As soon as Procomm recognizes a GIF graphics file, it opens a window and displays the graphic as it downloads. Procomm also provides DDE server support. You can, for instance, have your spreadsheet open a communications session, dial an on-line service, grab warehouse inventory data, and return it to your spreadsheet.

If you ever find yourself reconfiguring your current package's Zmodem for different on-line services, you'll appreciate Procomm's ability to create new Zmodem options in the transfer menu with assigned names. For example, with some services you may want crash recovery; with others, you may not.



### Term

Selecting the most popular communications product for Unix was tough. Unix enjoys a rich heritage of public domain software, so many application areas are fully addressed by software you can get for free. Communications is historically one of those areas. The most prevalent communications package in use on Unix systems is Kermit, available free from just about

everywhere. In some cases, however, you may want technical support by phone, and that's where commercial products fit in. Century Software's Term is one of the few commercial products on the market.

Term is a standard communications package with terminal emulation, a selection of file transfer protocols, and a scripting language. When you establish a connection, you specify one of the devices provided on your system, typically one of the modems in your modem pool. I installed my copy of Term onto bytepb, our 486-based Unix System V release 3.2 system, which has two modems attached to it. The idea was to install the software there, and then telnet into bytepb and access Term to dial out to other systems.

Unfortunately, that didn't work. Term provides terminal emulation, but it also expects your terminal to support some emulation so that the program can control your screen. All the systems in BYTE's Unix Lab run graphics screens with X Window System, and Term doesn't support X. When I specified the terminal type as SCOANSI and ran from the system console, however, it ran fine. If you plan on using Term, check with the company to make sure the package will work in your environment.

Term's interface is perfectly usable, although it has an outdated feel to it (see the screen). Perhaps because of Term's stark character screens, it felt like I was running on an old LSI/11 from years ago. Still, configuring Term to access my test BBS went easily, and file transfers worked well. Term doesn't support Zmodem, and the BBS doesn't support Kermit, so I ended up using Ymodem for the file transfer tests.

Term's scripting language is powerful, with lots of functions, yet it still feels primitive compared to some of the other languages I used during this review. The programs end up resembling Aspect or CASL programs, only with shorter, more cryptic keywords.

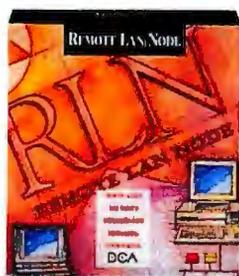
### Communications Solutions

I've used Procomm (the DOS version) on my DOS/Windows machines for several years now, and White Knight on my Mac ever since I bought it. Based on my evaluation experience, I might take a closer look at MicroPhone Pro. I didn't find Telix to be any better than Procomm—although it's just as good. If you are about to run out and buy a DOS communications package, download Telix first and try it.

Neither of the two Windows packages convinced me to stop running Procomm

# WE JUST PUT MORE DISTANCE BETWEEN RLN AND OTHER REMOTE ACCESS SOLUTIONS.

For some time, Remote LAN Node® has been acknowledged as the best



RLN comes preconfigured on a rack-mountable 486 server for 4, 8 or 16 simultaneous users, or as software-only for 2-16 simultaneous users.

remote node solution you can buy, letting users dial into their LANs and work just as if they were locally

connected. And it's been proven in use across the world. Now RLN™ 2.0 has really left the others in the dust.

RLN now supports tokenring as well as Ethernet. In fact, you can access either one with the same client software. RLN is the only remote access solution that works in virtually any single or interconnected network environment.

There's also new SNMP support, and a built-in Windows™-based Remote Manager console for server management from any remote PC. You can also simultaneously update user information on multiple servers from a single location. And RLN has a Custom Client Build utility, so configuring



your remote clients is easier.

RLN has always included powerful security features. But now that we've added enhanced data encryption, password aging and support for Challenge Handshake Authentication Protocol (CHAP), it's the most secure solution you can buy.

So call for more information and a free demo copy of RLN software that will let you dial in and see what it's like to be a remote node. We'll also send you an informative white paper on remote computing.

Like RLN users the world over, you'll see what lengths we've gone to, to make sure no other remote solution comes close.

1-800-348-3221, ext. 57DD\*



# DCA

The Freedom To Communicate.

\*Or call (404) 475-8380. © 1994 Digital Communications Associates, Inc. All rights reserved. DCA and Remote LAN Node are registered trademarks and RLN is a trademark of Digital Communications Associates, Inc. Windows is a trademark of Microsoft Corporation. All other trademarks are the property of their owners.

Circle 88 on Inquiry Card (RESELLERS: 89).

in a DOS window. Under Windows, the DOS version of Procomm manages better throughput at 2400 bps than the Windows communications programs, runs in the background, and has a simpler interface. When I need to transfer files faster than

2400 bps (that is, if our town, Peterborough, ever gets a faster Tymnet node), I'll have to choose between running the DOS Procomm package alone, without the speed restrictions of Windows, or clogging up my hard drive with a slower, fatter Win-

dows package to get background communications. Perhaps by the time I need a faster Windows package, something better will have come along.

Besides working with Term on the Unix system, I installed the DOS version. It may take you some time to get used to the interface, but the wide support of Term on Unix, VMS, DOS, Windows, Macintosh, and BTOS systems may make it the perfect solution for your environment.

You shouldn't overlook the cheap and free options, either. Kermit is available for just about every computer made. There are also a number of interesting DOS solutions besides Telix, and Macintosh communications enthusiasts are just as likely to suggest ZTerm as any commercial solution. Explore your local BBSes and on-line services first. But if shareware isn't what you want, one of these commercial packages could be just what you're looking for. ■

*Howard Eglowstein is a testing editor for the BYTE Lab. He can be reached on the Internet or BIX at [heglowstein@bix.com](mailto:heglowstein@bix.com).*

## About the Products

### Crosstalk

**for Windows 2.0** .....\$179

Digital Communications Associates, Inc.  
1000 Alderman Dr.  
Alpharetta, GA 30202  
(800) 348-3221  
(404) 442-4095  
fax: (404) 442-4366  
**Circle 1083 on Inquiry Card.**

**MicroPhone Pro 1.0** .....\$295

Software Ventures Corp.  
2907 Claremont Ave.  
Berkeley, CA 94705  
(510) 644-3232  
fax: (510) 848-0885  
**Circle 1084 on Inquiry Card.**

**Procomm Plus 2.01** .....\$129

**Procomm Plus**

**for Windows 1.02** .....\$179

Datastorm Technologies, Inc.  
3212 Lemone Blvd.  
P.O. Box 1471  
Columbia, MO 65205  
(314) 443-3282  
fax: (314) 875-0595  
**Circle 1085 on Inquiry Card.**

**Telix 3.21** .....\$39 (shareware)

deltaComm Development, Inc.  
P.O. Box 1185  
Cary, NC 27512  
(800) 859-8000  
(919) 460-4556  
fax: (919) 460-4531  
**Circle 1086 on Inquiry Card.**

**Term 6.2** .....\$495

for Interactive Unix single-user version (tested)  
Century Software  
5284 South 320 West,  
Suite C134  
Salt Lake City, UT 84107  
(800) 877-3088  
(801) 268-3088  
fax: (801) 268-2772  
**Circle 1087 on Inquiry Card.**

### White Knight

#### Telecommunications

**Software 11.14** .....\$139

The Freesoft Co.  
105 McKinley Rd.  
Beaver Falls, PA 15010  
(412) 846-2700  
fax: (412) 847-4436  
**Circle 1088 on Inquiry Card.**

**Y**ou love videography. It's your life. So why get involved with a video editing system that seems attractive now, but can't accommodate your needs in the future; an editing system that shows signs of age as soon as your entry-level video devices have to be upgraded?

The beauty of AmiLink CIP for Windows editing system is that it's totally devoted to your career. AmiLink CIP for Windows has been specifically designed to stay with you all the way no matter where it all leads.

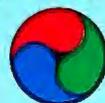
The day you're ready to improve your abilities in character generation, animation techniques or special effects, AmiLink CIP for Windows will be at your side. When you make the crucial decision to build your business on larger, more sophisticated projects and build a reputation of quality at the same time, AmiLink CIP for Windows will support each and every one of your efforts.

Not too surprising when you consider that AmiLink CIP's parents are video people not computer people. AmiLink CIP for Windows is from RGB, the same company delivering pro-quality editing to pro-editors and Video Toaster™ users all across the country.

## Are you about to marry an editing system that can't keep up with your career?

So shuttle over to your AmiLink dealer today. Or call RGB for more information about AmiLink CIP for Windows, the video editing system that will never let you down.

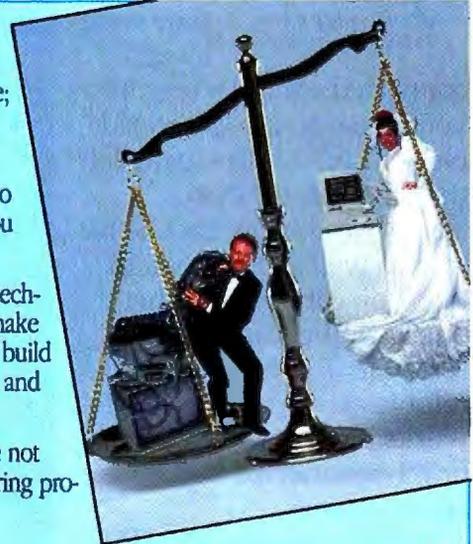
For more information call 1-800-535-7876.



**RGB Computer & Video, Inc.**

4152 W. Blue Heron Blvd., Suite 118  
Riviera Beach, FL 33404-4858  
TEL (407) 844-EDIT, FAX (407) 844-3699

*Picture Perfect*



# INTELLIGENCE RECOGNIZED!

"ZyXEL modems are now among the best performers" - PC Magazine

Leading publications are continuing to recognize, rave about and award the many smart performance features that make ZyXEL the industry leader. And why shouldn't they? Our Ultra High Speed Modems fit a wide range of configurations, giving you more Intelligent Features that save you time and money.



"ZyXEL modems are loaded with features, they comprise a virtual treasure box of surprises." -

Boardwatch Magazine

The ZyXEL U-Series offers Intelligent Features to ensure speed, reliability and true "plug-and-play" operating ease. Our new VoiceFax Software\* and two-way fax ability lets you send and receive voice mail from remote locations. Our Rackmount and NMS give you simultaneous control of hundreds of sites. And, if you're on the go, our New U-1496P Portable Modem/Fax offers cellular capability and portability.

"Some modems are good. Some modems are fast. ZyXEL modems are good and fast."



- Computer Shopper

The ZyXEL PLUS Series gives you up to 19.2 Kbps, with DTE speeds of up to 76.8 Kbps in modems that come with a 5-year warranty\*\* and will soon be upgradable to V.Fast Advantage.\*\*\*

"ZyXEL modems scored a three-way tie for best two-way communications modem."

- BYTE



Out of the 62 modems tested, ZyXEL was honored by PC Magazine as one of only three

modems proving 100% reliable connections.

Also, ZyXEL modems are compatible with most other modems and operate in both synchronous and asynchronous modes as well as in all environments: DOS,™ Windows,® OS/2,® Macintosh,® UNIX,® NeXT® and Amiga.™ And, with V.25bis for synchronous communications, ZyXEL is compatible with IBM's AS/400® and RS/6000.®

### ZyXEL's Intelligent Features:

- Ultra High Speed 19.2/16.8 Kbps
- V.32bis/V.32, V.22bis/V.22, BELL 212A
- V.17-14.4 Kbps, EIA Class 2, G3 Fax, S&R
- V.42/V.42bis with Selective Reject-MNP® 3/4/5
- Digitized Voice Capability
- Caller ID/Distinctive Ring
- Remote Configuration
- Auto Fall Forward/Fall Back
- Call-Back Security with Password Protection
- Line Probing Techniques
- 2/4 Wire Leased/Dial Line
- Auto Data/FAX/Voice Detection\*\*\*\*
- Upgradable by EPROM

Find out what the Industry Experts already know. Call ZyXEL. A Wise Investment. An Intelligent Modem. (800) 255-4101



To find out more about the

ZyXEL U-1496P

PORTABLE WITH CELLULAR call your ZyXEL sales representative today!



## ZyXEL

The Intelligent Modem

Circle 164 on Inquiry Card (RESELLERS: 165).



4920 E. La Palma Avenue, Anaheim, CA 92807 (714) 693-0808 BBS: (714) 693-0762 FAX: (714) 693-8811

\*Available with Windows, DOS,™ and Macintosh® versions. \*\*2-year warranty for Rackmount models. \*\*\*V.Fast upgrade price depends upon the model. This offer is valid in USA and Canada only. \*\*\*\*Auto Data/Fax/Voice detection available on DOS version, Window/Mac version available with Auto Fax/Voice detection. Prices and specifications are subject to change without prior notice. All trademarks and logos are the property of their respective owners.



June 29, 1993  
ZyXEL U-1496 PLUS



February 1993  
ZyXEL U-1496E PLUS



V.7, No. 7 "The ZyXEL U-1496E PLUS costs less than many of the V.32bis modems that it outperforms."



ZyXEL U-1496E PLUS



ZyXEL U-1496E



July 1993, ZyXEL U-1496E PLUS  
ZyXEL U-1496 PLUS  
Top 10 List



June 1993  
ZyXEL U-1496E



May 10, 1993 "The ZyXEL modem is faster...practically across the board."



ZyXEL U-1496 PLUS



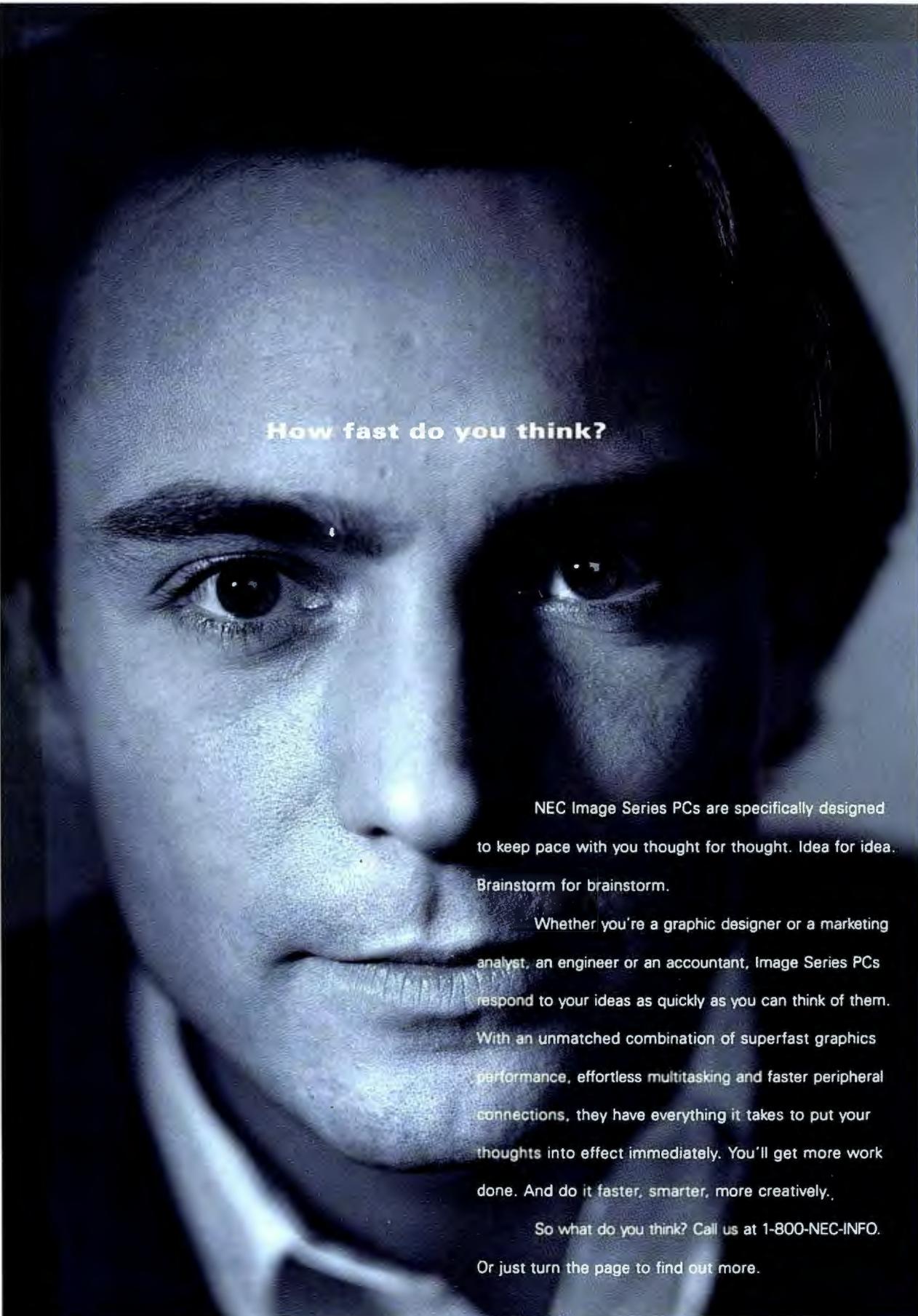
November 1992  
ZyXEL U-1496  
ZyXEL U-1496E



Winter 1992 ZyXEL U-1496  
Awarded 5 NextWorld Cubes

**How fast is an Image™ Series PC?**





**How fast do you think?**

NEC Image Series PCs are specifically designed to keep pace with you thought for thought. Idea for idea. Brainstorm for brainstorm.

Whether you're a graphic designer or a marketing analyst, an engineer or an accountant, Image Series PCs respond to your ideas as quickly as you can think of them. With an unmatched combination of superfast graphics performance, effortless multitasking and faster peripheral connections, they have everything it takes to put your thoughts into effect immediately. You'll get more work done. And do it faster, smarter, more creatively.

So what do you think? Call us at 1-800-NEC-INFO. Or just turn the page to find out more.

Some more information to bring you up to speed.

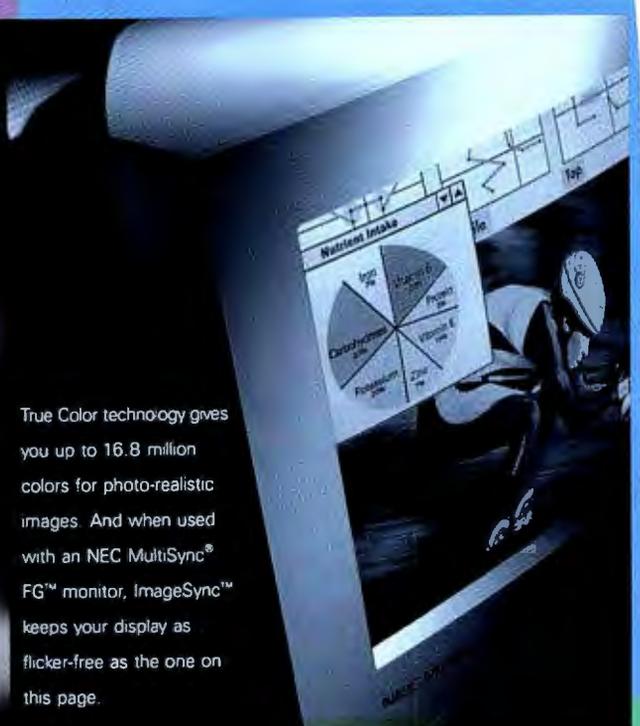
The Image 466es for advanced business and graphics applications.



Image 466es with optional MultiSpin™ 3X CD-ROM drive.

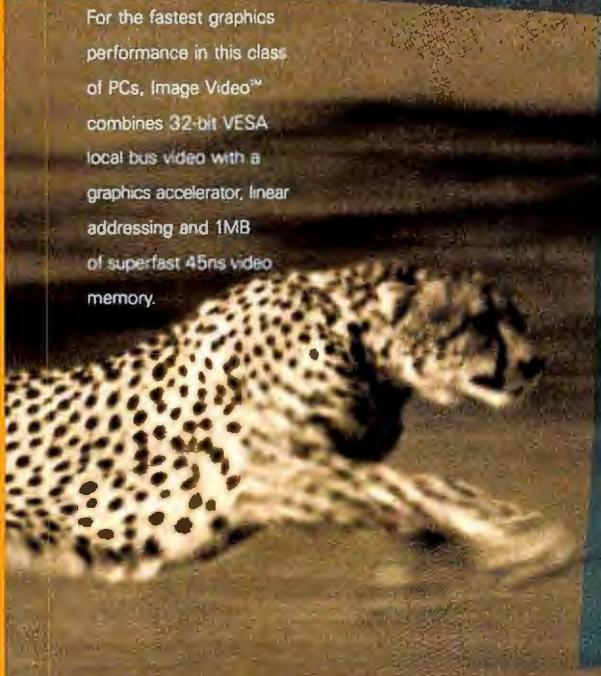
Image Series PCs respond quickly to your ideas because every feature is designed to work fast on its own. And even faster together.

The PowerMate® 466es for general business applications.



True Color technology gives you up to 16.8 million colors for photo-realistic images. And when used with an NEC MultiSync® FG™ monitor, ImageSync™ keeps your display as flicker-free as the one on this page.

For the fastest graphics performance in this class of PCs, Image Video™ combines 32-bit VESA local bus video with a graphics accelerator, linear addressing and 1MB of super-fast 45ns video memory.



At the heart of every Image Series PC is our 237-pin ZIF OverDrive™ socket, which ensures that upgrading to Pentium™ and faster processor speeds is quick and simple.



OptBus™ is a local bus IDE that can speed up your peripherals' performance by up to 50%. And, it gives green lights to entire blocks of data at one time — not the "one stop, one go" method other buses use.



Call 1-800-NEC-INFO for a data sheet, benchmarks and white papers. For FastFacts™, call 1-800-366-0476 and request document #46243.

MultiSpin, MultiSync and PowerMate are registered trademarks and Image, OptBus, Image Video, ImageSync and FastFacts are trademarks of NEC Technologies, Inc. The Intel Inside logo is a registered trademark of Intel Corp. All other trademarks or registered trademarks are the property of their respective holders. The Energy Star emblem does not guarantee EPA compliance of the product or service. Specifications subject to change without notice. NEC GSM#0000914000211 © 1993 NEC Technologies, Inc.

**NEC**

Circle 121 on Inquiry Card.

# A New Synergy for Windows

**ProdeaSynergy's graphical tools let you create complex scripts for automating Windows tasks across many different applications**

STEVE GILLMOR

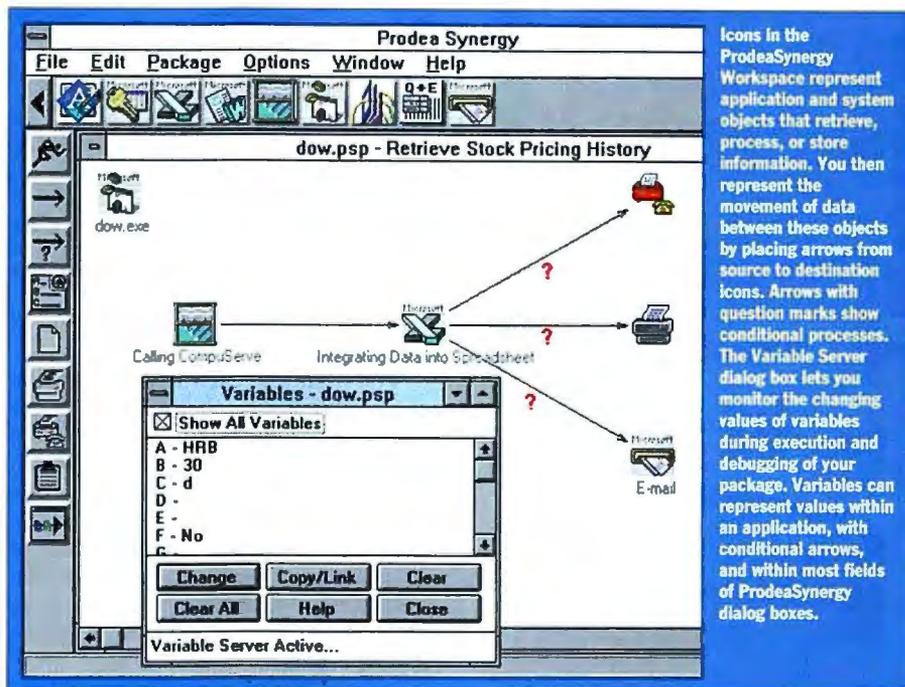
Sometimes in sports or the arts, a performer arrives with a talent so great that he or she makes the most difficult feats seem easy. Such is the case with ProdeaSynergy, a new application-integration software package that at first glance does not appear to have all that much to it. It's only when you try to accomplish what it can do in some other way that you begin to appreciate what is going on behind the scenes.

In simplest terms, ProdeaSynergy is a Grand Central Station that serves as the hub connecting software like databases, spreadsheets, and communications programs, both on individual machines and across a network. The visually oriented Windows development environment lets you derive data from any source, massage and format it, and then send it on via conditional choice of E-mail, fax, paper, or disk. You can do all this without needing to know the intricate details of proprietary messaging techniques, programming tools, or file-format compatibility.

## The Elements of Synergy

The power of Prodea's automated scripts depends on the software applications and desktop tools available to you locally or over a network. ProdeaSynergy can mediate between packages, selecting the best common format and the optimum interchange method, but it is not a programming language; it can't provide applications with any missing functionality. It also can't assume control from within an application. If you want to automate a procedure from within Excel, for instance, you'll need to develop an Excel macro to do the processing. You then use ProdeaSynergy to pass the output of the macro to other applications.

In the final analysis, a process automated by Prodea's software will work only as well as the mechanisms used to drive it. ProdeaSynergy is not a replacement for cross-application automation tools like Visual Basic for Applications or OLE 2 Automation. In fact, as VBA and OLE 2 Automation become more widespread, Prodea will be able to leverage these tools to link



Icons in the ProdeaSynergy Workspace represent application and system objects that retrieve, process, or store information. You then represent the movement of data between these objects by placing arrows from source to destination icons. Arrows with question marks show conditional processes. The Variable Server dialog box lets you monitor the changing values of variables during execution and debugging of your package. Variables can represent values within an application, with conditional arrows, and within most fields of ProdeaSynergy dialog boxes.

applications together in a visual way and facilitate development across several applications.

ProdeaSynergy has three major elements: the ProdeaSynergy Package, the ProdeaSynergy Library, and the Variable Server. You create packages by placing icons in the ProdeaSynergy Workspace that represent application and system objects that retrieve, process, or store information. You then represent the movement of data between these objects by placing arrows from source to destination icons. After defining object and arrow properties, you choose the Runner icon to execute the package.

The ProdeaSynergy Library provides a simple GUI where you can organize and launch various packages. Once created, a package can be published in a designated library, which can then be saved, copied, or E-mailed to another machine. A separate executable file that you can launch from the Workspace, the ProdeaSynergy Library supports password-protection security features; a subdirectory tree structure to group packages by related topics; and appearance options to modify the color scheme, the size and type of buttons, and

icons that represent topics and packages.

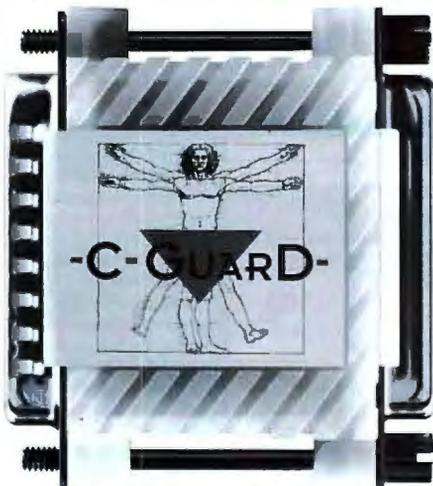
The Variable Server leverages ProdeaSynergy's ability to resolve relationships and communications at run time rather than at build time. The Variable Server provides 260 predefined global variables that can be set and referenced by each of the programs you are running in a package. These variables can be manipulated via DDE, OLE, and application menu add-ins that ProdeaSynergy often installs in a process dubbed *synergizing*. You can use variables with conditional arrows to control where the data flows based on changes at run time.

## Application Support

When you install ProdeaSynergy, it prompts you to select and define the applications you have on your system. The program accesses the Application Services Database, a predefined list of DOS and Windows applications that contains basic information such as program name and location, type or class of application, messaging protocols supported, and file formats supported. The Database also contains the key set of application functions and commands that ProdeaSynergy needs

Intelligent innovations  
for software protection

# Count on C-GUARD!



from **US \$ 12\***

**Reduce costs,  
optimize profits:**

With a completely  
new copy protection  
technology.

- Easy to operate.
- Program installation  
with C-GUARD.
- Continue working  
**without** dongle.
- No unauthorized copies.
- Ideal for laptops.

\* bulk discounts:

C-GUARD when ordering 1000: US \$ 12

C-GUARD when ordering 100: US \$ 15

Since 1985 over 1600 customers  
(as SIEMENS, AEG, IVECO) rely  
on our software protection  
products.



# MARX

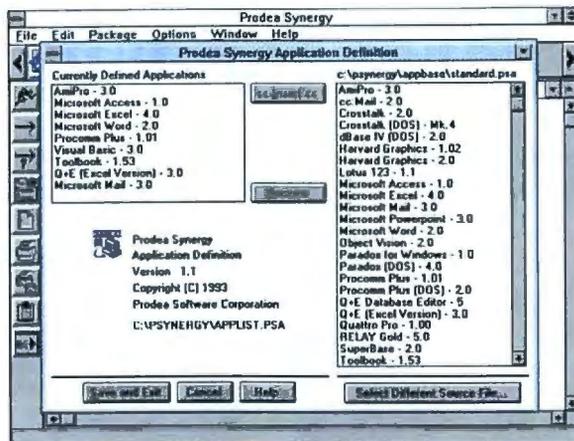
DATENTECHNIK  
DATENSCHUTZ GmbH

Vohburger Straße 68  
D-85104 Wackerstein  
Tel. ++ 49-8403-1555  
Fax ++ 49-8403-1500  
E-Mail: 100273.171@compuserve.com

**Currently looking for  
international distributors**

Circle 179 on Inquiry Card  
(RESELLERS: 180).

## Reviews A New Synergy for Windows



The Application Definition dialog box is available during installation or any time you want to update or add new applications. You can define applications that reside on both local and network drives.

to instruct each application to perform its tasks within the package.

You highlight each new application name in the list on the right side of the Application Definition dialog box and then click the Insert button to add the name to the Defined list on the left. ProdeaSynergy verifies the presence of the application on your system before inserting the name. If it doesn't find the application, the program gives you the opportunity to enter the appropriate path or choose the Browse button if you need help.

You can also use one of several "Any" applications to define your own applications within a class (e.g., word processor, spreadsheet, or database), to provide support for tools that are not currently predefined in the database. Prodea is constantly updating this data, which resides in files separate from the ProdeaSynergy main executables. Thus, you can get support for new programs and upgraded versions of existing products by downloading from the Prodea BBS or by mail, without needing to upgrade ProdeaSynergy itself or alter your existing packages and libraries.

The Workspace has five major elements: the Application Toolbar, the System Toolbar, the Menu Bar, the Status Bar, and the Package Window. Defined applications are represented by their program icons in the Application Toolbar, which runs across the top of the screen. You can double-click on an icon to run the associated application from within ProdeaSynergy.

### Putting ProdeaSynergy to Work

Creating a package couldn't be easier—you just click and drag an icon into the Package Window. Start with a simple example. Suppose you need to generate a

monthly report with data you regularly enter into a spreadsheet. Each month, you need to move a range of cells from the spreadsheet, place the data in a word processing document, and then print the document. After creating a new ProdeaSynergy Package, you would drag the appropriate spreadsheet icon to the upper left corner of the Package Window. Don't worry if you have Excel and you are creating a package to run on a machine that has only Lotus 1-2-3; ProdeaSynergy can automatically

substitute one spreadsheet application for another at run time.

Next, you select a word processor icon, drag it just to the right of the spreadsheet icon, and connect the two icons with an arrow showing the direction of the data flow. Finally, you select the Printer icon from the System Toolbar, drag it to the right of the word processor icon, and connect the two icons with an arrow. You can also add conditional arrows if you have more than one possible outcome.

Before continuing with the package design, you need to access a spreadsheet that contains the range to be moved. You can access the spreadsheet from within ProdeaSynergy by right-clicking on the spreadsheet icon and entering the worksheet filename in the appropriate field of the Application Object Properties dialog box. If you've defined a range, you need to right-click on the arrow between the spreadsheet and the word processor and enter the name of the range in the Range Definition From: field. Otherwise, all the data within the worksheet will be moved with no further work on your part. Click on the Runner icon, and your package will execute.

### Intelligent Choices

ProdeaSynergy manages and mediates between the applications, data files, and output devices you selected in creating the package. Moving your completed package to another machine reveals much more about ProdeaSynergy's underlying power. Perhaps the spreadsheet you employed on the original system is not available on another desktop. When you run the package on the new machine, ProdeaSynergy searches the Application Services Database for Excel and, not finding it, suggests Lotus 1-2-3 as a suitable replacement. The

# PROCOMM PLUS for Windows

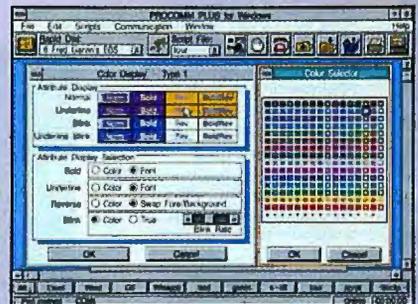
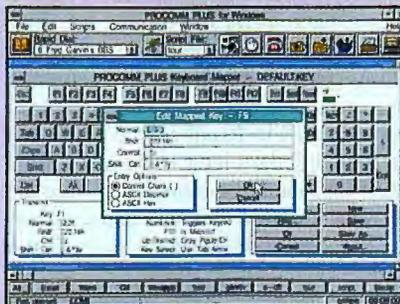


## The Streak Continues!

Introducing the Windows version of  
the best-selling communications software in the world.

PROCOMM PLUS has opened the eyes of the world to a superior communications package. Now, people with their sights set on communicating with Windows have a choice just as clear. PROCOMM PLUS for Windows.

The power and ease of use of PROCOMM PLUS combined with the elegance of Windows. Look for it now at your software dealer. And discover for yourself why PROCOMM PLUS for Windows leaves the competition in the fog.



Copyright © 1992  
DATASTORM TECHNOLOGIES, INC.  
All Rights Reserved

**DATASTORM**  
DATASTORM TECHNOLOGIES, INC.

P.O. Box 1471 • Columbia, MO 65205 • 314.443.3282

Circle 91 on Inquiry Card.

# "FirstClass Outperforms Competitors Easily"

BYTE Magazine  
09 /93

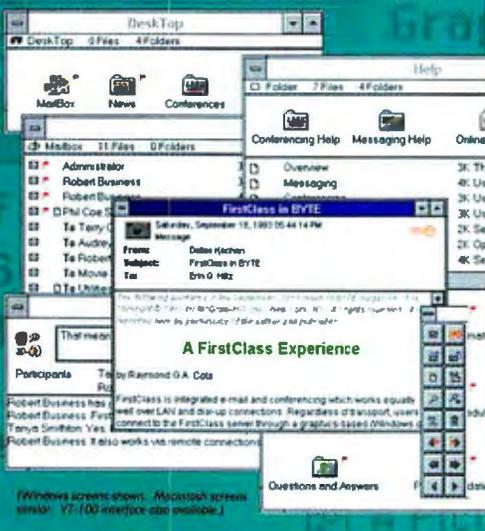
More than just a leading multi-platform e-mail system, FirstClass features electronic conferencing and remote access—all in the same package.

**E-mail**

**Conferencing**

**Remote Access**

BYTE magazine says "FirstClass blends conferencing and mail together under a remarkably clean interface that goes far beyond the capabilities of most mail systems ... a regrettably rare example of useful software."



**FirstClass™**

- ❑ Macintosh® and Windows support on the same network or via modem without costly file servers
- ❑ Easily accommodate upwards of 20 simultaneous modem connections and more than a hundred network sessions per server
- ❑ Connectivity via network or modem to other FirstClass servers or other mail systems
- ❑ Remote or local administration with the same client as others use
- ❑ Messages with multiple fonts, styles and colors & unlimited attachments
- ❑ Simultaneous multiple file transfers
- ❑ Background searching
- ❑ Gateways to the Internet with full Usenet newsgroup replicator
- ❑ Fax gateway for individual or broadcast faxing and more!

DEALER & CONSULTANT  
INQUIRIES WELCOME!



**SoftArc Inc.**  
Global-Area Communications

1902 Ridge Road, #325, West Seneca, New York, USA, 14224  
Fax: 416-754-1856 FirstClass: 416-609-2250 Internet: sales@softarc.com

Phone: 416-299-4723  
Circle 166 on Inquiry Card.

## Reviews A New Synergy for Windows

**Excel macros.** To replace a range of data with new data and then redefine the range, you'd have to write an Excel macro. ProdeaSynergy handles the chore seamlessly.

```
GET .DOCUMENT (1)
IF (NOT (ISBLANK (argRange) ))
    SELECT (GET .FORMULA (argRange) )
END .IF ( )
IF (argFormat>0, EDIT .DELETE
    (argFormat) ,CLEAR (3) )
END .IF ( )
OPEN (argFile, 0)
GET .DOCUMENT (1)
SELECT .LAST .CELL ( )
SELECT (:A1:ACTIVE .CELL ( ) )
COLUMN .WIDTH ( , , 3)
COPY ( )
ACTIVATE (C6)
PASTE .SPECIAL (2, 1, FALSE, FALSE)
DEFINE .NAME (GET .FORMULA (argRange) )
ACTIVATE (C13)
CANCEL .COPY ( )
ERROR (FALSE)
CLOSE ( )
ERROR (TRUE)
RETURN ( )
```

program uses built-in search heuristics to find files used in a package if they have been moved or, as is often the case, are stored in different locations on other machines.

Similarly, you may have defined Microsoft Mail as your package's Windows E-mail application, while another system uses Lotus cc:Mail. ProdeaSynergy automatically makes the appropriate adjustments, transparently switching messaging protocols from MAPI to VIM. Depending on the protocols supported by applications and registered in the current Application Services Database, ProdeaSynergy might use DDE to communicate with Quattro Pro for Windows, a combination of DDE and OLE with most word processors, and, if necessary (as in the case of Harvard Graphics), keystrokes.

ProdeaSynergy identifies and exploits the "richest" data/file format shared by source and destination applications. When you select two objects that don't have a compatible transfer file format, the Windows Clipboard can sometimes be used as an interface to automatically reformat source data and pass it on. For example, a graph created in Excel can be converted via the Clipboard icon to be read into a Word for Windows document, while the cell data is moved via DDE and a temporary file that ProdeaSynergy creates at run time.

Taken together, these automated services shield the user from much of the complexity in creating enterprise-wide integrated tools. Yet ProdeaSynergy goes

beyond ease of use in some instances to perform feats that are difficult to accomplish with other methods.

### Taking Stock

Take the example of a package designed to perform stock pricing analysis by downloading data from CompuServe, integrating it into a spreadsheet report, and then E-mailing, faxing, or printing the results based on user-defined instructions. First I'll describe how ProdeaSynergy constructs the package and then how, or if, it can be done another way.

You begin by using Visual Basic, Toolbook, or another authoring program to create a front-end user interface for entering user ID, password, stock symbol, period, and output choices. These values are sent via DDE commands to the Variable Server and are subsequently available to other applications running within the package.

Next you use Procomm Plus for DOS to record a script that logs onto CompuServe and downloads historical stock price data. You then press the Control key while double-clicking on the Procomm icon to open the script file and replace specific user information with variable references. ProdeaSynergy automatically substitutes these values in the script file before launching the communications program and then waits for its completion.

To import new pricing information, you create a spreadsheet in Excel and define a range to receive data. Next, draw an arrow from Procomm Plus to Excel and specify the input range in Excel in the Arrow Properties dialog box. ProdeaSynergy automatically replaces the specified range in Excel with the new information each time the package is run, resizing the range to fit as well.

If the stock price is up, the package should create a short note with the current price and send it with the attached spreadsheet to management via Microsoft Mail. You do this by drawing a conditional arrow from Excel to Microsoft Mail, which automatically brings the spreadsheet in. Use Notepad to create the note, adding a variable from the Variable Server to represent the current price. Enter the resulting filename in the Message Text field of the Application Object Properties dialog box. Also enter the variable containing the manager's name in the To: field. ProdeaSynergy automatically performs a comparison at run time; if the price is up, it substitutes the price in the note and E-mails the results with the spreadsheet.

Fax and printer icons with conditional



**\$425**



**\$3,280**

# KINGSTON PROCESSOR UPGRADES. SAVE YOUR SYSTEM AND A BUNDLE.



**Significant Savings, Equivalent Performance.** Kingston's IBM designed SLC/Now! plus SX/Now!, 486/Now! and MCMaster processor upgrades make existing systems perform like new 386SX, 486SX or 486DX models. They provide the power needed for today's software, perform comparably to new systems and cost at least 70% less.

Upgrade	Before	After	New System	System Supported
<b>SX/Now!</b>	IBM-AT	With SX/Now! 25	PS/2 Model 57SX-045	SX/Now!
Landmark Speed 2.0:	8 MHz	35 MHz	22 MHz	286-based systems from AST, Compaq, Epson, Everex, Hewlett-Packard, IBM, NEC, Toshiba and Zenith
Recount:	5:44 Min.	1:51 Min.	1:54 Min.	
Retail Price:		\$215	\$1,515	
<b>SLC/Now!</b>	PS/2 Model 50	With SLC/Now! 50	PS/2 Model 90-0H9	SLC/Now!
Landmark Speed 2.0:	13 MHz	114 MHz	84 MHz	IBM PS/2 Models 50, 50Z and 60
Recount:	3:34 Min.	:29 Sec.	:38 Sec.	
Retail Price:		\$425	\$3,280	
<b>486/Now!</b>	PS/2 Model 70-25MHz	With 486/Now! SX 25	PS/2 Model 90-0H9	486/Now!
Landmark Speed 2.0:	39 MHz	84 MHz	84 MHz	IBM PS/2 Models 70 and 80, Compaq Deskpro Models 386/16, 386/20, 386/20e, 386/25, 386/25e, 386/33
Recount:	:55 Sec.	:39 Sec.	:38 Sec.	
Retail Price:		\$495	\$3,280	
<b>MCMaster</b>	PS/2 Model 555X	With MCMaster SX 25	PS/2 Model 90-0H9	MCMaster
Landmark Speed 2.0:	16 MHz	84 MHz	84 MHz	IBM PS/2 Models 55, 56, 57, 65, 70, 80 and 90
Recount:	2:47 Min.	:36 Sec.	:38 Sec.	
Retail Price:		\$795	\$3,280	

All systems tested with 16MB installed except MCMaster, tested with 6MB on-board and 5MB on treacher board. All system prices are MSRP at standard configuration as of 4/1/93. Recount conducted on 3MB Excel for Windows spreadsheet generated by Kingston Technology.



**Quality is Assured.** Bench testing of each and every product with the original system diagnostics and certification by the National Software Testing Laboratory provides the maximum assurance of individual product quality and compatibility.



**Full Compatibility.** Kingston's processor upgrades are tested to be fully compatible with today's most popular operating environments including MS DOS, Microsoft Windows, IBM's OS/2 and Novell Netware.

**More Information.**

Contact your nearby Kingston dealer or give us a call at (800) 835-6575 to find out which processor upgrade is best for you.

**[800]**



**Kingston Reliability.** Like our memory products, every processor upgrade is individually tested prior to shipping, supported by free comprehensive technical assistance and backed by a five-year warranty.



THE INSIDE NAME IN UPGRADES

17600 Newhope Street, Fountain Valley, California 92708 (714) 435-2600 Fax (714) 435-2699

All Trademarks, Registered Trademarks and Logos are of their respective holders. Kingston and Kingston Technology are Registered Trademarks of Kingston Technology Corporation. MCMaster is a Trademark of Axx, Inc. Both SX/Now! and 486/Now! are currently certified by The National Software Testing Laboratory. Certification for recent introductions, MCMaster and SLC/Now! is pending. Developer tested only. Novell makes no warranties with respect to these products.

Circle 113 on Inquiry Card (RESELLERS: 114).

# Tired of resetting your PC clock?



## PRECISION TIME™

We've got your problem solved at an affordable price. PRECISION TIME with TimeGuard™ protects against drift and erroneous time and date changes. Your PC clock will be accurately set and maintained by accessing an Atomic clock. Requires minimum memory and disk space. Ideal for personal computers and networks. Completely self-contained with nothing else to buy, PRECISION TIME is compatible with MS-DOS, Novell and Microsoft Windows.\* Easy to install and use with automatic adjustments for Daylight Savings Time.



Regularly \$149.95  
**Introductory offer**  
**\$79.95**

VISA & Mastercard Accepted

### REQUIREMENTS:

IBM AT or compatible PC with  
80286 or higher microprocessor.  
MS-DOS or PC-DOS Version 3.3 or later.  
1200 BAUD modem for Atomic clock access.

**For Orders Only: 1-800-91-LOGIC**  
or 1-800-915-6442

For more information -  
Voice: 615-391-9100  
FAX Info: 615-391-5292  
BBS: 615-391-8065

\*All product names are trademarks of their respective companies.

## CRYSTALOGIC™

**PERFECTLY LOGICAL SOFTWARE**

2525 Perimeter Place Dr., Suite 121  
Nashville, TN 37214

Circle 183 on Inquiry Card (RESELLERS: 184).

Call or write for information on other available software:

**FreeStyle Report Writer** - Programmable Report Writer for Management

**Crystal Sort** - Programmable High Speed Sort

**Crystal VM** - Virtual Memory Management Library

**Crystal VW** - Virtual Windowing Management Library

## Reviews **A New Synergy for Windows**

arrows are configured in a similar fashion, with the complete package then published to a library. The great majority of development time here is spent in creating the user interface, recording the Procomm Plus macro script, and creating the Excel spreadsheet.

### The Hard Way

To duplicate this project with Visual Basic or a similar authoring program, you would begin by designing the same user interface that served as a front end to the ProdeaSynergy package. Recording the Procomm script would also be the same. But then the two paths quickly begin to diverge.

To emulate ProdeaSynergy's run-time script-variable substitution, you need to write a Visual Basic routine that reads through the entire script and replaces prompted fields, or one that generates the Procomm Plus script on the fly, filling in the necessary information.

Now you hit a major roadblock: Visual Basic needs to launch Procomm Plus for DOS and wait for it to complete execution of the script. Unfortunately, however, Visual Basic's Shell function runs other programs asynchronously. You can't be sure Procomm Plus has finished executing before your Visual Basic code continues on, and the workarounds are kludgy.

So, instead, you might use Procomm Plus for Windows and add commands to the recorded script to send DDE messages to Visual Basic when the script has completed. You also need to create Basic DDE server routines that wait in a procedural loop. You're leveraging two different programming tools here, with limited documentation another factor to consider.

If you test the application at this point, you'll notice that Procomm Plus for Windows won't overwrite an existing data file using CIS-B+ protocol, so what works the first time will not work the next. You need to add some Visual Basic code to handle this, while ProdeaSynergy's Application Services Database is aware of this anomaly and automatically deletes the file before running the package.

Using DDE to interface with Excel is easier than with some other products, but you'll probably have to use a combination of DDE commands and Excel's macro facility to emulate the ProdeaSynergy package. Excel does not have a built-in mechanism to replace an existing range with new

data and then redefine the range to include only this new data. The "Excel macros" listing shows some sample commands that would perform that task.

Since it's not possible to pass arguments to Excel macros via DDE, Visual Basic would need to POKE the values into the macro sheet or find some other way to duplicate ProdeaSynergy's run-time variable substitution.

As noted earlier, ProdeaSynergy can automatically switch messaging protocols, but in Visual Basic, you'd have to build both MAPI and VIM functionality into the application. You'd need to code all conditional logic and variable substitution, and to prepare modified versions for each target machine around the network. What would take an hour or two with ProdeaSynergy might take a day or two at best, if the project was ever undertaken at all.

You can see some of what ProdeaSynergy does under the hood by using the Watch feature, which posts much of the messaging data as the program steps through a package. You can toggle the Variable Server window so that it stays on top of your screens and use the Step function to debug your work.

### Wish List

Looking to the future, it would be nice if you could define new applications in a more robust fashion than is currently possible. The Any application interfaces are limited in their configurability, and the fax functionality does not allow complete hands-off automation of programs like WinFax Pro. Some integration with a robust macro recorder would also be desirable;

### About the Product

**ProdeaSynergy**.....\$495  
Prodea Software Corp.  
11095 Viking Dr., Suite 225  
Minneapolis, MN 55344  
(612) 942-1000  
fax: (612) 942-1010  
Circle 1079 on Inquiry Card.

able; the Windows Recorder is not directly supported in the Application Services Database. ProdeaSynergy is a DDE-aware application, so you can integrate it with your existing development environment.

With the imminent arrival of OLE 2 Automation, ProdeaSynergy is ideally positioned to leverage the interapplication power now available with off-the-shelf software. The program delivers a unique combination of embedded intelligence and ease of use. ■

*Steve Gillmor is director of Southern Digital, Inc., a computer and video consulting firm based in Charleston, South Carolina. He is also a professional developer and coauthor of Using Visual Basic 3 (Que/Prentice-Hall, 1993). He can be reached on the Internet at sgillmor@aol.com or on BIX c/o "editors."*

# ASK ANGLUS!

# Lower Prices, New Features. ZEOS<sup>®</sup> Is Your Best Value!



We're giving you more and more... for less and less! *PC World* agrees. In their latest testing, they awarded ZEOS the January 1994 Best Buy for our 486DX2-66! ZEOS continues to be an industry leader by providing

our customers with the latest technology without raising prices. In fact, *we've lowered prices* on many of our 486 Local Bus Upgradable configurations making them the best value ever!

The value doesn't stop. In addition to receiving 100% network compatible 486 systems in money-saving packages (many ready to ship the same day you order) or custom configurations, you also get the *best* service and support in the business.

ZEOS is the first company to provide its customers with 24-hour, toll-free technical support—365 days a year. Why was ZEOS

first? Because of our dedication to you and the belief that you come first. You receive affordable top-quality systems with the industry's finest service and support.

Apparently many companies are trying to emulate our support. Good Luck! ZEOS received *PC Magazine's* Readers' Choice for Service & Reliability—*three times!*

That isn't the end of our after-sale support. All 486 Upgradables also include a 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 your best value. Call your Systems Consultant now at 800-554-5226.





### PACKAGE 1

<b>486SX-25</b> .....	<b>\$1195</b>
Lease \$50/month	
<b>486SX-33</b> .....	<b>\$1295</b>
Lease \$55/month	
<b>486DX-33</b> .....	<b>\$1395</b>
Lease \$59/month	
<b>486DX-50</b> .....	<b>\$1495</b>
Lease \$63/month	
<b>486DX2-66</b> .....	<b>\$1695</b>
Lease \$61/month	

- Intel Verified: for the Pentium™ OverDrive™ Processor
- 2MB high-speed RAM
- 107MB local bus hard drive w/32K cache
- 3.5" floppy drive
- Diamond SpeedStar Pro Windows-accelerated local bus video with 1MB RAM
- 14" 1024 NI SVGA color monitor, .28mm dot pitch
- On-board SCSI socket
- Two VESA local bus, five 16-bit and one 8-bit expansion slots
- Six-bay desktop w/2 cooling fans
- 101-key space-saving keyboard
- MS-DOS 6.2 w/Tools



### PACKAGE 2

<b>486SX-25</b> .....	<b>\$1495</b>
Lease \$63/month	
<b>486SX-33</b> .....	<b>\$1595</b>
Lease \$58/month	
<b>486DX-33</b> .....	<b>\$1695</b>
Lease \$61/month	
<b>486DX-50</b> .....	<b>\$1795</b>
Lease \$65/month	
<b>486DX2-66</b> .....	<b>\$1995</b>
Lease \$72/month	

- Intel Verified: for the Pentium™ OverDrive™ Processor
- 4MB high-speed RAM
- 214MB local bus hard drive w/128K cache
- 3.5" floppy drive
- Diamond SpeedStar Pro Windows-accelerated local bus video with 1MB RAM
- 14" 1024 NI SVGA color monitor, .28mm dot pitch
- On-board SCSI socket
- Two VESA local bus, five 16-bit and one 8-bit expansion slots
- Six-bay desktop w/2 cooling fans
- 101-key space-saving keyboard
- Microsoft Mouse
- MS-DOS 6.2 w/Tools, Windows for Workgroups 3.11



### PACKAGE 3

<b>486SX-25</b> .....	<b>\$1995</b>
Lease \$72/month	
<b>486SX-33</b> .....	<b>\$2095</b>
Lease \$76/month	
<b>486DX-33</b> .....	<b>\$2195</b>
Lease \$79/month	
<b>486DX-50</b> .....	<b>\$2295</b>
Lease \$83/month	
<b>486DX2-66</b> .....	<b>\$2495</b>
Lease \$90/month	

- Intel Verified: for the Pentium™ OverDrive™ Processor
- 8MB high-speed RAM
- 426MB local bus hard drive w/128K cache
- 2X CD-ROM and 3.5" FDD
- Diamond SpeedStar Pro Windows-accelerated local bus video with 1MB RAM
- 14" 1024 NI SVGA color monitor, .28mm dot pitch
- On-board SCSI socket
- Two VESA local bus, five 16-bit and one 8-bit expansion slots
- Six-bay desktop w/2 cooling fans
- 101-key space-saving keyboard
- Microsoft Mouse
- MS-DOS 6.2 w/Tools, Windows for Workgroups 3.11
- Choice of Lotus Application



### PACKAGE 4

<b>486SX-25</b> .....	<b>\$2495</b>
Lease \$90/month	
<b>486SX-33</b> .....	<b>\$2595</b>
Lease \$94/month	
<b>486DX-33</b> .....	<b>\$2695</b>
Lease \$98/month	
<b>486DX-50</b> .....	<b>\$2795</b>
Lease \$101/month	
<b>486DX2-66</b> .....	<b>\$2995</b>
Lease \$108/month	

- Intel Verified: for the Pentium™ OverDrive™ Processor
- 16MB high-speed RAM
- 528MB local bus hard drive w/256K cache
- 2X CD-ROM and 3.5" FDD
- Diamond SpeedStar Pro Windows-accelerated local bus video with 1MB RAM
- 14" 1024 NI SVGA color monitor, .28mm dot pitch
- On-board SCSI socket
- Two VESA local bus, five 16-bit and one 8-bit expansion slots
- Six-bay desktop w/2 cooling fans
- 101-key space-saving keyboard
- Microsoft Mouse
- MS-DOS 6.2 w/Tools, Windows for Workgroups 3.11
- Choice of Lotus Application

### FAVORITE OPTIONS

<b>426MB to 528MB HDD UPGRADE</b> .....	<b>\$125</b>
<b>10-BAY VERTICAL CASE</b> .....	<b>\$95</b>
<b>ADAPTEC 6360 SCSI CONTROLLER CHIP</b> .....	<b>\$49</b>
<b>96/48/24 V.42 bis SEND/RECEIVE FAX MODEM</b> .....	<b>\$79</b>
<b>DIAMOND VIPER VIDEO CARD</b>	
1MB VRAM: <b>\$149</b> .....	2MB VRAM: <b>\$249</b>
<b>15-INCH SVGA MONITOR UPGRADE</b> .....	<b>\$95</b>

<b>LOTUS SMARTSUITE UPGRADE</b>	
Five Windows applications in one box! .....	<b>\$299</b>
<b>COMPLETE MULTIMEDIA PACKAGE</b>	
2X, multisession MPC2 CD-ROM, 16-bit Cardinal Digital Sound Pro 16 Card with Digital Signal Processor, stereo speakers .....	<b>\$299</b>
If your system includes a CD-ROM drive, upgrade with a sound card and speakers .....	<b>\$149</b>
<i>Many other affordable upgrades and options available. Call for details!</i>	

Fax Orders: 612-633-1325, Government: 800-245-2449, Hearing Impaired (TDD): 800-228-5389, Outside U.S. and Canada: 612-633-6131. Purchase orders, MasterCard, VISA, Am Ex, Discover, Z-Card™, COD and affordable leasing programs. Open 24 Hours a Day, 365 Days a Year!

**CALL NOW TOLL FREE**  
**800-554-5226**  
 24 HOURS A DAY



Purchase orders are subject to approval. Business leasing programs available. Lease prices based on a 36-month lease; 30% purchase option. All prices, specifications and availability are subject to change without notice; call to confirm these and warranty details. Prices do not include shipping. Novell compatibility is Developer Tested Only. Novell makes no warranties with respect to this product. All products and company names are trademarks or registered trademarks of their respective holders. Intel Inside is a trademark of Intel Corporation. ZEOS is a registered trademark; Z-Card and Computers Now! are registered servicemarks of ZEOS International Ltd. ©1994 ZEOS International Ltd., 1301 Industrial Blvd., Minneapolis, MN 55413 USA. ZEOS is a publicly traded company (NASDAQ symbol: ZEOS). UFG8BYT-9402



# How Do You Know You've Got The Right Software Protection?

Your software protection strategy shouldn't be a hit or miss proposition. But with so many conflicting claims about one vendor's product being better than another, we can understand why you might want to leave it to chance.

The fact is, what really makes one protection scheme better than another is the level of security it provides. For more than a decade, we have been pioneering seamless, reliable security systems for your applications and data. Software Security's many patents

are evidence of our continuing ingenuity in developing ways of protecting your intellectual property. Our latest advances in software distribution, network license control, and "metering" are worth looking at.

But that's only part of the story. We offer a wide range of developer tools including our very highly secure AEGIS System™ which requires only a few minutes to implement. In addition, we understand the importance of our relationship with our customers

**See us at CeBit – Hall 18, C50**

and are fully committed to the best developer support program in the business.

If you are serious about protecting your software, contact Software Security and ask for an evaluation kit. It contains everything you need to explore all of our outstanding protection methods. So call today and see why there's a big difference between the bull's-eye and the bull.

**SOFTWARE SECURITY** 

1011 HIGH RIDGE ROAD STAMFORD, CT 06905 800-841-1316 (In CT: 203-329-8870) Fax: 203-329-7428 BBS: 203-329-7253

Software Security International Ltd., London: +44-784-430-060 Fax: +44-784-430-050

\* SSI Belarus, Minsk: +(7) 0172-45-21-03 Fax: +(7) 0172-45-31-61

# HOOPS 4.0: Beyond 3-D

**The common API to most 2-D and 3-D libraries and hardware now offers a real-time mode and a powerful font engine**

JOEL ORR

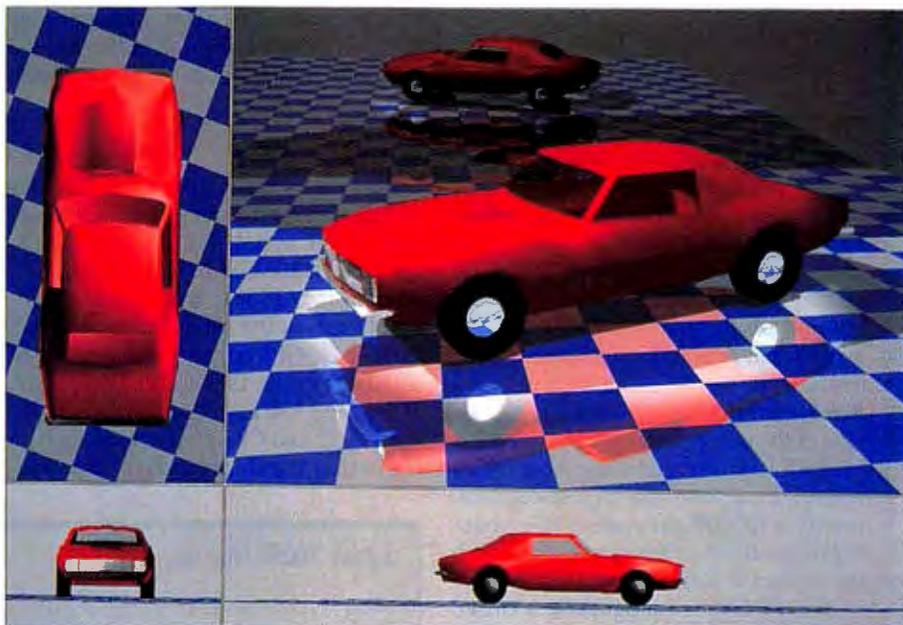
**T**he latest release of HOOPS, Ithaca Software's Hierarchical Object-Oriented Programming System, firmly establishes it as far and away the best tool for almost any kind of graphics programming—2-D and 3-D CADD, raster data processing, data representation graphics, and more. HOOPS supports graphical formats ranging from 2-D wireframe rendering through interactive photo-realism, as well as interactive display and hard copy, on platforms that range from Macs and 386-based PCs through high-end workstations. It has been selected for commercial use by some of the leading makers of CAD/CAM, mapping, scientific visualization, and multimedia software, including Autodesk and Computervision.

Like PostScript, HOOPS is truly platform independent. Graphics produced with HOOPS are 100 percent source code compatible across every major PC and workstation platform. Because of the product's scalable graphics pipeline, HOOPS programs run unaltered on all the platforms, taking advantage of special-purpose graphics hardware when it is present and substituting software for it when it is not.

## What Is HOOPS?

HOOPS is a subroutine library, a programming framework, or an API, depending on how you look at it. It is a declarative language: When you program in HOOPS, you view the universe that you affect as being in a particular default state; to change anything, you declare it to have a new value. Thus, you declare the existence of graphical entities, their locations, their attributes, and so on, and HOOPS acts on your declarations. To see your geometry, you insert cameras.

HOOPS's hierarchical nature is similar to that of PHIGS, a standard implemented by several companies. (HOOPS has defeated PHIGS's bid to be the standard in commercial applications.) All HOOPS programs consist of segment trees, which resemble a Unix file structure—in fact, HOOPS uses the same segment-naming conventions. A segment contains a list of geometry, a list of attributes, and a list of



**The latest release of HOOPS** from Ithaca Software delivers a rich library of graphics routines to a remarkable number of platforms. This screen was generated by the code in the listing "Sample HOOPS program."

subsegments. The tree has a "root" segment and subsegments. Subsegments—"leaves" of the tree—inheriting the parent segments' attributes unless they contain declarations that change them. If they do, their subsegments inherit those changes.

## In Name Only

*Object-oriented* is not an accurate description of HOOPS; the phrase was incorporated into the product name before the Smalltalk meaning was well established. In that HOOPS is declarative and nonprocedural and supports hierarchy, it is reminiscent of an object-oriented system. But it does not have separate classes and methods, nor does it support true instantiation or polymorphism.

In the world of graphics programming, two approaches are common: retained (or display-list) graphics and immediate-mode graphics. In retained graphics, the graphical database is used to construct an intermediate RAM-based file that is optimized for fast drawing. In immediate-mode graphics, the graphical database is used to redraw the screen after each change.

Each approach has its strengths and

weaknesses. Display lists allow faster and smoother redraws, but they challenge the programmer to maintain parity between the two representations of the data. Immediate-mode graphics always accurately reflect the integrity of the graphical database, but they need much more hardware horsepower to produce a level of performance similar to that of retained graphics. With retained-graphics systems like HOOPS, the programmer can work in higher-level constructs than with immediate-mode systems, so there is less programming drudgery.

Display lists are the approach of choice when the graphics do not change frequently, as in CADD. Immediate-mode graphics work better when the entire image changes often, as in some kinds of scientific visualization.

Tom Gross of Computervision describes the operation of HOOPS succinctly: "There are essentially four levels of data processing inside HOOPS: A *tree-walker* traverses the HOOPS display list and outputs data structures to the *segment renderer*, which converts them to 3-D floating-point graphics primitives. [These primitives] are then

## Drawing a line.

```
static float points [ ] = {0.2, 0.2, 0.0,
0.4, 0.7, 0.0, 0.6, 0.3, 0.0, 0.8, 0.8, 0.0};
main ( ) {
  HC_Open_Segment ("?picture");
  HC_Insert_Polyline (4, points);
  HC_Set_Line_Pattern ("-.-.");
  HC_Set_Color ("lines = red");
  HC_Set_Line_Weight (2.0);
  HC_Close_Segment ( );
  HC_Pause ( );
}
```

converted by the 3-D renderer into 2-D integer graphics primitives and rendered by the 2-D renderer. Depending on the current hardware platform, all or only some of this internal HOOPS processing might be performed by Ithaca's code." HOOPS understands the platform well enough to take advantage of its local graphics power.

## New Features

One of the new features of HOOPS 4.0 is HOOPS I.M. (for *immediate mode*). You can now intersperse immediate-mode commands in HOOPS programs while retaining the platform independence for which the product is famous.

HOOPS I.M. lets programmers embed user-defined graphics primitives and rendering techniques within the HOOPS segment tree. When these references are encountered during traversal, I.M. provides more direct control over how retained data is rendered, or it renders the application's own data directly. This mixed-mode system lets the programmer combine the best of both architectures in a unified manner.

In recognition of the de facto merger of computer typography into general graphics, HOOPS now sports a powerful font engine. TrueType and Adobe Type 1 fonts are supported.

Ithaca Software also offers a rendering system that integrates with the HOOPS framework: HOOPS A.I.R., based on technology licensed from Hewlett-Packard. World-class ray-tracing and radiosity computations are as accessible as all the other HOOPS capabilities and are just as platform independent; scan-line and z-buffer rendering is also supported. You can have constant, Gouraud, or Phong shading; contour, texture, bump, and environment data mapping; transparency; translucency; and reflectivity. With A.I.R., you can create interactive walkthroughs of radiosity-illuminated photo-realistic scenes. (For more information on radiosity, see "Radiosity," May 1992 BYTE.)

One problem with graphics APIs has

been their specificity. Some are designed for 2-D page description (PostScript); others deal with 2-D graphics and text but not 3-D (GDI, QuickDraw); some are specialized for 3-D (OpenGL, PEXlib); and others deal exclusively with image data (XIE). Unfortunately, few can combine all of these—and none can do so in a portable way.

## Portability

Portability is the major strength of this programming environment. HOOPS supports Apple System 7; DEC VMS, Ultrix, and OSF/1; HP UX; IBM AIX and OS/2; Microsoft DOS and Windows NT; Silicon Graphics Irix; Sony News; and Sun Solaris. HOOPS supports common graphical data formats: EPS, CGM, DXF, HMF, IGES, and PICT. It also supports FORTRAN, C, and C++ bindings, along with optimized interfaces to GDI (for Win-

dows), GPI, GL (Silicon Graphics), HPGL, PEXlib, PostScript, QuickDraw (Macintosh), Starbase (HP), XGL (Sun), and Xlib.

All the users I spoke with emphasized HOOPS's ease of learning and ease of use. HOOPS code is readable and concise. The source code in the listing "Drawing a line" shows what it takes to do just that. The "Sample HOOPS program" listing creates and displays four distinct views of an archived object. `Read_Metafile` causes the data from the HOOPS metafile `car` to be read from disk and placed in the segment named `?include library/car`. The `Include_Segment` places a reference to the `car` data into each of the four child segments.

In the segment front end, no camera setting is made, so the segment inherits the default camera settings. In the other \*view segments, the `Orbit_Camera` utility is used to modify the camera in the scene. The `Set_Window` commands subdivide the higher-level window into four quadrants. The projections created by

## Sample HOOPS program.

```
float target[ ] = {0.0, 0.0, 0.0}
float position[ ] = {1.0, 7.0, 2.0}

main ( ) {
  HC_Define_Alias ("?car", "?include library/car");
  HC_Read_Metafile ("car.hmf", "?car", "");
  HC_Define_Alias ("?mirror wall", "?include library/mirror wall");
  HC_Read_Metafile ("mirror wall.hmf", "?mirror wall", "");

  HC_Open_Segment ("?picture");
  HC_Set_Color ("windows=gray");

  HC_Open_Segment ("front view");
  HC_Set_Window (-1.0, -0.5, -1.0, -0.5);
  HC_Include_Segment ("?car");
  HC_Orbit_Camera (0.0, 0.0)
  HC_Close_Segment ( );

  HC_Open_Segment ("side view");
  HC_Set_Window (-0.5, 1.0, -1.0, -0.5);
  HC_Include_Segment ("?car");
  HC_Orbit_Camera (90.0, 0.0)
  HC_Close_Segment ( );

  HC_Open_Segment ("top view");
  HC_Set_Window (-1.0, -0.5, -0.5, 1.0);
  HC_Include_Segment ("?car");
  HC_Orbit_Camera (0.0, 90.0)
  HC_Close_Segment ( );

  HC_Open_Segment ("perspective");
  HC_Set_Window (-0.5, 1.0, -0.5, 1.0);
  HC_Include_Segment ("?mirror wall");
  HC_Insert_Spot_Light (position, target, "outer cone = 25 degrees");
  HC_Orbit_Camera (45.0, 45.0);
  HC_Zoom_Camera (0.7);
  HC_Set_Rendering_Options ("technology=ray-trace");
  HC_Close_Segment ( );
  HC_QSet_Camera_Projection ("?view", "orthographic");
  HC_Close_Segment ( );

  HC_Pause ( );
}
```

# Now Even Bad Reports Can Look Good.

New CA-RET™ 1.0: The Friendliest, Most Powerful Report Writer Ever.

Add bitmapped images anywhere in your report for graphic impact.



**The United States House Of Representatives**  
**THE HOUSE BANK** MONTHLY BANK STATEMENT-APRIL, 1993

Using different fonts adds pizzazz to your reports. CA-RET makes it a snap.

Create exciting output from your CA-Clipper, dBASE and text files.

**Phil A. Buster** Acct. # D 3320 67 55509  
 14 E. Park Barrel Lane, Potomac, MD 20519  
 (301) 555-0268  
 District 153 Party: Frequently  
 Campaign Slogan: "A Vote For Buster Is A Vote For Me"



Employee Of The Month  
 Bill Overdu  
 VR Bounced Checks Dept.

The allure of color: You get it in an easy, WYSIWYG environment.

Dozens of built-in number-crunching functions are available for powerful data analysis.

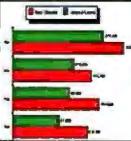
YTD SUMMARY	AMOUNT
Total Number of Bad Checks	6014
Average Daily Balance	-\$41,449.00
Average Amount of Bad Checks	\$19,242.00
Largest Overdraft	\$49,650.00
Outstanding Loans	\$55,320.00
Overdraft Fees (Waived)	\$1,250.00
Interest Owed (Waived)	\$5,360.43



**House Bank Special of the Month!**  
 This month we're offering a special no-interest, no-fee credit card that offers you unlimited credit without the inconvenience of monthly payments. In fact, you'll make no payments whatsoever with your pre-approved House Bank Credit card. Order yours for the family!

You can even turn your data into eye-catching graphs.

ACTIVITY SUMMARY					
Date	No.	Memo/Category	Payment	Deposit	Balance
3/17	5261	The Watergate Hotel	1,586.58		-20,503.00
3/21	5262	The Hair Club For Men	21,830.00		-47,188.00
3/28	5263	Club Med	3,850.78		-51,002.78
4/7	5264	Larry's Lexus Dealer	48,650.00		-97,883.78
4/15	5265	Burning Tree Country Club Annual Dues	10,000.00		-107,653.78
4/17	5266	American Express	23,400.09		-131,053.88



PREVIOUS BALANCE	\$25,623.00	TOTAL PAYMENTS	\$0.00
NEW BALANCE	\$131,053.88	AMOUNT DUE	\$0.00

And CA-RET's single-pass computation engine is the most efficient available.

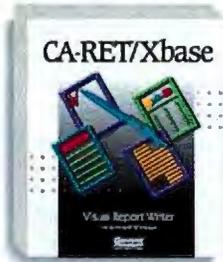
From dBASE to Clipper,



Whatever the news, make it look great with new CA-RET/Xbase, the visual report writer for Windows.

With drag and drop, WYSIWYG design, it's as easy to use as a word processor, yet powerful enough to produce stunning results. Choose a wide variety of pre-formatted tabular layouts, labels and form letters — or create your own. Now you can add dazzling color, fonts and bitmaps to any report.

Place database fields, computed fields and aggregate computations anywhere and use the more than 40 built-in functions for extensive analysis.



CA-RET/Xbase works with top databases (or text files) and acts as a DDE server so you can include reports in other Windows applications. And the unlimited use runtime license lets you distribute report applications for free.

To order, just call 1-800-531-5236 (in Canada: 1-800-665-5449). Competitive offer available for just \$79 (\$89 in Canada). Ask the operator for details.

Call today and find out how easy it is to turn the mundane into the magnificent.



© Computer Associates International, Inc., One Computer Associates Plaza, Islandia, NY 11788-7000. All product names referenced herein are trademarks of their respective companies.

# Save Disk Space

# PKZIP

## PKZIP version 2.0

PC WORLD



WORLD CLASS  
AWARD

PKWARE<sup>®</sup> introduces the next generation of its award winning compression utility. PKZIP 2.0 yields greater performance levels than achieved with previous releases of the software. PKZIP compresses and archives files. This saves disk space and reduces file transfer time.

Software developers! You can significantly reduce product duplication costs by decreasing the number of disks required to distribute your applications. Call for Distribution License information.

## Put Your Executables on a Diet

Software developers! Save disk space and media costs with smaller executables. You can distribute your software in a compressed form with PKLITE Professional.<sup>®</sup> PKLITE Professional gives you the ability to compress files so that they cannot be expanded by PKLITE. This discourages reverse engineering of your programs.



PKLITE increases your valuable disk space by compressing DOS executable (.EXE and .COM) files by an average of 45%. The operation of PKLITE is transparent, all you will notice is more available disk space!

## Compression for YOUR Application



The PKWARE Data Compression Library allows you to incorporate data compression technology into your software applications. The application program controls all the input and output of data, allowing data to be compressed or extracted to or from any device or area of memory.

All Purpose Data Compression Algorithm compresses ASCII or binary data quickly. The routines can be used with many popular DOS languages. A Windows DLL and an OS/2 32-bit version is also available!

# PKWARE<sup>®</sup> INC.

The Data Compression Experts<sup>®</sup>

9025 N. Deerwood Drive Brown Deer, WI 53223-2437  
(414) 354-8699 Fax (414) 354-8559

PKWARE Data Compression Library for DOS \$275 PKWARE Data Compression Library for OS/2 \$350  
PKWARE Data Compression Library DLL for Windows \$350  
PKZIP \$47.00 PKLITE \$40.00 PKLITE Professional \$140.00

Please add \$6.00 S&H per package in the US & Canada. \$11.25 overseas.  
Wisconsin residents add appropriate state sales tax & county sales tax.  
Visa and Mastercard accepted, no COD orders.

BY294

## Reviews

the four camera views are mapped to these screen windows.

Pause instructs the system to display the current graphics database and wait for user input. After an input event—such as a mouse click—happens, the program exits. The result of the program is in the screen on page 125.

HOOPS can work as an API layered above, say, PEXlib, a low-level subroutine interface to the PEX protocol. (PEX offers 3-D extensions to X Window System.) Not least of the benefits of using HOOPS in this context are simplicity and parsimony; drawing an initial line directly in PEXlib requires *six pages* of code. While coding directly in PEXlib gives you more control than in HOOPS, it's tedious and detailed and yields a program that must be rewritten for each different platform.

### Qualities

The HOOPS documentation has plenty of useful examples and is easy to use as a reference. But it's not the documentation that makes HOOPS easy to learn; it is the consistency of operation of the routines. You learn the template, as it were, so that even before you know the names of the calls by heart, you know what ought to exist—and when you look for it, there it is.

Under what circumstances would you not use HOOPS? Very few. HOOPS might

not be appropriate if your application is very small and easy to program and if memory is a concern—the HOOPS DLL for Windows, for example,

### About the Product

**HOOPS 4.0**...\$4200 per seat  
per platform

Ithaca Software  
1301 Marira Village Pkwy.  
Alameda, CA 94501  
(510) 523-5900  
fax: (510) 523-2880  
**Circle 1078 on Inquiry Card.**

takes about 1 MB—or if you are working with exotic hardware unknown to Ithaca.

Ithaca Software, a division of Autodesk, employs 15 programmers. It is a sign of the times that many of its customers, such as Computervision and Altium (formerly CADAM), are head-on competitors of Autodesk in the CADD arena, but this does not seem to trouble anyone. Tight security is maintained so that the confidentiality of Ithaca's many developers vis-à-vis Autodesk and one another is assured. ■

*Joel Orr (Virginia Beach, VA) is an internationally known CAD/CAM and computer graphics consultant. He is a founding member and past president of the National Computer Graphics Association. You can reach him on BIX c/o "editors" or on the Internet at 0004153485@mcimail.com.*

# Low-Priced Pentium PCs

In spite of high CPU costs, Pentium system prices are coming down

ED PERRATORE

**N**ow that Pentium-based PCs are hitting the market in force, the next natural step is lower prices. Gateway 2000 took that step first by offering a complete configuration of its P5-60 Pentium system for just under \$3000. Other vendors are not far behind, so buyers of these first inexpensive Pentium systems are not without choices for an Intel-based graphics workstation or low-end file server. For this roundup, BYTE asked for the most souped-up system the vendors offered beneath a \$4500 price ceiling.

The three systems I reviewed—Advanced Logic Research's Evolution V, Ambra Computer's Ambra DP60E/VL, and Gateway 2000's P5-60—deliver generally robust performance aided by local-bus architecture. The ALR system also had a caching IDE pass-through card that greatly boosted applications performance.

ALR's Evolution V is an ISA, VL-Bus desktop system that, for \$4314, comes with 16 MB of RAM, a 420-MB IDE hard drive, an IDE card with 1 MB of cache memory, a Western Digital VL-Bus graphics accelerator card, and an ALR Clear-View 15 monitor. Ambra's \$4399 EISA desktop offers 16 MB of RAM, a 540-MB SCSI-2 hard drive with a 256-KB cache/buffer, an ATI graphics accelerator card running in a VL-Bus slot, and a 15-inch monitor.

Gateway weighed in with the only PCI (Peripheral Component Interconnect) machine, an ISA tower model with 16 MB of RAM, a 528-MB IDE hard drive, an ATI PCI graphics accelerator card, and a 17-inch CrystalScan 1776 LE monitor. With a Mitsumi CD-ROM drive added to my test model, the Gateway costs \$3995.

All three systems came with DOS and Windows installed. The Gateway P5-60 also included Central Point Software's PC Tools for Windows and, on a CD-ROM disc, backups of the preinstalled software.

## ALR Evolution V

ALR typically sells its PCs through vertical-market VARs, who may configure the



Affordable, full-featured Pentium systems from (left to right) Ambra Computer, Gateway 2000, and Advanced Logic Research.

bare-bones Evolution V Model I with a hard drive and graphics card appropriate for the customer. For the system that I reviewed, ALR's choice of video adapter alternately raced and jogged, depending on the test. The Evolution V also fell short of the other two systems in color capability: It offered a maximum of 16-bit color at 800- by 600-pixel resolution, while the competing machines offered 24-bit color at that resolution. (I ran graphics performance tests on all the systems with 8-bit color at 640- by 480-pixel resolution.) Other than the WD90C33-based graphics accelerator card, which a CAD/CAM user might want to pass over in favor of a higher-end card, there is not much to criticize about the Evolution V.

The desktop system's sturdy case holds a 3½-inch floppy drive and three exposed 5¼-inch drive bays. Secured by two finger-turnable screws, the case is easy to remove. A printed chart inside the case lists bank-by-bank memory configurations up to the maximum 128 MB (using 32-MB SIMMs, which ALR promises it can supply).

Populating the motherboard are the 60-MHz Pentium CPU (cooled by an extra fan in the system's front panel as well as a top-mounted heat sink), 256 KB of secondary memory cache (the maximum), a Phoenix BIOS, Chips & Technologies and Opti chip sets, and six I6-bit ISA slots. Three of the slots have VL-Bus extenders. The Super VGA card sits on the VL-Bus,

as does the caching IDE card, which is able to accommodate up to 16 MB of cache RAM.

The ALR-made motherboard also has IDE and floppy drive connectors, but the optional caching IDE pass-through card is a wise choice if you're concerned about disk performance. The IDE board's write-back cache is optimized for Windows. The cache gave the Evolution V an outstanding disk index in the BYTE Lab's Windows benchmarks and largely accounts for the Evolution V's lead in the DOS and Windows application benchmarks. One thing to keep in mind, however, is that installing a good local-bus disk cache in the Gateway and Ambra systems might well even the score.

In low-level video testing, the Evolution V's performance was roughly double that of the competition. But in the more real-world Windows benchmarks, the system proved superior only in drawing pixels and performing BitBlts, often falling well behind in drawing lines, rectangles, and ellipses. The Western Digital board comes with only 1 MB of VRAM (video RAM), half what the two ATI boards came with, but it can hold 2 MB.

If what you want from the system is a file server, you're bound to be disappointed by the Evolution V's 200-W power supply, six expansion slots, and total of six drive bays. A better choice would be ALR's Evolution V-Q, which BYTE tested in our look at the first Pentium systems out of

# Reviews Low-Priced Pentium PCs

## Pentium Performance Benchmarks



\*The Compaq Deskpro 66M did not run the Windows low-level benchmarks.

All results are indexed, and higher numbers indicate better performance. For each test, a Compaq Deskpro 386/33L running DOS 5.0 and Windows 3.0 = 1. Current test systems ran DOS 6.0 and Windows 3.1. The Compaq Deskpro 66M (66-MHz 486DX2, 16-MB RAM, 256-KB memory cache, Compaq QVision video, and 510-MB IDE hard drive) was tested for comparison.

For a complete description of the tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks (version 2.4) are available in the byte.bmarks conference on BIX or by contacting BYTE directly.

**The ALR Evolution V** provides the best overall applications performance, mainly because of its caching IDE drive card—something you could add to the other systems. However, its good low-level performance gives it an edge in processor-intensive tasks regardless of peripheral configuration. Note the strong floating-point performance of the Pentium systems relative to the 66-MHz 486 Compaq, included for comparison.

the gate (see "Pentium PCs: Power to Burn," July 1993 BYTE). That machine features a 128-bit-wide data path to system memory, a tower case, 10 EISA slots appropriate for connecting lots of fast mass-storage devices, and 13 exposed drive bays. The Evolution V-Q also costs nearly \$2000 more than the Evolution V in a similar configuration.

And if what you want is PCI rather than VL-Bus in a Pentium system, ALR expects to soon ship the Evolution V STP, in 60- and 66-MHz versions. The former will start at \$3410 for an 8-MB system with DOS and Windows but no hard drive or monitor. Both versions will include a single-channel integrated Fast SCSI-2 controller as well. The PCI bus allows concurrent operation by the CPU and PCI peripherals, something VL-Bus doesn't yet allow.

### Ambra DP60E/VL

The 22-pound Ambra DP60E/VL seems to use only as much steel as necessary to support the 55-pound weight of Ambra's largest monitor. Yet the mostly plastic case not only is sturdy, it also removes without screws and can be converted to a mini-tower.

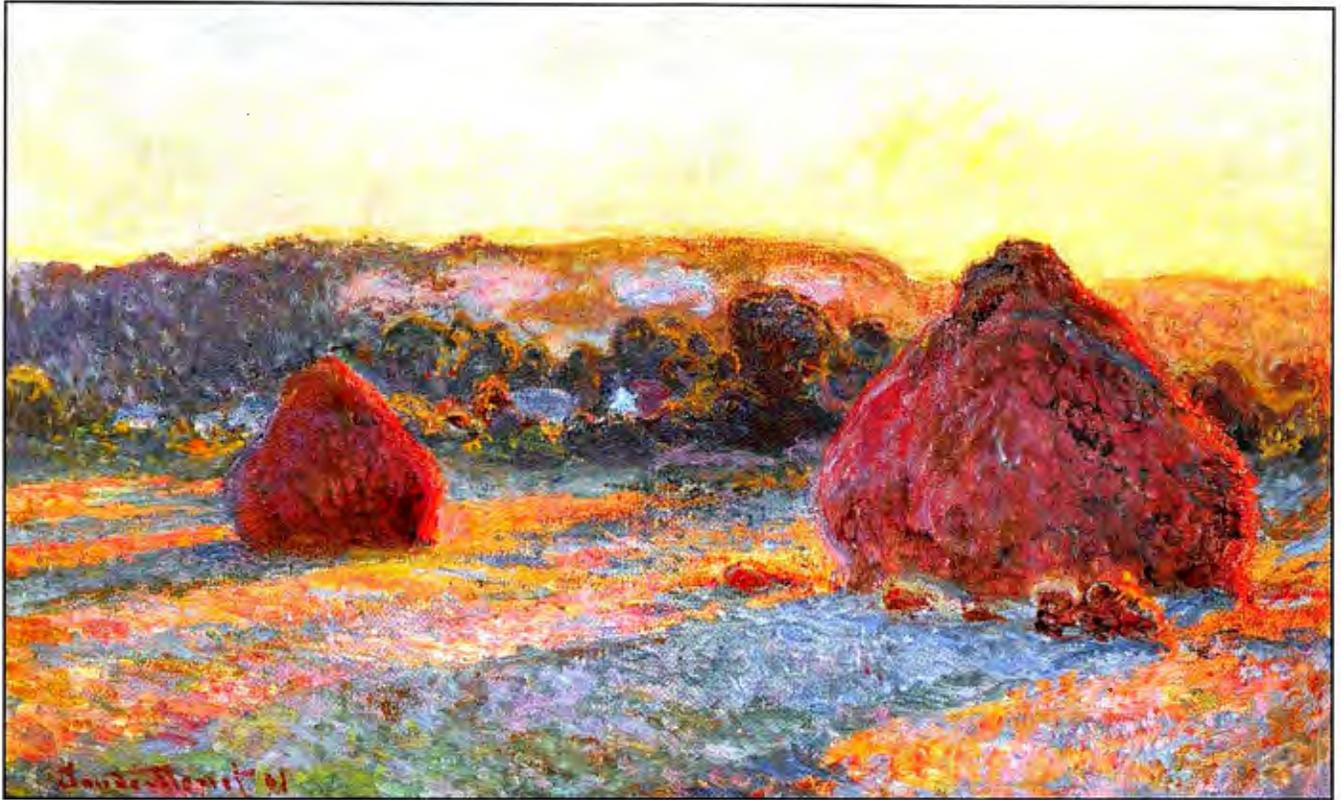
Inside you'll find some attractive features. Among them are an Adaptec AIC-7770P Fast SCSI-2 dual-channel chip set and connector that let you hook up as many as 14 SCSI devices; an Acer/Ambra-designed BIOS; and six EISA slots, two with VL-Bus extensions. An Opti chip set is spread between the motherboard and the CPU daughtercard, which also holds the external memory cache. The 16 MB of RAM is upgradable to 64 MB (actually 128 MB by design, but Ambra cannot guarantee shipment of 32-MB SIMMs any

time soon). My test model also came with a Seagate ST3610N SCSI-2 drive with 256 KB of on-board, write-back cache.

What I found less appealing were a few corners Ambra cut in its mission to deliver lower-priced systems than you'll ever see from parent company IBM. The design of the daughtercard housing the processor and secondary cache is worrisome; a plastic clip is all that holds it down tight. If I wanted to, say, upgrade the external cache from the standard 256 KB to the maximum 1 MB—or merely to leave it alone—I would prefer additional support in case the plastic fatigues.

The 3½-inch floppy drive has no spring-loaded dust cover, which I discovered does more than just keep out dust: It also prevents ejected floppy disks from flying across the keyboard. In addition, I discovered a jumper wire connecting two sites

# Don't get the wrong impression.



Claude Monet, Grainstacks (End of Summer), 1891, Arthur M. Wood in memory of Pauline Palmer Wood, photograph ©1993 The Art Institute of Chicago

Trying to find the facts about all of the different copy protection locks on the market can be as confusing as finding a needle in a haystack.

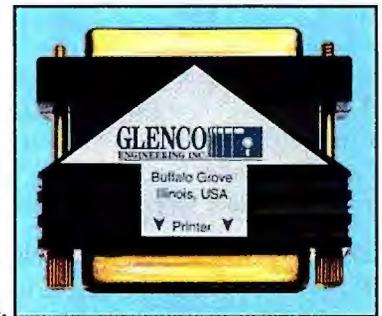
You may think all copy protection systems are the same, but the fact is that the Hardlock™ system is outstanding in its field.

Hardlock works better than the others in securing your applications against unauthorized use because it is the only lock that uses a programmable algorithm, far more complex to decode than simply reading the contents of a memory chip. Hardlock also features selectable anti-debugging and reverse engineering protection as well as protection against hardware emulators, which no other lock has.

Security. Quality. Technology.

Hardlock is state of the art.

Call us to find out more about how Hardlock can provide your masterpiece with the security it deserves.



**1-800-562-2543**

**GLENCO**  
ENGINEERING INC.

SERVING THE SOFTWARE INDUSTRY SINCE 1979

Software Protection • Data Security

Phone 708-808-0300 • Fax 708-808-0313

For DOS, Windows, Windows NT, OS/2, Unix, Xenix Single User, Network, CD-ROM Applications and More

For a distributor in Europe contact FAST Electronic GmbH, Tel: 49-89-53 98 00-20 Fax: 49-89-53 98 00-40 • In Brazil contact HT-MACH, Tel: 55-21-257-0314 Fax: 55-21-235-6808 • In Chile contact Datasoft S.A., Tel: 562-246-7443 Fax: 562-208-0591 • In Peru contact V.C.H.J., Tel: 51-14-440537 Fax: 51-14-475984

For International information circle 99, For Domestic information circle 100 on Inquiry Card.

From parallel 860s, to 386, 486 and Pentiums . . .

# NDP™ Fortran and C/C++ Drive Them All!

Microway's industry-leading 32-bit Fortran produces the highest quality numeric code and supports all x86 operating systems, processors and numeric devices. NDP Fortran was used to port industry standards like SRAC's COSMOS/M to the 486 and is required to use AspenTech's ASPEN PLUS, IBM's OSL, and Fluid Dynamics' FIDAP. The compiler uses advanced numeric optimizations and instruction scheduling which favor fast numerics and RISC devices.

## NDP Fortran, C/C++, Pascal and our new Fortran 90

for the 386, 486, Pentium, and 860 run under either Extended DOS, OS/2, NT, UNIX V.3/4, SOLARIS, or COHERENT.

The extended DOS compilers feature GREX, Microway's proprietary device-independent graphics library. To run large applications on DOS, our VCPI-based, demand paged virtual memory is superior to all alternatives. We also offer DPMI support for the OS/2 and the Windows DOS Prompt Box. The OS/2 compilers include support for OS/2's 32-bit graphics engine.

Microway's NDP Fortran 90 is a full implementation of the ANSI Fortran 90, which includes the entire array syntax notation, dynamic memory allocation, module definitions, and a complete library of intrinsics. Call for your free demo disk and white paper.

If you plan to use a 386, 486, 860 or Pentium and require portability across operating systems, numeric speed, precision and superior technical support, then NDP Fortran, C/C++ or Pascal is the only solution.



## QuadPutter®-860 . . . 200 Megaflops

The 200 megaflops of Microway's QuadPutter-860 are optimally harnessed using NDP Fortran-860, libraries from IMSL, NAG and KUCK, and the PSR Vectorizer.



## GIGACUBE™

Microway can build you a customized one gigaflop NFS computational server using five QuadPutters® running in one of our industrial grade Towers for under \$50K. We also configure less expensive 486 workstations. All feature industrial grade American power supplies based on Todd cores and flow-through filtered cooling.



To learn why more government research labs, universities and engineers worldwide specify "Microway" call our Technical Support Department.

To enroll in our Fortran 90 Professional Training Seminar in Boston in January or San Jose in March, please call 508-746-7341.

# Microway®

**Technology You Can Count On**

Corporate Headquarters, Research Park, Box 79, Kingston, MA 02364 USA • TEL 508-746-7341 • FAX 508-746-4678  
U.K. 081-541-5466 • Germany 40-524-5096 • Greece 01-222-3511 • India 11 681 0645 • 3-751-2929  
Italy 2-749-0749 • Japan 079 822 5855 • Poland 22-414115 • Portugal/Spain 1-351-458-2443 • Russia 095 155 0303

## 60-MHZ PENTIUM SYSTEM FEATURES

Gateway wins the features and price war, offering a 17-inch monitor, CD-ROM drive, and PC Tools for under \$4000. Although the ALR and Ambra systems come with smaller 15-inch monitors and higher price tags, the ALR Evolution V has a performance-boosting 1-MB caching IDE card and the Ambra has a capable SCSI-2 hard drive. All the reviewed systems have local-bus graphics cards.

Pentium System Features	ALR Evolution V	Ambra DP60E/VL	Gateway P5-60
System memory (as tested/max)	16 MB/128 MB	16 MB/64 MB*	16 MB/128 MB
Memory cache (as tested/max)	256 KB/256 KB	256 KB/1 MB	256 KB/256 KB
Processor-to-memory data width (bits)	64	64	64
Expansion bus	ISA/VL-Bus	EISA/VL-Bus	ISA/PCI
Storage	420-MB Western Digital Caviar 2420 IDE	540-MB Seagate ST3610N SCSI-2	528-MB Western Digital Caviar 2540 IDE
Graphics	Western Digital VL-Bus graphics accelerator with 1 MB VRAM	ATI VL-Bus graphics accelerator with 2 MB VRAM	ATI PCI graphics accelerator with 2 MB VRAM
Display	15-inch multiscan color monitor	15-inch multiscan color monitor	17-inch multiscan color monitor
Other features	DOS, Windows	DOS, Windows	Double-speed CD-ROM drive, DOS, Windows, Central Point Software PC Tools
Price as tested	\$4314	\$4399	\$3995

\* The Ambra DP60E/VL will be expandable to 128 MB when 32-MB SIMMs become available from Ambra Computer.

on the daughtercard—not something you want to see on any PC, let alone on a Pentium system.

Test results show that the Ambra trailed the Gateway system somewhat on most application benchmarks, and both fell behind the ALR system. Using an ATI VL-Bus graphics accelerator card with the same Mach32 chip set and 2-MB VRAM that the Gateway's PCI card had, the Ambra achieved Windows performance similar to that of the Gateway. In the DOS dBase IV database application test, however, the Ambra just about doubled the performance of the Gateway. The Ambra also led the Gateway slightly in word processing tests.

If it had been available in time, the better selection for this head-to-head comparison might have been the PCI version of this system, which Ambra announced on November 15 of last year. A 60-MHz system with 8 MB of RAM (upgradable to 128 MB), a 440-MB hard drive, Diamond Viper's PCI graphics accelerator with 2 MB of VRAM, a CD-ROM drive, and a 15-inch flat-square monitor will cost you \$3499.

### Gateway P5-60

Despite performance that falls behind that of the ALR system, the Gateway P5-60 offers the most features for the price. In

addition to its PCI architecture, CD-ROM drive, and extra software, the system also came with the best monitor. The Gateway CrystalScan 1776 LE is a 17-inch monitor offering a 0.26-mm dot pitch, a 32-character LCD panel displaying the current display mode, and Macintosh D-sub and BNC connectors in addition to a standard 15-pin Super VGA connector. This monitor is also the only one of the three with a detachable signal cable.

Inside the heavy-duty tower chassis is an Intel/AMI motherboard with its Pentium chip housed in a ZIF (zero insertion force) socket for future upgradability. An extra front-mounted fan pulls heat off the CPU's heat sink. The P5-60 uses Intel's Pentium/PCI chip set to support three PCI expansion slots in addition to five 16-bit ISA slots; one is a shared ISA/PCI slot. Eight drive bays provide plenty of storage expansion. The ATI PCI video adapter gave the system an edge in drawing lines, rectangles, and ellipses in BYTE's Windows benchmark test.

The Western Digital Caviar 2540 IDE drive, running directly off the motherboard, scored twice as high as the Ambra's Seagate on the BYTE Windows benchmarks' sequential file I/O test, and about 17 percent higher on the random I/O test, although it trailed the Ambra's disk subsystem in the low-level DOS tests. Windows

See Page 175  
**WHAT'S ANGUS SAYING?**

disk performance may have given the Gateway system a slight edge over the Ambra in several of the Windows application tests. Note that the P5-60 supports fast DMA transfers—good for sequential I/O—but the built-in 256-KB cache in the test-model Ambra's SCSI hard drive was double that of the Western Digital IDE drive that came with the P5-60.

The P5-60 produced a low CPU index on the DOS low-level benchmark because of its relatively slow memory system and the considerable weight that is placed on memory performance by the benchmark test. Because of this weighting, a Compaq Deskpro with a 66-MHz 486DX2 actually achieved a higher CPU index than the Gate-

way Pentium system did.

However, the P5-60's "memory effect" lessened in the Windows low-level memory test and essentially disappeared in the applications tests. In most applications tests, the P5-60 actually had a slight edge over the Ambra, reflecting the relative merits of the systems' hard drive and video subsystems more than memory performance differences.

Like the Ambra, the P5-60 showed a couple of design quirks. The first was a patch wire running a good 6 or 7 inches across the motherboard and indicating a product rushed to market. The second was an overnight language switch, from English to French, of the "Non-System disk or disk error" message you get

when there is an unbootable floppy disk in the drive at power-on. Both the Ambra and Gateway systems I reviewed were among the first off the production line, and the kinks should disappear by the time you read this.

### Performance a Tough Yardstick

What may be most important about my benchmarking of the ALR, Ambra, and Gateway Pentium-60 machines is that, by and large, differences in speed can be attributed more to configuration—the amount of disk cache or VRAM, for example—than to actual motherboard design. But when you factor in the care taken in design and manufacturing in this first wave of relatively low-cost Pentium systems, the choice becomes a bit easier: For high-end graphics or a small file server, I'd opt for peace of mind and go with the more mature ALR Evolution V. ■

*Ed Perratore is a BYTE news editor based in New York. You can contact him on the Internet or BIX at [eperratore@BIX.com](mailto:eperratore@BIX.com), or on MCI Mail as "eperratore/byte."*

### About the Companies

**Advanced Logic Research, Inc.**  
(Evolution V)  
9401 Jeronimo  
Irvine, CA 92718  
(714) 581-6770  
fax: (714) 581-9240  
**Circle 1080 on Inquiry Card.**

**Ambra Computer Corp.**  
(Ambra DP60E/VL)  
3200 Beechleaf Court  
Raleigh, NC 27604  
(919) 713-1550  
fax: (919) 713-1599  
**Circle 1081 on Inquiry Card.**

**Gateway 2000**  
(P5-60)  
610 Gateway Dr.  
P.O. Box 2000  
North Sioux City, SD 57049  
(800) 846-2000  
(605) 232-2000  
fax: (605) 232-2023  
**Circle 1082 on Inquiry Card.**

## FRACTAL IMAGE COMPRESSION REDUCES WHALE-SIZED IMAGES TO GUPPY-SIZED FILES.



Imagine storing up to 100 high-quality full screen images on a single floppy disk with enough room left over for the program to display them.

Fractal compression files average between 10KB and 32KB and display at barracuda speeds. These incredibly small files provide unmatched space savings in whatever storage media you may use. Using fractal compression, Microsoft *Encarta* was reduced from four CD-ROM disks to one.

Whether it's stills or full motion video, DOS or Windows, Iterated Systems' .OBJ and .DLL family of toolkits will help you conserve your resources.



**Iterated Systems, Inc.**

FOR ADDITIONAL INFORMATION:

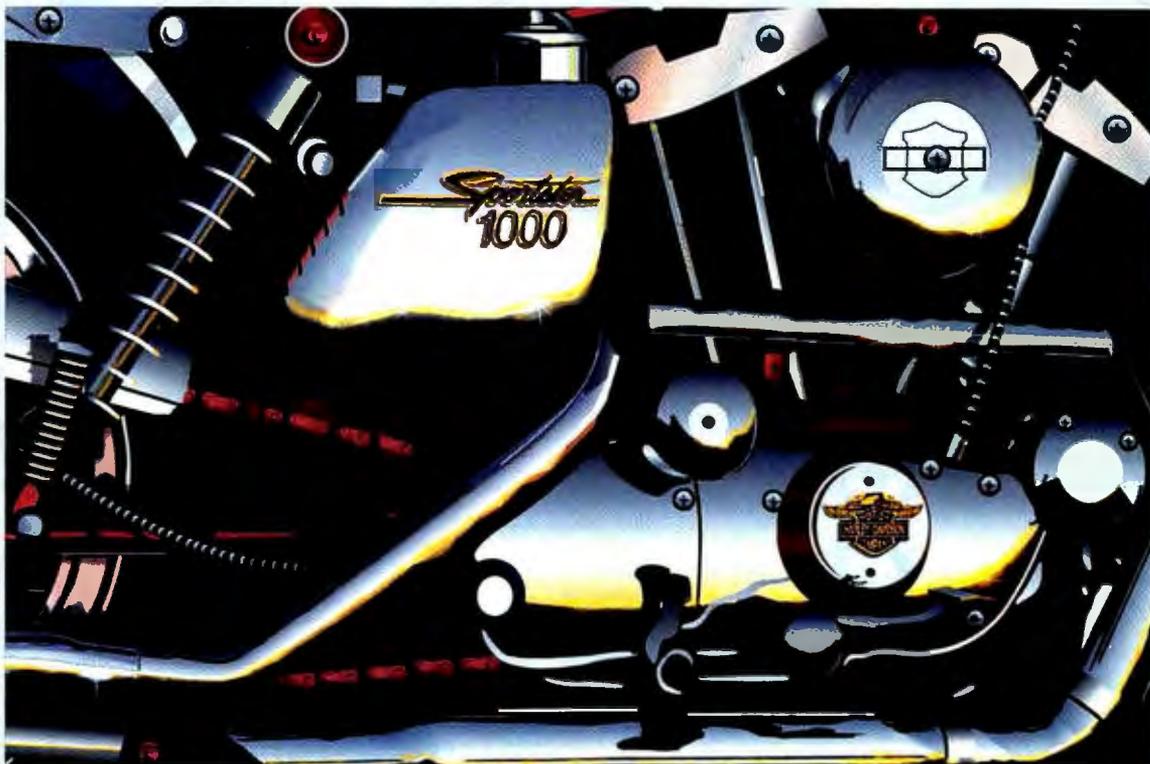
TEL: 800 437-2285 FAX: 404 840-0806  
5550A PEACHTREE PARKWAY NORCROSS, GEORGIA 30092



# Unleash the Creative Beast.



Multimedia Software Solutions



Created by Chad M. Little with Multimedia Software from AT&T

Let your creativity take off with the power of multimedia software from AT&T. We've been cruising for a while, but hang on tight...next year we'll be bringing you the multimedia technology you've dreamed about, at prices you thought were impossible.

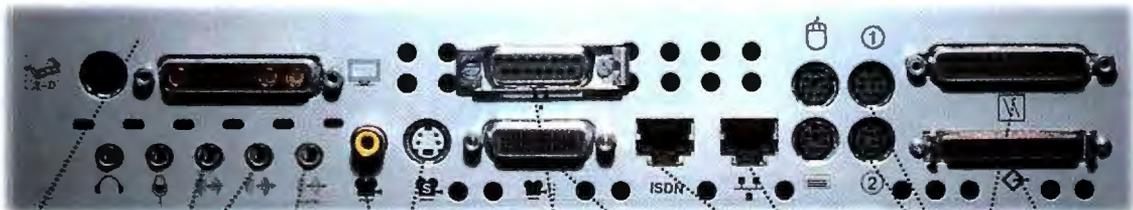
Get a handle on our current draw, animation and presentation products.

**Call for information or a demo:**

**1-800-448-6727**

Circle 177 on Inquiry Card (RESELLERS: 178).

# ANY PORT IN A BRAINSTORM.



#### GIO BUS OPTIONS

Indy Video™  
for I/O and  
special effects,  
or add JPEG  
compression.

#### ANALOG STEREO IN & OUT

Music,   
VOs, and  
effects in—  
out to VTRs  
or speakers.

#### DIGITAL STEREO IN/OUT

Record and  
playback  
CD-quality  
sound.  
Sweet.

#### DUAL VIDEOS IN

 Pipe in VHS,  
Laser disc, etc.  
Plus higher-  
quality S-Video,  
like Hi-8.

#### ETHERNET AUI

Zoom ideas,  
clips, and  
graphics all  
around your  
facility at  
high-speed.

#### INDYCAM™ PORT

For the Indy-  
Cam color  
digital video  
camera. Send  
 video-  
mail and see.

#### ISDN & ETHERNET 10BASE-T

Network with  
clients around  
the corner,  
or around  
the planet.

#### DUAL SERIAL & 1 PARALLEL

MAC-  
compatible.   
Talk to printers,  
scanners, MIDI,  
VTRs.

#### FAST SCSI-II

External disk  
and tape drives,  
CD-ROM,   
scanners,  
Photo CD™,  
You name it!



## Introducing INDY\* from Silicon Graphics.

Welcome to the most affordable member of the Indigo® family—  
packed with video and audio tools, like its own digital color camera.  
The flexibility of over a hundred digital media applications, and the  
thundering power of a 100MHz MIPS® R4000® 64-bit RISC processor.

Just think about it. Want one?

Call 1-800-431-4331 dept. B23 for the brochure.

# INDY™



**SiliconGraphics®**  
Computer Systems

 The Indy workstation includes all the features above, plus: 32MB of RAM (expandable to 256MB); IndyCam™ color digital video camera; microphone; 3 juggling balls; 8- or 24-bit

MSWord™ and MSExcel™; ability to read Kodak Photo CD, and IRIX 5.1 & Motif 1.2. © 1993 Silicon Graphics, Inc. Indigo is a registered trademark, and Indy is a trademark of Silicon Graphics, Inc. All others, registered and unregistered, are properties of their respective holders.

Play 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).

graphics w/ Virtual-24 support; 14", 16" or 19" high-resolution - color multi-scan monitor; external volume controls; 2 GIO32 high-performance expansion slots; space for 2 hard disk drives (accepts 21MB 3.5" floppy disk that reads/writes Macintosh, IBM® and UNIX® diskettes); Dis-

# PhotoStyler Fights Back

**Aldus closes the Photoshop gap with the release of PhotoStyler 2.0**

HOWARD EGLOWSTEIN

**A**sk anyone who does serious image processing on a personal computer: Adobe Photoshop for the Macintosh has been the undisputed king of the image editors for quite some time. Aldus is hoping to dethrone the Mac/Photoshop environment with the latest release of PhotoStyler. Like the Windows version of Photoshop, PhotoStyler 2.0 gives you full control over your images, providing scanner and printer support, conversion to many output formats, and just about every image manipulation control you might want.

PhotoStyler went through much more than a face-lift going from version 1.1 to version 2.0. Most of the new features either improve the package's performance on large images or give you better control over the final output. Aldus's philosophy in making all these changes was to eliminate the trial-and-error work that often goes into editing. If you're working with a 25- or 50-MB image, you don't want to wait for the system to catch up while you scroll through the image. And if you're adjusting the color balance of a freshly scanned image, you don't want to watch an hourglass while the system calculates the effect on 25 MB of data.

## A Sum of the Parts

The screen above shows a sample image from Corel's Professional Photos CD-ROM series. The model shot was part of an 18-MB Photo CD image. Loading the image into memory from a CD-ROM, especially an older standard-speed (150-Kbps) CD-ROM reader, takes quite a while.

PhotoStyler lets you crop out and just read part of an image as it loads, or you can select the Partial Edit feature. Partial Edit lets you select a region of the larger image to bring into memory while the rest of the image remains on disk. After making changes to this section, PhotoStyler puts it back exactly where it came from.

The old days of zooming in and out on an image to see where you are or to find a particular spot are gone, too. The Image Navigator provides a thumbnail view of the entire image, with a small gray box showing the current window selection.



**PhotoStyler 2.0** showing multiple document windows, the Image Navigator (for moving quickly around large images), and the enhanced magic wand selection. The image is from Corel's Professional Photos CD-ROM series sampler.

Simply move the box to the area you're interested in or select a new zoom factor from the handy slider.

The idea of working with thumbnails and previews extends throughout the product. For most commands, you can choose to preview the effect on a small thumbnail before committing it to the whole image. The screen on page 138 shows the Color Balance tool applied to a digital image I shot with a Kodak DCS200 digital camera. The image on the left is the original photo as read from the camera. The other two boxes show the effects that two different settings have on the image.

There's a bit of yellow cast on the image because the sun was beginning to set. In Test 1 (center), I shifted the image slightly toward blue to correct for the yellow. That setting took too much warmth out of the old wooden railing, so I switched to Test 2 (right) and tried another version. This time I chose to have the correction apply only to the highlights and applied a bit more correction. The sample shows the screen just after updating Test 2. I could then preview the entire image or apply the change permanently.

## Like Magic

PhotoStyler has some sophisticated new tools for selecting image areas. The editing in progress in the screen above shows one such tool enhancement—the magic wand. This feature, shared by most other image editors, lets you select a distance in color space and a point on the image and proceeds to select all adjacent pixels that lie within that color range. That works, but here I wanted to change the model's hazel eyes to blue. The center of her eye and the highlights were not green, but neutral in color. I wanted to select all the green portions without getting any of the dark gray.

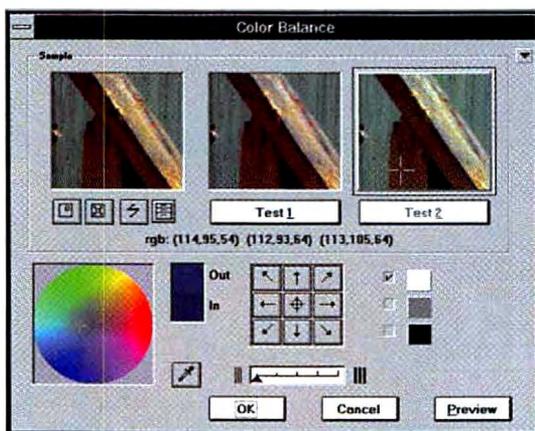
The right side of the screen shows the effect of putting the wand in hue-only mode. Instead of picking up any color that is more or less the same intensity, the hue wand requires that all pixels have the same basic color. The similarity adjustment takes care of selecting the range of green pixels.

The selected area in the photo is just the first selection. I then extended the selection to include some of the darker areas and used this as a mask to protect the white and center of the eyes from a paint-can

## PHOTOSTYLER PERFORMANCE

PhotoStyler 2.0 performs admirably against Photoshop on the Windows platform. All tests were run on a 33-MHz 486 machine with 24 MB of RAM. A dedicated 340-MB SCSI drive stored the images and provided virtual memory swap space. PhotoStyler ran with Windows' virtual memory enabled; Photoshop generally runs faster if you disable Windows' virtual memory and allow Photoshop to handle the virtual memory itself. Both test images were uncompressed TIFF files. Times are in minutes:seconds.

	LOAD 6-MB FILE	SHARPEN 6-MB FILE	SAVE 6-MB FILE	LOAD 26-MB FILE	SHARPEN 26-MB FILE
Photoshop 2.5	0:22	0:20	0:21	3:36	5:39
PhotoStyler 2.0	0:14	0:27	0:19	1:38	5:53



**An example of PhotoStyler's preview windows.** For most effects, PhotoStyler displays the original image and two practice or test areas. You apply the effect to these thumbnails to see what the final effect will be when you apply it to the entire image. Having two test areas lets you compare two possible effect settings.

fill. On the paint can, I used the hue-only fill and flooded the eyes with blue. The image on the left of the screen on page 137 shows the result. By contrast, Photoshop's wand uses only RGB color-space distance and doesn't have the flexibility of PhotoStyler's wand.

### Device Support

Rather than trying to support every conceivable input device, PhotoStyler uses TWAIN, an industry-standard Windows driver, as its basis for scanner support. Using the Epson-supplied TWAIN driver, I had no trouble getting PhotoStyler to recognize my Epson ES-300C scanner.

The only difficulty I had was in scanning large images. With the latest Epson TWAIN driver, PhotoStyler couldn't scan in any image much larger than 6 or 7 MB: the software reported that it couldn't allocate sufficient memory for the scanning process. I called Aldus's technical support and found that, because the product was so new, the company hadn't had a chance to test PhotoStyler with the Epson TWAIN

driver that I was using (version 1.02E). Aldus is working with Epson on the problem. Scanning with other TWAIN sources is supposed to work just fine.

In the meantime, Epson owners will have to be content with smaller scans or use the proprietary Epson driver that came with PhotoStyler 1.1a. The older driver is available directly from Aldus if you don't have the older version of the program. Neither Photoshop nor Picture Publisher had any trouble scanning a 25-MB test image using Epson's

TWAIN driver.

On the output side, PhotoStyler uses Kodak's Precision Color Management System to match your screen to the intended output device. CMS installs as a Windows Control Panel to select your monitor, input device, and output device from a menu of known devices. PhotoStyler uses CMS to map all colors to your monitor for display and adjusts the color coming in from your scanner. To make sure you don't create something you can't print, CMS also changes your screen display to match the color gamut, or range, of your printer or print process.

Kodak's CMS is new and doesn't support many devices yet. My system configuration included a standard NEC MultiSync monitor, the Epson 300C scanner, and Kodak's ColorEase dye-sublimation printer. CMS supports neither my scanner nor my printer, and the monitor selection is limited to two standard phosphor types. More device support should be forthcoming from Kodak and device manufacturers as CMS becomes more of a standard.

If you're working on one output type but plan to use the images on a different type, the Soft Proof option lets you see how the output will look. For example, you may be using a

dye-sublimation printer but planning to use the images in a four-color printed brochure; Soft Proof adjusts the colors on your monitor to reflect how the image will appear after going through the printing process.

### The Price of Power

There's a price to pay for this power, and I'm not just referring to the \$795 retail price tag on the box. I did this review on a seriously hopped-up 33-MHz 486 with 24 MB of RAM, a 24-bit display card, and about 1 GB of disk space. The 486 was poky handling images larger than 10 MB, and PhotoStyler didn't like editing images much larger than physical free memory.

Aldus recommends at least 8 MB and a 33-MHz 486, but for serious editing work you'll want the biggest, fastest machine you can get. I ended up clearing space on a 340-MB SCSI drive to make room for PhotoStyler's temporary files.

To be fair, Photoshop claims to run on any 486 with 8 MB of RAM, but Photoshop and PhotoStyler ran at about the same speed on my machine. If I were planning to use either package for serious prepress image editing, I'd want at least a 50-MHz 486DX or 66-MHz 486DX2 machine with 32 MB of RAM and a huge hard drive.

This review also pointed out one reason the Mac is still the most popular image-editing environment: Windows isn't very good at handling big programs. Several times, I got unrepeatably, unrecoverable memory errors and protection faults. I checked with Photoshop users and found that my experience wasn't that unusual. For my tastes, Windows simply isn't stable enough to use as a primary image-editing platform. I've been using PhotoStyler 1.1 since it came out, to scan images with my Epson scanner, but these are usually small enough (less than 1 or 2 MB) to save often.

PhotoStyler 2.0 is a major improvement over 1.1. The emphasis is on providing powerful tools to get you to the right part of the image and make the right changes the first time, without time-consuming trial and error. I'm a registered user of 1.1, and I was planning to abandon PhotoStyler for Adobe Photoshop, but now I probably

won't. If you've got the iron to run it, PhotoStyler 2.0 is a world-class image-editing/retouching package. ■

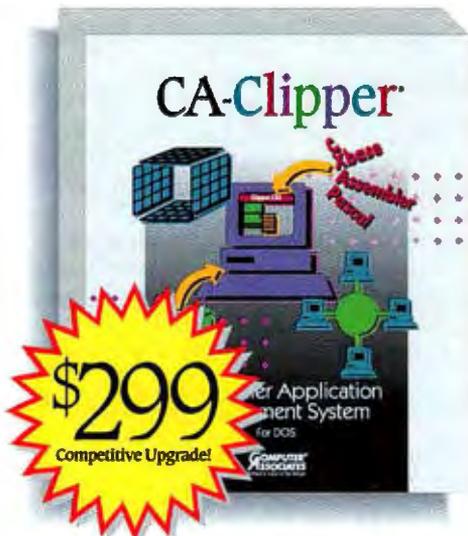
*Howard Eglowstein is a testing editor for the BYTE Lab. You can contact him on the Internet or BIX at [hglowstein@bix.com](mailto:hglowstein@bix.com).*

### About the Product

**PhotoStyler 2.0** .....\$795  
Aldus Corp.  
411 First Ave. S  
Seattle, WA 98104  
(206) 628-2320  
fax: (206) 343-3360  
**Circle 1077 on Inquiry Card.**

# Extraordinary Exo-Upgrade.

Upgrade To CA-Clipper® 5.2 For \$299 And Get A Copy Of  
New CA-Clipper®/ExoSpace™ And Your Choice Of  
Another Product Absolutely FREE!



Break Through  
The 640k Barrier With  
New CA-Clipper/ExoSpace!

CA-Clipper®/ExoSpace™ increases directly addressable memory by up to 2,500% – from 640k to 16 megabytes. Eliminate virtual memory swapping, greatly improve performance and run

your Clipper applications in protected mode. Existing 5.2 users can get CA-Clipper/ExoSpace for only \$99!

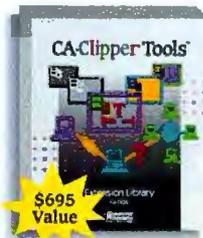


CA-Clipper 5.2: Winner in eight categories, including best application development product for the second year in a row. CA-Clipper/ExoSpace: Chosen best new product of 1993.



\$99 Value

Break through the 640k barrier with the ultimate extended memory manager! Increase directly addressable memory from 640k to 16 megs.



\$695 Value

Over 550 time-saving, problem-solving functions in one high performance package. Raise your productivity with this valuable library.



\$395 Value

Compile almost any dBASE IV application in three easy steps – and produce executable (.EXE) files with the efficiency of CA-Clipper.



\$550 Value

dBASE apps come alive with new CA-dBFirst 2.0 – the first dBASE compatible database and language for Windows.

CA-Clipper 5.2: The Complete, Professional Programming Environment.

CA-Clipper® 5.2 is a robust language, an efficient linker, a flexible preprocessor and a high-performance compiler. It includes: an editor, debugger and make utility for creating PC- and LAN-based applications.



PC Magazine Editor's Choice for dBase development.



DBMS Readers' Choice award for dBase development system.

New RDDs For FoxPro, Paradox and dBASE IV.

Replaceable database drivers for all the most popular development systems. Plus you can customize CA-Clipper with user-defined commands and functions. And seamlessly integrate modules from languages such as C, Assembly, dBASE and Pascal. There are no runtime fees, no additional licenses, no LanPaks.

So what are you waiting for?

Call right now and upgrade to the new standard in Xbase development.

**COMPUTER ASSOCIATES**  
Software superior by design.

Feature	CA-Clipper	FoxPro	dBASE IV
Lexical Variable Scoping	YES	NO	NO
User-defined Commands	YES	NO	NO
Code Blocks	YES	NO	NO
Nested Multidimensional Arrays	YES	NO	NO
Predefined Object Classes	YES	NO	NO
Variables Modifiable in Debugger	YES	NO	NO
Customizable Reactive Error Handling	YES	NO	NO
Reads and Writes FoxPro (.CDD) Files	YES	YES	NO
Reads and Writes dBASE IV (.MDX) Files	YES	NO	YES
Reads and Writes Paradox (.DB/FOX) Files	YES	NO	NO

Comparison based on FoxPro Version 2.5 for DOS and dBASE IV Version 1.5.

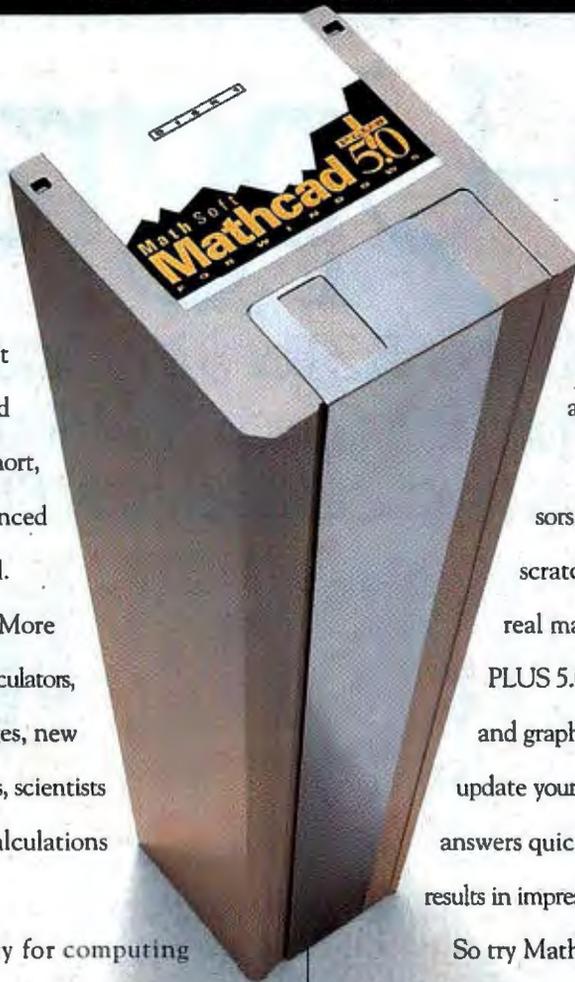
SEE YOUR LOCAL  
DEALER TODAY OR CALL  
COMPUTER ASSOCIATES AT  
1-800-225-5224, Dept. 20500.

## New CA-Clipper 5.2.

© Computer Associates International, Inc., One Computer Associates Plaza, Islandia, NY 11788-7000. 1-800-225-5224. All product names referenced herein are trademarks of their respective companies. Free copy shipped direct from Computer Associates when you register product.

Circle 82 on Inquiry Card.

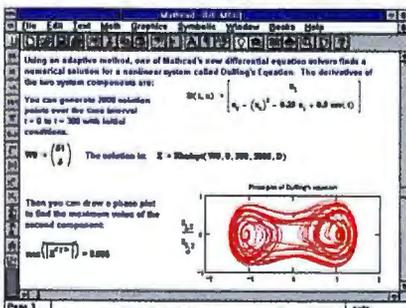
# WE'VE EXAGGERATED HOW MUCH CALCULATING POWER IS IN NEW MATHCAD PLUS 5.0. BUT ONLY SLIGHTLY.



It gives you more advanced math capability than ever before. It lets you tackle harder problems and solve even tougher equations. In short, it's the most powerful, most advanced version of Mathcad<sup>®</sup> ever released.

And that's no exaggeration. More powerful than spreadsheets or calculators, easier than programming languages, new Mathcad PLUS 5.0 gives engineers, scientists and educators more tools to do calculations with greater speed and ease.

You get more functionality for computing derivatives and integrals, differential equations, advanced vector and matrix operations, statistical functions, curve fitting, and fast Fourier and wavelet transforms. You can choose from a wider range of symbolic capabilities, and



Mathcad PLUS 5.0's on-screen worksheet lets you easily combine equations, text and graphics.

instantly cut and paste hundreds of formulas into your work. And with Mathcad PLUS Function Packs you can add even more remarkable

calculating power in specific disciplines like signal processing, data analysis, statistics and graphics.

Plus, like its Mathcad predecessors, it's as easy and intuitive as using a scratchpad. Simply enter equations in real math notation anywhere on Mathcad PLUS 5.0's on-screen worksheet. Add text and graphics. Change variables and instantly update your work. Mathcad PLUS 5.0 calculates answers quickly and accurately, then prints your results in impressive, presentation-quality documents.

So try Mathcad PLUS 5.0 today, and tomorrow you'll be ten times more productive. Well, maybe we're exaggerating again. But only slightly. Mathcad PLUS 5.0 is priced at just \$299<sup>MSRP</sup>. To order, or to receive even more information, call 1-800-967-5075. Or mail or fax the coupon below (Fax: 716-873-0906).

graph in 2-D and 3-D polar, contour and parametric plots. MathSoft's Electronic Books, based on the most popular reference books, let you

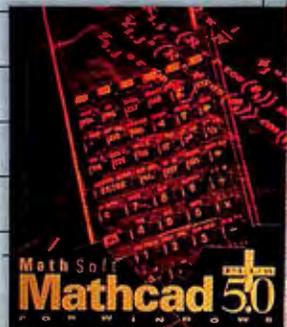
instantly cut and paste

## FREE MATHCAD PLUS 5.0 INFORMATION KIT

For more information on Mathcad PLUS 5.0, mail or fax this coupon.

a07a1

Name	Title
Company	
Address	
City	
State	Zip
Country	Phone



# WinFax Pro Hits the Network

**Delrina's Windows fax package offers workgroups easy access to shared modems and room to grow**

**STAN MIASTKOWSKI**

**F**or good or ill, faxes have become a fact of life. But in a small business or corporate environment, equipping every computer with its own fax modem can mean installation and support nightmares; and then there's the cost of a fax-dedicated telephone line for each user. So, having one or more centralized fax modems connected to a LAN has become an attractive alternative. Unfortunately, the network fax software market waters have been more than a bit muddy.

At the high end of the market are products like Castelle FaxPress and Intel Net Satisfaction, which can cost \$2000 or more and are designed for large networks and high fax traffic. Some products in this class require proprietary hardware and an experienced network guru to install and maintain the system. Early forays into the low-cost end of the market, such as the initial version of Nuko Information Systems' Message Port, offered a low price but limited features. That's changing, as exemplified by WinFax Pro for Networks, as well as by updates of Message Port and lower prices on other packages (see the text box "Other Faxes Received").

## A Familiar Face

WinFax Pro for Networks has an advantage over other low-cost network fax packages, in part because it is built around WinFax Pro 3.0, one of the industry's best-selling Windows fax software packages since its introduction in 1990. WinFax Pro for Networks adds the "hooks" necessary for network use but retains the original product's ease of installation and use. The network version also retains the core set of WinFax Pro features, including the ability to send faxes directly from any Windows application and combine documents from multiple applications into a single outgoing fax. There's a phone-book utility that can be shared over the network, as well as fax annotation and forwarding and a full-featured cover-page designer. You can also schedule fax transmissions for low-telephone-rate hours, as well as broadcast individual faxes or groups of faxes to many recipients automatically.

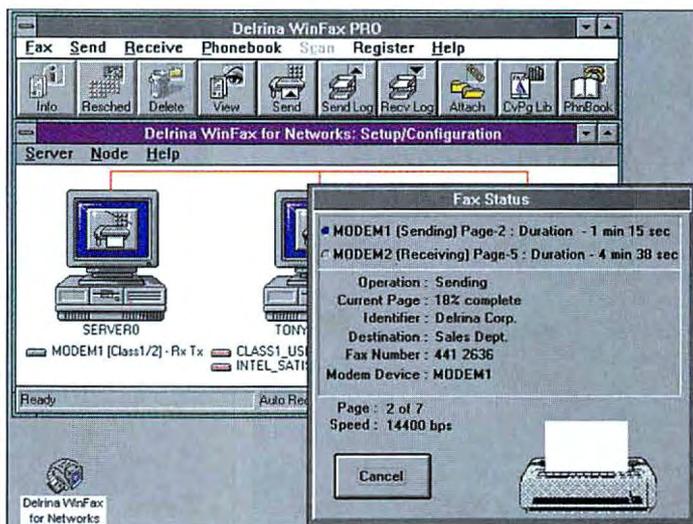
For \$399, WinFax Pro for Networks provides a server component (both DOS and Windows versions) and two network client packages. Each server can support up to four fax modems. For a small office environment or a small workgroup in a corporation, that's a logical and inexpensive way to get started.

Scalability sets WinFax Pro apart from its low-cost fax-modem-sharing software competitors. As fax requirements evolve, you can add to a WinFax Pro for Networks installation in a building-block fashion. Any workstation on the network can be a WinFax Pro for Networks server. Additional server packages cost \$179 each. Client software ranges from \$99.90 per seat for a 10-user license to \$85.98 each for a 50-user license. Existing WinFax Pro 3.0 users can upgrade to WinFax Pro for Networks clients for free: You call Delrina for a new serial number that makes your copy of WinFax Pro 3.0 network-aware. There's a limit of four servers (up to 16 fax modems total) in any one WinFax Pro for Networks workgroup, and an absolute limit of 255 users.

## Getting On the Network

WinFax Pro for Networks works on any IPX- or NetBIOS-based DOS network. This includes the usual list of popular server-based and peer-to-peer LANs, including Novell NetWare, Artisoft LANtastic, and Microsoft Windows for Workgroups. Because of the way it uses the network, WinFax Pro for Networks works equally well with both types of LANs. Any station can be the WinFax Pro for Networks server as long as it has a common drive accessible to WinFax Pro for Networks clients. For example, using the DOS version, you can

turn an "obsolete" 286-based system into a capable WinFax server. (After all, pumping data to and from telephone lines doesn't exactly require Pentium-level processing power.)



**Except for the multiple modem-status lines at the top of the Fax Status Screen, using WinFax Pro for Networks is virtually identical to using WinFax Pro 3.0. You can also see a graphical representation of networked fax resources, as shown in the background here.**

For this review, I installed multiple copies of WinFax Pro for Networks on a five-station LANtastic 5.0 network, with two stations configured as servers under Windows. One server (a Gateway 33-MHz 386) had both an internal Intel Satisfaction 400 fax modem and an external Microcom Deskport fax modem. The second server (a 66-MHz 486DX2-based system) had an external ATI 14400 ETC-E fax modem. For several weeks, I used this setup for my day-to-day fax traffic, sending and receiving a variety of short and long faxes using all three modems and three different telephone lines.

Overall, WinFax Pro for Networks' performance (both imaging time and transmission time) was basically identical to that of the stand-alone version. This wasn't surprising, since WinFax Pro for Networks handles all imaging and storage locally. I simulated a heavy load by having one of the servers perform an involved database sort at the same time it was sending and receiving faxes. While performance slowed

For DOS And Windows!

Checking Out Hot  
Multimedia Products?

# Check Out The 'Eyes!



## ComputerEyes/RT

Video Frame Grabbers

- Easily capture high-quality images into your computer from any video camera, VCR, camcorder, or Laserdisk
- Accurate, true 24-bit color video frame grabber
- Captures both still images and motion video clips!
- Excellent, easy-to-use DOS and Windows control software
- Hundreds of applications - desktop publishing, image databases, paint and presentation programs, graphic arts, Video For Windows, etc.
- ComputerEyes/RT for IBM PC - \$399.95  
ComputerEyes/RT Monochrome - \$299.95  
New ComputerEyes/LPT parallel port frame grabber for laptops or any PC - \$399.95

New!

## TelevEyes/Pro

Computer-to-TV Converter

- New, no-compromise video scan converter easily converts any computer output for display to large TV monitors, video projectors, or video tape
- Same hardware works with both Macintosh and IBM PC - all cables included
- Simultaneous computer and TV display
- Excellent for use with all large-screen monitors, video projectors, and TVs
- Full genlock allows for overlaying computer output over a live video for video titling, editing, and special effects
- New TelevEyes/Pro - only \$799.95  
Low-cost TelevEyes - \$299.95

See Your Dealer Or Call For More Information

Digital Vision, Inc.

270 Bridge St., Dedham, MA 02026  
(617) 329-5400 (800) 346-0090

Circle 276 on Inquiry Card.

## Reviews WinFax Pro Hits the Network

# Other Faxes Received

Low-cost fax-modem-sharing software is an idea whose time has come. Here are a couple of other choices:

Type	Station ID	Subject	Printer	Modem/Mod. Sub	Pages	Out. Document
AE CV	908 257 1464	Ray	Complete	126-01193 08 44	1	1 26
AE CV	444 21 82	Fr. Zurich	Complete	130-01193 21 22	2	1 30
AE CV	www.ccmr.com/ATC	Registration	Complete	100-01193 06 14	1	1 03
AE CV	303 862 7974	Fr. Jim Labovian	Complete	130-01193 08 36	1	0 08
AE CV	408-543-7141	Book	Complete	100-01193 08 08	1	3 40
AE CV	31 0090-1200	Ray	Complete	100-01193 08 11	5	3 40
AE CV	45 542 1 030	Book	Complete	100-01193 10 54	1	0 14
AE CV	6240500000	Book	Complete	100-01193 11 12	2	0 17
AE CV	45 542 1 030	Book	Complete	100-01193 11 19	4	3 14
AE CV	416-784-2114	Fr. Computer-D	Complete	130-01193 11 22	1	1 31
AE CV	908 257 1464	Ray	Complete	100-01193 12 21	1	1 08
AE CV	416-784-2114	Fr. Clark, Grant	Complete	100-01193 12 20	1	1 30
AE CV	(709) 679-3450	Registration	Complete	100-01193 14 56	1	0 48
AE CV	0	Fr. Dan Kummer	Complete	100-01193 15 20	1	3 10

Message Port/Pro from Nuko Information Systems is the latest incarnation of Message Port, a package that does more than share fax modems on a network. It's unique in offering low-cost modem pooling, which allows data modems to be shared as well. Originally designed for Microsoft Windows for Workgroups, Message Port/Pro now supports all IPX- and NetBIOS-based LANs, so it covers nearly all PC bases.

The package was in prerelease testing at press time and unavailable for review. But I looked at an earlier version of Message Port and found it lacking some essential features, such as wide modem support and the ability to create customized fax cover pages. A company spokesperson says the new version supports all Class 1, Class 2, and CAS (Communications Applications Specification) fax modems and provides advanced features like OCR (optical character recognition). Nuko also says the product can automatically route incoming faxes by using OCR to recognize the name of the recipient. Message Port uses a true client/server approach, with all faxes stored on the server before transmission.

Modem pooling can be handy, but it may create heavy network traffic that bogs down LAN performance. Users with considerable data communications needs are often better

off with their own dedicated modems. Message Port/Pro is priced aggressively, starting at \$79 for a stand-alone, non-networked version. A 10-user license is \$399; 20 users, \$698; 50 users, \$898; and 100 users, \$998.



DataFax for Workgroups from Trio Information Systems has been available for over two years and is widely used in Europe. It shines in the area of network integration, with drivers for nearly all commonly available networks. Besides the usual server-based and peer-to-peer LANs supported by the other packages mentioned here, this product also supports Banyan Vines and Windows NT Advanced Server.

DataFax for Workgroups supports nearly all fax modems. Its server component is unique: you can set it up as a nondedicated server or as a true dedicated server. As the latter, it can support up to 24 fax modems on a single PC.

Recognizing that many people use faxes mainly to send quick notes, Trio has provided a QuickFax function that lets you click on an icon and fire off a

fax without having to deal with changing printer drivers. This product has the most extensive security features of the products covered here. And, for its features, it's also priced aggressively: two-user license, \$249 (additional single users are \$89 each); five users, \$429; 10 users, \$795; 20 users, \$1195; 50 users, \$1595; 100 users, \$1895.

### About the Companies

**Nuko Information Systems, Inc.**  
1609A South Main St.  
Milpitas, CA 95035  
(800) 995-2166  
(408) 262-2225  
fax: (408) 262-2261  
Circle 1076 on Inquiry Card.

**Trio Information Systems, Inc.**  
8601 Six Forks Rd., Suite 615  
Raleigh, NC 27615  
(800) 880-4400  
(919) 846-4990  
fax: (919) 846-4997  
Circle 1077 on Inquiry Card.

(as expected), it was much the same as it would have been on a non-networked system. The bottom line is that, except for the potential wait for a free fax modem, WinFax Pro for Networks is no slouch in the performance department.

WinFax Pro for Networks is one of the easiest-to-install LAN packages I've used. I had the two servers and five clients installed and running on a LANtastic 5.0 network in less than an hour. You set up the server component on the PC that has the fax modem or modems that you want network users to be able to access. The installation leads you step by step through the process. Other than giving your workgroup a unique name, selecting and setting up your fax modem, and selecting the maximum number of users that can access it, you have few major decisions to make.

WinFax Pro has always been versatile at setting up modems, and the network version is no exception. Setup automatically detects whether you have a Class 1, Class 2, or CAS (the Intel-specific Communications Applications Specification) fax modem installed and pops up a menu of specific related modems. The initial release of WinFax Pro for Networks has over 300 fax modems in its menu. If your modem isn't among them, you can haul out your fax modem's manual and set things up manually. (You can specify whether a particular modem is send-only, receive-only, or send-and-receive, or even if it's private to the server.) There are other (optional) settings as well. If you have multiple fax modems, you can separate them into groups and specify which should be used first if all are available. This option comes in handy if one of your modems is connected to a long-distance line with the lowest rates.

#### **Cramming RAM**

There is one "gotcha" to the WinFax Pro for Networks server software: It requires a DOS TSR program that takes about 90 KB of RAM. Luckily, setup gives you the option of running the server TSR in UMBs (upper memory blocks) or in extended memory. If you're running a loaded system, this could require some tweaking, especially if you're using a memory manager like 386Max or QEMM. On my server, all the UMBs were already in use, and my copy of 386Max wasn't set up to supply extended memory. Furthermore, I didn't have enough room to run the server in low memory. Reconfiguring 386Max to supply extended memory solved the problem nicely.

*continued*



## **COMPUTEX TAIPEI '94**

### **Taipei International Computer Show**

#### **JUNE 2-6, 1994**

COMPUTERS • BOARD-LEVEL PRODUCTS • SOFTWARE/APPLICATIONS

PERIPHERALS • COMPONENTS • DISPLAYS/MONITORS

MULTI-MEDIA • NETWORKING & COMMUNICATIONS • MASS STORAGE



Organizers:  
China External Trade  
Development Council



TAIPEI COMPUTER  
ASSOCIATION



Sponsor:  
TAIPEI WORLD  
TRADE CENTER

Venue: TAIPEI WORLD TRADE CENTER EXHIBITION HALL, 5 Hsinyi Rd., Sec. 5, Taipei, Taiwan, Republic of China Tel: 886-2-725-1111 Fax: 886-2-725-1314 Telex: 28094 TPEWTC



Circle 545 on Inquiry Card.

# Reviews WinFax Pro Hits the Network

One unusual aspect of the server installation is that you don't set up user accounts—except for a client account on the server if you also want to use the server PC for directly sending faxes. This saves lots of time, but the product's unique approach to network security will make some control-oriented system administrators a bit nervous, especially in large installations. Users set up accounts as they install the client software on their workstations. That's not as strange as it seems at first, because each client must have a unique serial number. That means, for example, that someone couldn't make a copy of the client software and run it from another machine on the network. The server would reject the duplicate serial number.

## Serving the Client

Setting up the client side of WinFax Pro for Networks is almost identical to installing WinFax Pro 3.0 for Windows. The setup detects that the network server version has already been installed, so there's no need to choose a modem. The only additional network-specific chore is to specify your network E-mail system if you're using one. WinFax Pro for Networks supports all VIM (e.g., Lotus cc:Mail), MAPI (e.g., Microsoft Mail), and Novell MHS-based E-mail systems.

Finishing up the client installation requires a few additional choices, such as choosing a default cover page, filling in default fax-header information, and deciding whether you want to automatically enable the OCR (optical character recognition) that's built into the package. Delrina's OCR, based on Caere's AnyFax technology, is accurate and fast. Of course, whether you'll want to use OCR depends largely on the type of fax traffic you receive. I usually receive short faxes that I read and discard. But if you need to store or edit faxes, OCR's ability to turn graphical fax images into editable text can be handy.

After installation, you can create and send faxes just as with the stand-alone package. You can fax directly from Windows applications by using the WinFax printer driver, which is automatically installed during setup. If you have more than one fax modem on your network, there's only one additional step when you send a fax. You can

choose to use the first available modem, a specific modem, or the first-available modem in a group (if the servers have been set up that way).

## Saving Server Cycles

When you tell WinFax Pro for Networks to send a fax, the package checks for a free modem (or for whether a specified modem is free). If a modem is free, the fax gets routed to the server and immediately sent. But what happens if it can't immediately send the fax is unusual. Unlike with competing packages, the pending outgoing fax isn't stored in the server until the fax modem becomes free. Instead, it's stored locally on the workstation. This has both advantages and disadvantages.

One advantage is security. Since the fax isn't stored on the server, it can't be accessed by someone who has access to that machine. Another advantage is that the server doesn't need to have large amounts of free hard disk space for storing outgoing faxes.

On the minus side, network traffic increases, because the client continually polls the server until the fax modem frees up. This isn't a problem for small or lightly used networks, but it can create performance problems on large, heavily used networks with lots of fax traffic: the network can get bogged down with lots of packets looking for a free fax modem. Delrina says this situation will be handled soon with an optional WinFax Pro for Networks module that will implement true server-based fax queuing. It should be available by the time you read this, but pricing wasn't available at press time.

## The Incoming-Fax Shuffle

Faxing gets a lot more complicated when it comes to handling incoming transmissions—because of a limitation of fax technology, not the product. Unfortunately, the easiest way to route incoming faxes to their intended recipients is to install the WinFax Pro for Networks server on a PC used by someone whose designated responsibility is to handle incoming faxes—what the setup calls the “fax receptionist,” who views faxes and sends them to the correct recipient.

The easiest way to do this is via E-mail. But if your network does not have E-mail, WinFax Pro for Net-

works can send faxes within the network: The fax receptionist refaxes the incoming fax to the recipient. This sounds strange, but it works well. Of course, the major problem with all these manual methods is that incoming faxes are far from secure. Anyone can read them. But that's true with a standard fax machine, too.

There are ways to automatically route incoming faxes directly to the correct recipient on the network, but the process isn't simple, at least at the present time. It also requires special hardware. DTMF and DID (direct inward dial) direct incoming-fax routing requires Intel Satisfaxion modems on the WinFax Pro for Networks server and sending fax machines that support direct routing. (At present, few do.) The fax sender has to enter an extension number and then send the fax, which gets directly routed to the correct recipient.

There is hope for a simpler way in the future. The CCITT, which sets international telecommunications standards, is working on an automatic fax-routing protocol that would work with an expanded version of the telephone company's Caller ID. Delrina says WinFax Pro for Networks will support that service when it becomes available. But realistically, for most users of WinFax Pro for Networks, manual routing of incoming faxes is what you'll need to use, inconvenient or not.

## The WinFax Future

By the time you read this, client support should be available for both WinFax Pro for DOS and WinFax Pro for Macintosh, as well as the above-mentioned server fax queuing. Further out, the company plans modules that offer enhanced system administration and security, as well as a module for modem pooling, sharing modems used for data communications.

The easy installation and scalability of WinFax Pro for Networks make it a logical choice for a variety of networks. Its ability to grow with and adapt to changing company needs is unique. It won't meet the needs of everyone, especially large corporate network installations with special needs (e.g., a customer-support department). But for many users, WinFax Pro for Networks is an elegant solution to the thorny problem of LAN-based faxing. ■

*Stan Miastkowski is a BYTE consulting editor. He has wide experience in connectivity and communications and is the coauthor of the Windows for Workgroups Bible (Addison-Wesley, 1993). You can reach him on the Internet or BIX at stanm@bix.com, or via MCI Mail at 530-9979.*

## About the Product

### WinFax Pro for Networks

Basic package (one server and two clients) .....	\$399
Additional server .....	\$179
10-user package .....	\$999
25-user package .....	\$2249
50-user package .....	\$4299
Free network upgrade for existing WinFax Pro 3.0 users	

Delrina Corp.  
6830 Via Del Oro, Suite 240  
San Jose, CA 95119  
(800) 268-6082  
(408) 363-2345  
fax: (408) 363-2340  
**Circle 1075 on Inquiry Card.**

Winner 1994  
**USA**

# A Winner of the Best Value!



JANUARY 1994  
**BYTE**  
BEST VALUE  
GENERAL BUSINESS  
COLOR MONITOR

"KFC packs quite a lot into this \$495 product. The 15-inch CA 1507 offers resolutions as high as 1280 by 1024 pixels at 60 Hz noninterlaced.... The monitor provides a full set of image-adjustment controls, including pinushion, image rotation, and power management. It uses the VESA-DPMS power management control signals to meet Energy Star requirements."

"The CA1507 offers controls that let you adjust image size and position, correct image tilt and pinushioning, recall factory mode settings, and set the power down delay interval.... Its image-quality score was well above average."

- BYTE Magazine, January 1994 -

**PC Digest**  
RATING REPORT

★★★★★ Recommendation

"The KFC CA 1507, recipient of the EPA's Energy Star, offers a full range of image adjustment controls. This monitor complies with the DPMS power management standards suggested by the VESA and will work with any VESA-compliant computer."

- PC Digest, November 1993 -



KFC's new green monitors consume less than 1.5 Watts when inactive, and less than 20 Watts when on stand-by. Compared to the average of 85-100 Watts for an ordinary monitor, each KFC monitor contributes substantially to a greener environment. And you're not just sharing the contribution, you're also saving money.

**KFC**

**1.800.2.KFC.USA**

KFC USA, INC.  
1575 Sunflower Ave., Costa Mesa, CA 92626  
Tel: (714) 546-0336 • Fax: (714) 546-0315

Circle 112 on Inquiry Card.

CA1716 was the Best Value Runner-up for Spreadsheet & Graphics Color Monitor in BYTE Magazine's January 1994 BYTE/NSTL Lab Report.  
CA1507 (picture not shown) was awarded the "Best Value: General Business Color Monitor" by BYTE Magazine in January 1994 BYTE/NSTL Lab Report.



All products and brand names are registered trademarks of their respective companies.

**HANDS-ON TESTING**

# 76 CARDS FOR FAST GRAPHICS

Our custom tests use real-world applications to find the fastest accelerator cards for Windows and the Macintosh

**JIM HURD AND MARK PAXSON**

Users have always wanted faster graphics and truer colors, but until today's sophisticated chip technologies and new bus architectures appeared, these goals were attainable only at high costs. But for this report, we tested 76 color graphics accelerators for Windows and the Macintosh and found dozens of fast cards that are also economical, whether your work centers on mainstream Windows tasks or high-end Macintosh graphics applications.

Our test sampling included both DRAM- and VRAM-based (video RAM) accelerators, in configurations that ranged from 1 MB of video memory to 4 MB or more. However, to be considered for this roundup, a board had to run at a minimum of 1024- by 768-pixel resolution with 256 colors in noninterlaced mode. Our rankings also include boards that run at 1024 by 768 resolution with 64,000 and 16.7 million colors, as well as at 1280 by 1024 resolution with 256 colors. We tested boards only in their noninterlaced modes.

If you just need the power of a 1-MB video board to run general-business applications, a DRAM-based adapter fits the bill for a low cost. We tested 10 such boards that retail for less than \$200. If you need higher resolutions and more colors, you'll need a more expensive VRAM-based board to achieve good picture quality. While the fastest boards we tested all use VRAM, our tests show that the performance difference is

## How to use this guide

To find the best graphics accelerator board for your needs, follow the main headings until you come to the appropriate

bus architecture and then look for the subcategory that is most relevant to your work.

### Need speed for general business?

PC-based accelerators are grouped by the resolutions and color levels they support rather than traditional Lab Report rankings based on best overall and low cost (our Mac rankings follow the traditional breakdowns).

The time (in seconds) it took the graphics adapter and driver to draw a screen image. The tests use a collection of screens from top Windows and Macintosh applications. Lower numbers indicate faster performance.

#### GENERAL PURPOSE Hercules Dynamite VL Pro D602



All the adapters based on the Tsing Latac ET4000/W32 chip offered uniformly excellent performance and under-\$250 prices. But we give the nod to the Hercules Dynamite VL Pro for its superior documentation, configuration software, and support. The 0.7-second average screen draw for the W32-based boards puts them among the fastest boards for 256-color, 1024- by 768-pixel display resolution, despite their budget DRAM-board design.



	SPEED (SECONDS)	CHIPSET	PRICE AS TESTED	RAM MB	ACCELERATION TECHNIQUE	STANDARD DISPLAY RESOLUTION	WINDOWS 3.11	OS/2	UNIX
HST Hercules Dynamite VL Pro D602	0.697	▲▲▲	\$299	2 MB	Tsing Latac ET4000/W32	✓	✓	✓	
▲▲▲▲ Onyx Designers Choice VL3	0.700	▲▲▲	\$349	1 MB	Tsing Latac ET4000/W32	✓	✓	✓	
▲▲▲▲ HP Penta Transputer/W32	0.698	▲▲▲	\$189	1 MB	Tsing Latac ET4000/W32	✓	✓	✓	
▲▲▲▲ HP Diamond View VL3	0.687	▲▲▲▲	\$499	2 MB	WinLab Power 9000	✓	✓	✓	✓
▲▲▲▲ HP Hercules Dynamite VL Pro D602B	0.693	▲▲▲	\$549	1 MB	BT AGX215	✓	✓	✓	✓

▲▲▲▲ (Excellent) boards came with installation software and the clearest manuals; ▲▲▲ (good) identifies boards that can be installed without checking the documentation; ▲▲ (fair) boards required a check of the user's manual; ▲ (poor) boards needed jumper resettings.

Price as configured; typically, the cost varies based on the amount, kind, and speed of RAM installed.

## Accelerator Essentials

### VIDEO MEMORY

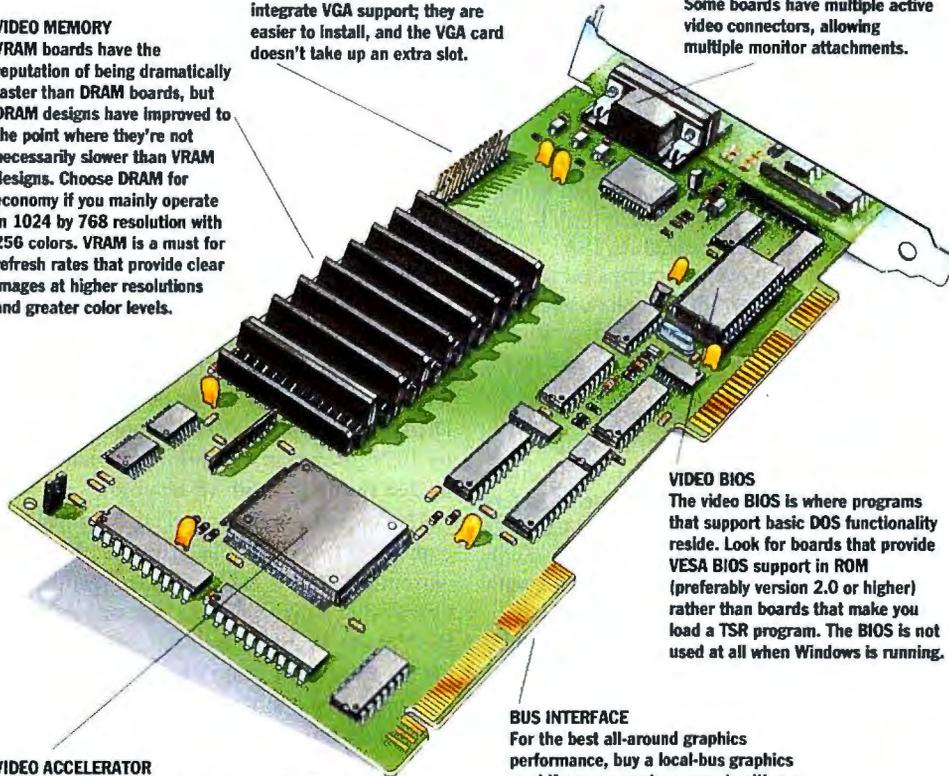
VRAM boards have the reputation of being dramatically faster than DRAM boards, but DRAM designs have improved to the point where they're not necessarily slower than VRAM designs. Choose DRAM for economy if you mainly operate in 1024 by 768 resolution with 256 colors. VRAM is a must for refresh rates that provide clear images at higher resolutions and greater color levels.

### PASS-THROUGH CONNECTOR

Commonly called a feature connector, this is required for boards that must use a separate VGA card. When possible, choose cards that integrate VGA support; they are easier to install, and the VGA card doesn't take up an extra slot.

### MONITOR INTERFACE

Most video cards provide a single video connection based on the standard D-shell, 15-pin VGA connector. Some high-end boards offer RGB connectors (i.e., BNC). Some boards have multiple active video connectors, allowing multiple monitor attachments.



### VIDEO ACCELERATOR

Most accelerators combine VGA compatibility into the accelerator chip to save cost. The fastest boards in our tests used accelerators from Tseng Labs, Weitek, or IIT, or a proprietary design. The lowest-cost accelerator designs pack the DAC (D/A converter) onto the accelerator chip, but most video boards still have a separate chip responsible for turning the digital information stored on the card into an analog signal to drive the monitor.

### VIDEO BIOS

The video BIOS is where programs that support basic DOS functionality reside. Look for boards that provide VESA BIOS support in ROM (preferably version 2.0 or higher) rather than boards that make you load a TSR program. The BIOS is not used at all when Windows is running.

### BUS INTERFACE

For the best all-around graphics performance, buy a local-bus graphics card if your computer supports either a PCI (Peripheral Component Interconnect) or the VL-Bus. These interfaces give you the highest bandwidth connection to your video card. The difference is especially noticeable in raw pixel copies.

usually minuscule; often a fast DRAM adapter will outperform an average VRAM board.

To gauge performance for real-world conditions, we used 15 test screens that included such commercial graphics-intensive applications as CorelDraw, Microsoft Excel, and Aldus Persuasion. We based our tests on actual applications because many video adapters continue to be tuned more for benchmarks rather than for real-world use.

We tested adapters for four different bus interfaces: VL-Bus, ISA, EISA, and NuBus. Some drawing operations do not stress the bus speed enough to show any significant performance advantages of using the faster VL-Bus. But copying images from memory to screen (known as *Blitting*), which is especially important for graphics illustration and multimedia ap-

plications, was the major exception: VL-Bus adapters generally outperformed their ISA and EISA counterparts by a margin of more than 2 to 1 in this operation.

Our test sample also included a wide variety of graphics accelerator chip sets. The most inexpensive boards were based on the Cirrus Logic GD5426 accelerator. The fastest chip sets varied by application and vendor implementation, but boards powered by the Tseng Labs ET4000/W32; the Weitek Power 9000; the IIT AGX015; and proprietary accelerators by Compaq, SuperMac, Appian, and Matrox ran fastest. Our rankings don't include boards that use the Texas Instruments 340x0 coprocessor. Although it is flexible, the 340x0 architecture is being overtaken by the lower-cost, higher-performance boards with fixed-function graphics accelerator chips.

FEBRUARY 1994  
**BYTE**  
BEST  
GRAPHICS  
CARD

**BEST**

### VL-BUS GENERAL-PURPOSE

#### Hercules Dynamite VL Pro D602

The \$299 Dynamite VL Pro D602 offers performance and price that are similar to those of the handful of other DRAM-based boards that use Tseng Labs' W32 chip set. The Dynamite VL Pro D602 gets the winning nod thanks to its superior documentation, configuration software, and technical support.

PAGE 149

### ISA BUS GENERAL-PURPOSE

#### Paradise/Western Digital Accelerator 24

This \$199 board's installation is somewhat cumbersome because of jumpers that may need to be reset, but once you get over this small hurdle, the Accelerator 24 offers excellent performance, solid support, and the best value for those who use ISA systems for general-business applications.

PAGE 155

### MACINTOSH NUBUS

#### Radius PrecisionColor Pro

In overall speed, this was the fastest of the 10 24-bit NuBus boards we tested. The PrecisionColor Pro also offers the added advantage of letting you change resolutions without rebooting your Macintosh.

PAGE 161

### EISA BUS GENERAL-PURPOSE

#### Compaq QVision 1280/E

Ranked best for general-purpose applications, this board also excelled for use with CAD applications. Its speed for 256-color graphics modes runs as fast as many VL-Bus boards, thanks to Compaq's well-tuned drivers. The board's text and complex-graphics speeds rank with those of the fastest boards designed for use with any type of bus.

PAGE 165

# VL-BUS SYSTEMS

**W**e saw the biggest speed gains from VL-Bus in the true-color cards designed for graphics illustration and desktop publishing. For example, SuperMac Technology's Spectrum/24 for VL-Bus was over 30 percent faster than its Spectrum/24 for ISA.

To rank cards for the general-purpose category, we compared test results for all cards that ran in 1024 by 768 resolution with 256 colors. Although the Diamond Viper VLB was the fastest adapter when using 256 colors, it was less than 5 percent faster than the top three general-purpose adapters, which cost less than the Viper VLB.

All of the top three boards used the Tseng Labs ET4000/W32 accelerator chip, whose speed and price make it the best value for this mainstream market. By using four-way memory interleaving, Tseng Labs' chip wrings out remarkable performance from low-cost DRAM. The W32-based adapters were only hundredths of a second slower than the Diamond Viper VLB and faster than many VRAM designs. By virtue of its compatibility with Tseng's popular ET4000 chip, the ET4000/W32 comes out of the box with reliable drivers for all popular operating systems.

Our favorite W32-based adapter is the Hercules Dynamite VL Pro D602. However, because W32-based cards are so similar, we recommend that you shop around and compare the Dynamite VL Pro to its W32-based cousins to get the best price (but don't forget to factor in support).

Interlaced displays are a bad buy at any price because of their high levels of flicker. Either pocket the \$50-\$60 it will cost you for an extra megabyte of memory or put the money toward an adapter that can take advantage of the extra memory.

Our direct-color rankings considered boards capable of 1024- by 768-pixel resolution with 64,000 colors, which excluded boards with less than 2 MB of memory.

Boards like the \$490 Appian Technology Renegade 1280 VL Pro and the ATI Graphics Ultra Pro VLB make 16-bit color increasingly affordable and attractive.

The ATI Graphics Ultra Pro was the only adapter we received with a shipping direct-color driver for Windows NT.

Our desktop publishing rankings considered boards capable of providing 16.7 million colors at 1024- by 768-pixel resolution. Well-established in the Macintosh world, SuperMac Technology is acting like anything but a newcomer with the Spectrum/24 VL for Windows.

The board was a shade slower

## Promising Beta

Although it wasn't yet in production during our testing, we found the beta version of the Actix Systems Graphics Engine 32 VL plus particularly interesting. The board is based on a prototype S3 86C805I accelerator chip, which adds memory-interleaving support to the widely used 86C805 chip. The Actix 32 VL plus board is notable as perhaps the first DRAM design that offers noninterlaced 1280 by 1024 resolution with 8-bit color and 1024 by 768 resolution with 16-bit color.

Also of note are the beta S3 drivers that come with the 32 VL plus. Even on the current-generation 86C805-based boards, such as the Nth Graphics Nth S3 Advantage/VL and the Volante Warp10LB, these new drivers offer a 25 percent speed improvement, which is enough to put those boards at the top of the performance pack.

## PCI: STILL JUST A PROMISE

At the time of testing, we could obtain only three PCI-based (Peripheral Component Interconnect) video adapters; all were preproduction models. Our test-bed system, however, was a production model of IBM's PS/ValuePoint P60/D. Aside from its being available, the other interesting aspect of this system was its built-in video, from ATI Technologies. We used this feature to examine the self-configurability of the PCI adapters.

Of these three adapters, only Diamond's Viper PCI worked flawlessly. The other two PCI cards, the Graphics Ultra Pro PCI from ATI Technologies and the IGP64 PCI from Infotronic America, had compatibility problems.

The ATI Graphics Ultra Pro PCI failed to run in the IBM system; however, it did run in a preproduction system from Gateway. IBM and ATI theorized that the PCI BIOS resource manager had a problem with the concurrency of the two ATI video controllers. Infotronic's IGP64 board and driver still needed a lot of development and cleanup work.

The problems that we encountered demonstrate that PCI technology is not quite ready for the mass market.

PCI SYSTEM	RESPONSE TIME (SECONDS)		
	1024 by 768; 256 colors	1024 by 768; 64,000 colors	1280 by 1024; 256 colors
Diamond Viper PCI	.586	.607	.626
Infotronic IGP64 PCI	N/A	N/A	.843
IBM ValuePoint system, with built-in ATI PCI	.788	N/A	N/A

N/A = not available.

than the fastest board in this category, the Matrox MGA Impression/3/V, but lower cost and higher resolution tip the scales in the Spectrum/24's favor: The board retails for \$300 less than the Impression/3/V. What's more, the Spectrum/24 supports 16.7 million colors at 1152 by 910 resolution, versus 16.7 million colors at 1024 by 768 resolution for the Impression/3/V. Those extra pixels can mean the difference between a full page and an "almost-full" page in your favorite desktop publishing package. One serious flaw with the Spectrum/24, however, is its requirement of a separate VGA adapter connected via the pass-through connector.

We are tempted by the Pro Graphics 1280's greater value, but it seems Media Vision needs more time to tweak its drivers.

For CAD/CAM evaluations, we considered cards capable of 1280- by 1024-pixel resolution with 256 colors. For people who make their living using CAD, we recommend the Matrox MGA Impression/3/V. The board is clearly geared for CAD: It comes with a separate manual just for Matrox's AutoCAD software.

If you work with Windows-based CAD packages, you'll benefit from the MGA Impression/3/V's unique mode-switching. The board can fool Windows into treating it like a 24-bit board even when you're operating in 8-bit mode.

With this feature you can define a monstrous 1600- by 1200-pixel virtual desktop with hardware panning in which to do your design work. At any time you can see the rendered result in true 24-bit color by simply pressing a key.

The lower-priced alternatives in this category support a form of hardware-assisted panning and provide AutoCAD-specific drivers and documentation.

## BYTE BEST

## VL-BUS GRAPHICS ACCELERATORS

Need speed for general business?

### GENERAL PURPOSE Hercules Dynamite VL Pro D602



All the adapters based on the Tseng Labs ET4000/W32 chip offered uniformly excellent performance and under-\$350 prices. But we give the nod to the Hercules Dynamite VL Pro for its superior documentation, configuration software, and support. The 0.7-second average screen draw for the W32-based boards puts them among the fastest boards for 256-color, 1024- by 768-pixel display resolution, despite their frugal DRAM-based design.



		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Hercules Dynamite VL Pro D602	0.697	▲▲▲	\$299	2 MB	Tseng Labs ET4000/W32i	✓	✓	✓	
RUNNER-UP	Sigma Designs Concorde VLB	0.700	▲▲▲	\$349	1 MB	Tseng Labs ET4000/W32i	✓	✓	✓	
RUNNER-UP	Focus Truespeed/W32	0.698	▲▲▲	\$169	1 MB	Tseng Labs ET4000/W32	✓	✓	✓	
RUNNER-UP	Diamond Viper VLB	0.667	▲▲▲▲	\$499	2 MB	Weitek Power 9000	✓	✓	✓	✓
RUNNER-UP	Hercules Graphite VL Pro HG720	0.683	▲▲▲	\$549	2 MB	IIT AGX015	✓	✓	✓	

Do you need 64,000 colors?

### DIRECT COLOR Appian Renegade 1280 VL Pro



For displaying 1024 by 768 resolution with 64,000 colors, nothing could touch the speed and price of the Renegade 1280 VL Pro. The board was one of the few we tested that ran faster in 64,000 colors than in 256 colors (0.65 second versus 0.71 second).

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Appian Renegade 1280 VL Pro	0.650	▲▲▲	\$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	Matrox MGA Impression/3/V	0.701	▲▲▲	\$1299	3 MB	Matrox MGA	✓	✓	✓	✓
RUNNER-UP	ATI Graphics Ultra Pro VLB	0.780	▲▲▲	\$499	2 MB	ATI Mach 32	✓	✓	✓	✓
RUNNER-UP	Diamond Viper VLB	0.880	▲▲▲▲	\$499	2 MB	Weitek Power 9000	✓	✓	✓	✓

When true color is mandatory...

### DESKTOP PUBLISHING SuperMac Spectrum/24 VL



Offering 16.7 million colors at a maximum resolution of 1152 by 910 pixels, the Spectrum/24's 0.8-second average screen draw was second only to that of the more expensive and lower-resolution Matrox MGA Impression/3/V. The Spectrum/24's documentation and driver reliability are impeccable. Unfortunately, it requires a separate VGA adapter.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	SuperMac Spectrum/24 VL	0.798	▲▲	\$999	3 MB	Proprietary				✓
RUNNER-UP	Media Vision Pro Graphics 1280	0.839	▲▲▲	\$995	4 MB	Media Vision MVV451	✓	✓	✓	
RUNNER-UP	Matrox MGA Impression/3/V	0.779	▲▲▲	\$1299	3 MB	Matrox MGA	✓	✓	✓	✓
RUNNER-UP	STB Systems Pegasus VL	1.015	▲▲▲	\$849	4 MB	S3 86C928	✓	✓	✓	

For high resolution and fast performance...

### CAD/CAM Matrox MGA Impression/3/V



This board combines fast performance with a unique mode-switching capability that lets you go from 256 colors to 16.7 million colors and back with a single keystroke.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Matrox MGA Impression/3/V	0.795	▲▲▲	\$1299	3 MB	Matrox MGA	✓	✓	✓	✓
RUNNER-UP	Appian Renegade 1280 VL Pro	0.821	▲▲▲	\$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	Hercules Graphite VL Pro HG720	0.852	▲▲▲	\$549	2 MB	IIT AGX015	✓	✓	✓	
RUNNER-UP	Diamond Viper VLB	0.827	▲▲▲▲	\$499	2 MB	Weitek Power 9000	✓	✓	✓	✓

#### KEY

Ease of Use:

Excellent ▲▲▲▲ Fair ▲▲  
Good ▲▲▲ Poor ▲

\*SCO Open Systems' version of the X Window System.

# How We Tested

**F**or most applications, the video adapter is the biggest bottleneck in system performance. For example, a modern hard disk can load a 3-D bar chart in 40 milliseconds, while a fast video adapter needs about 700 ms to display the same image.

To create a comprehensive series of tests to identify the graphics accelerators that can shorten the performance bottleneck, we first sought to identify the most important markets for video adapters. We concentrated on four PC applications and the high end of Macintosh graphics, as outlined below.

**General-purpose.** 1024 by 768 resolution with 256 colors; for general-business applications and mainstream Windows users.

**Direct color.** 1024 by 768 resolution with 64,000 colors; for high-end Windows graphics applications, graphic designers, and multimedia producers.

**Desktop publishing.** 1024 by 768 resolution with 16.7 million colors; for desktop publishers and graphics illustrators creating color publications.

**CAD/CAM.** 1280 by 1024 resolution with 256 colors; for engineers, architects, and draftspersons.

**Macintosh graphics.** 1152 by 870 resolution with 16.7 million colors; for desktop publishers and graphics illustration.

We required test boards for the PC platform to support a minimum of 1024 by 768 pixels with 256 colors in noninterlaced mode. Boards had to have a minimum of 1 MB of memory, but if an adapter could support higher amounts of RAM, we asked vendors to supply the greater amount. up to 4 MB.

Beyond the scope of this roundup are video adapters with coprocessors, such as the Texas Instruments 34020 chip. We tested a board in each resolution and at a color level that the board supported in noninterlaced mode. Because of screen flicker, we don't recommend using any board in interlaced mode for a

prolonged period of time.

On the Macintosh, we concentrated our tests exclusively on 24-bit, true-color adapters capable of displaying 16.7 million colors on monitors up to 21 inches in size. We limited our testing to this class primarily because most Macintosh motherboards are equipped with excellent video capabilities for less-demanding applications.

Performance was our primary criterion for selecting winners. After we chose the top performers in each category, we ranked the winners and the runners-up by considering the

cost, support options, usability, and any unique features the boards offered. Because of differences in retail and street prices, we considered a 15 percent cost difference to be insignificant.

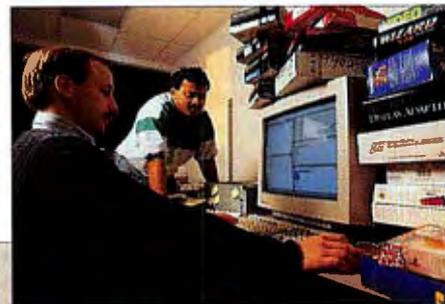
In ease-of-use scores, adapters received a rating of "good" if an average user could install them without referring to the manual. An "excellent" ranking was reserved for those adapters that had exceptionally clear and complete documentation and installation software. Boards that were rated "fair" required you to consult the documentation, while boards receiving a rating of "poor" needed a variety of jumper changes and/or a call to the company's technical support to configure them correctly.



Jim Hurd (top photo, left) developed the graphics tests for this issue. Here, he and technical analyst Siva Kumar analyze test results. Chandrika Krishnamurthy and Mark Paxson (seated, bottom photo) discuss graphics accelerator board rankings with Alan Joch.

## Comparing Scores

When comparing performance scores among various boards, consider differences of less than 5 percent to be unnoticeable in actual use. You're likely to spot the difference in a board that ran 10 percent faster than a competitor, but the difference may not be enough to affect your productivity. A 25 percent speed difference is great enough to choose a board for the productivity gains it offers compared to a slower alternative.



performance for the rest of that board's life.

We also considered any unique utilities or hardware features that gave a board an advantage in any of our application rankings. For example, the Matrox MGA Impression/3/V offers mode switching, which lets CAD designers display 24-bit output with 8 bits per pixel and then switch dynamically to true 24-bit color for 3-D rendering. This feature and the board's CAD-specific documentation helped the Impression/3/V rise to the top in our VL-Bus CAD/CAM evaluations. Finally, we did not consider adapters for honors unless they could complete the entire test without compatibility problems, and they had to produce a clear, stable picture.

We also gave higher marks to boards that didn't require a separate VGA adapter, which not only slows the installation process but takes up an additional slot in your system. Finally, boards received higher marks if you could reach the company's support staff through a variety of methods, including a company BBS, a toll-free phone number, and a fax number.

## PERFORMANCE

**W**hen writing our performance tests, we placed the most emphasis on pro-

# TO WIN THE PAPER CHASE

Fax

Print

Scan

Cut  
and  
Paste

Copy

## STOP CHASING PAPER



### DOC-IT INCREASES YOUR PRODUCTIVITY AT WORK.

We've just brought the paper chase to a resounding and refreshing halt with the invention of DOC-IT, the revolutionary, desktop document processor that combines a multitude of talents.

With DOC-IT, Okidata has integrated faxing, printing, copying, scanning, cutting and pasting in one unit with a footprint so compact, it takes up just a corner of your desk. Incorporating graphics capability compatible with Windows™ and most major software, DOC-IT lets you create and communicate finished presentation-quality documents—complete with visuals—without having to get out of your chair.

No more standing in line. Everything sits on the corner of your desk: simple, handy, productive and private; and incredibly easy to use. If DOC-IT looks good to you on paper, come see it in action at your nearby authorized Okidata DOC-IT dealer. **TO RECEIVE YOUR OWN ON-SCREEN DEMO DISK, OR THE NAME OF A DEALER NEAR YOU, CALL 1-800-OKI-TEAM, EXT. 264.**

THE SMARTEST  
CORNER OF  
YOUR DESK.  
DOC-IT™ BY  
**OKIDATA**  
a division of Oki America, Inc.

# How We Tested *(continued)*

ducing tests that were a meaningful reflection of real-world conditions. To reproduce the performance of graphics applications, we designed our tests using images produced from CorelDraw, Corel Presents, Microsoft Excel, and Microsoft Word for Windows. In all, we required each board to display 15 test screens, ranging from straight text, to 2-D and 3-D bar charts, to complex full-color drawings. See the box at right for test samples.

We had hoped to use CorelDraw and Corel Presents as cross-platform applications for both our Windows and Macintosh tests, but delays in QuickDraw GX sidelined CorelDraw for Macintosh. Instead we used Corel's export filters to convert our drawings into PICT format. We also incorporated images from the Macintosh versions of Microsoft Word, Microsoft Excel, and Aldus Persuasion. (Because the pictures we used were specific to the platform, you should avoid making generalizations about Mac performance versus PC performance on the basis of these test results.)

In addition to mirroring real-world demands, we also designed our tests to be "cheat proof." Some graphics benchmarks, for example, use profiling to define real-world usage; however, the tests consist simply of lines being drawn on top of each other. A clever writer of video drivers can improve speeds in such tests by adjusting the driver to draw the first line and ignore the rest.

To avoid this problem, we used full application screens exactly as they are produced by applications. To further increase our test accuracy, we used microsecond resolution timing. This allowed us to accurately measure a single screen paint, and it avoids the problem of drawing the same screen repeatedly (which is unrealistic and easy to "optimize away" in the driver).

Our Windows test software draws each of the 15 application screens into both system memory and video memory using four different color modes for more than 120 tests in all. We also measured the time it took to refresh the screen from an image cached in memory at screen depths of 1, 2, 4, 8, 16, and 32 bits per pixel. (Well-written applications will cache display images in system memory whenever possible to improve response times.)

To reach an overall response time, we averaged test results using weights

### Test Samples



This Microsoft Excel bar chart helped represent business graphics.



A CorelDraw image helped gauge color graphics speed.



This world map tested speeds for complex monochrome drawings.

derived from profiling typical Windows usage. The overall response time is the average time needed to repaint the entire screen. Use this number to gauge the performance of boards that support resolutions and color levels appropriate to your applications.

Our Macintosh tests performed similarly, except that we tested only in 24-bit-color mode, and drawing in memory was not a consideration because this relies only on the Macintosh Toolbox code and not on the video adapter.

## TEST-BED

We tested the ISA and EISA boards in a 66-MHz 486DX2 Compaq Deskpro 66M with 8 MB of memory. For the VL-Bus boards, we used DEC's MTE 486/66 with 16 MB of memory. Technicians conducted all tests using Microsoft Windows 3.1. Macintosh test-

ing was done on a Mac Quadra 840AV with 16 MB of RAM.

## Contributors

**Jim Hurd**, Vice President of Research and Development/NSTL, wrote the graphics benchmarks for this report. He has developed numerous tests for hardware and software during the last 10 years.

**Helen 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.

**Chandrika Krishnamurthy**, Technical Analyst/NSTL, evaluates peripherals and systems.

**Siva Kumar**, Technical Analyst/NSTL, specializes in hardware and network operating-systems testing.

**Mark Paxson**, Manager of Design-Verification Testing Services/NSTL, specializes in hardware compatibility testing.

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.

# CompuServe Highway



CompuServe would like to introduce you  
to our information highway.  
Complete with visitor centers, shopping malls,  
town squares, and other world travelers.

You've probably been hearing a lot about the information highway lately. But before you take your next trip, maybe you should make sure the highway you're on is a superhighway. Like CompuServe.

CompuServe has nearly 2,000 places for you to go, things for you to see, and fun for you to have. You can turn in to one of our many forums where nearly every hardware and software vendor is represented, along with almost every shade of political opinion. Our Electronic Mall<sup>®</sup> is filled with the newest merchandise, and our CB Simulator and Electronic Convention Center let you just stop by and chat.

Other services range from renowned reference databases to timely financial data and thousands of freeware and shareware programs.

Plus, CompuServe has over a million and a half

members worldwide. So, you're bound to find plenty who will share your interests, be able to offer advice, or just become fast friends.

For only \$8.95 a month, you can get unlimited connect time — day or night — to a full package of more than 50 basic services. That includes news, stock quotes, travel arrangements, movie and restaurant reviews, 60 E-mail messages a month, and more. Plus, a whole universe of other services is available at nominal additional charges.

So, get on the fast track. For more information or to order, see your computer dealer or call 1 800 848-8199. And take our information highway straight into the next century.



**CompuServe<sup>®</sup>**

The information service you won't outgrow.<sup>™</sup>

Circle 80 on Inquiry Card.

# THE BEST GRAPHICS ACCELERATORS FOR ISA-BUS SYSTEMS

While VL-Bus video receives most of the attention, ISA video adapters are offering more capabilities than ever at bargain-basement prices of as low as \$149. Even more surprising is the fact that the ISA cards that we tested typically performed just 5 percent to 15 percent slower overall than comparable VL-Bus cards.

Why isn't ISA slower? After all, ISA offers a modest bandwidth of 8 MBps maximum, compared to VL-Bus's maximum of 132 MBps. However, for most graphics operations, VL-Bus adapters don't move data at speeds anywhere near the bandwidth of the bus.

The VL-Bus advantage is most evident in *Blting*, which is a straight pixel copy from memory to the screen. (*Blt* is an abbreviation for "block transfer.") For example, a fast ISA card on a straight pixel copy will attain just under 7 MBps, while a fast VL-Bus adapter will top 16 MBps. This corresponds to a complete screen repaint (using 1024 by 768 pixels by 256 colors) of under .05 second for VL-Bus versus .11 second for ISA.

The Achilles' heel of ISA video cards is the limited address range of the ISA bus. Many of the fastest cards, such as Compaq's QVision 1280/L, gain their speed by mapping VRAM into high memory. The QVision drivers that we tested would work only in this "flat-mapped" memory configuration. The ATI Graphics Ultra Pro ISA will work with or without flat-mapping, but flat-mapping offers a substantial performance boost. The problem with flat-mapping in an ISA system is that you are generally limited to 12 MB of system RAM, an amount that seems smaller every day.

The Paradise/Western Digital Accelerator 24 offers the best

## When Video Drivers Matter

Under Windows (but not the Mac), video-driver software is vital for drawing images in system memory. Typically, video acceleration hardware cannot be used for this task, so the performance rests solely on the cleverness of the driver software.

The speed of drawing images in system memory is crucial to overall system response time, because many applications will prepare the image in memory and then copy the finished image to the screen.

Even on fast 486/66 machines, the performance of the software driver is often more important than the speed of the video hardware. We found instances where a new driver would boost a board's performance by 25 percent, enough to move it from the bottom of the heap to near the top. If you haven't upgraded your driver recently, it might pay to check out your vendor's BBS for any recent enhancements.

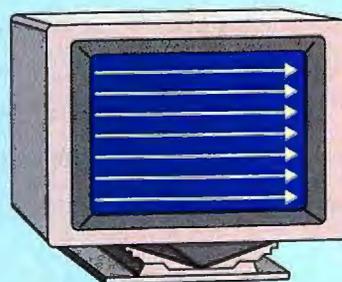
The difference in driver performance is even more dramatic when using operating systems other than Windows. Our top-performing board for use with Windows NT was the Hercules Dynamite VL Pro D602, a low-cost DRAM board; its faster driver far outweighed its marginally slower hardware.

## AVOID INTERLACING

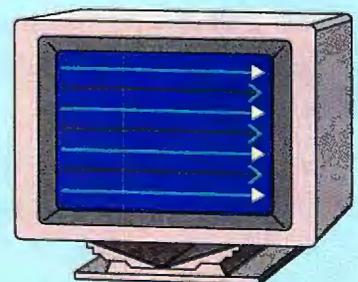
In deciding what graphics accelerator to buy, make sure you weed out those that support only resolutions that are used in interlaced mode, because eyestrain will result if you work for long periods of time with an interlaced display. Nevertheless, vendors continue to provide interlaced modes, even though monitors designed with the slow phosphor needed for interlacing are rare. Worse, many vendors don't make it clear what resolutions require interlacing. We strongly suggest that you ignore interlaced modes when making your purchase decision.

Also, be wary of advertised resolutions that require 90-Hz refresh rates. Usually, this indicates that interlacing has been implemented by the vendor: The actual refresh rate is 45 Hz, which is doubled to cover the two refresh sweeps.

At the time of our testing, all the DRAM-based boards implemented interlacing in modes that required 2 MB of memory. For this reason, we recommend that you purchase DRAM-based boards with only 1 MB of memory if they only run interlaced modes with 2 MB.



Noninterlaced



Interlaced

**Need top performance and economy?**

**GENERAL-PURPOSE Paradise/W D Accelerator 24**



This board was a top performer among the low-cost DRAM-based adapters. Unlike the top-performing Compaq QVision 1280/I, the Accelerator 24 won't limit your memory expansion. The Accelerator 24 is more difficult to configure than most adapters due to its reliance on jumpers.



value for general-purpose applications (1024 by 768 pixels with 256 colors). Despite its price/performance strengths, the Accelerator 24 offers only fair usability: It was among a handful of boards we tested that may require you to change jumpers, depending on your system configuration.

The S3 86C801-based STB PowerGraph X-24 also lists for \$199 and, also like the Accelerator 24, it is DRAM-based. The PowerGraph was the slowest of the boards ranked for this category, but new S3 drivers, which were in beta at the time of our testing, showed a noticeable improvement over the released drivers we used for our formal rankings.

The lowest-cost boards we tested were based on the Cirrus Logic GD5426 chip. These boards include the STB Horizon VGA (\$159) and Cardinal's VideoSpectrum XL (\$149).

The standard GD5426 drivers are not the easiest to install, however; you must separately install a DOS utility to set the monitor refresh.

You'll need higher-cost VRAM-based boards to produce stable images with 16-bit color at 1024 by 768 pixels. Like its VL-Bus cousin, the 1280 VL Pro, the Appian Renegade 1280 ISA is one of the few adapters that actually ran faster using 16-bit color than it did while using 8-bit color. We didn't like the 1280 ISA's unnecessarily complex installation.

For CAD/CAM applications (1280 by 1024 pixels with 256 colors), our two top choices use S3's 86C928 chip. The Sigma Designs WinMach 1600 was the fastest board in this category by a slim margin, but the Pixelworks WhirlWin-II was \$100 cheaper. We gave the nod to the WinMach 1600 for its support of 24-bit color (16.7 million colors) at 800 by 600 resolution.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Paradise/W D Accelerator 24	0.733	▲	\$199	1 MB	WD90C31	✓	✓	✓	
RUNNER-UP	Compaq QVision 1280/I	0.721	▲▲▲	\$599	1 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP	Hercules Graphite Pro HG310	0.744	▲▲▲	\$399	1 MB	IIT AGX015	✓	✓	✓	
RUNNER-UP	Volante Warp20-2	0.766	▲▲▲	\$499	1 MB	IIT AGX-14	✓	✓	✓	
RUNNER-UP	STB Systems PowerGraph X-24	0.865	▲▲▲	\$199	1 MB	S3 86C801	✓	✓	✓	

**The speed leader in 64,000 colors**

**DIRECT COLOR Appian Renegade 1280 ISA**



Appian Technology builds the Renegade 1280 ISA specifically for direct-color use: It runs faster in 64,000-color mode than in 256-color mode. If you are looking to step up to direct color and want to say good-bye to using palettes, consider the Renegade 1280 ISA.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Appian Renegade 1280 ISA	0.659	▲▲▲	\$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	ATI Graphics Ultra Pro ISA	0.803	▲▲▲	\$499	2 MB	ATI Mach 32	✓	✓	✓	✓
RUNNER-UP	Compaq QVision 1280/I	0.840	▲▲▲	\$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP	Nth Graphics Nth Edge 1280	0.787	▲▲▲	\$995	2 MB	Chips & Technologies 481	✓		✓	
RUNNER-UP	Sigma Designs WinMach 1600	0.832	▲▲▲	\$995	2 MB	S3 86C928		✓	✓	

**For the best speed in true color...**

**DESKTOP PUBLISHING SuperMac Spectrum/24 ISA**



Long a major force in the Macintosh market, the company's offerings dominated our tests for cards capable of 16.7 million colors at 1024- by 768-pixel resolution. However, the board requires a separate VGA graphics adapter.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	SuperMac Spectrum/24 ISA	1.288	▲▲	\$999	3 MB	Proprietary				✓
RUNNER-UP	Raster Ops PaintBoard PC	1.963	▲▲▲	\$999	3 MB	S3 86C924	✓		✓	
RUNNER-UP	Number Nine #9GXE	2.700	▲▲▲	\$895	4 MB	S3 86C928		✓	✓	

**For switching resolutions on the fly...**

**CAD/CAM Sigma Designs WinMach 1600**



The WinMach 1600 supports hardware panning and allows basic image manipulation, such as compression/decompression, antialiasing, rotation, and scaling. The board supports 16.7 million colors at 800 by 600 resolution for photo-realistic rendering and can change resolutions via a hot key.

		SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
							AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
BEST	Sigma Designs WinMach 1600	0.808	▲▲▲	\$995	2 MB	S3 86C928		✓	✓	
RUNNER-UP	Pixelworks WhirlWin-II	0.815	▲▲▲	\$895	2 MB	S3 86C928	✓	✓	✓	✓
RUNNER-UP	Compaq QVision 1280/I	0.857	▲▲▲	\$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP	Appian Renegade 1280 ISA	0.886	▲▲▲	\$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP	ATI Graphics Ultra Pro ISA	0.967	▲▲▲	\$499	2 MB	ATI Mach 32	✓	✓	✓	✓

\*SCO Open Systems' version of the X Window System.

KEY	
Ease of Use:	
Excellent ▲▲▲▲	Fair ▲▲
Good ▲▲▲	Poor ▲

# Windows NT Drivers: Better Late Than Never?

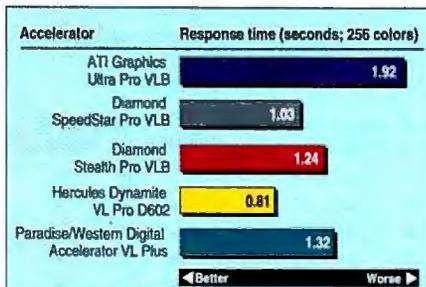
Many of the best-performing accelerators we tested had only beta Windows NT drivers during our test cycle. In fact, the only shipping NT drivers at the time of testing seemed to be those that ship with NT itself. Aside from the drivers with results shown in the accompanying bar chart (all shipped on the Windows NT CD-ROM), we received beta drivers for the SuperMac Spectrum/24 VL for Windows, Diamond Viper VLB, Hercules Graphite VL Pro HG720, and Matrox MGA Impression/3/V.

At this early stage, the low-cost Hercules Dynamite VL pro D602 walks away from the field (but it is still slower than it is in Windows 3.1). The NT tests ran on a 486/66 DEC MTE.

For Windows NT testing, we used software based on the same code as the Windows tests with a few conditional compilation switches. Testing graphics performance under NT can be tricky, thanks to NT's automatic GDI (Graphical Device Interface) instruction batching and dictatorial grasp of memory.

The instruction batching seeks to minimize the overhead of making many small requests to the graphics driver by grouping many small requests into one big request. Carelessly constructed tests can end up measuring the time it takes to place an instruction into this cache, rather than the time it takes to paint the screen.

The memory problem stems from NT's refusal to lock more than 128 KB of a process into memory. This limitation causes problems when testing adapters with 4 MB of VRAM. An unintentional swap can disrupt results.



## HOW TO BUY A GRAPHICS ACCELERATOR

### Find the Right Color Depth

Although 8-bit boards capable of 256 colors are adequate for Windows and general-purpose applications, consider stepping up to a 16-bit board with 64,000 colors. Ideal for multimedia applications, 16-bit color requires 2 MB of VRAM for 1024 by 768 resolution. For Windows users, the greater color depth avoids the distracting "color flash" that 8-bit boards can produce when you change windows or move among multiple open applications.

### Which Bus Is Best?

Overall, little performance difference exists between the fastest ISA, EISA, and VL-Bus graphics accelerators when you run at a relatively small color depth, such as 1024 by 768 pixels with 256 colors. But when you increase the color depth to 24 bits, you will see some significant performance differences between ISA and the other bus types. Therefore, if you're only using 256 colors in your applications and you have an ISA system, the inexpensive ISA-based cards should serve you well.

### When Is VL-Bus a Must?

VL-Bus cards can become faster as you add memory to your system. This speed benefit comes because properly designed applications will use available system memory to cache screen information that can then be quickly copied to the screen. This image copying (called Blt'ing) is what really separates VL-Bus cards from other cards: Speedups of over 2 to 1 are common for this operation.

### How Much Memory?

Be wary of misleading vendor claims. A board may be advertised as being able to display 16.7 million colors. However, if the board only has 1 MB of video memory, then this color level is possible only at the undesirable resolution of 640 by 480 pixels. If you need lots of color, use the following table as a guide to determine your minimum memory needs.

If you run this resolution	And you use this many colors	Video memory should be at least
640 by 480	16.7 million	1 MB
800 by 600	64,000	1 MB
800 by 600	16.7 million	2 MB
1024 by 768	256	1 MB
1024 by 768	64,000	2 MB
1024 by 768	16.7 million	3 MB
1280 by 1024	256	2 MB
1280 by 1024	64,000	3 MB
1280 by 1024	16.7 million	4 MB

### Consider Support

Be sure that your vendor is able to provide you with updated drivers in a convenient manner. Often substantial performance gains will result from the latest, more efficient drivers. On the other hand, high-performance Windows drivers are immensely complex, so there's always a chance that some bug will prevent correct operation, and you should be able to download company fixes quickly.

# VIDEO MACHINE

Simply the best all-in-one Desktop Video Studio, for

- video editing
- animation-to-video
- video presentations

All hard- and software included. And it runs on your standard Windows-PC or Macintosh!

Features include an edit control unit, a video mixer with 6 inputs, a character and graphics generator for titling, a 300+ digital video effects unit, and 4-channel audio re-recording in CD stereo quality.

Video Machine gives you full studio quality for a price **you** can afford!

## But don't just take our word for it:

"A Dream Machine... FAST has produced a real winner" **AV Video**

"Seems like magic... an outstanding achievement..."

**Byte**

"The FAST Video Machine is the closest thing to a one-step solution you will find. Video Machine offers the most bang for the buck of any solution on any platform" **High Color Magazine**

"Add up prices for stand-alone gear, and you'd be hard-pressed to top this board for ten times the money" **Videomaker**

"Seeing is believing!" **Broadcast Hardware**

**We couldn't say it any better.**



**Imagination. Made in Europe.**



**USA:**  
FAST Electronic U.S. Inc.  
5 Commonwealth Road  
Natick MA 01760  
Tel. (800) 248-FAST  
Fax (508) 650-0447

**International:**  
FAST Electronic GmbH  
P.O. Box 20 07 19  
D-80007 München  
Tel. ++49 89 50206-0  
Fax ++49 89 50206-199

**Circle 96 on Inquiry Card (RESELLERS: 97).**

**YES,** I take your word for it! Send me more information about:

- Video Machine for PC
- Video Machine for Macintosh

Address \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

# MACINTOSH NUBUS SYSTEMS

**W**e tested 10 two-page, true-color display adapters for Macintosh-based graphics illustration and desktop publishing. All these NuBus boards were easy to use and produced clear, stable pictures. We used a Mac Quadra 840AV for testing, which is a typical target platform for these cards, because its maximum 2 MB of VRAM leaves it 1 MB shy of what's needed for dual-page, true-color displays.

Our best-overall rankings identified the speed leaders, without concern for price. Our low-cost rankings were limited to boards priced below \$1800. Not surprisingly, these boards offer slower response times than the higher-priced boards, but they sell for about \$700 less.

Our tests showed only modest performance differences among the boards ranked as best overall. If you don't need the absolute best performance, the lower-cost SuperMac Spectrum/24 PDQ Plus may offer better value than the Radius PrecisionColor Pro.

The top two product families, the accelerators from Radius and SuperMac Technology, provide an interesting contrast in design philosophies (the SuperMac/E-Machines Ultra LX is a SuperMac design, so these comments apply to it as well). The Radius adapters excel at moving photographic images to the display from memory. The SuperMac adapters, on the other hand, are outstanding at executing streams of graphics primitives, such as lines, polygons, and text. SuperMac claims to accelerate 80 percent of all QuickDraw operations, a claim that was borne out in our test results: With the exception of Radius's PrecisionColor Pro in the best-overall category, SuperMac boards consistently posted the fastest overall speeds among the ranked boards.

However, since just about every program does a combination of image transfers and graphics primitives, it would be fair to say that the two designs offer roughly equivalent overall performance. Users primarily interested in running Adobe Photoshop or other image-editing software will prefer a Radius adapter; the top-ranked PrecisionColor Pro moves pixels to the screen at an impressive 5.4 million pixels per second, compared to under 3 million pixels per second for all the SuperMac adapters.

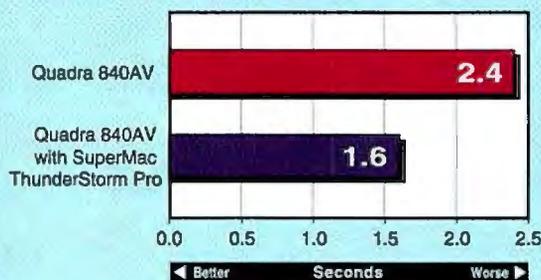
The SuperMac cards offer *hardware panning*, which allows you to pan across a large desktop more quickly than you could by using the normal interface. This feature would be most useful for people who use CAD programs. Large virtual desktops force you to drop down to 8 bits of color, which limits the usefulness of this capability for graphics and publishing work. The SuperMac Spectrum/24 Series IV is ranked in the best-overall and low-cost categories, but be cautious about comparing its score directly to those of the other boards. Its top resolution is 1024 by 768 pixels, and it was tested at this resolution.

The SuperMac Thunder series of boards allow you to add memory for on-board *GWorlds* (i.e., images that exist in memory but are not displayed on-screen). This may offer an additional acceleration for applications that are written to take advantage of GWorlds, but you have to weigh the advantage

## DSP Acceleration

Several of the SuperMac display adapters come equipped with DSPs (digital signal processors) to accelerate image-processing algorithms. The SuperMac DSP-based PhotoFlash architecture uses two AT&T DSP16A chips. SuperMac provides software to speed up existing Adobe Photoshop image-processing filters and to add new filters, including a new motion-blur filter. JPEG operations are significantly accelerated, even on a Mac Quadra 840AV, using Storm Technology's QuickPress. Using QuickPress makes JPEG practical for 160- by 120-pixel video editing using QuickTime editors such as Adobe Premiere.

### Displaying a JPEG-Compressed Picture



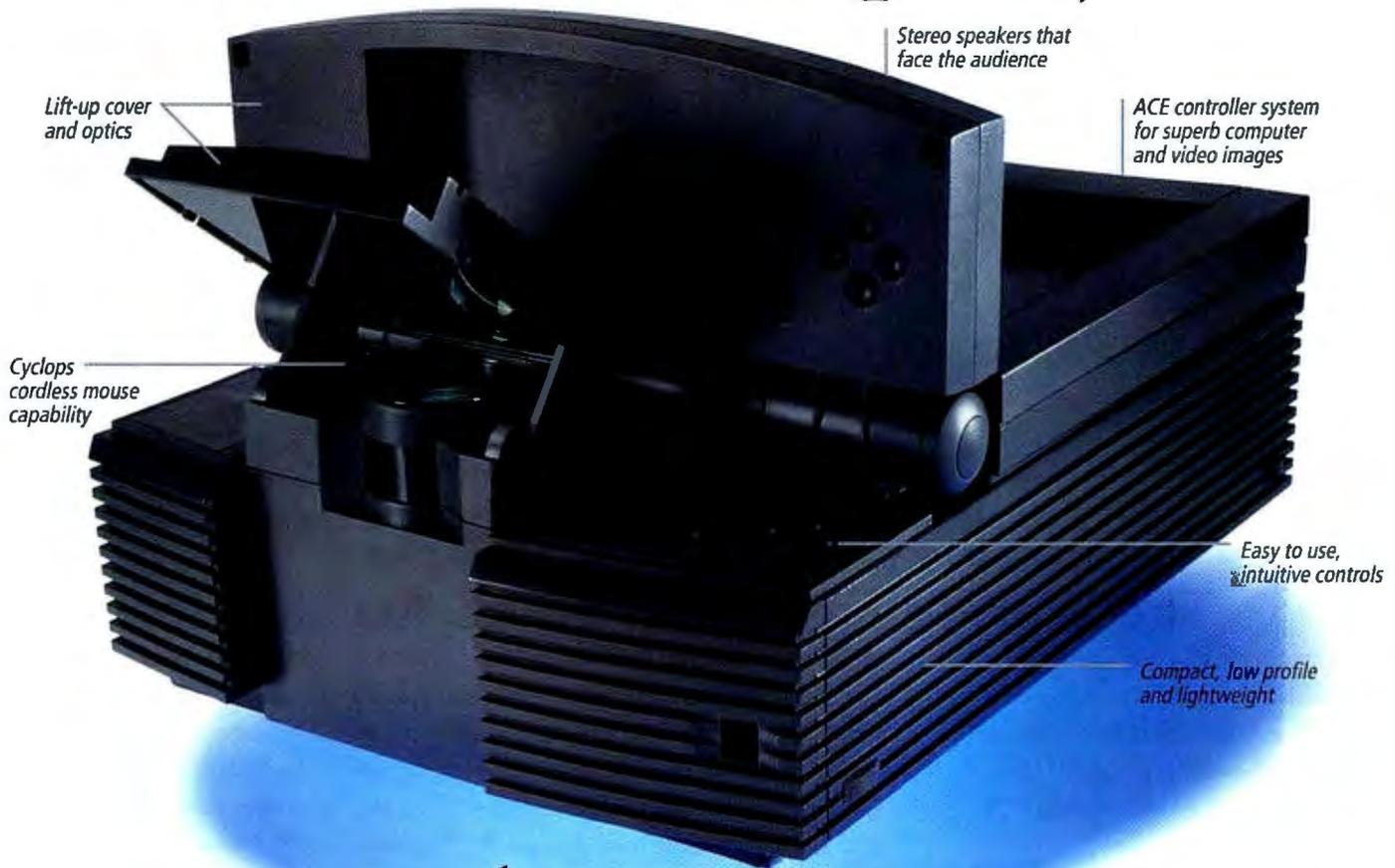
of putting the memory on your display adapter rather than putting it in your system. Additional memory on the display adapter means the acceleration hardware can update off-screen images and, more important, the off-screen image can be copied to the screen without having to squeeze through the NuBus.

The two offerings from Radius don't offer hardware panning, but they allow you to change the resolution of the screen without restarting your Macintosh. This might be useful if you use a 17-inch monitor, as you might want to temporarily view the entire page (at 1152 by 870 pixels) and then revert back to the normal-size image (832 by 624 pixels) to continue your design work. This feature is of no apparent use on a 21-inch monitor, however.

The RasterOps PaintBoard Turbo XL significantly lagged behind the pack in performance. It would be an especially poor choice for image-editing applications such as Photoshop; its time of 1.5 million pixels per second is less than a third of the speed of the more expensive Radius PrecisionColor Pro. However, its text-display speed is better than that of the Radius boards and within 5 percent of the speed of the SuperMac boards.

All the NuBus boards slow down dramatically when displaying 16-bit images (when using 24-bit-color mode). The Radius PrecisionColor adapters move 16-bit images to the display at one-tenth the speed of 24-bit images. The SuperMac

# 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.

And that saves you time and money.



Of course, you can also project brilliant presentations that captivate your audience. Not only do Desktop Projectors let you incorporate sound, motion, and our amazing Cyclops cordless mouse, but they eliminate the need for slides, flip charts, and transparencies.

### Any computer, any application

Proxima's Desktop Projectors connect just like a monitor to any PC or Mac and work with your favorite productivity-enhancing software. Starting as low as \$4,995, and weighing as little as 18 pounds, there's a model for almost any budget or application—from high-performance color to multimedia projection.

So whether it's a sales presentation, management discussion, or training session, Proxima's Desktop Projector series lets you project the power of your computer in the meeting room.

For more information or the dealer nearest you, call us today.



Portable Desktop Projectors go where the action is.

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 160 on Inquiry Card (RESELLERS: 161).



# 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.

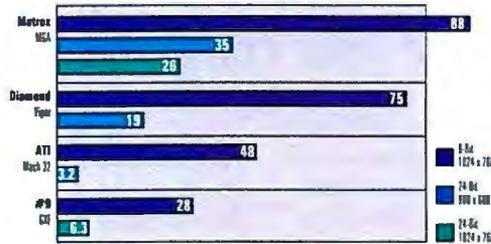
### MGA Ultima Specifications

- Up to 90 million WinMarks<sup>1</sup> of blazing speed
- Up to 35 million WinMarks<sup>1</sup> 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  
 ©1993 All rights reserved. Matrox, Matrox MGA, Matrox QCDP, Matrox Instant Modeswitch are registered trademarks of Matrox Electronic Systems, Ltd.

(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.



boards move 16-bit images at about one-fifth the speed of 32-bit images. The lesson here is to be sure to switch to the color mode that matches the image that you are editing or viewing.

The performance penalty for displaying 1-, 2-, 4-, and 8-bit images is far less severe. One-bit images display at half the speed of 32-bit images on the Radius adapters and only 15 percent slower on the SuperMac adapters. The significance of this is that you can work with these lower-color images (monochrome is particularly common for desktop publishing) without resetting the colors on your monitor.

When comparing the results of the Macintosh display systems, it becomes clear that Apple is under serious attack by the Windows products for high-end graphics applications. VL-Bus adapters such as the SuperMac Spectrum/24 VL for Windows and the Media Vision Pro Graphics 1280 offer equal or better performance than our top-rated Macintosh display adapters at a fraction of the cost.

Because the tests were not identical (we used popular Mac programs to create tests for the Mac and popular Windows programs to create tests for the PC), we cannot make an overall comparison between the graphics performance of the Mac and that of the PC. But on one comparable test, the time required to copy a 32-bit image from system memory to display memory (a common operation in Adobe Photoshop), the VL-Bus adapters show a decided price/performance advantage. For example, the top-ranked PrecisionColor Pro for NuBus clocks in at 5.4 million pixels per second. The SuperMac Spectrum/24 VL for Windows produces an equally impressive 5.3 million pixels per second, but at less than half the cost.

# BYTE BEST

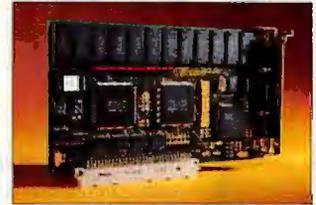
# NUBUS GRAPHICS ACCELERATORS

## Need the best 24-bit Mac card?

### BEST OVERALL Radius PrecisionColor Pro



The Radius PrecisionColor Pro was the fastest Macintosh-based board overall, beating out the SuperMac Thunder cards by a narrow margin. The PrecisionColor Pro shows its biggest speed advantage when copying photographic images to the screen: At 5.4 million pixels per second, it was 80 percent faster than the Thunder II, the significantly more expensive card that won out in our rankings for high-speed imaging. For text speed, however, the PrecisionColor Pro was 33 percent slower than the Thunder II. The PrecisionColor Pro has the ability to change resolutions without requiring you to reboot the machine. The 3 MB of VRAM in our test configuration is also the maximum amount of memory that is supported by the PrecisionColor Pro.



		OVERALL SPEED (SECONDS)	TEXT SPEED (SECONDS)	IMAGING SPEED (SECONDS)	BIT-MAP SPEED (SECONDS)	PRICE AS TESTED	RAM AS TESTED	EASE OF USE	ACCELERATOR CONTROLLER
BEST	Radius PrecisionColor Pro	1.349	0.243	1.881	0.186	\$2499	3 MB	★★★★	Radius Custom
RUNNER-UP	SuperMac Thunder/24	1.421	0.193	1.967	0.367	\$2599	3 MB	★★★★	Proprietary
RUNNER-UP	SuperMac/E-Machines Ultrara LX	1.430	0.207	1.980	0.367	\$1299	3 MB	★★★★	Proprietary
RUNNER-UP	Radius PrecisionColor 24X	1.473	0.445	2.028	0.207	\$2499	3 MB	★★★★	Radius Custom
RUNNER-UP	SuperMac Spectrum/24 PDQ Plus	1.464	0.224	1.993	0.423	\$1499	3 MB	★★★★	Proprietary

## Are you cost-conscious?

### LOW COST SuperMac Spectrum/24 PDQ Plus



The overall speed of the Spectrum/24 PDQ Plus beats the Raster Ops PaintBoard Turbo XL by a narrow margin. The Spectrum/24 performed especially well in tests that measured imaging and bit-map speed. The Spectrum/24's price beats that of the Raster Ops PaintBoard Turbo XL by more than \$200. The performance and retail price of both cards are roughly comparable. The Spectrum/24 can provide hardware panning at less-than-24-bit color. Although the less expensive Spectrum/24 Series IV looks impressive, be aware that its maximum resolution is 1024 by 768 pixels. If you can work within this limit, the Series IV can be a good, low-cost choice, especially if fast bit-map speed is important to you.

		OVERALL SPEED (SECONDS)	TEXT SPEED (SECONDS)	IMAGING SPEED (SECONDS)	BIT-MAP SPEED (SECONDS)	PRICE AS TESTED	RAM AS TESTED	EASE OF USE	ACCELERATOR CONTROLLER
BEST	SuperMac Spectrum/24 PDQ Plus	1.464	0.224	1.993	0.423	\$1499	3 MB	★★★★	Proprietary
RUNNER-UP	Raster Ops PaintBoard Turbo XL	1.858	0.225	2.534	0.666	\$1749	3 MB	★★★★	Proprietary
RUNNER-UP	SuperMac Spectrum/24 Series IV	1.450	0.313	2.057	0.298	\$949	3 MB	★★★★	Proprietary

## When speed matters...

### HIGH-SPEED IMAGING SuperMac Thunder II



Most of the Macintoshes to appear since the Mac II are starved for NuBus slots. The Thunder II includes a dual DSP accelerator while still occupying a single NuBus slot. Even on the top-of-the-line Quadra 840AV, the board's DSP acceleration gave us a 50 percent speedup while displaying JPEG-compressed images. The DSP acceleration also speeds up image filtering in Adobe Photoshop. The Thunder II provides performance that's equivalent to that of the Radius PrecisionColor Pro and faster than that of any of the other cards we tested.

		OVERALL SPEED (SECONDS)	TEXT SPEED (SECONDS)	IMAGING SPEED (SECONDS)	BIT-MAP SPEED (SECONDS)	PRICE AS TESTED	RAM AS TESTED	EASE OF USE	ACCELERATOR CONTROLLER
BEST	SuperMac Thunder II	1.400	0.182	1.953	0.334	\$3999	6 MB	★★★★	Proprietary
RUNNER-UP	SuperMac Thunder II Light	1.444	0.198	1.964	0.424	\$2999	3 MB	★★★★	Proprietary
RUNNER-UP	SuperMac ThunderStorm Pro	1.422	0.194	1.968	0.366	\$3199	3 MB	★★★★	Proprietary

KEY	
Ease of Use:	
Excellent ★★★★★	Fair ▲▲
Good ▲▲▲	Poor ▲

# EISA-BUS SYSTEMS

**A**fter testing six graphics cards designed for EISA, we were pleasantly surprised to find that EISA video speeds can keep up with VL-Bus speeds. We still believe that VL-Bus is the best choice for graphics performance, but some EISA systems, notably Compaq's M series, lack a local bus. For those systems, cards such as the Compaq QVision 1280/E are competitive with the best of the breed for any bus attachment.

Users of EISA systems can also consider ISA-based video accelerators, and we found that these boards usually work flawlessly in an EISA system. Accordingly, we considered the entire sampling of EISA and ISA cards for all awards in this section. Nevertheless, our tests show that while they are compatible with EISA systems, ISA boards are slower and less flexible than EISA boards, which can fully participate in EISA's automatic configuration scheme. (The EISA version of the Appian Renegade 1280 didn't arrive in time for testing.)

A major advantage of the EISA bus over ISA is the 32-bit address space (4 GB), compared to 24 bits (16 MB) for ISA. Compaq's ISA-based QVision 1280/I in particular requires a large chunk of the ISA address space; using this board limits your overall ISA system memory to 12 MB.

The QVision 1280/E earned our highest rankings for general-purpose and CAD/CAM. With even IBM now moving to third-party graphics designs, Compaq is one of the last system vendors to make its own video accelerators and write its own drivers. The QVision 1280/E is a remarkable success; it dominated all the other cards in the 256-color graphics modes. However, its drivers for 64,000 colors are newer and not as well tuned. Consequently, it placed only sixth in those tests.

The QVision 1280/E gains much of its speed through highly tuned drivers; it was one of the few cards to quickly handle a display of a 24-bit DIB (device-independent bit map). By mapping the entire VRAM into the system-address space, the QVision 1280/E saves time that would otherwise be spent paging memory over other designs.

For the best general-purpose alternatives to the QVision 1280/E, look to the ISA cards we've ranked. At \$199, the Paradise/Western Digital Accelerator 24 offers good value as a low-cost general-purpose card for EISA systems. The Hercules Graphite Pro HG310 and the Volante Warp20-2 are nearly twins. Both are ISA boards based on IIT AGX accelerators and provide 1 or 2 MB of VRAM at similar prices.

Both of these boards are also competitive choices for the best direct-color and CAD/CAM boards. (Their maximum 2 MB of memory is not enough for serious color publishing applications, however.) We give a slight edge to the Graphite Pro HG310 here because of its broad range of support options, the strength of its bundled utilities, and its better performance.

The Appian Renegade 1280 was our choice for 64,000 colors on VL-Bus and ISA, and EISA is no exception. The 8-bit drivers for the ISA-based Renegade 1280 are uninspired; displaying a 24-bit DIB takes a whopping 22 seconds in 1024 by

## How Bus Architecture Affects Graphics

The effect of the different buses on graphics performance is modest when using typical business applications. Our tests showed similar performance among boards for various bus architectures at 256- and 64,000-color resolutions. This changes, however, at 16-million-color resolutions, where the VL-Bus demonstrates at least a 25 percent improvement.

Applications usually draw an image directly into video memory. The amount of data that's required to pass through the bus at any given time for this operation is well within the bandwidth of the 16-bit ISA bus. However, some applications will draw an image outside of video memory as well and then transfer that image into video memory when necessary. This requires large blocks of data to pass through the bus, and the more advanced buses have an advantage over ISA.

### ISA

Market forces made the original bus for the IBM PC a de facto standard. The performance of graphics adapters in an ISA bus is still acceptable, even compared to the more advanced bus technologies. However, in applications where extensive raw pixel copying from system memory to video memory is required, the ISA bus just can't keep up with VL-Bus or EISA.

Users with ISA systems that contain more than 12 MB of memory find that many of the new ISA graphics adapters either won't run or perform miserably. Since the video memory won't fit cleanly into the 16-MB limit, the board will fail or the driver has to perform acrobatics to access the memory.

### EISA

ISA adapters can work in an EISA system; however, EISA-specific adapters can take advantage of the 32-bit address and data capabilities as well as the 33-MHz operating speed of that bus. Sharing interrupts and DMA channels, bus mastering, and other features make the EISA (and Micro Channel as well) superior to the ISA bus in performance and abilities. Consequently, true 32-bit EISA graphics adapters will demonstrate marked performance gains over ISA in pixel copies from system to video memory.

### VL-Bus

VESA designed its local-bus specification for the 32-bit Intel 486 processor. Consequently, a VL-Bus on a non-486-processor-based system cannot reside directly on the local bus. Instead, it uses a separate layer of hardware that converts the non-486 local bus to the VESA specification. This layered implementation is very similar to that of the PCI bus. The biggest limitation of the VL-Bus is loading. Adding peripherals to the bus causes signal degradation. The faster the bus, the fewer the number of peripherals that will operate reliably. In application, the VL-Bus will support up to three peripherals running at 33 MHz.

### PCI

To avoid the processor dependency of the local bus, Intel developed the PCI (Peripheral Component Interconnect) specification, a bus design that interfaces to any local bus. It uses a hardware layer that isolates the PCI from the CPU local bus and operates at 33 MHz instead of the speed of the processor. The processor's independence also allows PCI adapters to operate in non-Intel-processor systems that have the PCI bus.

PCI provides specifications for 32- and 64-bit interfaces, which should meet performance demands through the end of the century. Another feature of the PCI specification is the self-configuration of installed products, which gives users the benefit of plug-and-play. Although PCI is still in its infancy (as demonstrated in our tests), a committee consisting of about 200 companies, including Apple, is clearly driving the PCI standard forward.

# Pacific DirectNet. Automatically easier.

**FREE!**  
PostScript  
Language Emulation SIMM with purchase of  
Pacific DirectNet for Novell/UNIX/TokenTalk  
Offer valid until February 28, 1994

Pacific DirectNet was designed to make life on a network easier. It's fast. It's easy to use. And, unlike JetDirect from Hewlett-Packard, it can adapt to whatever network protocol comes its way. Automatically.

The board connects to any Ethernet network, supporting Novell NetWare, UNIX TCP/IP, and EtherTalk operating systems. With automatic switching, users won't be troubled by having to switch protocols at the printer front panel.

Because it supports standard UNIX printing and file transfer protocols, setup in UNIX is a breeze. Pacific DirectNet connects to virtually all UNIX TCP/IP networks including Sun, HP, IBM, DEC, SCO, Solaris, and Interactive UNIX. And it also contains an SNMP agent that allows network management software to recognize and manage printers like it does other network devices.

Pacific DirectNet offers support for an unlimited number of file servers and queues, as well as for multiple, simultaneous PSERVER and RPRINTER connections on Novell networks. This way users are provided greater flexibility to select any printer on the LAN.



	Pacific DirectNet™	HP JetDirect®
Automatic Novell, EtherTalk and TCP/IP switching on LaserJet 4		
Support of standard UNIX printing and file protocols for broad cross platform support		
Fast and easy UNIX setup — simply enter IP address		
Novell/UNIX/EtherTalk list price	<b>\$599</b>	<b>\$499</b>
LJ4 PostScript Language Emulation SIMM	<b>included*</b>	<b>\$499</b>
	<b>\$599</b>	<b>\$998</b>

## The easiest way to share a LaserJet printer on a network.

And because we've incorporated Flash memory onto each card, Pacific DirectNet can be updated to add support for new network operating systems or to upgrade features for an existing one. Pacific DirectNet is compatible with the Hewlett-Packard LaserJet® III, IIID, IIISi, 4, 4M, 4Si, 4Si MX, PaintJet® XL300, DeskJet® 1200C, and DesignJet®. It comes with a lifetime warranty, 60-day money back

guarantee of satisfaction, and free technical support. And, for a limited time, the Novell/UNIX/EtherTalk board comes with PostScript® emulation — all for the standard low price of \$599! Or, if you only need Novell NetWare support now, start with our Novell version for only \$399 (HP price \$499), and upgrade later. For more information on Pacific DirectNet, a dealer near you, or to order direct from Pacific Data Products, call us at (619) 625-3671, FAX (619) 552-0889.



**PACIFIC DATA  
PRODUCTS**

\* PostScript SIMM is included with the MIO version of Pacific DirectNet only. Prices effective 9/1/93. Pacific Data Products, Inc., 9125 Hedco Rd., San Diego, CA 92121. In Europe, call (353) 61 47609. Pacific DirectNet is a trademark of Pacific Data Products, Inc. HP, JetDirect, LaserJet, PaintJet, DeskJet, and DesignJet are registered trademarks of Hewlett-Packard Co. Novell and NetWare are registered trademarks of Novell. UNIX is registered trademark of UNIX System Laboratories, Inc. PersonalPage is a registered trademark of Phoenix Technologies Ltd. All other brands and product names are trademarks or registered trademarks of their respective manufacturer. © 1994 Pacific Data Products, Inc.

# AVOID DELAYS GETTING TO WORK.



Don't waste precious time. Use Sony QD2120 formatted QIC-80 data cartridges. The perfect shortcut for your QIC-80

**ONLY  
ON  
SONY  
DATA MEDIA**



drive.\* Saving you up to two hours of formatting time for more productive pursuits.

Like backing up your critical data. To keep your PC system running on schedule, take the quick route. For more data, just call 201-476-8199. **SONY**

© 1993 Sony Electronics Inc. Sony and Only On Sony are trademarks of Sony. Reproduction in whole or in part without written permission is prohibited. All rights reserved. \*QIC-80 drives from Colorado Memory Systems, Corner Peripherals, Iomega, Summit Memory Systems and Wangtek

Circle 282 on Inquiry Card.

768 resolution, and 37 seconds in 1280 by 1024 resolution. The 16-bit (64,000 colors) drivers, however, are a masterpiece, displaying the same 24-bit DIB in only four-tenths of a second. The Renegade 1280 ISA was one of the few adapters that were faster using 64,000 colors than they were using 256 colors. The Renegade 1280 uses Appian's own accelerator technology.

A more polished, though somewhat slower, board is the ATI Graphics Ultra Pro EISA. Like the Renegade 1280 ISA, the Graphics Ultra Pro shines its brightest using 16-bit, direct color. The Graphics Ultra Pro could not match the Renegade 1280's overall speed, but it was significantly faster at Blt'ing (i.e., making raw pixel copies from memory to screen): 3.5 million pixels per second for the Graphics Ultra Pro, compared to 2.5 million pixels per second for the Renegade 1280. (An EISA version of the Renegade 1280 would probably be faster, however.)

Blt'ing performance is the all-important parameter for multimedia applications and image-editing applications. Considering ATI's advanced support for Video for Windows, the Graphics Ultra Pro looks like a natural for people with a special interest in multimedia. The Graphics Ultra Pro is based on ATI's own Mach 32 accelerator.

The main alternative to the QVision 1280/E for CAD/CAM applications is the Sigma WinMach 1600. The WinMach 1600 is our CAD/CAM choice for ISA systems, but it can't match the speed of the QVision 1280/E on EISA systems. (S3 has an improved driver in the works, but it was in beta at the time of our tests.) The WinMach 1600 offers the added enticement of hardware panning, a 1600-by-1200-pixel desktop, and a strong package of special imaging utilities.

## BYTE BEST

## EISA-BUS GRAPHICS ACCELERATORS

Need to speed business applications?

### GENERAL PURPOSE

#### Compaq QVision 1280/E



This accelerator was the equal of better-known designs and fast enough to be on a par with VL-Bus video accelerators. Like all non-VL-Bus boards, the QVision 1280/E has relatively poor pixel-copy speeds, but its speed in displaying text and complex graphics is among the fastest of any board.



	SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
						AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
<b>BEST</b> Compaq QVision 1280/E	0.641	▲▲▲	\$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP Paradise/W D Accelerator 24	0.733	▲▲	\$199	1 MB	WD90C31	✓	✓	✓	✓
RUNNER-UP Hercules Graphite Pro HG310	0.744	▲▲▲	\$399	1 MB	IIT AGX015	✓	✓	✓	✓
RUNNER-UP Volante Warp20-2	0.766	▲▲▲	\$499	1 MB	IIT AGX-14/15	✓	✓	✓	✓
RUNNER-UP ATI Graphics Ultra Pro EISA	0.859	▲▲▲	\$549	1.5 MB	ATI Mach 32	✓	✓	✓	✓

### EISA leaders in 64,000 colors

### DIRECT COLOR

#### Appian Renegade 1280 ISA



Although we tested the ISA version of the board here, the Renegade 1280 was 17 percent faster than the second-place ATI Graphics Ultra Pro EISA. The Renegade 1280 is not without warts: it is one of the few cards that requires a driver to be loaded during the DOS boot.

	SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
						AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
<b>BEST</b> Appian Renegade 1280 ISA	0.659	▲▲▲	\$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP ATI Graphics Ultra Pro EISA	0.769	▲▲▲	\$549	2 MB	ATI Mach 32	✓	✓	✓	✓
RUNNER-UP Compaq QVision 1280/E	0.859	▲▲▲	\$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP Nth Graphics Nth Edge 1280	0.787	▲▲▲	\$995	2 MB	Chips & Technologies 481	✓	✓	✓	✓
RUNNER-UP Sigma Designs WinMach 1600	0.832	▲▲▲	\$995	2 MB	S3 86C928	✓	✓	✓	✓

### Want the best for true-color work?

### DESKTOP PUBLISHING

#### SuperMac Spectrum/24 EISA



The Spectrum/24's 1152 by 910 resolution with 16.7 million colors makes a good match for programs such as QuarkXPress and Adobe Photoshop. The other boards ranked here offer credible performance.

	SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
						AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
<b>BEST</b> SuperMac Spectrum/24 EISA	1.058	▲▲	\$999	3 MB	Proprietary			✓	
RUNNER-UP Raster Ops PaintBoard PC	1.963	▲▲▲	\$999	3 MB	S3 86C924	✓		✓	
RUNNER-UP Number Nine #9GXE	2.700	▲▲▲	\$895	4 MB	S3 86C928		✓	✓	

### For high resolution and speed...

### CAD/CAM

#### Compaq QVision 1280/E



The 1280/E's performance puts it in the league of VL-Bus graphics adapters, but its main drawback is the 2-MB maximum VRAM, which limits resolution compared to the more expensive 3- and 4-MB boards.

	SPEED (SECONDS)	EASE OF USE	PRICE AS TESTED	RAM AS TESTED	ACCELERATOR CONTROLLER	STANDARD DRIVERS			
						AUTOCAD	OS/2	WINDOWS 3.1	UNIX*
<b>BEST</b> Compaq QVision 1280/E	0.687	▲▲▲	\$599	2 MB	Proprietary	✓	✓	✓	✓
RUNNER-UP Sigma Designs WinMach 1600	0.808	▲▲▲	\$995	2 MB	S3 86C928	✓	✓	✓	✓
RUNNER-UP Pixelworks WhirlWin-II	0.815	▲▲▲	\$895	2 MB	S3 86C928	✓	✓	✓	✓
RUNNER-UP Appian Renegade 1280 ISA	0.886	▲▲▲	\$490	2 MB	Appian AGC98032	✓	✓	✓	✓
RUNNER-UP ATI Graphics Ultra Pro EISA	0.948	▲▲▲	\$549	2 MB	ATI Mach 32	✓	✓	✓	✓

\*SCO Open Systems' version of the X Window System.

#### KEY

#### Ease of Use:

Excellent ▲▲▲▲ Fair ▲▲  
Good ▲▲▲ Poor ▲

# HONORABLE MENTIONS



**The Colorgraphic Twin Turbo gives not one,** but two accelerated displays. Two VGA connections support two monitors: The Windows driver stretches the desktop across both monitors so that windows can be dragged seamlessly from one monitor to the next as if you had one big monitor.

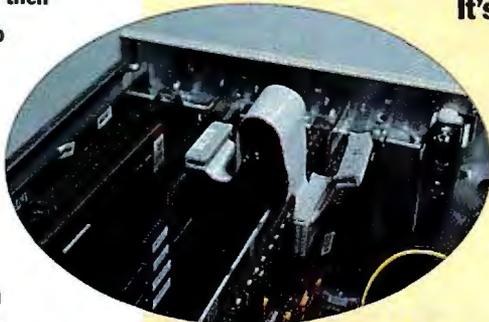
**There's a variety of ways** to tell your software how fast your monitor can be refreshed, but the best we've seen is the mode-selection utility that's shipped with the Elsa Winner adapters. The Winner 1000VL

board lets you choose the refresh rate via a Windows

control panel and then conducts a test to make sure your choice will work.

An incorrect setting causes the screen to flash for a few seconds and then

revert to the previous setting, allowing you to try another selection. Other products force you to restart Windows, making it difficult to reset your video settings using the control panel if you've made an incorrect selection.



**Hercules excels at the little touches** that differentiate its products from similarly priced and performing competitors. One of the company's latest innovations is a utility that determines the maximum refresh rate of your monitor. Setting your video adapter to use a vertical refresh rate higher than what the monitor can accept can cause physical damage to the monitor. Users can easily configure the Hercules boards for the best picture.

**The Appian Renegade 1280 offers top-notch Windows performance and, as an added bonus for software developers, can run two-screen "hard-mode" Windows debuggers such as MultiScope, SoftIce/W, and Turbo Debugger. Just hook any VGA monitor to the VGA port and connect your 17- or 21-inch**



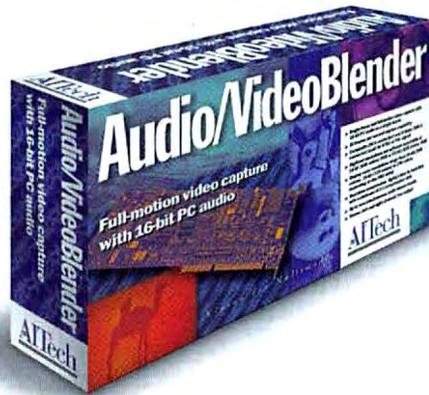
**monitor to the Renegade 1280's unique IGC port: Your debugger appears on the VGA screen while Windows gets the high-resolution screen.**

## Dubious Achievements

**It's annoying to find** that some display adapters for the PC market do not integrate VGA support, but the SuperMac Spectrum/24 adapters and the Nth Edge 1280 all require you to purchase a separate VGA adapter with a feature connector and connect the two adapters via a pass-through cable. This is no fun to install, and the VGA card takes up its own slot.

**The Appian Renegade 1280** adapters are among the few that actually require you to read the manual to install them. The back plate of each Renegade 1280 card has two connectors, labeled "VGA" and "IGC." Connecting the monitor to the VGA connector allows the machine to boot and run in VGA mode, but the monitor goes totally black when you start Windows. To use both DOS and Windows, you must connect the monitor to the IGC connector instead (the manual sheds no light on the meaning of *IGC*). Once you're able to get the board up and running, however, we find the IGC connector to be of great value (see Honorable Mentions).

# Introducing Audio/VideoBlender...



## twice the blast, half the slots.

Now, for the first time, you can get single-frame and full-motion video capture with 16-bit audio on a single board!

AI Tech's new Audio/VideoBlender provides this double blast in one. Receive the same high-quality sound of the leading audio board. Plus full-motion video capture. All on one board!

Audio/VideoBlender eliminates the need for a separate audio card for capturing, digitizing and playing back video and sound. Saving an expansion slot. And, the additional cost of purchasing individual video and audio boards.

With one integrated audio/video board, compatibility issues also decrease. Spend time on producing videos rather than configuring audio and video boards.

So, with Audio/VideoBlender, create

and edit videos for business and home presentations with not only full-motion video, but 16-bit PC audio. Display color resolutions of 16-bit (64K) colors, 15-bit (32K) colors or 256 colors are available. Plus, connectors for NTSC or PAL signals. Conversion from the AI Tech format to various video capture formats including Microsoft AVI and Intel Indeo is also provided.

For increased sound impact, Audio/VideoBlender offers 16-bit digital recording with stereo line-in and microphone input. Up to two simultaneous audio source inputs with software selection control for microphone input or audio line-in are also available.

If audio functions aren't a requirement, AI Tech offers the VideoBlender. All the

features of the Audio/VideoBlender are offered except built-in audio.

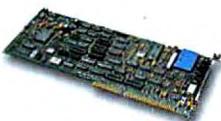
AI Tech can assist you with other desktop video needs too. We offer a complete line of fully compatible DTV products, including integrated audio/video output, compression and genlock/overlay products, and audio/video encoders.

For a double blast in one, or information on our other products, contact your local dealer or call us at 1-800-882-8184 or 1-510-226-8960, or fax 1-510-226-8996.

AI Tech International, 47971 Fremont Blvd.,  
Fremont, CA 94538

# AI Tech

Audio/VideoBlender



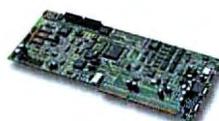
VideoSurge



WaveWatcherTV



audioSHOW



gamePlayerTV



ProPC/TV Plus



V i s i o n   f o r   M u l t i m e d i a

© AI Tech International, 1993. Audio/VideoBlender, VideoBlender, VideoSurge, WaveWatcherTV, audioSHOW, gamePlayerTV and ProPC/TV Plus are trademarks of AI Tech International. All other trademarks are the property of their respective holders. Specifications are subject to change without notice.

Circle 66 on Inquiry Card.

# ROLL CALL OF ACCELERATORS

VL-BUS

IMAGE-RENDERING TIME (AVERAGE, IN SECONDS)<sup>1</sup>

VENDOR	MODEL	1024x768;	1024x768;	1024x768;	1280x1024;	PRICE (WITH RAM AS TESTED)	RAM AS TESTED (MB)	BASE RAM (MB)	MAXIMUM RAM	RAM TYPE (MB)
		256 COLORS	64,000 COLORS	16 MILLION COLORS	256 COLORS					
Actix Systems, Inc.	Graphics Engine 32i VL	0.707	0.767	—	0.812	\$319	2	2	2	DRAM
Actix Systems, Inc.	ProStar VL	0.958	—	—	—	\$179	1	1	2	DRAM
Actix Systems, Inc.	Ultra VL plus/2MB	0.720	—	—	—	\$495	2	2	2	VRAM
Advanced Integration Research	AView2V	0.917	1.010	—	1.165	\$250	2	1	2	DRAM
Alaris, Inc.	Tomahawk	0.947	—	—	—	\$139	1	1	1	VRAM
American Megatrends, Inc.	Fastview VLB	0.601	0.888	—	0.952	\$385	2.5	1.5	2.5	VRAM/D
Applan Technology	Renegade 1280 VL Pro	0.708	0.650	—	0.821	\$490	2	2	2	VRAM
ATI Technologies, Inc.	Graphics Ultra Pro VLB	0.785	0.780	—	1.004	\$499	2	2	2	VRAM
Boca Research, Inc.	Vortek VRAM Local Bus	0.739	0.931	—	0.910	\$625	2	1	2	VRAM
Cardinal Technologies	VideoSpectrum VL	0.957	—	—	—	\$199	1	1	2	DRAM
Cardinal Technologies	WarpSpeed VL90/2MB	0.749	0.903	—	0.947	\$599	2.5	1.5	2.5	VRAM/D
Diamond Computer Systems, Inc.	SpeedStar Pro VLB	0.958	—	—	—	\$179	1	1	1	DRAM
Diamond Computer Systems, Inc.	Stealth Pro VLB	0.799	0.918	—	—	\$449	2	1	2	VRAM
Diamond Computer Systems, Inc.	Viper VLB	0.667	0.880	—	0.827	\$499	2	2	2	VRAM
Elsa, Inc.	Winner 1000 VL	0.958	—	—	1.176	\$449	2	1	2	VRAM
Focus Information Systems, Inc.	Cheetah XL 5428	0.955	—	—	—	\$179	2	1	2	DRAM
Focus Information Systems, Inc.	Truespeed/W32	0.698	—	—	—	\$169	1	1	1	DRAM
Focus Information Systems, Inc.	Truespeed/W32i	0.695	—	—	—	\$229	1	1	2	DRAM
Genoa Systems Corp.	VideoBlitz	0.759	0.886	—	0.959	\$549	2	2	2	VRAM
Genoa Systems Corp.	WindowsVGA 24 Turbo 8500 VL-28	0.953	—	—	—	\$229	1	1	2	DRAM
<b>Hercules Computer Technology</b>	<b>Dynamite VL Pro D602</b>	<b>0.687</b>	—	—	—	<b>\$299</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>DRAM</b>
Hercules Computer Technology	Graphite VL Pro HG720	0.683	0.775	—	0.852	\$549	2	2	2	VRAM
Matrox Electronic Systems	MGA Impression/3/V	0.721	0.701	0.779	0.795	\$1299	3	3	3	VRAM
Matrox Electronic Systems	MGA Impression/3/V/H	0.768	0.707	0.770	0.811	\$1499	3	3	3	VRAM
Media Vision	Pro Graphics 1280	—	—	0.839	—	\$995	4	4	4	VRAM
Nth Graphics, Ltd.	Nth S3 Advantage/VL	0.983	—	—	—	\$695	1	1	2	DRAM
Orchid Technology	Celsius VLB	0.908	—	—	—	\$349	1	1	2	VRAM
Orchid Technology	Fahrenheit VA/VLB	1.068	—	—	—	\$349	1	1	2	DRAM
Paradise/Western Digital	Accelerator VL Plus	0.752	—	—	—	\$299	1	1	2	DRAM
Sigma Designs, Inc.	Concorde VLB	0.700	—	—	—	\$349	1	1	2	DRAM
SixGraph Computing, Ltd.	Wizard 9000VL	0.758	0.889	—	0.963	\$550	2	2	2	VRAM
STB Systems, Inc.	Horizon VL	0.991	—	—	—	\$159	1	1	1	DRAM
STB Systems, Inc.	Pegasus VL	0.828	0.957	1.015	1.004	\$849	4	4	4	VRAM
STB Systems, Inc.	PowerGraph VL24	0.830	—	—	—	\$199	1	1	1	DRAM
SuperMac Technology	Spectrum/24 VL for Windows	—	—	0.798	—	\$999	3	3	3	VRAM
Volante, Inc.	Warp10LB	0.975	—	—	—	\$399	1	1	2	DRAM

ISA

Applan Technology	Renegade 1280 ISA	0.788	0.659	—	0.886	\$490	2	2	2	VRAM
ATI Technologies, Inc.	Graphics Ultra Pro ISA	0.781	0.803	—	0.967	\$499	2	2	2	VRAM
Boca Research, Inc.	SuperX Accelerator VGA	1.087	—	—	—	\$219	1	1	2	DRAM
Boca Research, Inc.	Vortek VRAM Accelerator	0.923	—	—	—	\$595	1	1	2	VRAM
Cardinal Technologies	VideoSpectrum XL	0.945	—	—	—	\$149	1	1	1	DRAM
Colorgraphic Communications	Twin Turbo Accelerator	1.235	—	—	1.616	\$1195	2	1	2	VRAM
Compaq Computer Corp.	QVision 1280/I	0.721	0.840	—	0.857	\$599	2	2	2	VRAM
Hercules Computer Technology	Graphite Pro HG310	0.744	—	—	—	\$399	1	1	2	VRAM
Nth Graphics, Ltd.	Nth Edge 1280	0.909	0.787	—	1.145	\$995	2	2	2	VRAM
Number Nine Computer Corp.	#9GXE	—	1.093	2.700	—	\$895	4	4	4	VRAM
Orchid Technology	Fahrenheit VA	1.169	—	—	—	\$269	1	1	1	DRAM
<b>Paradise/Western Digital</b>	<b>Accelerator 24</b>	<b>0.733</b>	—	—	—	<b>\$199</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>DRAM</b>
Paradise/Western Digital	Paradise Accelerator Pro	0.832	—	—	—	\$349	1	1	2	VRAM
Pixelworks, Inc.	WhirlWin/Lite	1.560	—	—	—	\$450	1	1	1	VRAM
Pixelworks, Inc.	WhirlWin 1280-VGA	—	—	—	2.090	\$1695	2	2	2	VRAM
Pixelworks, Inc.	WhirlWin-II	0.807	—	—	0.815	\$895	2	2	2	VRAM
Raster Ops Corp.	PaintBoard PC	—	—	1.963	—	\$999	3	3	3	VRAM
Sigma Designs, Inc.	WinMach 1600	0.705	0.832	—	0.808	\$995	2	2	2	VRAM
SixGraph Computing, Ltd.	Wizard 924	1.214	—	—	—	\$170	1	1	1	VRAM
STB Systems, Inc.	Horizon VGA	1.016	—	—	—	\$159	1	1	1	DRAM
STB Systems, Inc.	PowerGraph X-24	0.865	—	—	—	\$199	1	1	1	DRAM
SuperMac Technology	Spectrum/24 ISA for Windows	—	—	1.288	—	\$999	3	3	3	VRAM
Volante, Inc.	Warp10+	1.128	—	—	—	\$299	1	1	1	DRAM
Volante, Inc.	Warp20-2	0.766	—	—	—	\$499	1	1	2	VRAM

EISA

American Megatrends, Inc.	Fastview EISA	1.341	—	—	—	\$375	1.5	1.5	2.5	VRAM/D
ATI Technologies, Inc.	Graphics Ultra Pro EISA	0.859	0.769	—	0.948	\$549	2	2	2	VRAM
Compaq Computer Corp.	QVision 1024/E	0.835	1.506	—	—	\$509	1	1	2	VRAM
<b>Compaq Computer Corp.</b>	<b>QVision 1280/E</b>	<b>0.841</b>	<b>0.859</b>	—	<b>0.687</b>	<b>\$599</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>VRAM</b>
Elsa, Inc.	Winner 1000 EISA/ISA*	0.996	—	—	1.266	\$449	2	1	2	VRAM
SuperMac Technology	Spectrum/24 EISA for Windows	—	—	1.058	—	\$999	3	3	3	VRAM

NUBUS

VENDOR	MODEL	1024x768;	1024x768;	1152x870;	1280x1024;	PRICE (WITH RAM AS TESTED)	RAM AS TESTED (MB)	BASE RAM (MB)	MAXIMUM RAM	RAM TYPE (MB)
		256 COLORS	64,000 COLORS	16 MILLION COLORS	256 COLORS					
Radius, Inc.	PrecisionColor 24X	—	—	1.473	—	\$2499	3	3	3	VRAM
<b>Radius, Inc.</b>	<b>PrecisionColor Pro</b>	—	—	<b>1.349</b>	—	<b>\$2499</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>VRAM</b>
Raster Ops Corp.	PaintBoard Turbo XL	—	—	1.858	—	\$1749	3	3	3	VRAM
SuperMac Technology	Spectrum/24 PDQ Plus	—	—	1.464	—	\$1499	3	3	3	VRAM
SuperMac Technology	Spectrum/24 Series IV	—	—	1.450*	—	\$949	3	3	3	VRAM
SuperMac Technology	Thunder II	—	—	1.400	—	\$3999	6	6	6	VRAM
SuperMac Technology	Thunder II Light	—	—	1.444	—	\$2999	3	3	3	VRAM
SuperMac Technology	Thunder/24	—	—	1.421	—	\$2599	3	3	3	VRAM
SuperMac Technology	ThunderStorm Pro	—	—	1.422	—	\$3199	3	3	3	VRAM
SuperMac Technology/E-Machines	Ultara LX	—	—	1.430	—	\$1299	3	3	3	VRAM

\* = BYTE Best. ✓ = yes. \*Dashes indicate unsupported modes. \*Blanks indicate modes not supported as noninterlaced.

# TESTED

ACCELERATOR CONTROLLER	MAXIMUM RESOLUTION (NONINTERLACED) <sup>1</sup>			STANDARD DRIVERS					TOLL-FREE PHONE	PHONE	INQUIRY NO.
	256 COLORS	64,000 COLORS	16 MILLION COLORS	AUTOCAD	IBM OS/2	WINDOWS 3.1	WINDOWS NT	UNIX <sup>2</sup>			
S3 86C805i	1280x1024	1024x768	640x480	✓	✓	✓			(800) 927-5557	(408) 986-1625	1346
Cirrus Logic GD5428	1024x768	800x600	640x480	✓		✓	✓		(800) 927-5557	(408) 986-1625	1347
S3 86C928	1280x1024	1024x768	640x480	✓	✓	✓		✓	(800) 927-5557	(408) 986-1625	1348
S3 86C805	1024x768	800x600	640x480	✓	✓	✓		✓	(800) 866-1945	(408) 428-0800	1349
Cirrus Logic GD5426	1024x768	800x600	640x480	✓	✓	✓		✓	N/A	(510) 770-5700	1350
Weitek Power 9000	1280x1024	1024x768	800x600	✓	✓	✓			(800) 828-9264	(404) 263-8181	1351
Appian AGC98032	1280x1024	1024x768	640x480	✓	✓	✓		✓	(800) 727-7426	(408) 730-8800	1352
ATI Mach 32	1280x1024	1024x768	800x600	✓	✓	✓		✓	N/A	(905) 882-2600	1353
IIT AGX015	1280x1024	1024x768	800x600	✓	✓	✓			N/A	(407) 997-6227	1354
Cirrus Logic GD5428	1024x768	800x600	640x480	✓	✓	✓			N/A	(717) 293-3000	1355
Weitek Power 9000	1280x1024	1024x768	800x600	✓	✓	✓			N/A	(717) 293-3000	1356
Cirrus Logic GD5428	1024x768	800x600	640x480	✓	✓	✓		✓	N/A	(408) 736-2000	1357
S3 86C928	1280x1024	1024x768	800x600	✓	✓	✓		✓	N/A	(408) 736-2000	1358
Weitek Power 9000	1280x1024	1024x768	800x600	✓	✓	✓		✓	N/A	(408) 736-2000	1359
S3 86C928	1280x1024	1024x768	640x480	✓	✓	✓			(800) 272-3572	(415) 615-7799	1360
Cirrus Logic GD5428	1024x768	800x800	640x480	✓	✓	✓			(800) 925-2378	(510) 657-2845	1361
Tseng Labs ET4000/W32	1024x768	800x600	640x480	✓	✓	✓			(800) 925-2378	(510) 657-2845	1362
Tseng Labs ET4000/W32i	1024x768	1024x768	800x600	✓	✓	✓			(800) 925-2378	(510) 657-2845	1363
Weitek Power 9000	1280x1024	1024x768	800x600	✓	✓	✓		✓	(800) 934-3662	(408) 432-9090	1364
Cirrus Logic CL5428	1024x768	800x600	640x480	✓	✓	✓			(800) 934-3662	(408) 432-9090	1365
<b>Tseng Labs ET4000/W32i</b>	<b>1024x768</b>	<b>1024x768</b>	<b>640x480</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>(800) 532-0600</b>	<b>(510) 623-6030</b>	<b>1366</b>
IIT AGX015	1280x1024	1024x768	800x600	✓	✓	✓			(800) 532-0600	(510) 623-6030	1367
Matrox MGA	1280x1024	1152x870	800x600	✓	✓	✓		✓	N/A	(514) 685-2630	1368
Matrox MGA	1600x1200	1152x870	800x600	✓	✓	✓		✓	N/A	(514) 685-2630	1369
Media Vision MVV451			1280x1024	✓	✓	✓			(800) 348-7116	(510) 770-8600	1370
S3 86C805	1024x768	800x600	640x480	✓	✓	✓			(800) 624-7552	(512) 832-1944	1371
IIT AGX015	1280x1024	1024x768	800x600	✓	✓	✓			(800) 767-2443	(510) 683-0300	1372
S3 86C805c	1024x768	800x600	640x480	✓	✓	✓			(800) 767-2443	(510) 683-0300	1373
WD90C33	1024x768	800x600	640x480	✓	✓	✓			(800) 832-4778	(714) 932-5000	1374
Tseng Labs ET4000/W32i	1024x768	800x600	640x480	✓	✓	✓			(800) 845-8086	(510) 770-0100	1375
Weitek Power 9000	1280x1024	1024x768	800x600	✓	✓	✓		✓	N/A	(514) 332-1331	1376
Cirrus Logic GD5426	1024x768	800x600	640x480	✓	✓	✓			(800) 234-4334	(214) 234-8750	1377
S3 86C928	1600x1200	1280x1024	1024x768	✓	✓	✓			(800) 234-4334	(214) 234-8750	1378
S3 86C805	1024x768	800x600	640x480	✓	✓	✓			(800) 234-4334	(214) 234-8750	1379
Proprietary			1152x870	✓	✓	✓			(800) 334-3005	(408) 541-6100	1380
S3 86C805	1024x768	800x600	640x480	✓	✓	✓			(800) 253-8831	(512) 329-5055	1381
Appian AGC98032	1280x1024	1024x768	640x480	✓	✓	✓		✓	(800) 727-7426	(408) 730-8800	1382
ATI Mach 32	1280x1024	1024x768	800x600	✓	✓	✓		✓	N/A	(905) 882-2600	1383
Cirrus Logic GD5428	1024x768	800x600	640x480	✓	✓	✓			N/A	(407) 997-6227	1384
IIT AGX014	1024x768	800x600	640x480	✓	✓	✓			N/A	(407) 997-6227	1385
Cirrus Logic GD5426	1024x768	800x600	640x480	✓	✓	✓			N/A	(717) 293-3000	1386
S3 86C928	1280x1024	800x600	640x480	✓	✓	✓			N/A	(404) 455-3921	1387
Proprietary	1280x1024	1024x768	640x480	✓	✓	✓		✓	(800) 845-1518	(713) 378-8820	1388
IIT AGX015	1280x1024	1024x768	800x600	✓	✓	✓			(800) 532-0600	(510) 623-6030	1389
Chips & Technologies 481	1280x1024	1024x768	640x480	✓	✓	✓		✓	(800) 624-7552	(512) 832-1944	1390
S3 86C928	1600x1200	1280x1024	1024x768	✓	✓	✓			(800) 438-6463	(617) 674-0009	1391
S3 86C801	1024x768	800x600	640x480	✓	✓	✓		✓	(800) 767-2443	(510) 683-0300	1392
<b>WD90C31</b>	<b>1024x768</b>	<b>800x600</b>	<b>640x480</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>(800) 832-4778</b>	<b>(714) 932-5000</b>	<b>1393</b>
IIT AGX014	1280x1024	1024x768	800x600	✓	✓	✓			(800) 832-4778	(714) 932-5000	1394
S3 86C924	1024x768	640x480		✓	✓	✓		✓	(800) 247-2476	(603) 880-1322	1395
Chips & Technologies 481	1280x1024			✓	✓	✓			(800) 247-2476	(603) 880-1322	1396
S3 86C928	1280x1024	640x480		✓	✓	✓		✓	(800) 247-2476	(603) 880-1322	1397
S3 86C924			1024x768	✓	✓	✓			(800) 729-2656	(408) 562-4200	1398
S3 86C928	1600x1200	1024x768	800x600	✓	✓	✓		✓	(800) 845-8086	(510) 770-0100	1399
S3 86C924	1024x768	640x480	640x480	✓	✓	✓		✓	N/A	(514) 332-1331	1400
Cirrus Logic GD5426	1024x768	800x600	640x480	✓	✓	✓			(800) 234-4334	(214) 234-8750	1401
S3 86C801	1024x768	800x600	640x480	✓	✓	✓			(800) 234-4334	(214) 234-8750	1402
Proprietary			1152x870	✓	✓	✓			(800) 334-3005	(408) 541-6100	1403
S3 86C801	1024x768	800x600	640x480	✓	✓	✓		✓	(800) 253-8831	(512) 329-5055	1404
IIT AGX-14	1280x1024	800x600	800x600	✓	✓	✓			(800) 253-8831	(512) 329-5055	1405
Weitek Power 9000	1280x1024	1024x768	800x600	✓	✓	✓			(800) 828-9264	(404) 263-8181	1406
ATI Mach 32	1280x1024	1024x768	800x600	✓	✓	✓		✓	N/A	(905) 882-2600	1407
Proprietary	1024x768	1024x768	640x480	✓	✓	✓		✓	(800) 845-1518	(713) 378-8820	1408
<b>Proprietary</b>	<b>1280x1024</b>	<b>1024x768</b>	<b>640x480</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>✓</b>	<b>(800) 845-1518</b>	<b>(713) 378-8820</b>	<b>1409</b>
S3 86C928	1280x1024	1024x768	640x480	✓	✓	✓			(800) 272-3572	(415) 615-7799	1410
Proprietary			1152x870	✓	✓	✓			(800) 334-3005	(408) 541-6100	1411
Radius Custom	—	—	1152x870	N/A	N/A	N/A	N/A	N/A	(800) 227-2795	(408) 434-1010	1412
<b>Radius Custom</b>	<b>—</b>	<b>—</b>	<b>1152x870</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>(800) 227-2795</b>	<b>(408) 434-1010</b>	<b>1413</b>
Proprietary	—	—	1152x870	N/A	N/A	N/A	N/A	N/A	(800) 729-2656	(408) 562-4200	1414
Proprietary	—	—	1152x870	N/A	N/A	N/A	N/A	N/A	(800) 334-3005	(408) 541-6100	1415
Proprietary	—	—	1024x768	N/A	N/A	N/A	N/A	N/A	(800) 334-3005	(408) 541-6100	1416
Proprietary	—	—	1380x1024	N/A	N/A	N/A	N/A	N/A	(800) 334-3005	(408) 541-6100	1417
Proprietary	—	—	1152x870	N/A	N/A	N/A	N/A	N/A	(800) 334-3005	(408) 541-6100	1418
Proprietary	—	—	1152x870	N/A	N/A	N/A	N/A	N/A	(800) 334-3005	(408) 541-6100	1419
Proprietary	—	—	1152x870	N/A	N/A	N/A	N/A	N/A	(800) 334-3005	(408) 541-6100	1420
Proprietary	—	—	—	N/A	N/A	N/A	N/A	N/A	(800) 334-3005	(408) 541-6100	1105

<sup>1</sup>SCO Open Systems' version of the X Window System.

<sup>2</sup>Supports EISA and ISA.

<sup>3</sup>Supports 1024x768 resolution at 16 million colors.

N/A = not applicable.

# INTRODUCING CodeBase++™ 5.0

## Now C++ programmers can discover the DBMS power of dBASE, FoxPro & Clipper.



Not only is the new **CodeBase++ 5.0** 100% compatible with the data, index

and memo files of dBASE®, FoxPro® and Clipper®, you also get all the important benefits of programming in C++.

### You get C++ speed and size.

Most developers are familiar with the amazing speed and compact size of C and C++ programs. Now harness this speed for your own database programs. Compare the performance with those "executables" of dBASE, FoxPro, Clipper (which contain imbedded interpreters) to those of similar C and C++ programs. Also, be sure to compare the size of their EXE's to those created with **CodeBase++** (which are as small as 45K!).

### You get object oriented programs.

**CodeBase++ 5.0** is a C++ class library for database management. Now you can experience the object oriented productivity gains of C++, together with the power of a complete DBMS.

### You get multi-user sharing with dBASE, FoxPro and Clipper.

Now your multi-user C++ programs can share data, index and memo files at the same time as concurrently running FoxPro, Clipper and dBASE programs. Turbo-charge critical xBase applications sharing data on a network with C++ and **CodeBase++** with no incompatibilities.

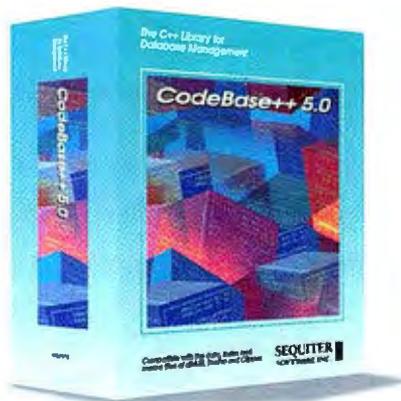
### NEW-You get xBase queries and relations with instant results.

We've added Bit Optimization Query Technology to **CodeBase++** for stunning query performance (**BOT** is similar to FoxPro's Rushmore). Our product analyzes your queries using index information, so a record is only actually retrieved when it belongs in your query solution set.

With **CodeBase++** you can literally query a huge 500,000 record data file in less than a second on a 25MHz 80386!

### You get C++ portability.

As with C, ANSI C++ is an international standard across all hardware platforms. This means you can port **CodeBase++** applications between DOS, Windows, NT, OS/2, Unix, and Macintosh—today.

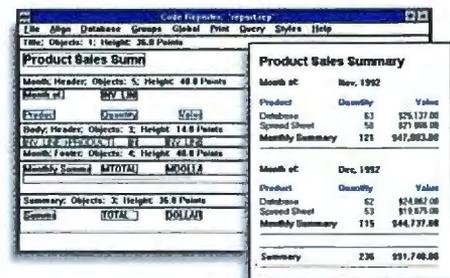


The new CodeBase++ is your best C++ solution for xBase file access and database management.

TRY OUR  
C, BASIC AND PASCAL  
VERSIONS!

### NEW - You get code generation.

Save hours of coding time with our automatic source code generation, containing all of the specialized class definitions needed to support your data structures.



Using our visual report writer is easy, simply draw your report, then include it in any program you write.

### PLUS-You get CodeReporter FREE!

Our visual report writer, **CodeReporter**, uses the speed of **BOT** to run reports lightning fast. To test this amazing performance yourself, call: 403/437-2410 for your free working model.

**CodeBase++™ 5.0**  
The C++ Class Library for Database Management

**Call Now**  
**403-437-2410**



FREE  
CodeReporter

Risk-Free  
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

# Genetic Programming with C++

**Mutating computer programs can evolve superior methods for solving loosely defined problems**



**ANDY SINGLETON**

Could a computer create better software than you could? Could 100,000 computers do the job? Can any purely mechanical process match the creative power of the human mind? Consider natural evolution. You may design a better mousetrap, but evolution, by the simple mechanical process of blind trial and error, can design a cat.

This is the challenge of genetic programming (GP for short)—to evolve a solution that is as elegant and sophisticated as a cat on the hunt. With an improved understanding of evolution and with the power of massively parallel computers, this goal is in sight. In this article I describe GPQUICK, a simple GP system in C++.

GP is one application of an important new technology known as *genetic algorithms* (or GAs). GAs can evolve a variety of computer-based objects and solutions. They are used for optimization—producing a better route map, a more efficient manufacturing schedule, or a more cost-effective alloy mixture. They can be used for interactive evolution: teamwork between a person and a machine to design pictures, buildings, or machines. And they can provide a superior method of computer learning for speech, vision, financial trading, fault detection, and so on.

## How Does a GA Work?

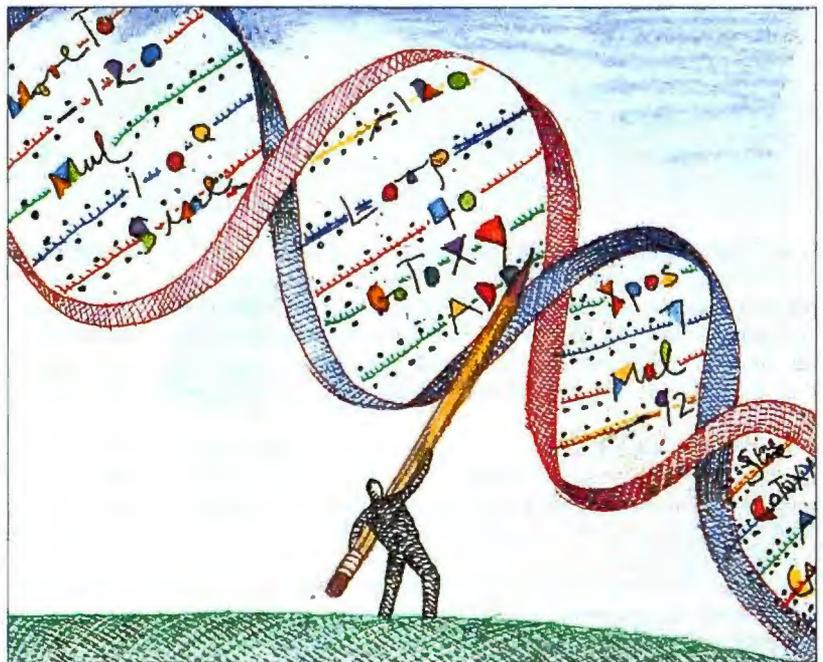
A GA is a simple tactic for computer learning that is inspired by natural evolution. The computer produces a whole population. It then picks the best “individuals” and changes them, producing a new population of variations on the best individuals, with the hope that some of the new individuals will be even better. If this simple process is carried on for many generations, the results can be impressive.

A GA is simple; it is just a form of trial and error, with two elements making it more effective. The first is that it tries out variations of only the best individuals, making it more likely to be trying something good. The second is that it builds a good solution piecewise. It uses crossover (or mating) to combine the good parts of one individual with the good parts of another.

A genetic algorithm consists of three operations: *evaluation*, *selection*, and *reproduction*. Evaluation is the process of assigning a fitness score so you can find the

best individuals. You need to make a fitness function that scores the output from each individual. Next, you select the individuals to be used as parents for the next generation. An automated GA usually picks the individuals with the highest fitness scores. Last, you reproduce those parents with genetic operations to generate new and possibly better individuals in the next generation.

The two main classes of genetic operations are *mutation* and *crossover*. Mutation operates on a single parent by randomly changing some part of it. For instance, a 1 might be changed to a 0, a number might be changed to another number, or a function might be changed to a different function. This operation is analogous to mutation of genes, in which the code for one amino acid changes to the code for a different amino acid. Crossover acts by combining parts of two parents. It is analogous to mating in biological organisms.



ALAN E. COBER © 1994

## How Can a GA Be Used for Programming?

If you can define selection, mutation, and crossover operators, you can use a GA to generate almost anything. GP is simply the application of a GA to generate computer programs. Numerous computer languages or representations have been tried, with varying degrees of success.

In 1975, John Holland, the inventor of GAs, proposed a form of GP known as a *classifier system*. Classifiers are IF... THEN rules, such as “If you fall down, then cover

# Hands On Some Assembly Required

## CHROME AND FUNCTION CLASSES

CLASS	IMPORTANT DATA STRUCTURES	IMPORTANT MEMBER FUNCTIONS
Chrome	<pre>// Stack (Instruction) pointer int ip;  // Actual GP code node *expr;  // Fitness on last eval float lastfitness;  // Array of pointers to Functions from // the current Problem Function** funclist;  // Initialization and evaluation // parameters ChromeParams* params;</pre>	<pre>// Initialize a new chrome with random // *ramped half and half* expression. Chrome(ChromeParams* p, CFitness* cf,        Function** f, retval* c);  // Eval the expression at ip. retval eval() {     ip++;     return funclist[FUNCNUM(stack[ip])]-&gt;eval(this); };  // Eval the whole expression. retval evalAll();  // Cross with mate and return a new chrome. Chrome* CrossTree(Chrome* mate); // Mutate self. void Mutate();  // Write the expression to a stream. void write(int pretty, ostream&amp; ofile = cout); // Read and parse an expression int Load(istream&amp; istr);</pre>
Function	<pre>// Written name char name[30];  // Number of arguments. Used to initialize // and traverse arguments. int argnum;  // Number of variables in variable table // of op code. Used to initialize node.idx. int varnum;  // Selection frequency relative to other // functions. Used in initialization, mutation. int weight;  // Pointer to evaluation code. Not a virtual // for speed reasons. EVALFUNC evalfunc;</pre>	<pre>// Active ingredient retval eval(class Chrome* st) {     return (evalfunc)(st); };</pre>

your face." These rules can be represented as strings of 1s and 0s. For instance, a bit could represent whether you (1) are or (0) are not falling down, and another bit could represent whether or not you should cover your face. A GA can evolve these strings by testing them for effectiveness under a variety of circumstances and then reproducing the most effective ones with mutation and crossover.

In 1985, Nicheal Kramer proposed evolving computer program code directly and demonstrated the evolution of simple arithmetic expressions. He also proposed a tree representation with the special form of crossover used in GPQUICK.

John Koza demonstrated the evolution of Lisp expressions that are actually computer programs in 1987. He started using the term *genetic programming* to describe this process. In 1989 he applied for a patent on the use of GP for evolving a wide variety of applications. Like many software patents, it is controversial. Koza has written a book called *Genetic Programming: On the Programming of Computers by Means of Natural Selection & Genetics* (MIT Press, 1992) that details numerous GP experiments and provides practical advice.

*S-expressions*, more commonly known as Lisp expressions, have become the mainstream GP representation. Researchers are investigating other GP representations, including object structures, direct evolution of machine code, and the design of processors and machine languages that would be amenable to GP.

### S-Expressions Make You Lisp

The form of GP that Koza described and GPQUICK uses generates S-expressions. An S-expression consists of a function followed by zero or more arguments. Each argument is in turn also an S-expression. You can represent "2+2" as (ADD 2 2), and "2+3\*5/2" as (ADD 2 (MULTIPLY 3 (DIVIDE 5 2))).

A function in an expression is called a *node*. Functions with no arguments, such as numeric constants, are called *terminals*. All functions return some value. Functions can also perform actions, otherwise known as *side effects*. You could have functions like (TURN\_RIGHT), (TURN\_RIGHT number\_of\_degrees), and so on, which give S-expressions procedural abilities.

The PROG function can string actions together into a procedural program, such as (PROG GO\_FORWARD GO\_FORWARD TURN\_RIGHT). If you add conditionals such as (IF condition do\_this otherwise\_do\_that), looping constructs such as (WHILE condition do\_this) or (FOR count do\_this), and a memory array with (SET element value) and (GET element), you have a Turing complete programming language that can represent any structured program.

### Achieving Closure

To do GP, you chop a piece off one program and stick it together with a piece of another program, on the off chance that something good may result. If you tried this with one of your C++



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](mailto:sales@age.com)



## Hands On Some Assembly Required

programs, you'd have approximately a 0 percent chance of creating a working program. With S-expressions, though, you can rig the game so that you have a much higher probability of success.

You design your functions so that they all return the same argument type, usually a floating-point number, and they all accept arguments of this type. This situation is called *closure*. Now you can use any expression as an argument for any other expression. You can swap a subexpression from one program for a subexpression in another program and always end up with a syntactically valid program. It might be completely useless, but it will never send smoke billowing out from under the CPU.

### Crossover

GPQUICK uses subtree crossover. First you select two parents. Then you pick a node, any node, from the first parent. This node is, by definition, the beginning of some complete subexpression. If you wrote the expression out as a parse tree, the subexpression would be a branch or subtree. You extract this, leaving a hole in the program. You then pick a node in the second parent, extract the following subexpression, and swap it with the first subexpression.

For example, I could cross (ADD 2 (MULTIPLY 3 (DIVIDE 5 2))) with (ADD (MULTIPLY 7 11) 23). In the first parent, I pick the fourth node, 3. In the second parent, I pick the second node, or (MULTIPLY 7 11). Swapping, I end up with (ADD 2 (MULTIPLY (MULTIPLY 7 11) (DIVIDE 5 2))).

### Mutation

Any random change to a program qualifies as a mutation. There are many types of changes that you can make to an S-expression and still end up with a syntactically valid program. For simplicity, I have included in GPQUICK one type of mutation that picks a random function and changes it to a different function with the same number of arguments.

Applying this mutation to (ADD 2 (MULTIPLY 3 (DIVIDE 5 2))), I select the third node, MULTIPLY, for mutation. I can

change it to any two-argument function. I select ADD at random, ending up with (ADD 2 (ADD 3 (DIVIDE 5 2))). To mutate a terminal, you would substitute another terminal.

### The GP Code and the Incredible Shrinking Interpreter

GPQUICK uses a representation for the GP code called *linear prefix jump table*, which was suggested to me by Mike Keith. Programs coded this way are small and evaluate quickly. When you evaluate populations of several thousand programs, size and speed are very important.

The GP code is an array of 2-byte structures of type `node`, defined by the following:

```
typedef struct {
    unsigned char op;
    unsigned char idx;
} node; // node type
```

Structure member `op` (for `op` code) is a function number. The `idx` is an immediate operand that can represent a table or a constant index. The GP code is stored in an object called a *Chrome*, short for *chromosome*.

In GPQUICK, functions are represented by objects of class *Function*. All the functions are stored in the array `funcarray` and given an array index. You could install the functions `NUMBER` (to return numeric constants), `ADD`, `SUBTRACT`, `MULTIPLY`, and `DIVIDE` as functions 0, 1, 2, 3, and 4. Function `NUMBER` uses the `idx` to determine which number to return. Other functions do not use `idx` and leave a zero value.

The expression (ADD 2 (MULTIPLY 3 (DIVIDE 5 2))) would be represented in our GP machine language as {(1, 0) (0, 2) (3, 0) (0, 3) (4, 0) (0, 5) (0, 2)}, where the first element (1, 0) is an `ADD` (`op` code 1) node, and the second (0, 2) is a `NUMBER` (`op` code 0) node returning the value 2.

Our *Chrome* method to evaluate the function at position `ip` in the code stack looks like this:

*continued*

## POP AND PROBLEM CLASSES

CLASS	IMPORTANT DATA STRUCTURES	IMPORTANT MEMBER FUNCTIONS
Pop	<pre>// Allocated array holding the // actual chromosomes Chrome** pop;  // The current Problem Problem* problem;  // Number of Chromes UINT popsize;  // Number of individuals // generated so far long gencount;  // Index of current best Chrome int BestMember;</pre>	<pre>// Set up a population for a particular problem. Pop(Problem* prob, ChromeParams* par, UINT size);  // Generate a new chrome. Return its fitness. Generate until // reaching time max_time, evaluating maxevals individuals, // or reaching maxfitness. virtual Chrome* generate();  virtual Chrome* go_until(time_t max_time,     long maxevals, float maxfitness);</pre>
Problem	<pre>// Array of primitive functions Function** funclist;</pre>	<pre>// Install the primitives and initialize the // evaluation environment. Problem();  // Add a Function to the funclist. void AddF(Function* f);  // Pure virtual fitness function. It should evaluate the chrome // in an appropriate environment and return a fitness value. virtual float fitness(Chrome* chrome);</pre>

# "MEET ANGUS FROM ANGOSS"



You've heard of Ann Landers, Dr. Ruth and numerous others who give advice. Their columns are read by millions of people seeking solutions to their problems. It's only human! But what do computers do when they need help?

Ann Landers' advice isn't worth two bits to a computer. At least, that's what Angus tells us. He's our very entrepreneurial computer at **ANGOSS Software** and he's chock full of A.I. Angus has been (dare we say) networking. His computer pals tell him they need the kind of advice only he can give. After all, their Humans have their nodes to the grindstone every day and offer little in the way of thanks. So these boxes need a counsellor to sympathize with them and provide solutions straight from the Motherboard, so to speak.

As a result, coming soon to this space is the world's first Computer Advice Column **"ASK ANGUS"**. We're not totally convinced, but Angus complains we're always dumping on him so we're going to give him a chance. He says he'll dazzle those disk drives with his sage advice on practical software solutions for the 90's like...

- ▲ **ANGOSS SmartWare** COMBINING APPLICATION DEVELOPMENT WITH INTEGRATED OFFICE AUTOMATION
- ▲ **ANGOSS RAD**, THE REVOLUTIONARY RAPID APPLICATION DEVELOPMENT SYSTEM THAT ACCELERATES YOUR PRODUCTIVITY AND ENHANCES YOUR CREATIVITY
- ▲ **ANGOSS KnowledgeSEEKER** FOR PRACTICAL, AUTOMATIC ANALYSIS AND DECISION-MAKING
- ▲ **ANGOSS VOICE** ENABLING YOU TO OPERATE YOUR COMPUTER WITH SIMPLE SPOKEN WORDS

We have to admit, Angus knows his stuff. And yes, we'll acknowledge that his advice can boost your computer's productivity plus get you working at a fraction of the time and cost you've spent before. So who knows, maybe he's on to something?

SEE FOR YOURSELF. WATCH THIS SPACE FOR **"ASK ANGUS"**... COMING SOON.

**ANGOSS** Software

Available on DDS/LAN and numerous UNIX platforms.

North America: Tel 416 593 1122 • Fax 416 593 5077 • United Kingdom: Tel 011 44 483 452 303 • Fax 011 44 483 453 303 • Germany: Tel 011 4989 613 81250 • Fax 011 4989 613 81259

Circle 275 on Inquiry Card.

**ANGOSS™**  
  
Software

The Shape of  
Things to Come

## Hands On Some Assembly Required

```
ip++;return funclist[expr[ip].op]->
    eval(this);
```

This calls the appropriate `Function eval` method. The `Function eval` method calls the `Chrome eval` method recursively to get its arguments. The `eval` method for function `ADD` is as follows:

```
return chrome->eval() + chrome->eval();
```

The `eval` method for function `NUMBER` is

```
return chrome->expr[ip].idx;
```

That's all there is to the interpreter. Add functions to suit your taste.

### GPQUICK Architecture

The object-oriented architecture of GPQUICK is divided into three pieces: the `Chrome` and `Function` classes, which are the underlying program representation; the `Problem` class, which holds the objectives, functions, and data necessary to define and solve a particular GP task; and the `Pop` (short for *population*) class, which holds a population of `Chromes` and runs a GA on them, calling the fitness function in the `Problem` to do an evaluation. This three-part architecture has worked well for me in a variety of applications.

Obviously, there is a tremendous variety of potential `Problems`. Also, many different kinds of GAs can be associated with subclasses of `Pop`, each with different methods of selection, a different mix of genetic operations, and a different topology for the population (e.g., single, parallel, or distributed processors). As long as they share the same `Chrome` representation, most `Problems` can run with most `Pops` and GAs.

The `Chrome` class is the carrier of a genetic program. A `Function` object carries information that the `Chrome` needs for initializing, displaying, and evaluating expressions that contain that function. Many functions, such as the arithmetic functions, are problem-independent; however, some functions, such as data terminals, require the data structures and evaluation environment of a particular problem. The table "Chrome and Function Classes" lists important data structures and member functions.

`Pop` carries an array of `Chromes`, evaluates them with the fitness function provided in the current `Problem`, and performs a GA to generate new and better `Chromes`. `Pop` uses a steady-state GA, generating one new `Chrome` and replacing one old one at a time, as opposed to making a whole new batch as a generation.

The `generate` method is the agent that selects one or more parents and applies mutation or crossover. This virtual method could be replaced by code with different strategies for selection, reproduction, or interaction with parallel populations. (The important data structures and member functions are listed in the table "Pop and Problem Classes.")

To do GP, you must have a fitness function that defines the problem and a set of primitive operations sufficient for solving it. Any implementation of GPQUICK must have a subclass of `Problem` that includes the appropriate fitness function and primitive functions.

Most programs need to be evaluated in a particular context. If you're trying to evolve a program that can navigate a maze, you need to define the maze. Setting up the environment should be done in the `Problem` constructor and at the beginning of the fitness function.

### Is SSRProb Useful?

The default problem for GPQUICK attempts to evolve an arithmetic formula matching `John*(George-Paul)+2.5*Ringo`. This sort of problem is known as symbolic regression. Using symbolic regression to discover a function that you already know is not useful, but you can modify `SSRProb` to learn prediction and classification from real-world examples. This is called *genetic induction*, and it has several advantages compared to competing statistical or neural techniques.

To do genetic induction, set up a training database that includes the value you want to predict and fields for each of the input variables in your model. Load the training database into a memory array. Add a static variable for the current record number. Add terminals that return the input field values for the current record. In the fitness function, evaluate for a set of randomly chosen records, and calculate the error compared to the desired value. The resulting expression will hopefully return accurate values for new input examples. I use a souped-up version of genetic induction to evolve traders and list selectors.

### The Future of GP

GPQUICK can produce arithmetic expressions, but it will never produce an operating system. Its successors may.

The trend to use more and faster processors will increase GP capabilities. GP consumes huge amounts of processor time evaluating millions of candidate programs. As the programs' behavior becomes more sophisticated, time spent on evaluation rises.

Fortunately, GP is ideally suited to massively parallel computers of almost any design. Just as evolution can proceed among a population that is spread out over a continent, so GP can proceed with populations that are distributed among a multitude of processors, with good individuals traveling occasionally from one processing neighborhood to the next for interbreeding. The *Creation Mechanics* GP toolkit supports *desktop supercomputing*, which links a network of PCs into a population for parallel processing. GP may well become a core application for the next generation of parallel computers.

As understanding of evolution and the mechanics of creation improves, so will GA effectiveness. We are working to understand specific problems; a basic problem concerns finding the right fitness function and environment for rapid evolution. We are also investigating the evolution of evolvability—finding the types of structures that respond well to mutation and crossover. Perhaps the most important question concerns modularity and hierarchy: how to build up the organs and cells, subroutines and data structures, of a genetic program.

Knowledge of the design of genetic algorithms is improving rapidly. Ultimately, we will be able to deploy an even more effective weapon—continuous, evolutionary improvement in the creative mechanism itself. We will build GP systems that can evolve a better version of themselves. This will quickly and dramatically extend GP capacity in ways that we cannot predict. We will have to call this thing by another name: artificial life. ■

Editor's note: *The source code and executable files (for MS-DOS or Microsoft Windows) are available electronically. See page 5 for details.*

---

*Andy Singleton is president of Creation Mechanics, Inc. (Dublin, NH), a software development company specializing in genetic programming for financial analysis. He can be reached on BIX c/o "editors" or on the Internet at p00396@psilink.com.*

# Inside the PCI Local Bus

**This new PC bus offers an industry standard, high throughput, and room for future growth**



**GUY W. KENDALL**

The expansion bus in most of today's PCs is based on a design that's over a decade old. However, this 16-bit IBM AT bus—now called the ISA bus—was built to accommodate devices that are considered slow by modern standards. Today's multitasking operating systems and feature-rich applications require not only faster processors but better throughput to system peripherals, such as the hard drive and display hardware. The ancient ISA bus has thus become a bottleneck that chokes system performance.

The fastest bus in a computer system is the local bus, which comes out of the microprocessor. Thus, the simplest way for designers to meet the throughput requirements of ISA-bus-based PCs has been to interface fast peripherals directly to the processor. Computers have been built with graphics chips or other peripherals built onto the motherboard and tied directly to the processor's local bus.

While this approach achieved the desired high throughput, it had two distinct disadvantages. First, PC vendors got caught in what is called the "processor treadmill": Because the components are so intimately tied to the processor bus, a PC's entire I/O subsystem has to be redesigned every time a faster processor becomes available. Second, users, who were stuck with having the peripherals on the motherboard, became unhappy when the fast-paced graphics market made the graphics controllers on their motherboards obsolete.

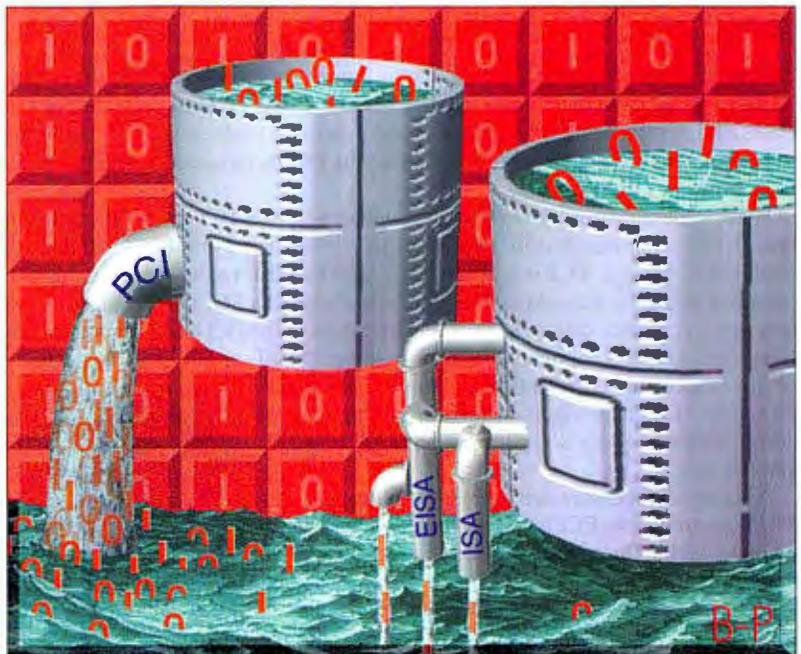
The solution was to have the graphics controller reside on expansion boards to make upgrading an easy task. This in turn drove each motherboard vendor to create its own proprietary way to connect expansion boards to the processor's local bus. This solution provided both upgradability and expandability. Unfortunately, this strategy also required users to buy new peripherals from the original motherboard supplier. De facto standards started to emerge, but there was enough chaos in the industry to warrant a true standard.

## A Standard Local Bus

The PCI (Peripheral Component Interconnect) local bus is a high-performance connection between motherboard components and expansion boards. It was first proposed at an Intel Technical Forum in December 1991, and the

first version of the specification was released in June 1992. The PCI Steering Committee members who developed the initial version of the specification were Compaq, DEC, IBM, Intel, and NCR. In June 1992, PCI became an open industry standard controlled by the newly formed PCI SIG (PCI Special Interest Group). In April 1993, revision 2.0 of the PCI specification was released.

Vendor support for the PCI standard has been widespread. Apple has announced that it will support the PCI bus in a future version of its PowerPC RISC Macintosh. (Note that first-generation PowerPC Macs will use the NuBus to support existing NuBus peripheral boards.) DEC intends to support PCI in its Alpha-based systems, and the company's high-speed DECchip 210066 RISC processor implements a PCI interface on the chip itself. This kind of support, in addition to that from many vendors of 80x86-based systems, paves the way for PCI to become a universally accepted component interconnect

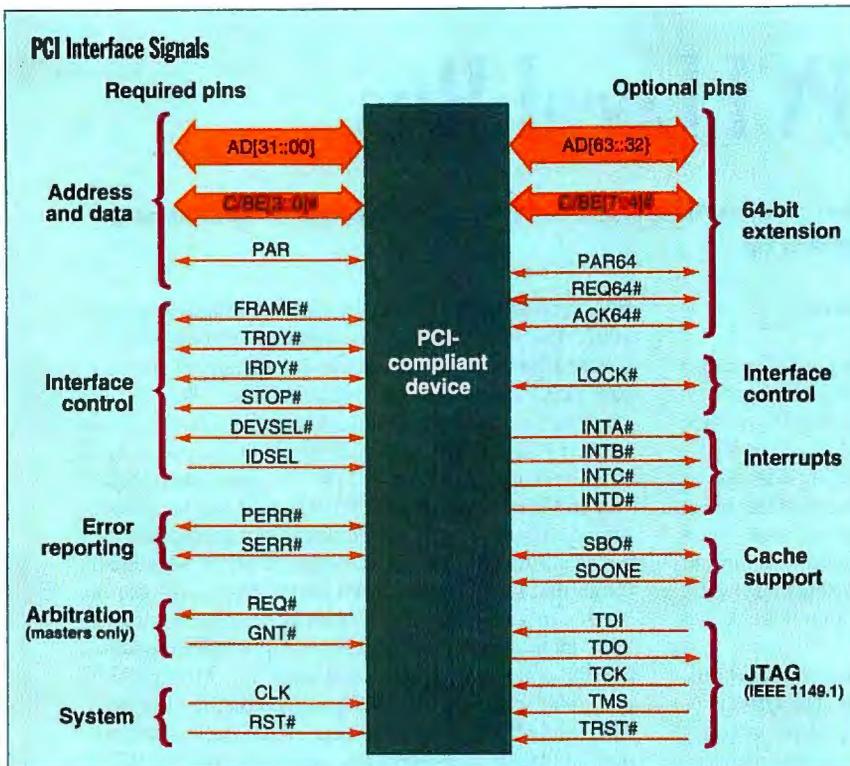


LYN BOYER-PENNINGTON © 1994

and expansion-bus standard.

The motivation for PCI was the fact that PC I/O architecture was so slow in relation to the processor that further improvements in processor technology would not have produced any noticeable improvements in overall system performance. PCI removes systems designers from the processor treadmill by isolating the I/O subsystem from the processor/memory/cache subsystem.

A fundamental part of a PCI design is the PCI-to-host



**PCI pins and signals.** The required pins are signals that are needed to implement a PCI bus. The optional pins help implement a 64-bit bus, exclusive memory access (the LOCK signal), and cache support.

bridge chip that connects the PCI bus to the processor's local bus. PCI peripherals are then connected directly to the PCI bus. Once a host bridge chip is available, a new processor has access to all available PCI components. This allows the PCI bus standard to be processor independent.

When a new processor becomes available, only the PCI-to-host bridge chip needs to be replaced; the rest of the system remains unchanged. PCI is a component- and board-level bus; other I/O buses, such as a SCSI bus, can be included in a PCI system with a controller chip or a board that interfaces to the PCI bus. Designers of I/O components such as graphics, SCSI, or LAN controllers can now concentrate on improving the performance of their products instead of continually re-designing their products for different processor speeds and bus types.

Although processors are quickly moving past 33-MHz operation, the PCI bus is defined to operate only up to 33 MHz. The processor speed can be faster than the PCI bus speed, however, because the host-to-PCI bridge isolates the processor bus from the PCI bus. The bridge chip can contain buffering to enhance performance and bus utilization. This is especially useful when using a processor, such as the 486, that doesn't support burst writes. Since the PCI bus does support burst writes, the host bridge can buffer a nonburst write from the processor and present it to the PCI bus as a burst write. A bridge might contain other system-support logic, such as for a cache controller or for handling the PCI bus's centralized arbitration mechanism.

PCI won't replace the standard expansion buses that are popular today, but instead it will complement them.

These expansion buses are added to a PCI system by the inclusion of a PCI-to-expansion bus bridge chip. The standard expansion buses (e.g., ISA, EISA, Micro Channel, and NuBus) are lower in performance, but they provide for maximum system expandability for less-demanding peripherals.

## PCI Bus Design

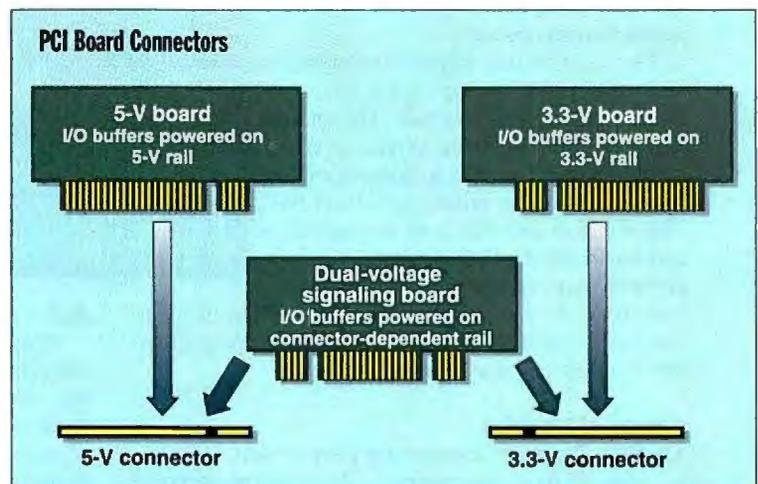
The design goals of the PCI bus standard were threefold. First, it would produce a low-cost, high-performance local-bus interface. Second, it would provide automatic configuration of components and add-in boards. Finally, the design would have the versatility to support future generations of peripherals.

The cost and size of connectors, chips, and motherboard traces increase as the number of pins needed to implement a bus increases. The PCI standard reduces costs by using a multiplexed address and data bus that reduces the pin count and size of the components. A PCI target (which is defined later) can be implemented with only 47 pins, and a PCI master can be implemented with only 49 pins.

Despite the small number of lines, this setup can manage bus addressing, data transfer, arbitration logic, and interface control.

The figure "PCI Interface Signals" lists the PCI bus pins, with both the required and optional pins shown. Note that the optional pins provide support for a cache and atomic operations. Other optional pins implement a 64-bit bus, giving the PCI standard a growth path for future systems.

Two sizes of add-in boards are specified: a standard length (about 12 inches long) and a short length (about 7 inches long). Note that the PCI bus is limited to 10 loads. Chips on the motherboard take up one load each, and add-in boards in PCI slots consume two loads each. For example, if devices on the motherboard consume four loads, this leaves six loads available, allowing three PCI slots. Too much loading can cause signals to



**A keyed notch on the PCI board determines what signal levels it supports. This allows an easy hardware transition from 5 V to 3.3 V.**

violate timing specifications, which leads to system failures.

To accommodate the industry's shift from 5-V signals to 3.3-V signals, PCI also defines a 3.3-V PCI specification. PCI add-in boards and slots are keyed so that 5-V boards plug only into corresponding 5-V PCI slots and 3-V boards plug only into 3-V slots. The PCI SIG is encouraging add-in board vendors to design "universal" boards that operate at both voltages and can plug into either a 5- or a 3.3-V PCI slot (see the figure "PCI Board Connectors" on page 178).

PCI defines three types of address space: memory, I/O, and configuration. Configuration space is a 256-byte area inside each PCI device that contains information about the device. Such information includes the type code, which indicates whether the device controls a mass-storage unit, a network interface, a display, or other hardware. Multifunction devices are supported, as long as there is only one physical connection to the PCI bus, such as one chip that supports both SCSI and Ethernet. The configuration space also contains the PCI control, status, and latency timer registers; the location of the device's expansion ROM; and the base-address registers. At power-up, the system scans the configuration space of all devices on the PCI bus and then assigns each device a unique base address and an interrupt level.

A PCI device's expansion ROM contains code to initialize the device, or devices. The ROM's contents are arranged in little-endian (i.e., Intel) format, but there's nothing in the design to

## PCI BUS COMMAND CODES

C/BE[3:0]#	COMMAND TYPE
0000	Interrupt acknowledge
0001	Special cycle
0010	I/O read
0011	I/O write
0100	Reserved
0101	Reserved
0110	Memory read
0111	Memory write
1000	Reserved
1001	Reserved
1010	Configuration read
1011	Configuration write
1100	Multiple memory read
1101	Dual-address cycle
1110	Memory-read line
1111	Memory write and invalidate

prohibit other processors from making use of the information. The ROM can contain different code images that initialize the device for different processor architectures. PCI provides true plug-and-play; the system takes care of hardware configuration automatically. A user just plugs in a board, and it works.

## PCI Bus Operation

A PCI transaction takes place between a master and a target. *Master* is a term used by the PCI standard for a bus master (i.e., a device that takes control of the bus and initiates accesses, such as a processor or a bus-mastering SCSI controller). *Target* is a term for a slave device (i.e., a device that only responds to accesses, such as memory or a VGA controller).

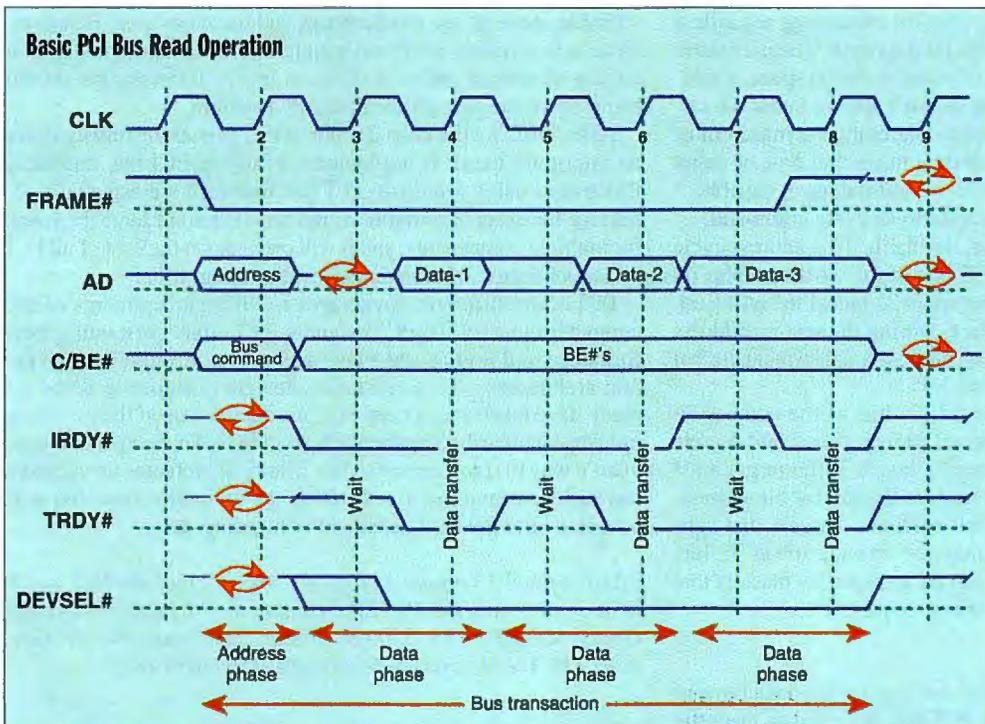
The PCI bus does all transfers as burst reads and writes to optimize performance.

A normal bus access requires a new address before each data transfer, whereas a burst transfer starts with one address and then performs multiple data transfers to or from consecutive address locations. For PCI, a burst transfer begins with an address phase, followed by one or more data phases. This allows one data transfer to be performed during each clock period. This gives a 33-MHz PCI bus a burst transfer rate of 132 MBps on a 32-bit bus and 264 MBps on a 64-bit bus. Bursts can be either to the memory or to the I/O space.

PCI burst transfers have an indefinite length, whereas most other architectures have a limited, fixed burst length. PCI bursts continue until the master or target requests the transfer to end or

until a higher-priority device needs to use the bus. Each PCI device has a latency timer that defines the longest period of time that that device is allowed to use the PCI bus. This timer is accessed through the configuration space and is programmed by the processor. The processor can optimize overall system performance by intelligently programming the latency timers of all devices on the PCI bus.

The master specifies the type of burst transaction by using bus commands. These commands are issued by driving the command/byte enable (C/BE[3:0]#) lines during the address phase of a burst. The table "PCI Bus Command Codes" shows each command's encoding and type. During the data phases, the C/BE[3:0]# lines carry byte-enable information that indicates which byte lanes on the bus carry data. The figure "Basic PCI Bus Read Op-



**A read transaction starts with the address phase, with FRAME# asserted, AD[31:0] driving the address onto the bus, and C/BE# containing a valid PCI bus command. The data phase follows, which can have any number of data transfer and wait cycles. During the data phase, C/BE# indicates what byte lanes are used.**

eration" gives details on a PCI burst read; the figure "Basic PCI Bus Write Operation" gives details on a burst write.

Another way to improve the performance of any bus running at a particular speed is to reduce its *overhead*, which is time that the bus is in use but data is not being transferred. When a PCI device wants to access the PCI bus, it must request use of the bus from the central arbiter (which can be located in the PCI-to-host chip) by using its REQ (request) signal. The arbiter uses its GNT (grant) signal to allow the device to use the bus. On most buses in use today, the arbitration process takes up cycles that could be spent transferring data. PCI eliminates this loss by allowing the arbitration for the next access to occur while the current access is still in progress.

The PCI bus can transfer data 32 bits or 64 bits at a time. The optional signals REQ64 and ACK64 allow a 64-bit master to ask if a target is capable of 64-bit data transfers. A 64-bit transfer occurs only if a master asks for a 64-bit transfer and a target responds that it can do such transfers.

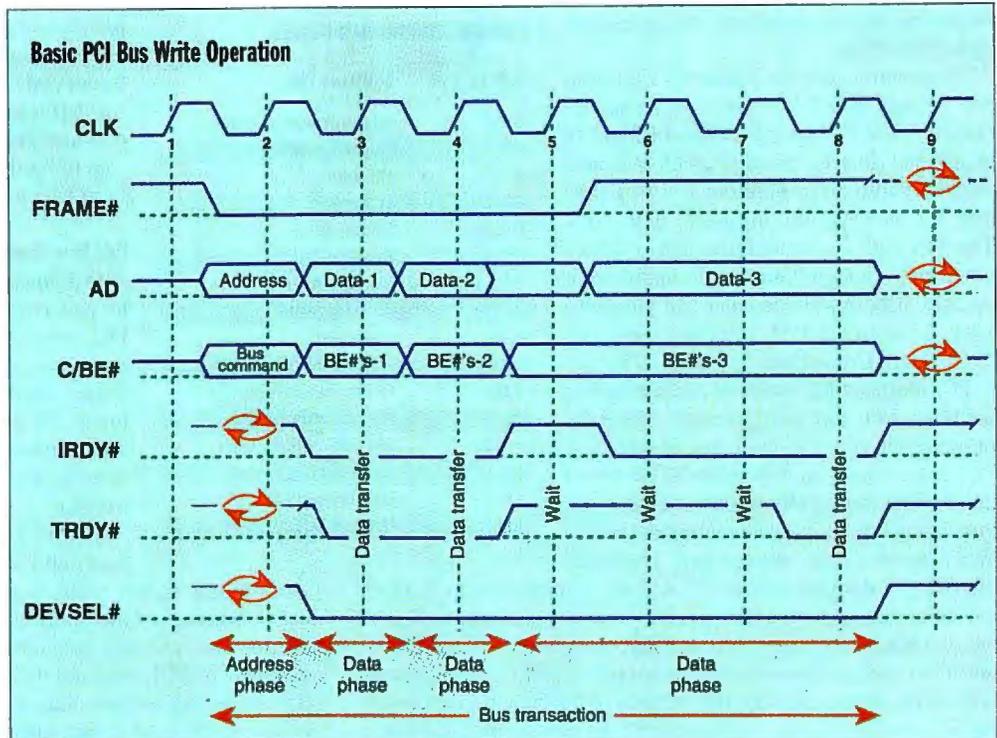
A PCI master can support 32- or 64-bit addressing regardless of whether it supports a 32- or a 64-bit data path. Since a master might not be able to look at a target's configuration space, a master that supports 64-bit addressing doesn't always know if a target supports 32- or 64-bit addressing. Therefore, the master must be able to present an address in a format that either type of target can accept. The master addresses 32- or 64-bit devices capable of 64-bit addressing by issuing a dual-address-cycle command.

To implement such a command, during the first address cycle the master first drives the lower 32 bits of the 64-bit address on the lower 32 bits of the bus, and the upper 32 bits of the 64-bit address on the upper 32 bits of the bus. During the second address cycle, the upper 32 bits of the 64-bit address are driven again, but this time on the lower 32 bits of the bus.

A 64-bit target will take in the full 64 bits of the address on the first clock cycle, ignore the second address phase, and decode the 64-bit address with no additional delay. A 32-bit target must wait an additional clock cycle to receive the full 64-bit address, since it is transferred in two 32-bit portions. Targets that support only 32-bit addressing are mapped into the lower 32 bits (4 GB) of address space, so they can be accessed by masters that support 32- or 64-bit addressing transparently.

## PCI's Future

In the past, many interfaces were designed with only current rather than future needs in mind. PCI was designed to meet the needs of today's systems while leaving plenty of room for growth. The PCI local-bus architecture provides the bandwidth required to accommodate the demands of today's high-performance op-



**A PCI write transaction is similar** to a read transaction. The data phase of read and write transactions ends when both IRDY# and TRDY# are asserted. The wait states shown here are inserted only when a slow device is accessed.

erating systems. This interface is finding its way into everything from portables to high-end file servers and workstations.

Currently, a PCI motherboard requires multiple components—in addition to the processor—to implement PCI. This consumes valuable space on the motherboard and increases cost. However, since it is a widely accepted standard, PCI components from a variety of sources and with different levels of integration should bring down the size and cost of a PCI system.

Also, DEC's DECchip 210066 RISC processor foreshadows an important trend: It implements a built-in PCI bus interface. Processors using a built-in PCI bus interface are especially attractive for users of portable computers that don't have the space for multiple components, and it will drive down the cost of all PCI systems because of the greater level of integration.

PCI offers different advantages to different segments of the computer industry. To PC designers, PCI offers outstanding performance and a plug-and-play mechanism through a new system architecture. To workstation designers whose systems already have buses faster than PCI, it offers access to the low-cost, industry-standard components used in PCs. To everyone, it provides a way to resolve many of the historical problems the industry has had by providing a well-thought-out architecture that will propel us into the next decade of computing. ■

*Editor's note: To obtain a copy of revision 2.0 of the PCI specification or to join the PCI SIG, contact the PCI Special Interest Group, M/S HF3-15A, 5200 Northeast Elam Young Pkwy., Hillsboro, OR 97124, (503) 696-2000; fax (503) 693-0920.*

*Guy W. Kendall is an applications engineer with the Microelectronics Products Division of NCR Corp. (Colorado Springs, CO). He supports the company's family of PCI-SCSI I/O processors. He can be reached on the Internet at [guy.kendall@fcollinsco.ncr.com](mailto:guy.kendall@fcollinsco.ncr.com) or on BIX c/o "editors."*

# Windows for Workgroups 3.11

Previews of two new technologies—Chicago and At Work—make this the most advanced version of DOS-based Windows now available



**JON UDELL**

I've long thought Windows for Workgroups a vastly underrated product. The original version (3.1), dubbed Windows for Warehouses, languished in part because the MIS crowd saw its peer-networking capabilities as a security risk. That view seemed shortsighted to me. Peer file sharing was always an optional feature of WFW. Subtract that, and WFW would still be an extremely useful complement to a server-based LAN. Mail, group scheduling, Clipboard sharing, and network DDE are powerful enhancements to the basic NetWare file and print services. Thanks to WFW's dual-shell capability, a Windows workgroup enjoying these extra services can co-exist comfortably with a preexisting NetWare LAN.

WFW 3.11 improves on the original version in ways that preview two new technologies that are strategic for Microsoft. Its new 32-bit file and network I/O move toward the protected-mode device-driver model we'll see in Windows 4.0 (aka Chicago). And version 3.11's fax software plays into the smart-office initiative known as At Work.

What about those MIS security concerns? Version 3.11 enables an administrator to control file, print, and Clipboard sharing. An encrypted file stored locally on each WFW 3.11 machine selectively enables or disables these features. An administrator can force the security settings stored in that file to synchronize, at start-up, with canonical settings stored on the network. With version 3.11, an administrator can also choose to reform version 3.1's troubling habit of caching passwords, arguably its worst security flaw.

## On the Road to Chicago

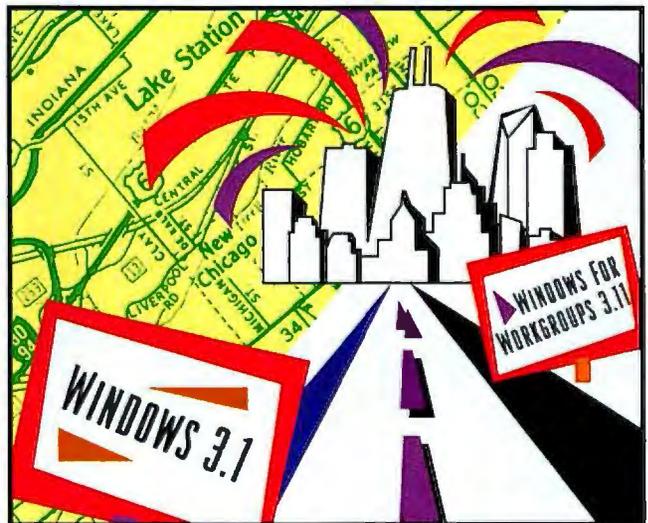
The big story isn't security, however. New 32-bit file and network I/O technologies put WFW 3.11 a half-generation ahead of any current DOS-based version of Windows—and within shouting distance of Chicago. Like many newfangled Windows features nowadays, these are implemented as VxDs (virtual device drivers) that run in a true 32-bit environment unavailable to normal Windows applications.

Most Windows users got their first taste of 32-bit device support in the form of FastDisk, the protected-mode BIOS interceptor that debuted in Windows 3.1. On machines with WD1003-compatible (or older ST506) drive controllers—this covers most Windows machines, including the majority now sold with IDE controllers—Windows 3.1 can hook INT 13h and talk directly to the

hard drive, bypassing the system BIOS.

The full implications of this technique weren't always apparent to users, though, because of a quirk of user-interface design. You enable FastDisk in the Virtual Memory dialog box that's accessible from the 386 Enhanced section of the Control Panel, a dialog box primarily used to configure the swap file. Knowing that Windows bypasses DOS and uses low-level BIOS calls to communicate with a permanent swap file, many users assume (not unreasonably) that FastDisk applies only to this special case. In fact, it works for all files.

FastDisk can help performance in several ways. WDCTRL, the VxD that talks to the drive controller, will in many cases be faster than the system BIOS. Use of WDCTRL eliminates one costly switch between protected mode and real mode. And WDCTRL can sometimes han-



MARK MURPHY © 1994

dle I/O asynchronously, letting Windows do other work while a request completes.

## Sending DOS to the Sidelines

With FastDisk intercepting the BIOS, the bottleneck is DOS itself. Under Windows 3.1, it's still necessary to switch from protected mode to real mode so that DOS can look up the location of a requested piece of a file in the FAT (file allocation table) and then back to protected mode, where WDCTRL can field the resulting INT 13h call.

Why not take DOS out of the loop as well? That's what WFW 3.11's 32-bit file access feature does, using a pair of new VxDs. VFAT.386 delivers protected-mode

# In Touch With Tomorrow's Consumer

the Los Angeles Computer Fair  
March 18, 19, 20, 1994

Opening in the nation's largest computer retail market, this unique, first-ever event combines the exhibits and educational programs of traditional trade shows with the high-volume excitement of today's superstores.

The Los Angeles Computer Fair is the first in a series of regional consumer-oriented computer trade fairs presented by National Productions. Come see, compare, and learn more about hundreds of products. Take advantage of special show pricing, great bargains and build your knowledge base.

If you're looking for great buys and solid information, the Los Angeles Computer Fair is the place to be. Look for us in Los Angeles in March, '94 and Atlanta in October, '94.

**Call for more information:  
1-800-800-5600**

Presented by National Productions, California's leading producer of computer retail shows for over ten years.

Co-Sponsors:

**MICROTIMES**



**PIBMUG**

Pasadena IBM Users Group

National Productions, Inc.  
16175 Monterey Road, Ste. 4  
Morgan Hill, CA 95037  
TEL (408) 778-5200  
FAX (408) 779-1374



## Hands On Beyond DOS

INT 21h services, and VCACHE.386 is a protected-mode replacement for the SmartDrive disk cache. As with FastDisk, and still a bit confusingly, you enable this 32-bit feature (per drive) by way of the Virtual Memory dialog box.

The results can be impressive. An Advanced Logic Research Flyer 32LCT 4DX2/66 with an IDE controller more than doubled its sequential file I/O throughput using the VFAT/VCACHE combo, while bettering its random file I/O throughput by about a third. But on an Everex Step 486DX2/50 with an Adaptec AHA-1742 controller, and an IBM PS/2 Model 90 XP 486 with an IBM SCSI-2 controller, the story was quite different. Here, random file I/O throughput improved by 73 percent and 83 percent, respectively. These marks were close to (for the Everex) or better than (for the PS/2) those posted by Windows NT on the same two machines. But in both cases, 32-bit file access hurt sequential file I/O performance. The PS/2 lost a fifth of its 16-bit throughput; the Everex lost a fourth. This degradation made application load times noticeably slower on the two SCSI machines.

As you've probably now realized, VFAT and VCACHE don't require FastDisk—although they do prefer it. That's fortunate, because controller manufacturers didn't support FastDisk as unanimously as Microsoft hoped they would. Some companies, including Ultrastor and Future Domain, offer FastDisk drivers for their SCSI controllers; others, notably Adaptec, do not.

You should note, therefore, that VFAT and VCACHE seem to perform rather differently on FastDisk and non-FastDisk systems. If you can use FastDisk, 32-bit file access seems like a clear winner. But if you can't, don't assume it will boost throughput in all cases. You should probably test your bread-and-butter applications with and without VFAT/VCACHE to determine whether they help or hinder.

You should also know that while VCACHE unifies caching for local hard drives (VFAT) and remote ones (VREDIR), it won't cache floppy or CD-ROM drives. To cache these, you'll still want to use the provided SmartDrive 5.0 (which also comes with MS-DOS 6.2).

### 32-bit Networking

The 32-bit networking components of version 3.1 included the NetBEUI transport, the NetBIOS interface, the server, and the redirector. Version 3.11 adds 32-bit (NDIS 3.0) adapter drivers and a 32-bit SPX/IPX protocol stack with a Novell-compatible NetBIOS. A 32-bit TCP/IP stack is in the works, too, but unfortunately it didn't ship with version 3.11.

Using NetDDE to ship a 50-KB chunk of data between two stations, I found the 32-bit network-card NE2000 and SMC drivers to be 25 percent faster than their 16-bit counterparts. As with the 32-bit disk and file technology, the dominant effect is almost certainly the reduction in protected-to-real-mode switching.

Configuring for the test, however, proved more challenging than I'd have thought. For a given protocol, WFW 3.11 offers four driver options: Novell's ODI (Open Data-Link Interface), real-mode NDIS, real- and protected-mode NDIS, and protected-mode NDIS. You use the ODI option for NetWare connectivity or if your adapter lacks bundled NDIS support. With ODI, you can access network hardware in real mode only. The NetWare shell, of course, runs in real mode, too, but you can still layer on that foundation either or both of the 32-bit transports (i.e., NetBEUI and SPX/IPX) for use by the Windows networking components.

Real-mode NDIS, like ODI, puts 16-bit adapter support underneath 32-bit transports. The real-and-protected option, confusingly, installs 16- and 32-bit adapter support; Windows uses



RHETOREX  
S.M.A.R.T. Developer

## Now, HAND OUT INSTANT INFO VIA FAX.

FaxFacts is the revolutionary fax-on-demand system that allows your customers and prospects to request information by simply pressing a few phone buttons. In seconds, a fax "full of facts" is sent to the caller.

- Instant information available 24 hrs. a day.
- Reduces operating costs.
- Ideal for dispersing literature, specs, pricing or customer support.
- Provides answers, while customer's interest is peaked.
- Credit card charge per fax.
- Easy to install by non-technical person.

TRY THIS DEMO:  
708/924-3030  
DOC. NO. 889812

**Faxfacts**<sup>®</sup>

by Copia International Ltd.

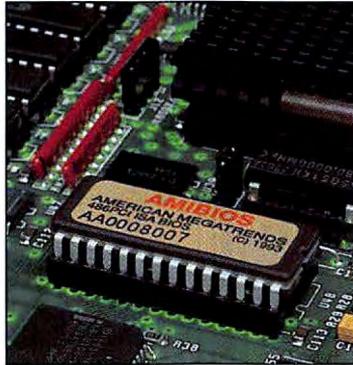
Wheaton, Illinois 60187

708/682-8898

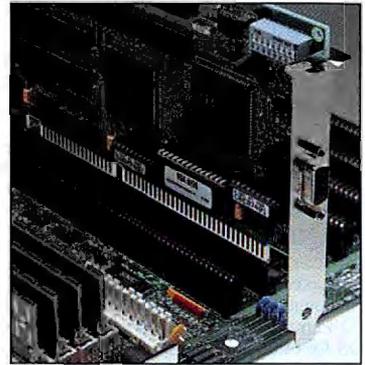
# Experience the Difference



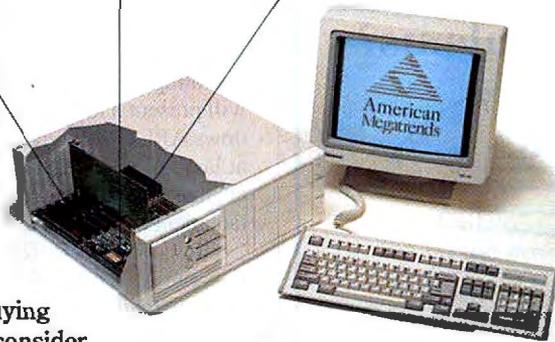
**MOTHERBOARDS**  
PCI, VESA, EISA, ISA  
486 and Pentium™ CPUs



**BIOS PRODUCTS**  
Green PC, System BIOS,  
Keyboard, PCMCIA, PCI



**ADD-IN PRODUCTS**  
SCSI, Sound, SVGA  
Communications, PCMCIA



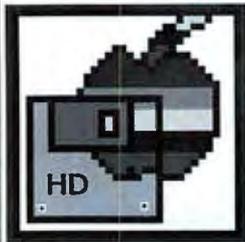
Whether you are building or buying a PC, the only components to consider are those from American Megatrends, the BIOS people known for their world famous AMIBIOS. Now, with hardware, you can get the same compatibility and performance that has made the AMIBIOS world famous. With high quality motherboards

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, 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

# Your PC goes Mac!!



## MacDisk\*

Reads, writes and formats  
Mac 1,44 MB floppies.

Under Windows, file exchanges between Word, Excel, PageMaker, XPress, and other sibling applications, without any hardware modification.

## MacSQ\*

Reads/writes 44/88 MB  
Mac SyQuest cartridges.

Transfer of scan files, colour separations. Supports Adaptec/ASPI-compatible adapters, low-cost adapters and parallel port solutions (Puma, D2-Para). Under Windows with ASPI, under DOS for other configurations.



## MacScuzzy\*

A superset of MacSQ, formerly announced and advertised as MacDisk Pro, also drives 128 MB MO cartridges and 90 MB Bernoullis and soon even bigger Mac SCSI volumes (600 MB MO).

### Logiciels & Services DUHEM

21, rue La Bruyère - F-75009 PARIS (France)  
Tél. (33.1) 49 70 04 55/Fax (33.1) 49 70 04 56

Free leaflet and demo disk. Offer good until supply lasts.

MacDisk 125 \$, MacSQ 200 \$, MacScuzzy 245 \$ (without S&H fees).

EEC residents, add French VAT (18,6 %). We accept most credit cards.

Dealers welcome. Software in French/English/German, Manual in French/English.

\* Registered trademarks of LSD in France and trademarks of LSD elsewhere.

# Hands On Beyond DOS

the 32-bit code, but the 16-bit code is available for use in DOS. Finally, protected-mode NDIS installs and uses only the 32-bit NDIS 3.0 driver.

To make things even more interesting, WFW 3.11 installs both NetBEUI and SPX/IPX transports on top of whichever flavor of driver you choose and makes SPX/IPX the "default" protocol. The availability of a routable protocol, namely SPX/IPX, is a great thing. As I discussed last month, you can dispense entirely with NetBEUI in this version of Windows for Workgroups and run file, printer, and Clipboard sharing solely on SPX/IPX.

If you happen to operate a NetWare WAN (wide-area network), this arrangement WAN-enables Windows networking in a way that was never before possible. But I ran into problems using the SPX/IPX stack (and its companion NetBIOS) with WFW's NetDDE. When SPX/IPX was the default protocol, Clipboard sharing and other light-duty NetDDE operations worked, but the 50-KB transfer I used to measure over-the-wire performance failed.

The same transfer worked flawlessly when I used NetBEUI as the default transport. So while my NetDDE test didn't satisfy my curiosity as to whether NetBEUI or SPX/IPX is the faster 32-bit transport, it did raise concerns about the suitability of SPX/IPX as the preferred transport for Windows networking.

### The Fax Connection

The Chicago technology in WFW 3.11 is tantalizing, if a bit rough around the edges. Microsoft's At Work technology that debuts in version 3.11 is equally tantalizing and, while limited in scope, quite successful. At Work is an umbrella standard that Microsoft hopes will enable PCs, telephones, printers, copiers, and fax machines to cooperate intelligently on a network.

A compliant fax machine, for example, will run the At Work operating system (a 16-bit real-time preemptive multitasker) and will present a touchscreen user interface based on a subset Windows API. (Prototypes of these smart fax machines were shown at last fall's Comdex.) A pair of fax devices will be able to exchange not only conventional faxes, but also compact binary attachments that survive as editable documents.

How does this differ from E-mail? It doesn't, really. For PC Fax, the At Work-compliant fax-server software in WFW 3.11, fax is E-mail. A sender need actually render an image of a document only when the receiver indicates it cannot receive a more compact and infinitely more useful binary transfer.

The current limitation is that there aren't any At Work devices other than WFW 3.11 PCs. Thus, for most users in the near future, PC Fax will operate as a conventional fax server. In that capacity, however, it excels. Outbound and inbound faxing on one WFW machine with an attached SupraFaxModem was trivial, as was sharing that modem from another WFW machine. Because PC Fax is implemented as a form of E-mail, you can broadcast to a mixture of E-mail and fax destinations using a single distribution list. Equally important for integrators, you can send faxes programmatically using simple MAPI (Messaging API).

Announced last June, At Work has now begun to emerge from shrouds of vapor. It's a grab bag of rendering, communications, and real-time operating-system technologies, none of which is by itself earthshaking. But if vendors buy into this vision of smart networked office equipment, At Work could do more for millions of workers than any version of Windows. ■

Jon Udell is a BYTE technical editor at large. You can reach him on the Internet or BIX at [judell@bix.com](mailto:judell@bix.com).

## Subscription Problems?



We want to help!

If you have a problem with your BYTE subscription, write us with the details. We'll do our best to set it right. But we must have the name, address, and zip of the subscription (new and old address, if it's a change of address). If the problem involves a payment, be sure to include copies of the credit card statement, or front and back of cancelled checks. Include a "business hours" phone number if possible.

## BYTE Magazine

Attn. Subscriber Service, P.O. Box 555  
Hightstown, NJ 08520

JERRY POURNELLE

# Upgrades from Hell

I've been told that my best columns happen when I've had a whole lot of problems. That ought to make this one a doozy. I've been tearing my hair out for a week. All's more or less well now, but I sure have a lot to tell you.

It all started when I asked Alex to install ATI Technologies' CD Sound Dimension Multimedia Upgrade Kit in SuperCow, our Gateway 2000 486DX2 with local-bus video. It's fast and reliable. It sits on a computer cart, making it nearly ideal as a test-bed for new equipment. Alex installed the full-length sound and CD-ROM controller board, but he noted there were no mounting rails for the CD-ROM drive, so he didn't unpack that. He did get the sound board working, and pretty soon Chaos Manor was filled with the sounds of Captain Kirk, Dr. McCoy, and Mr. Spock, generated by Berkeley Systems' After Dark screen saver, and a screwy program called Icon Hear It.

I have reports from sound experts that the ATI sound board is not quite 100 percent compatible with Sound Blaster Pro, but it has played all the sounds, in-

cluding games, that we've tried with it, and we've had no problems. I can suggest one improvement. The board has an option to connect the sound output of your system to the board, where you have volume control, but to do that you must disconnect the internal speaker, which means that you must have an external speaker connected to the board or you'll get no sound at all. I wish they'd set it up so the internal speaker is activated when you unplug the external speakers. Other than that, the ATI board is quite acceptable, and it's easy to set up.

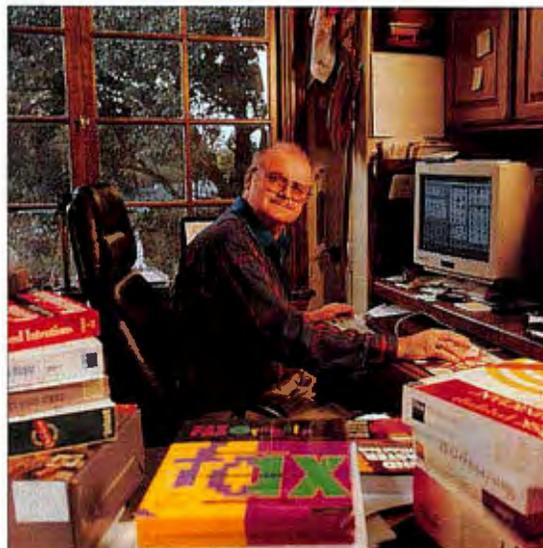
Mind you, no sound board has as good quality for the money as Turtle Beach Systems' MultiSound. Unfortunately, it's for Windows only, and it won't play the sounds used by just about all the game designers. If you're serious about sound, get the MultiSound. Incidentally, it will coexist quite nicely with the ATI board or Sound Blaster Pro, but you have to be a real sound fanatic to go that route.

**The ATI CD-ROM drive** didn't need any mounting rails. When I unpacked the Mit-

sumi-labeled Matsushita drive, I found it comes in a little metal cage that replaces mounting rails; it makes a snug fit, but it's easy to install in the half-height bay that's below SuperCow's floppy drives. I like the drive design a lot; you press on the drive face and the whole thing slides out. Open a lid on top and drop in your CD; no caddy needed. I've always had mixed emotions about those caddies. If CD-ROMs came in them, it would be different; but no, CD-ROMs are shipped in jewel boxes, and you have to provide the caddies yourself. I have never been able to open a caddy without a fight. Anyway, the ATI system doesn't use them.

There's only one way the CD cable will attach to the drive, so that was no problem. Alas, it's quite possible to attach the cable the wrong way to the sound board. Fortunately, the installation diagrams show where pins 1 and 2 are on both drive and board, and once I noticed that, all was well.

The software installation is pretty simple, but I found one subtle problem, which I'll explain in just a minute. There's a place to set the start-up



AMY ETRA © 1994

**Installing CD-ROM drives and graphics accelerator cards turns into pitched battles between Jerry and the Chaos Manor computers**

configuration, and Alex had set the CD-ROM drive to disable. Enabling it is easy enough, but when you do, the board can't find that CD-ROM drive until you power down and turn the machine back on. Meanwhile, you can set the interrupt channel (i.e., IRQ [interrupt request] number) and I/O port addresses for the CD-ROM drive. That's all explained quite well in

the ATI manuals, but the screen setup is simple enough that you probably won't look into the manual at all.

**I was awakened at 0700 by the telephone. It was a flack from the Dithering and Redundancy Corporation.**

machine and tried again. Same thing. Time for some logic.

I set things up, powered down, noted that the CD-ROM light flashed when the machine powered up, and tried to access the CD-ROM drive. "Drive not ready." I reset the

First thing, eliminate any distractions. SuperCow had the Maximum Storage Duette optical drive running off a Future Domain SCSI board; eliminate that and comment out the software device installations in CONFIG.SYS. Reset. Still no joy.

Next, cables: I disconnected the cable from the ATI board, liberally spread on Stabilant 22 (a connection enhancer), and connected again. Reset. This time it worked. Now enter Windows for Workgroups 3.11, go to File Manager, and access the CD-ROM drive. The system locked up to hardware reset.

Clearly some kind of conflict, probably in the interrupt processing: each of these devices must be assigned a unique IRQ number. The sound board was set to IRQ 7. There were several possibilities for the CD-ROM drive, but the default was IRQ 5, and I saw no reason to change it. Now to look at the network board. That's an Intel EtherExpress, and it's examined and set with a simple-to-use Intel program called SoftSet. SoftSet told me that, sure enough, the network board was set to use IRQ 5, the same as the ATI board was using for the CD-ROM drive.

The subtle bug I mentioned earlier is that the ATI software will warn you if you try to *change* to an interrupt line that's already in use, but it doesn't notice if the default IRQ creates a conflict when you first activate the board. Anyway, I told SoftSet to change EtherExpress to use IRQ 10. Then I did extensive tests of the CD-ROM drive under DOS. No problem, so bring up Windows for Workgroups. The system again locked up to hardware reset.

Maybe, I thought, I needed to power down the system after changing the EtherExpress settings. I tried that, made sure I could get the directory on the CD-ROM drive, and brought up Windows for Workgroups again. That came up fine. Go to File Manager and try to access the CD-ROM drive. System locks up.

By then it was quite late at night. I reset, noted that I could get a CD-ROM directory when in DOS, left the machine logged to the CD-ROM drive, fired off an angry fax to ATI Technologies' technical-support staff, and went to bed.

**I was awakened at 0700** by the telephone. A flack representing the Dithering and Redundancy Corporation had got my telephone number and called to find out if I'd received their product. When I pointed out that it was 0700, she was apologetic. "I didn't know it was your home number," she said.

"No, but you knew it was my private line. Do you know how many products I

# Tripp Lite SmartOmni UPS<sup>®</sup> Out-Networks APC Smart-UPS<sup>®</sup>

Only one UPS system provides network managers with the most enhanced network protection and control abilities — Tripp Lite's SmartOmni line interactive UPS. SmartOmni has a substantial advantage over APC Smart-UPS in critical networking applications.

## Tripp Lite SmartOmni OUT-NETWORKS APC Smart-UPS!

	Tripp Lite SmartOmni w/PowerAlert PLUS	APC Smart-UPS w/PowerChute Plus*
* Master network log pools power alarms from all UPSs on network to one concise file	STANDARD	Not available
* Realtime view of both servers AND WORKSTATION UPS power data from any node	STANDARD	Not available
* Customizable alarm points for low voltage, % load, and temperature on each and every UPS	STANDARD	Not available

## Tripp Lite SmartOmni OUT-MANAGES APC Smart-UPS!

	Tripp Lite SmartOmni w/SNMP-2 Adaptor	APC Smart-UPS w/SNMP Adaptor
* Redundant AC input on SNMP adaptor prevents loss of control of connected UPS	STANDARD	Not available
* "Out of Band" network communication when Ethernet disabled	STANDARD with your modem	Not available
* Ambient temperature and humidity reports	STANDARD	Extra Cost Option
* Remote power control of HVAC or other peripherals	STANDARD	Not available
* SNMP adaptor controls up to 4 UPSs	4 STANDARD	Up to 2, only

## Tripp Lite SmartOmni OUT-POWERS APC Smart-UPS!

* Lowest correctable brown-out voltage without battery drain	87 volts	98 volts
* Over-voltage correction peak without battery	140 volts	Not available



Find out what else  
SmartOmni  
UPSs can do.

Call today for more  
information on the  
SmartOmni  
advantage!



500 N. Orleans,  
Chicago, IL 60610-4188  
(312) 755-8741  
Fax (312) 644-6505  
FaxBack Service (312) 329-9717  
Ask for Dept. 51

Smart-UPS and PowerChute Plus are registered trademarks of American Power Conversion, Inc.

# THE COMM PROGRAM FOR THOSE WHO INSIST ON TAKING THE EASY WAY OUT.

Our users know it. The reviews and awards confirm it. And the increasing number of people moving to Crosstalk® for Windows proves it.

Whether you need a way out to an on-line service, your favorite bulletin board or your company's host computer, the easy way is Crosstalk.

We make communicating easier with features like our QuickBar toolbar and our QuickPad™ editor, which lets even non-programmers build customized controls for frequent sessions. And those are just a couple of the reasons why Crosstalk has been the *PC Magazine* Editors' Choice for the last two years.

Everything about the Crosstalk interface is designed for speed and convenience. And naturally, along with all that ease-of-use, you get the unmatched power that Crosstalk has always been known for. *PC World* wrapped up

its recent review by saying, "Thanks to its clean and easy-to-use interface backed by its solid set of emulations and transfer protocols, strong scripting capabilities and remote access tools, Crosstalk easily rates a Best Buy."

For a limited time, you can trade up to Crosstalk for Windows™ from any competitive product for only \$49 when you call DCA® directly.

So why make it hard on yourself? Take the easy way out.

1-800-348-3221, ext. 63DD\*



*"If you like a clean, uncluttered Windows interface with some of the best-designed icons anywhere, Crosstalk won't disappoint."*

— PC World Best Buy, November 1993



You can easily create your own customized QuickPads, or use our pre-built ones for on-line services.

# DCA

The Freedom To Communicate.

\*Or call (404) 475-8380. Offer good through June 30, 1994. ©1993 Digital Communications Associates, Inc. All rights reserved. DCA and Crosstalk are registered trademarks and QuickPad is a trademark of Digital Communications Associates, Inc. Windows is a trademark of Microsoft Corporation. All other trademarks are the property of their owners.



Circle 90 on Inquiry Card.

# Attention U.S. BYTE Subscribers

Watch for the next **BYTE DECK** mailing that will be arriving in your mailbox soon!

Use this as a fast, convenient tool to purchase computer products and services. It's loaded with essential hardware and software products that you should be aware of when making your buying decisions. . . and it's absolutely FREE!

If you have a computer product or service, and would like to reach 275,000 influential **BYTE** magazine subscribers, please give Brad Dixon a call today at (603) 924-2596.



## BYTE DECK

Here's what a **BYTE Deck** advertiser has to say:

*"The **BYTE Deck** does very well for us - we've been in for over two years - and will continue advertising in '93."*

Karen Tacy  
Rainbow Technologies, Inc.

## Pournelle

get every day? If the flacks representing those products were all to call to see if I got them, I would never get any writing done," I said. "Let me tell you about a wonderful invention called E-mail. It lets you send messages to people through computers. You do know what a computer is?"

I may have been unduly harsh—I don't guarantee that I'll be either civil or coherent at 0700 after fighting an installation problem all night—but someone in her firm ought to have had better sense. I sometimes suspect these PR flacks get paid by the "contacts" they make, even though few of their messages warrant the urgency of a telephone call. Anyway, that's how the day started.

**Rick Osborne of ATI Technologies'** technical-support staff called about 10:00 a.m. I hauled the phone over to SuperCow. It was still running, but it would no longer access the CD-ROM drive. That was suspicious. I reset the machine, logged on to the CD-ROM drive and got a directory, went into Windows for Workgroups, and locked the machine when I tried to access the CD-ROM drive. Reset. Use the ATI installation program to be sure of the settings: sound board at IRQ 7, CD-ROM drive at IRQ 5. Now use SoftSet to check the network board. It was set to IRQ 5.

I was absolutely certain I had set that to IRQ 10. I set it to IRQ 10 again. Still in DOS, I accessed the CD-ROM drive; it worked fine. Enter Windows for Workgroups. Machine locks to hardware reset. Reset. Now I can bring up Windows for Workgroups, but going to File Manager and trying to access the CD-ROM drive locks the machine. Reset. Use SoftSet—and find that EtherExpress is set to IRQ 5 again.

Something is real weird, folks. OK, use SoftSet to set EtherExpress to IRQ 10 again; and this time get out all eight floppy disks and install Windows for Workgroups again. Tediously I swapped disks. Finished. Powered down and then back up. Can't enter Windows for Workgroups. Reset. Now I can enter, but accessing the CD-ROM drive locks up the machine—and EtherExpress is set to IRQ 5.

The conclusion is clear: the evil Microsoft daemon inside Windows for Workgroups 3.11 is resetting EtherExpress, and it's doing that without telling me. The first remedy was to leave EtherExpress at IRQ 5 and change the CD-ROM drive to IRQ

10. That worked just fine, so I let Rick Osborne, who had been patiently listening as I went through all this, go back to work.

**The problem is that to** change the network settings for Windows for Workgroups, you have to be inside Windows. Invoking Setup in DOS lets you change video drivers, but not network card settings. However, when Alex got home, he reminded me of something I had forgotten.

**The evil daemon inside Windows for Workgroups 3.11 will reset your network board interrupt without checking for clashes—and without telling you what it did.**

If you're running Windows for Workgroups, you can access Windows without the network: simply invoke it with WIN /N <return>.

Once you're in Windows, you have available all the controls, including a new program group that Windows for Workgroups 3.11 automatically installs for you. Inside it are some neat tools that include a Network Setup icon; open that, use the drivers button to open a second window, use the setup button to pop up yet another box, and lo!, there is the

EtherExpress IRQ setting.

I did all that and changed that setting to IRQ 10. Immediately I got a warning box: IRQ 10 was in use. Interesting, I thought: this part of the program is smart enough to detect interrupt clashes. I told it to use IRQ 10 anyway. Then I exited Windows and went to the ATI Setup program to set the ATI CD-ROM board from IRQ 10 back to IRQ 5. Once again I got a warning box: IRQ 5 was in use, as of course it was since I hadn't changed the network board; and once again I ignored the warning.

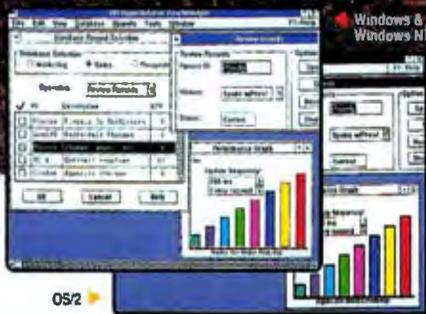
Then I tried to enter Windows for Workgroups again. As expected, the system locked up. Power down. Power back up. Test the CD-ROM drive in DOS. Worked perfectly. Enter Windows for Workgroups. No problem. Access the CD-ROM drive: still no problem, not then, and not later.

**The conclusion is clear:** the ATI software worked fine, but Windows for Workgroups will reset your network board interrupt without checking for clashes—and without telling you what it did. This is an evil bug masquerading as a feature, and we can hope that Microsoft will exorcise it as soon as possible.

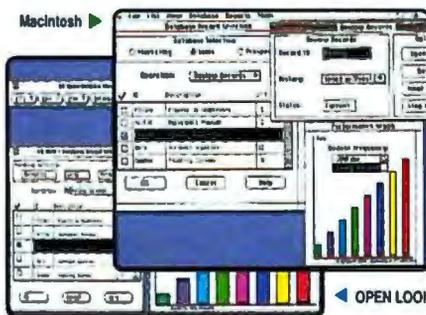
As for the CD Sound Dimension Multimedia Upgrade Kit, if you can get one at a good price, you'll probably be happy with it. The ATI sound board is good enough, although in my judgment Sound Blaster Pro is better. The ATI CD-ROM

WINDOWS  
 WINDOWS NT  
 OS/2  
 MACINTOSH  
 OPEN LOOK  
 OSF/MOTIF  
 CHARACTER SYSTEMS

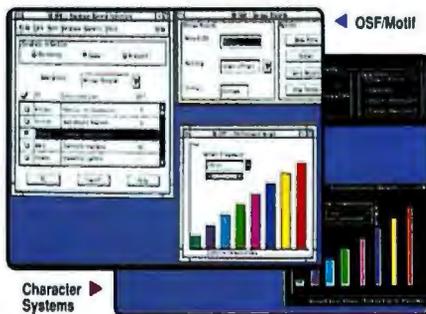
# Develop Cross-Platform GUI Applications in a Single Stroke.



OS/2



Macintosh



OPEN LOOK

OSF/Motif

Character Systems

## Master the art of multi-platform GUIs.

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

## XVT gives you simultaneous original GUIs.

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

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

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

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

## Developers Judge XVT to be a masterpiece.

XVT is the base document for the IEEE's GUI standardization effort. Our thousands of customers include internal and commercial developers like: Alcoa, Amoco, AT&T, Avis, Ford, General Motors, Grammatik/Reference Software, Kodak, Lockheed, NCR, NEC, NIST, Novell, Rockwell, Siemens, Sony, Southwestern Bell, Tandem, Uniplex, Unisys, US Army and US West.

## Call now for a Free XVT Demo and Technical Overview.

1-800-678-7988

NEW!  
 XVT-PowerObjects



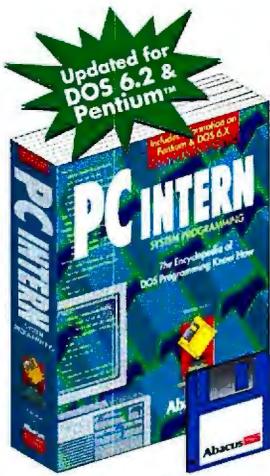
The portable GUI development solution.

XVT Software Inc. 4900 Pearl East Cir. Boulder, CO 80301  
 (303) 443-4223 FAX (303) 443-0969

For European inquiries, contact: Precision Software GmbH  
 Phone: 49 0 61 03/37 94 0 Fax: 49 0 61 03/36 95 5

Circle 153 on Inquiry Card (RESELLERS: 154).

XVT, XVT-Design, XVT-Design++ and XVT Portability Toolkit are trademarks of XVT Software Inc. Other product and company names are trademarks or registered trademarks of their respective holders.



# Work Smarter

## PC Intern System Programming

with Updates for MS-DOS 6.2 and Pentium™

This is a re-release of our all-time best selling PC system programming book. Now PC Intern will include the latest information on programming for DOS, through version 6.2, and programming for the Pentium™ processor. PC Intern is a literal encyclopedia for DOS programmers and contains more than 1300 pages of valuable programming knowledge. The book contains dozens of practical parallel working examples in Assembly language, C, Pascal, and BASIC, for programming video cards,

sound, and TSR's. Covers processors, the motherboard, controller, bus and chip sets (NEAT); overview of ports, interrupts, interrupt calls and their significance; the BIOS memory map and services; and much, much more.

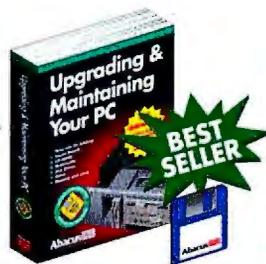
**\$59.95 with companion diskette. Item #B145**



## DOS 6 Complete Special Edition with Updates for MS-DOS 6.2

The most authoritative and up-to-date DOS reference book available. Your guide to Microsoft's latest version of DOS. It's an encyclopedia of the most recent DOS knowledge, for the computer whiz and the everyday user. Includes many useful tips for outfitting any computer with MS-DOS versions 6 through 6.2.

**\$39.95 with companion diskette. Item #B251**



## Upgrading and Maintaining Your PC

How to turn your PC into a high performance machine. It tells you what you'll see when you open the "hood". How to add a new hard drive, increase memory, upgrade your monitor, or turn an XT into a 486 screamer. Includes utilities and SystemSlueth diagnostics software on companion diskette.

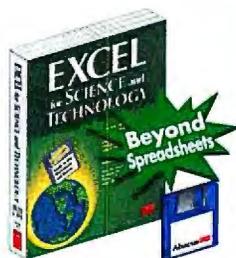
**\$34.95 with companion diskette. Item #B167**



## Multimedia Mania

Explores the evolving multimedia explosion. How to set up a complete multimedia system and how to create presentations. Contains terminology and info about popular programs. Covers audio technology, sound boards and sound recording, CD and CD-ROM technology. Companion CD-ROM features example programs and techniques.

**\$49.95 with companion CD-ROM. Item #B166**

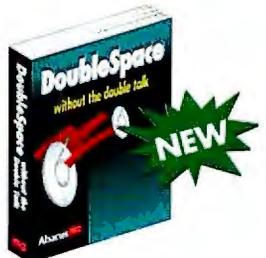


## EXCEL for Science & Technology

Excel beyond the spreadsheet. Learn about Excel Solver, Scenario Manager, Mathematics Functions, Physics, Chemistry, Technology Conversion and many other topics.

Macros and worksheets on the companion disk allow you to immediately apply what you learn. Excel for Science and Technology is more than a book; it's an indispensable professional work tool.

**\$34.95 with companion diskette. Item #B196**



## DoubleSpace Without The DoubleTalk

This book is for DOS 6 users who want to double the amount of disk space on their hard drive with DoubleSpace. The most effective way to learn all about DoubleSpace and make the best use of the program. Presented in short, complete learning units with icons that depict the complexity of the unit's topic.

**\$19.95 Item #B250**

**Order TOLL FREE 1-800-451-4319 Ext. B2**

**Ask for our FREE Catalogs of books and software**

**Abacus**

Dept B2, 5370 52nd Street SE  
Grand Rapids, MI 49512  
1-800-451-4319 Toll Free  
Phone 616-698-0330  
FAX 616-698-0325

## Poumelle

drive is definitely better than the single-speed CD-ROM drives in Creative Labs' early multimedia kits. However, Creative Labs' new Sound Blaster multimedia kits have modern two-speed drives, too, and I'm told they have genuine SCSI rather than the proprietary almost-SCSI the original kits had; more on that next month.

ATI gives you a couple of CD-ROM discs of shareware, most of it not very interesting, nothing like the mountain of software you get with Creative Labs' multimedia upgrade.

The bottom line is that ATI's CD Sound Dimension Multimedia Upgrade Kit is easily installed and is configurable with easy-to-understand software—no jumpers to set. It gives pretty good sound, and the CD-ROM drive is fast and reliable. I'd look at the competition, but if you can get an ATI kit at a good price, go for it; it's more than good enough.

**When you get your CD-ROM drive set up, use Norton Speeddrive. It does a great job of speeding up a CD-ROM drive. I also recommend it over Microsoft's SmartDrive even if you don't have a CD-ROM drive, but there it's not so clear. Windows 3.1 looks at your drive controller and, if it's suitable, offers a 32-bit disk access mode. You can turn that on from the control panel. In the control panel, open the enhanced button (the one that looks like a computer chip); in that, open virtual memory and click on the change button. If you're offered the option of 32-bit disk access, take it.**

Fair warning: be sure you have a good backup of your WIN.INI and SYSTEM.INI files before you do this. I don't know anyone who has got locked out using this (other than the frazzled Alex), but caution is always wise.

If you're running Windows for Workgroups and you've upgraded to version 3.11, you may be offered a second option, 32-bit file access. If you click on that, you'll also be offered the chance to specify a cache size. Mine wants 4 MB, which speeds things up but is silly; on the other hand, cutting that to 512 KB doesn't seem to speed things. I found that 1 MB gives all the improvement I'm going to get.

These 32-bit accesses work with SmartDrive, and they do speed things up. I haven't had a chance to test them with Speeddrive, so I don't even know if that will work at all, much less show a speed improvement. More next month.

**Once we had the CD Sound Dimension Multimedia Upgrade Kit installed in SuperCow, we played with new CD-**

# INTRODUCING THE EVOLUTION V ST

from ALR. As the newest member of ALR's EVOLUTION V family, this system delivers true record-breaking 60 or 66-MHz Pentium processor horsepower. Power that has earned the ALR EVOLUTION V family top honors from BYTE, InfoWorld, and PC/Computing. Engineered to



maximize the Pentium processor,

this powerful system boasts a 64-bit cache/memory design with your choice of 32-bit local bus architectures; VESA VL or PCI.

Large enough to hold gigabytes of storage and eight expansion cards, yet small enough to fit on a desktop, the EVOLUTION V ST is perfect for both small networks and expansion hungry power users. With four drive bays accessible from the front (six total), it's the ideal system for advanced desktop publishing, multimedia design, and other

Starting at  
**\$2995**

# Stylish, Fast and POWERFUL

TECHNOLOGY

## COMPARE!

	The ALR EVOLUTION V ST	The Compaq Deskpro XE 5/60
Pentium 60-MHz	YES	YES
External Cache	256-KB	OPTIONAL add \$325*
VESA Local Bus IDE	YES (VL Systems)	NO
Integrated SCSI-II	YES (PCI Systems)	NO
Drive Bays	6	3
Available Slots	8	3
Power Supply	250 Watts	145 Watts
Warranty	5 Year/15 Month	3 Year
Price	<b>\$2995</b>	<b>\$3024</b> <small>*\$2,799 plus \$225</small>

### ALR bests three other 60MHz Pentium systems

Advanced Logic Research Inc. Evolution V™ **82.2**

AST\*Research Inc. Premmia™ LX P/60 **72.6**

Winstone 94 Version 1.0 Compaq\* Computer Comp. Deskpro™ 60/M **69.2**

IBM\* ValuePoint™ P60.D **75.9**

### Longer bar indicates better performance.

PC Week November 1, 1993 page 21: Winstone 94 measures overall system performance, using one script for each 12 popular Windows applications. It computes the amount of time each script takes to finish, and uses those times to produce an overall score. Timed results are weighted based on the relative market share of each 12 applications.



Starting as low as  
**\$2495**

### EVOLUTION V

- 60- or 66-MHz Pentium Processing
- Supports Pentium Write-Back Mode
- 8-MB RAM (Expandable to 128-MB)
- True 64-bit Data/Cache/Memory Path
- Integrated 256-KB Write-back Cache
- Integrated MULTUS (Multi-seeking) IDE Controller
- Six ISA Expansion Slots
- 3 32-bit VESA VL Local Bus Slots
- Six Drive Bays
- 200 Watt Power Supply



Starting as low as  
**\$4995**

### EVOLUTION V Q

- 60 or 66-MHz Pentium Processor
- Quadflex 128 Architecture (ALR Custom ASICs) with Dual 64-bit Path cache to Memory
- Supports Pentium Write-Back Mode
- Dual 256-KB (512-KB total) 64-bit integrated Write-back Cache
- 16-MB RAM (Expandable to 1-GB)
- True 64-bit Data/Memory Path
- Ten 32-bit EISA Expansion Slots
- 3 VESA VL Local Bus Slots
- 13 Drive Bays
- 415 Watt Power Supply

FREE LOCAL BUS GRAPHICS\*

applications requiring both CD ROM drives and removable hard drives.

And the EVOLUTION V ST is covered by one of the most comprehensive service and support programs in the industry. Even a full year of ON-SITE service is FREE\*



To order the EVOLUTION V ST visit your local ALR reseller or call ALR today.

**800-444-4ALR**

**ALR**

Advanced Logic Research, Inc.

ALR can be reached on CompuServe--GOALRINC

9401 Jeonimo Irvine, CA 92718 (714) 581-6770 FAX: (714) 581-9240

\*One year free on-site service requires registration fee of \$9.95. Not available in all areas. Call for complete details. Systems shown with optional monitors and equipment. Prices, specifications and configurations are subject to change without notice. Verify competitive pricing with manufacturer. Prices based on U.S. dollars. ALR is a registered trademark of Advanced Logic Research, Inc. Intel Inside and Pentium logos are trademarks of Intel Corporation. All other brand and product names are trademarks or registered trademarks of their respective owners. ©1993 by ALR



*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

©1993 Persoft, Inc. SmartMouse is a trademark and Persoft and SmarTerm are registered trademarks of Persoft, Inc. Other trademarks mentioned are properties of their respective companies.

Circle 127 on Inquiry Card.

## REASON #1

# Why *di-ogix*™ is so AMAZING:



It's the world's only integrated Database Management System/Full-Function Spreadsheet/Application Generator that's so easy to use, you don't even have to know what any of this means! With *di-ogix*, anyone can design powerful relational databases, generate detailed reports, mailing labels and graphics and even create complex custom applications and demos — with no programming experience.

Now, there's another **100,000 FREE** reasons... all of them

\*Only \$9.95 shipping and handling in continental U.S..

For years, *di-ogix* has been the world's best-kept software secret. Now, for a limited time, the first 100,000 people who respond can own this powerhouse of a program — for just the cost of shipping & handling.

This DOS version (certified to run from within Windows 3.1) needs just 2 megs of disk space and is as easy to learn and run as any popular spreadsheet — in fact if you know Lotus 1-2-3, you're already an expert *di-ogix* programmer!

Here's what you get with *di-ogix*:

- 400-pg. Manual and Tutorial
- Spreadsheet with over 200 functions
- Relational report generator
- Full-screen debugger
- Powerful application generator
- Utilities to create mailings, business graphics and more
- Royalty-free run-time module

Ask about versions for Windows, Novell and UNIX, too!

**1-800-454-4426**

Order by FAX **1-800-454-4490**

or contact ON TOP SYSTEMS,  
P.O. Box 676, Northbrook, IL 60062

## A MESSAGE TO OUR SUBSCRIBERS

FROM TIME TO TIME WE MAKE THE BYTE SUBSCRIBER LIST available to other companies who wish to send our subscribers material about their products. We take great care to screen these companies, choosing only those who are reputable, and whose products, services or information we feel would be of interest to you. Direct mail is an efficient medium for presenting the latest personal computer goods and services to our subscribers.

Many BYTE subscribers appreciate this controlled use of our mailing list, and look forward to finding information of interest to them in the mail. Used are our subscribers' names and addresses only (no other information we may have is ever given).

While we believe the distribution of this information is of benefit to our subscribers, we firmly respect the wishes of any subscriber who does not want to receive such promotional literature. Should you wish to restrict the use of your name, simply send your request to the following address.

**BYTE** Magazine

Attn: Subscriber Service  
P.O. Box 555, Hightstown, NJ 08520



## Pournelle

installation program demands your name and a company name, and you can't leave the company name blank. I solved that one by typing in "Blast your eyes" when it wanted to know what company. Then it demanded a serial number, which sent me scurrying around looking for the program's box in hopes that somewhere in that box I'd find the registration card with my serial number on it. Eventually I found it. It's a long thing, with several letters and a seven-digit number, and I assumed I'd got it right; the program never said. The installation trundled along and then reset the machine.

Alas, the Bravo LP 4/33 AUTOEX-EC.BAT is set to bring the system up in Windows—and Windows was totally unusable. The cursor was a large black blob that left striped trails whenever I moved it. I couldn't even close Windows with the mouse.

This happened just after I'd spent hours on the phone over the multimedia upgrade problem, and I fear I was a little shrill when I called Binar Graphics. Their technical-support people told me there was an uninstallation program, so apparently there was going to be no problem getting things back. First, though, to get out of Windows. I punched the reset button.

Of course, their disk was in the 3 1/2-inch drive—and there is only one drive on the Bravo LP 4/33. I got the dreaded message that this was not a boot disk. One dreads this message because it is the most common method of virus infection, and even the most reputable publishers have distributed disks with a boot sector virus. In one case I know, a disgruntled employee at the place that manufactured disks was putting a boot sector virus on every thirty-fourth disk sent out.

Meanwhile, it was time to deal with AnyView. We managed to get it uninstalled. Then I installed it again, giving it slightly different information, and this time it worked. I was able to change screen resolutions on the fly without exiting Windows.

Alas, that doesn't turn out to be quite as useful a feat as I thought it was going to be. For one thing, if you change the number of colors, you'll still have to exit Windows. For another, it turns out one rarely wants to change screen resolution. Still, it does work, and I'll try it out on other machines when I've got more time.

Now, though, I had to check the machine for a virus. The only way to do that is to boot the machine with a write-protected floppy disk that has never been exposed to a virus; and, alas, I didn't have

# 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:

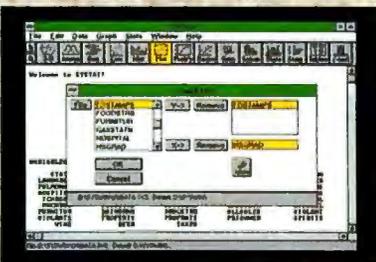
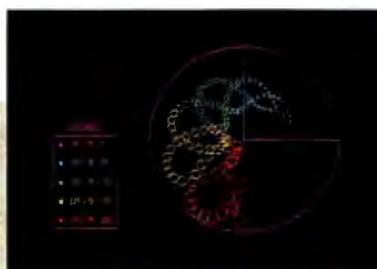
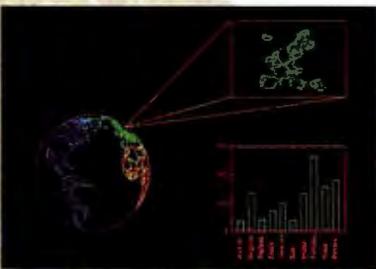
- multiway crosstabs with log linear modeling
- nonparametric statistics
- principal components and factor analysis
- cluster analysis
- time series
- nonlinear estimation
- correlation matrices
- means, effect, and dummy models
- post hoc tests

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



"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 142,  
For IBM/DOS circle 143.



**SYSTAT**®

For more information call or write: SYSTAT, Inc., 1800 Sherman Avenue, Evanston, Illinois 60201-3793. Tel: 708.864.5670, Fax: 708.492.3587

Australia: Hearne Marketing 61.3.8661766, Holland: Oasis 31.34.0266336, Denmark: Agrolab 45.64.406575, France: Deltasoftware 33.76.418508, Germany: STATCON 49.55.4272075, Italy: PiSoft 39.587.213640, Japan: HuLinks 81.33.5902311, New Zealand: Hoare Research 64.7.8582675, Poland: COMPANION 48.12.360791, Spain: AddLink 34.3.4157268, Switzerland: Fritschy & Partner 41.31.3125151, SYSTAT UK: 44.81.4620093

© 1992 SYSTAT®, Inc. *Software Digest* Ratings Report U.S. May, 1991. *Software Digest* is a registered trademark of NSTL, Inc.

a known-clean 3 1/2-inch boot disk. The first thing, then, would be to make one; however, to do that, I had to boot SuperCow with a known-clean 5 1/4-inch disk and install the latest copy of Dr. Solomon's Anti-Virus Toolkit. It was about time I did that anyway.

Installing Dr. Solomon's is simple, and the program runs itself. Once it had

When you get Dr. Solomon's monthly updates, there are both 5 1/4- and 3 1/2-inch disks, so that was no problem.

I hadn't expected a virus, and naturally there wasn't one; but my rule is, if you get the "this is not a system disk" message, it's time to check the machine for a virus. It's unlikely you'll find one, but it doesn't hurt to be careful.

**SPEEDS RELATIVE TO 486SX/20**

Win Tachometer on Jerry's machines. Higher numbers are better.

	WORD PROCESSING	CAD	SPREADSHEET	PAINT	OVERALL
Bravo LP 4/33	14.64	25.9	32.4	17.61	22.64
Cheetah 486/25	13	11.92	18.43	22.52	16.47
Gateway 486/33 DX2	19.09	16.48	36.19	33.02	26.20
Cheetah 386/25	0.45	0.65	0.71	0.62	0.61
Cheetah 486/33	9.42	17.45	17.92	12.13	14.23
Cheetah 486/33	17.76	18.32	27.34	35.79	24.30
Cheetah 486/33	20.37	32.76	38.60	44.37	34.02

checked SuperCow, I used SuperCow to make a 3 1/2-inch boot disk. Then I tried to pry out the little door that makes a 3 1/2-inch disk writable, but I couldn't do it, so I got some Duco Cement and glued that door open. Then I used the disk to boot the Bravo LP 4/33 and ran Dr. Solomon's.

tions: word processing, CAD, a spreadsheet, and a paint program. It gives you a speed estimate for each of those tasks as well as an overall speed relative to a 486SX/20 with standard VGA. This program is freeware, and it can be obtained from BBSes, including the "listings" sec-

tion of the tojerry conference on BIX.

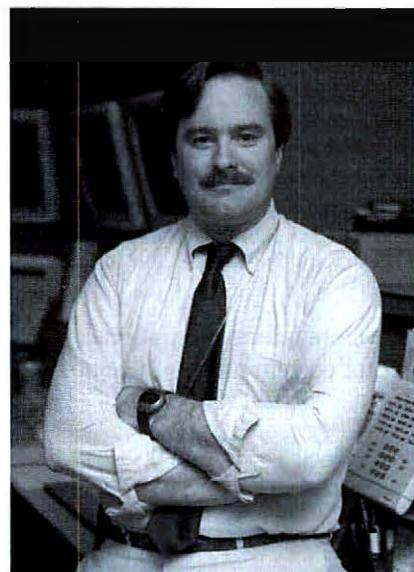
I do not like most benchmark programs. Longtime readers will recall that I once wrote one of my own. Unlike most benchmarks current back then, mine was designed to simulate doing some practical work with the computer. Win Tachometer has the same philosophy, and I like it quite a bit.

I applied it to a number of machines. The table shows the results. Note that all the systems except the Bravo LP 4/33 are running Windows for Workgroups 3.11. The Bravo is running the latest version of Windows 3.1. Both Cheetah 486s have Intel OverDrive DX2 chips, as does SuperCow. In all cases unless otherwise noted, the only open application program is Win Tachometer.

You will note there are three entries for the Cheetah 486/33, and that the first one is astonishingly slow compared to all the others, including the Cheetah 486/25. It was the value I got when I first went around testing the various machines. Needless to say, I wasn't pleased: my main machine, the one I spend my life at, is the slowest of the lot.

A puzzlement. Clearly, the 486DX2/33

**Now it was** time to do some speed tests. I was eager to do that because I had just received a new copy of Texas Instruments' program Win Tachometer. This is a very neat benchmark program that simulates a number of practical applica-



**TIM HEFLIN**  
*Manager, End-User Services*  
**Microsoft, Inc.**

*Network Topology: Ethernet*  
*Networking Protocol: TCP/IP*  
*Host: DEC VAX*

## “DynaComm® is Microsoft’s® choice for terminal emulation.” It should be yours.

Evaluating terminal emulation software? Consider the one Microsoft chose for communicating across their world-wide network. FutureSoft's DynaComm for Windows™ offers a single solution for PCs communicating across multi-platform networks to host computers.

DynaComm features:

- 16 Terminal emulation types for UNIX, DEC, Hewlett-Packard, IBM, and Data General systems
- 19 Network interfaces including TCP/IP and IPX
- Powerful development tools for creating GUI front ends to host applications

**800-989-8908**



**FutureSoft.**

12012 Wickchester Lane, Suite 600 • Houston, Texas 77079-1222 USA  
 713.496.9400 • 713.496.1090 FAX • 800.989.8908 Sales (USA)

Windows is a trademark of Microsoft Corporation. Microsoft is a registered trademark of Microsoft Corporation. DynaComm and FutureSoft are registered trademarks of Future Soft Engineering, Inc.

# TRUTH IN HARDWARE

Vendors make performance claims. Compatibility claims. Support promises.

As a buyer of PCs and peripherals, you need the TRUTH. Based on objective, head-to-head tests of major competitors in each product category. So you can choose the right products the first time.

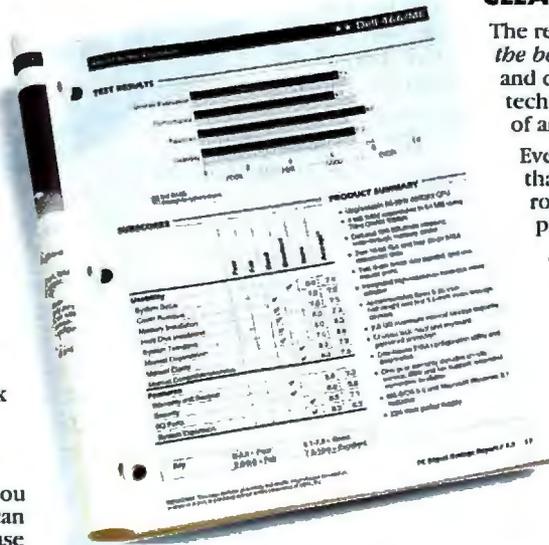
Since the dawn of the microcomputer era, buyers making high-stakes purchases have been using National Software Testing Laboratories (NSTL) for authoritative evaluations of standalone and networked systems and peripherals.

NSTL originated the concept of testing PC products. Today our state-of-the-art benchmarks and methodologies set the mark that others imitate.

### ACCESS TO NSTL TEST RESULTS

PC Digest, published by NSTL/BYTE, gives you direct access to NSTL's test results. So you can make smarter, easier, more confident purchase and upgrade decisions.

No other testing system uncovers core performance, versatility and usability differences. We force products to show their strengths and weaknesses in head-to-head, feature-to-feature competition. In real-world, applications-based environments like the one you work in every day.



PC Digest is published 20 times a year by NSTL, the industry's first and most authoritative independent testing laboratory.

### CLEAR-CUT WINNERS

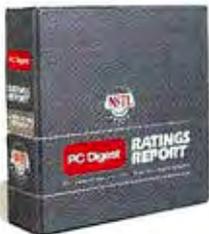
The result: clear-cut winners that give you the best value for your money. Concisely and clearly described by expert test technicians — without ads or distractions of any kind.

Every issue focuses on a new technology that you need to know — or features a roundup of established technologies in price-competitive categories.

- 486 66MHz systems
- EISA Ethernet cards
- Pen systems
- Mobile computers
- Multimedia upgrades
- Unix servers
- High res monitors
- Color notebooks
- SCSI disk drives
- PostScript printers
- CD-ROMs
- 9600 V.42 bis modems

PC Digest's features charts are so complete that vendors consult them before designing upgrades. Shouldn't you consult us before buying your next piece of equipment?

### FREE BINDER



To help you build your resource library, you get a FREE durable, 3-ring binder with tabbed subject dividers upon payment.

### 2 FREE ISSUES

Include payment with your order now (check or credit card) and receive two additional issues with our compliments.



## ORDER NOW!

YES, please enter my subscription to PC Digest for one year (20 issues) at \$445, and send my free binder with my first issue. If I elect to include payment now, add two additional issues to my subscription at no cost. I must be completely satisfied with PC Digest or I will receive a full refund of my entire investment.

MAIL TO: PC Digest, P.O. Box 551, Hightstown, NJ 08520-0551

NAME \_\_\_\_\_

COMPANY NAME \_\_\_\_\_

COMPANY ADDRESS \_\_\_\_\_

CITY/STATE/ZIP \_\_\_\_\_

PHONE \_\_\_\_\_

#### PAYMENT INFORMATION:

Payment enclosed

Please bill me P.O. # required \_\_\_\_\_

Charge my:  Visa  MasterCard  AMEX

ACCOUNT NUMBER \_\_\_\_\_

EXPIRATION DATE \_\_\_\_\_

SIGNATURE \_\_\_\_\_

Orders outside North America: Please add US \$20. for airmail delivery.

PCBB241

PCBP240



### PHONE

1-800-257-9402

### FAX

609-426-5434

### MONEY-BACK GUARANTEE

If at any time you are not COMPLETELY satisfied with your subscription, you will receive a full refund of your entire investment.

processor is as fast as SuperCow and faster than the 486/25. It wasn't likely to be the Perceptive Solutions caching controller; so it had to be the video card. On reflection that wasn't surprising. While I am quick to experiment with my other machines, I do not often make changes in Big Kat; so as improved video boards came in, they went to the other systems. Indeed, when I got out the records, I found that I was using one of the earliest ATI Technologies video accelerator boards, fully two years old (ancient in the Windows business), and the video drivers weren't much more recent. Time for a change, and fortunately I had a new ATI Technologies Graphics Ultra Pro accelerator board. I figured it wouldn't take long to install.

That didn't turn out to be the case.

**I have often sworn to find** and beat senseless the person who designed the IBM PC board-mounting system, and I have just renewed my vows. I have yet to change boards in a big machine without losing at least one screw down in the system and tearing the skin off one or more knuckles. Eventually I got the board in and powered up. No problems, so now it

was time to install drivers.

ATI has a nifty installation program that guides you at every step, and there was no difficulty copying over and activating the Graphics Ultra Pro drivers; but when I tried to access Windows for Workgroups, the system locked up to hardware reset. This was serious, because the column was due, and this isn't a test-bed system, this is Big Kat, the machine I do all my work on. This was panicsville.

The ATI installation program has an uninstall, and if I'd been thinking I would have used that, but all I could think of was a line from the musical *Li'l Abner*: "Put 'em back, the way they was!" I took out the Graphics Ultra Pro accelerator board and put the old one back in, powered up, and while it worked just fine in DOS, I couldn't get into Windows. That forced a realization on me: while I write this column in Q&A Write, a DOS word processor, and I send

it in with Procomm Plus 2.0, a DOS communications program, I would really hate it if I had to operate without Windows. Indeed, not only am I hooked on Windows,

I'm hooked on Windows for Workgroups and easy networking.

I like my system, with the six CD-ROM drives and a whole bunch of other assets available on demand.

Fortunately, there was a way to get back to where I was earlier in the day. I may do some silly things, but I'm

not crazy. Before I made

any changes at all to Big Kat, I did a complete backup to the Palindrome DAT (digital audiotape) drive. Restoration was a snap: I deleted the entire C:\WINDOWS directory and subdirectories, invoked Palindrome's Network Archivist, and issued the command TNARECOV.

Having said that, honesty compels a confession: it could have been that simple, but it wasn't. Instead, I fooled around



## GREAT THINGS COME IN SMALL PACKAGES

*This powerful print server can tackle your biggest network printing problems*

- Connects any parallel printer directly to your Ethernet LAN
- Fully Novell Netware 286 and 386 compatible
- Can attach to 8 file servers simultaneously
- Fast and easy to install
- Combines high-speed printing and exceptional printer control
- Supports encrypted passwords, forms, notify, cancel, and others
- Full one-year warranty and unlimited free technical support
- Made in the U.S.A.



## Make the Rose Connection



10850 Wilcrest Drive • Houston, Texas 77099 • Phone (713)933-7673 • Fax (713)933-0044

**1-800-333-9343**

# EXPLORE the INTERNET!

# FREE!

DELPHI is the only major online service to offer you full access to the Internet. And now you can explore this incredible resource with no risk. You get 5 hours of evening/weekend access to try it out for free!

Use DELPHI's Internet mail gateway to exchange messages with over 20 million people at universities, companies, and other online services such as CompuServe and MCI Mail. Download programs and files using **FTP** or connect in real-time to other networks using **Telnet**. You can also meet people on the Internet. **Internet Relay Chat** lets you "talk" with people all over the world and **Usenet News** is the world's largest bulletin board with over 3500 topics!

To help you find the information you want, you'll have direct access to powerful search utilities such as "Gopher," "Hytelnet," "WAIS," and "the World-Wide Web." If you aren't familiar with these terms, don't worry; DELPHI has hundreds of expert online assistants and a large collection of help files, books, programs, and other resources to help get you started.

Over 600 local access numbers are available across the country. Explore DELPHI and the Internet today. You'll be amazed by what you discover.

## 5 HOUR FREE TRIAL

Dial By Modem 1-800-365-4636, Press return until you get a prompt  
At Username, enter JOINDELPHI. At Password, Enter SMM42

Complete details are provided during the toll-free registration

Circle 281 on Inquiry Card.

**Attention Current Internet Users:** See what DELPHI can offer you! Stock quotes, Grolier's Encyclopedia, newswires, and hundreds of other services are just a few keystrokes away. Telnet to delphi.com and enter the username and password above for a free trial.

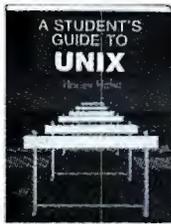
# DELPHI

Questions? Call 1-800-695-4005.  
Send e-mail to INFO@delphi.com

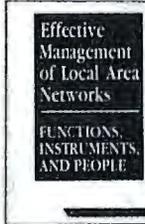
# 4 books for only \$4<sup>95</sup>

Values to \$184.45

when you join the *Computer Professionals' Book Society*



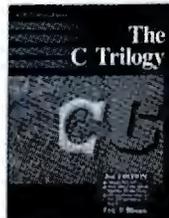
0255113H \$26.50



063638H \$40.00



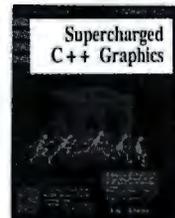
881691P-XX \$39.95  
Counts as 2/Softcover



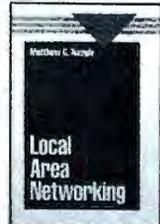
3946P \$26.95  
Softcover



006215H \$40.00



3489P \$24.95  
Softcover



046455H \$38.00



0464618H \$40.50



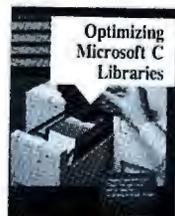
157673H-XX \$50.00  
Counts as 2



051218H-XX \$39.95  
Counts as 2



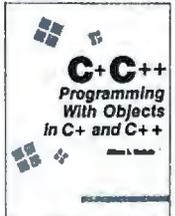
881776P \$27.95  
Softcover



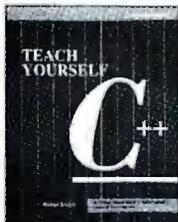
3735H \$34.95



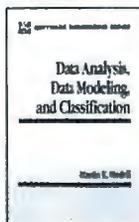
4114P-XX \$39.95  
Counts as 2/Softcover



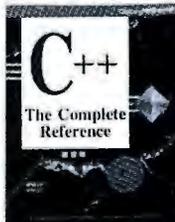
029662P \$24.95  
Softcover



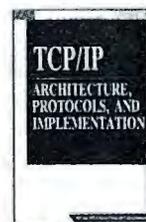
881760P \$24.95  
Softcover



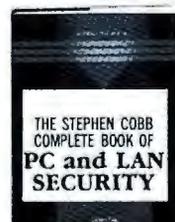
042634H \$40.00



881654P \$29.95  
Softcover



020346H-XX \$45.00  
Counts as 2



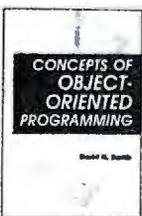
3280H \$36.95



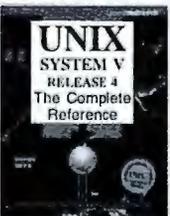
042588H \$45.00



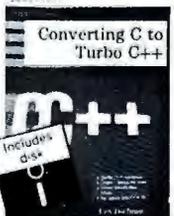
4340P-XX \$34.95  
Counts as 2/Softcover



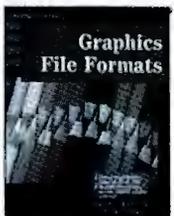
10039P \$24.95  
Softcover



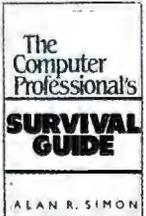
881653P-XX \$29.95  
Counts as 2/Softcover



4084H-XX \$39.95  
Counts as 2



3969H \$36.95



057574H \$24.95



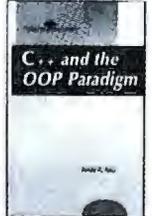
4196H \$32.95



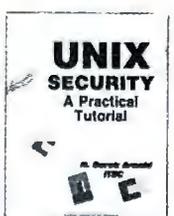
3279P \$24.95  
Softcover



9309P \$29.95  
Softcover



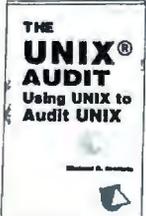
051140H \$40.00



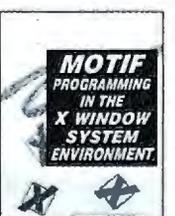
0025606P \$24.95  
Softcover



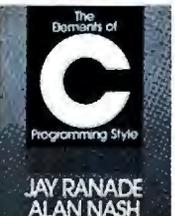
881796P \$27.95  
Softcover



025127H \$29.95



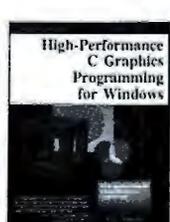
031722H \$45.00



JAY RANADE  
ALAN NASH  
051278P \$29.95  
Softcover



054028H \$44.95



4103H \$34.95



881933P-XX \$39.95  
Softcover

## As a member of the Computer Professionals' Book Society . . .

. . . you'll enjoy receiving Society bulletins every 3-4 weeks containing exciting offers on the latest books in the field at savings of up to 50% off of regular publishers' prices. If you want the Main Selection do nothing and it will be shipped automatically. If you want another book, or no book at all, simply return the reply form to us by the date specified. You'll have at least 10 days to decide and if you ever receive a book you don't want, due to late mail delivery of the News, you can return it at our expense. And you'll be eligible for **FREE BOOKS** through the Bonus Book Program. Your only obligation is to purchase 3 more books during the next 2 years, after which you may cancel your membership at any time.

If you select a book that counts as 2 choices, write the book number in one box and XX in the next. All books are hardcover unless otherwise noted. Publishers' prices shown. A shipping/handling charge and sales tax will be added to all orders. ©1994 CPBS

If card is missing, write to:  
Computer Professionals' Book Society, Blue Ridge Summit, PA 17294-0870

# No Doubt

YOU're  
the  
Expert!

BYTE READERS are considered **experts** in today's complex computer environment. When you need to make decisions, BYTE editorial is there to give information on current products and emerging technologies.

And when you order products, **BYTE advertisers** are ready to answer your every need. Use the convenient toll-free numbers in this issue, and remember to say:

You Saw it in  
**BYTE**

## Pournelle

with Palindrome's rather arcane command structure for a quarter of an hour and then in panic called Jeff Sloman, who often works with the Palindrome people. Alas, I was off by an hour on his time zone and woke him up. He was very nice about that, but he couldn't help, so I had to do the ultimate: I found the Palindrome manual. Much of that manual is no model of clarity, but one section, on how to restore an entire volume, is not only clear, but gently written in soothing language designed to produce calm. It told me to use TNARECOV, which I did. Fifteen minutes later all was well.

**I fired off another fax** to ATI Technologies and went to bed, disgruntled that Big Kat was still the slowest machine in

the house. The next morning I talked to Jeff Sloman as well as the ATI technical-support people. They all told me the same thing: ATI makes wonderful hardware, but their drivers are perhaps not the best. Jeff put it more strongly: "When you get ATI boards, you join the driver-of-the-week club." Everyone agreed that the ATI board would work, but I should get the latest ATI drivers.

Those are available from the ATI BBS or from CompuServe. I don't currently have a CompuServe account, so there was nothing for it but to set the Demon Dialer to try to access the ATI BBS; after about 20 tries I got through. The BBS gives clear instructions, and soon I was downloading the newest driver file. There was a lot of line noise, so this took longer than I

## For More Information

The **AnyView Screen Commander for Windows** (\$69.95) lets you change screen resolutions without having to restart Windows. Contact **Binar Graphics, Inc.**, 30 Mitchell Blvd., San Rafael, CA 94903, (415) 491-4182; fax (415) 491-1164. **Circle 1146 on Inquiry Card.**

I like the **Bravo LP 4/33** (with 4 MB, \$1467; with 8 MB, \$1676; with 16 MB, \$1885; 14-inch monitor, \$402; 15-inch monitor, \$517). Contact **AST Research, Inc.**, 16215 Alton Pkwy., Irvine, CA 92718, (800) 876-4278 or (714) 727-4141; fax (714) 727-9355. **Circle 1147.**

The **CD Sound Dimension Multimedia Upgrade Kit** (\$399) is easily installed and configurable, with easy-to-understand software. It gives pretty good sound, and the CD-ROM drive is fast and reliable. Fortunately, when it was time to change the video accelerator board in Big Kat, I had a new **Graphics Ultra Pro** board (\$499). Contact **ATI Technologies, Inc.**, 33 Commerce Valley Dr. E, Thornhill, Ontario, Canada L3T 7N6, (905) 882-2600; fax (905) 882-2620. **Circle 1148.**

Installing **Dr. Solomon's Anti-Virus Toolkit** (for DOS, £99; for Windows, £125; for OS/2, £149) is simple, and the program runs itself. Contact **S&S International, Ltd.**, Berkley Court, Mill St., Berkhamsted, Hertfordshire HP4 2HB, U.K., +44 442 877877; fax +44 442 877882. **Circle 1149.**

The **Library of the Future, 2nd Edition** (\$299) has a number of classic works on CD-ROM, some of which aren't readily available. If you're doing scholarly work, having the texts in electronic form for searches and comparisons is a real boon. Contact **World Library, Inc.**, 12914 Haster St., Garden Grove, CA 92640, (800) 443-0238 or (714) 748-7197; fax (714) 748-7198. **Circle 1150.**

MicroProse's **Master of Orion** (\$59.95) is a game of interstellar colonization, conquest, and diplomacy. If you like complex strategy games, you'll like this a lot. Contact **MicroProse**, 180 Lakefront Dr., Hunt Valley, MD 21030, (410) 771-1151; fax (410) 771-1174. **Circle 1151.**

The **Microsoft Musical Instruments CD-ROM** (PC and Mac versions, \$79.95 each) has hypertext links, pictures of the instruments, explanations of the parts, sound recordings of the instruments in action, and the Sound Box, which lets you click on notes and hear the result. This CD-ROM is definitely a keeper. Contact **Microsoft Corp.**, 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080; fax (206) 883-8101. **Circle 1152.**

A small plastic stand with a spring to hold up your mouse tail, **Mouse Tamer** (\$4.95) works wonders. I cannot imagine how I ever lived without this thing. Contact **American Business Concepts**, 4400 Sunbelt Dr., Dallas, TX 75248, (800) 877-4797 or (214) 380-8724; fax (214) 407-9096. **Circle 1153.**

No sound board has as good quality for the money as Turtle Beach's **MultiSound** (\$599). If you're serious about sound, get this board. Contact **Turtle Beach Systems**, 52 Grumbacher Rd., York, PA 17402, (717) 767-0200; fax (717) 767-6033. **Circle 1154.**

When you get your CD-ROM drive set up, use **Norton Speedrive** (\$99). It does a great job of speeding it up. Contact **Symantec Corp.**, 10201 Torre Ave., Cupertino, CA 95014, (800) 441-7234 or (408) 253-9600. **Circle 1155.**

A wonderful CD-ROM called **Twain's World** (\$39.95) has everything Mark Twain wrote and includes biographical data, maps, historical background, sounds, and video; a Twain lover's delight. It's a lot more than just books on CD-ROM. Highly recommended. Contact **Bureau of Electronic Publishing**, 141 New Rd., Parsippany, NJ 07054, (800) 828-4766 or (201) 808-2700; fax (201) 808-2676. **Circle 1156.**

thought, but eventually I had it.

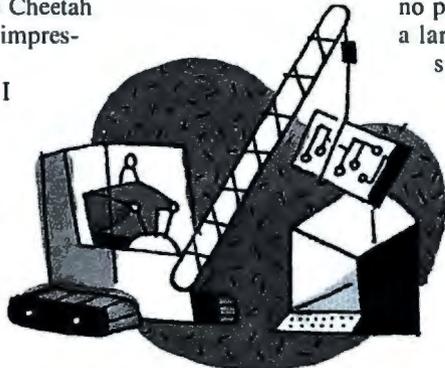
Once again I took out the old board and put in ATI Technologies' Graphics Ultra Pro. Then I installed the latest ATI Mach 32 drivers, accessed Windows, and found the machine locked up to hardware reset. This time, though, I ran the ATI uninstallation program. When I went to Windows Setup, I found there was no currently installed video driver. One of my choices was the ATI Ultra Pro 1024 by 768 driver. I selected that, entered Windows without any problem at all, and when I ran Win Tachometer, I got the results shown in the second entry for the Cheetah 486DX2/33. Pretty impressive, no?

As an epilogue, I spent an hour today with ATI Technologies' technical-support people in a futile effort to make the Mach 32 driver work with this system. Eventually we gave up, concluding that there's some conflict with Windows for Workgroups 3.11. I can live without the Mach 32 driver until they get that fixed; meanwhile, it's nice to see Big Kat up there in contention as the fastest machine in the house. This certainly wasn't bad for a 4-year-old computer.

Last-minute flash: the third entry is with the Graphics Ultra Pro with Mach 32 drivers, which I was able to install by turning off the 32-bit file access capability in Windows for Workgroups. I don't know

why you must do this, and neither does ATI; but wow does it ever work.

**Bottom line on Windows for Workgroups:** if you use Windows and are contemplating networks, seriously consider it; and if you are already using Windows for Workgroups, by all means upgrade to version 3.11. The new version fixes many bugs and glitches, although, alas, it does not solve the problem of it locking up when doing long writes across the network to optical drives. I can read from optical drives, and short writes are no problem; but copying a large directory can do some very weird things. More on that another time.



Meanwhile, the panting sound punctuated with cries of wild triumph you may hear in the background is Alex celebrating. He now has Windows

for Workgroups 3.11 working with Novell NetWare. Much more on that next month, along with a story from the front on Microsoft versus Novell.

**The gadget of the month** is Mouse Tamer. This is about the simplest thing you can imagine, a small plastic stand with a spring to hold up your mouse tail. It works wonders. I used to have mouse-tail problems every hour or so. Even when the desk is covered by a paper blizzard, I can

now reclaim my rodent. I cannot imagine how I ever lived without this thing. Recommended.

**The computer book** of the month is by Daniel P. Dem, *The Internet Guide for New Users* (McGraw-Hill, 1993); everything you need to know about getting onto the information highway. The book of the month is by Nicholas Bomoff, *Pink Samurai*, (Pocket Books, 1993); everything you ever wanted to know about the courtship, dating, and mating habits of the modern Japanese, with some interesting observations on Japanese culture.

The game of the month remains MicroProse's Master of Orion, but do be sure to download the latest bug fix patches from GENie or the MicroProse BBS. Master of Orion is a game of interstellar colonization, conquest, and diplomacy, and, if you like complex strategy games, you'll like this a lot.

Next month: Alex and the memory monster; the new Q&A for Windows; QEMM versus EMM386; Windows for Workgroups and NetWare; and a roundup of the usual suspects. It's a great life if you don't weaken. ■

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

# ROMDISK™

## SOLID STATE Disk Emulators and PCMCIA Products

### Board Level Disk Emulators

- Direct replacement for mechanical drives in embedded systems
- Capacities from 180K to 14MB
- Flash, EPROM and battery-backed SRAM technologies
- Mixed technology models available
- Dual Drive and Hard Drive emulation support
- High performance and low cost models available
- 8 and 16 Bit ISA Bus support

### PCMCIA Carddrives and Host Adapters

- Add PCMCIA sockets to your desktop or embedded system
- 100% PCMCIA 2.1 compliant
- Dual socket models available
- Software support for all types of memory and I/O Cards
- Support for Type III ATA Drive Cards
- Internal model fits in 3 1/2" drive bay
- External models also available

### 3 1/2" and 5 1/4" Disk Drive Models

- Read/Write Flash IDE drives with capacities from 2.5 to 40MB
- DRAM Based high performance SCSI drives with capacities from 16MB to 256MB. Built-in battery back-up. Fast SCSI-2 supports 10MB/s transfer rates.

### Features and Applications

- Autoboot capability, all drives. Support for all popular operating systems. High performance and solid state reliability.
- **Applications:** Embedded Systems, Diskless PCs, High Performance PCs, LANs, Medical, CAD/CAM, POS, Industrial Control, Graphics Imaging, Multimedia, Database and On-Line Transaction Processing, etc.

*Industry Leader in Disk Emulation Products*

**CURTIS, INC.**

For PCMCIA Products circle 86, OTHER Products circle 87 on Inquiry card.

418 W. County Rd. D • St. Paul, MN 55112 • 612/631-9512 • FAX 612/631-9508



**BEFORE SURE!MAPS,  
THIS WAS THE ONLY WAY  
TO ACHIEVE  
PIN-POINT ACCURACY.**



*Expand Sure!MAPS with detailed information on major metropolitan areas.*



*Street maps let you pin-point locations by address or latitude/longitude.*



Now there's a better way: Sure!MAPS™ CD-ROM based desktop mapping software from Horizons Technology. No more colored stick pins. No more holes in your office wall. Sure!MAPS brings detailed mapping capabilities directly to your DOS or Windows PC. Import your database into Sure!MAPS to reveal geographic trends that will help you make faster and better business decisions. Whether it's real estate listings, office locations, customer sites or virtually any kind of point-specific data, Sure!MAPS can open your eyes to a world of valuable insights.

The Sure!MAPS base product includes a continental U.S. map and two world maps. You can expand your map coverage by ordering full-color raster USGS Map Sets of major metropolitan areas, complete with terrain contours and details like airports, parks, rivers, buildings and bridges. Street-level maps and satellite imagery are available, too. All you have to do is pick the Map Set that contains your city or region and Sure!MAPS does the rest. It even imports spreadsheet and database files, calculates distance and area, and scrolls from map to map in one seamless presentation.

Pin-point mapping will never be the same after Sure!MAPS. So throw away those little pins and call **1-800-828-3808**. Or plot a course to your local distributor, reseller or computer store to get your copy today.



Circle 278 on Inquiry Card (RESELLERS: 279).

Horizons Technology, Inc.  
3990 Ruffin Rd.  
San Diego, CA 92123-1826  
**(800) 828-3808**

Sure!MAPS is a trademark of Horizons Technology, Inc.  
Street-level maps are copyrighted by Etak, Inc.

# What's New Hardware



## DESKTOP INK-JET ▲

Based on the company's first internally developed engine, Lexmark's (Lexington, KY) IBM ExecJet II 4076 prints at a speed of 300 characters per second in draft mode and at 167 cps in letter-quality mode for an output of 3 ppm. The monochrome ink-jet printer (\$349) includes features such as scalable fonts and Print Quality Enhancement Technology for 600- by 300-dpi resolution. Built-in IBM Proprinter data stream and HP DeskJet 500 emulation provide compatibility with most software applications.

Phone: (800) 358-5835 or (606) 232-2000.

Circle 1314 on Inquiry Card.

## PARALLEL-PORT BACKUP



A parallel-port tape-backup and recovery system, FileSafe Side-Car II (\$475) is designed for peer-to-peer networks, stand-alone PCs, and portable computers. From Mountain Network Solutions (Scotts Valley, CA), the system's integrated pass-through allows sharing of the port with a printer. The unit stores up to 305 MB of data on a single DC2120 cartridge and has a data transfer rate of up to 10 MB per

minute. The system is compatible with FileSafe for Windows and ships with the company's Format-on-the-Fly, which formats the tape as it is used.

Phone: (408) 438-6650.

Circle 1323 on Inquiry Card.

## SHARE A PRINTER

The Sprinter II line of printer-sharing devices (from \$499) lets multiple users share multiple printers. From Belkin Components (Compton, CA), the Sprinter II queues the data in its buffer as the data is sent and then directs it to the specified printer in the order received. With four output ports on each unit, Sprinter II permits as many as four printers to be hooked up at a time. A cascade feature allows any computer to access any printer anywhere on the Sprinter II network.

Phone: (310) 898-1100.

Circle 1332 on Inquiry Card.

## MULTIMEDIA PC

The Beethoven MPC-2 (\$1495) is a TV-ready, 486SX-based, MPC Level 2-compliant PC. The 25-MHz Windows-based system from Weames Technology (San Jose, CA) includes the company's double-speed CDD-110 CD-ROM drive, which has a

307-KBps transfer rate with a burst transfer rate of 1.2 MBps. The PC has audio pass-through, letting you play standard audio CDs in the background while you're running an application. The included Beethoven Wave/DSP 16-bit stereo sound board has record and playback resolutions of from 5.5 kHz to 48.4 kHz and is compatible with most standard sound boards.

Phone: (408) 456-8838.

Circle 1331 on Inquiry Card.

## PRESENTATION SYSTEMS

The Impact 256 dual-scan color passive-matrix projection system (\$4995) features a wireless remote control and built-in memory that saves adjustments from previous viewing sessions. You can store up to 40 setup combinations; when the LCD panel senses the unique incoming VGA, SVGA, or Mac video signal, it automatically applies the correct setting to provide the best image. The NovaCorp (Roches-

ter, NY) panel also has the ability to compress and display SVGA images of up to 800 by 600 pixels on the panel's 640-by 480-pixel display.

Phone: (716) 647-6510.

Circle 1317 on Inquiry Card.

The DPS-I (\$5995) from IntelliMedia (Benton Harbor, MI) is a self-contained digital presentation system with a Windows-based software utility. You insert a 3½-inch disk containing your presentation, power up the system, and then use the infrared remote to control the presentation or add audio and video effects. Since the digital video signals are produced directly within the system, the DPS-I provides computer-generated images and full-motion video. Two internal speakers provide sound from MIDI and WAV files. The unit displays resolutions of up to 640 by 480 pixels.

Phone: (800) 706-0077 or (708) 834-7141.

Circle 1318 on Inquiry Card.

## CELLULAR DATA TRANSFER

A 1-pound cellular communications device designed for use with portable computers, the AirCommunicator lets you use your current software applications to send and receive E-mail, faxes, and data files. When you unplug the device, you have a fully featured cellular phone.



The AirCommunicator connects to the serial port of your portable PC and transmits over standard cellular phone networks; an RJ-11 jack lets you connect to standard phone lines. You can send data at a transfer rate of up to 57.6 Kbps and send and receive faxes at up to 14.4 Kbps. The device automatically switches between different standard protocols for maximum efficiency. Cost is \$1495.

Contact: Air Communications, Sunnyvale, CA, (800) 247-3282 or (408) 749-9883.

Circle 1308 on Inquiry Card.

## NETWORK IN A KIT

The Pocket WinLAN Instant Networking Kit (\$229 per PC) from Apex Technology (Boise, ID) provides everything you need to create a workgroup consisting of two to 30 PCs. You snap the included Pocket WinLAN adapter onto your PC's parallel port, connect the PCs with the included phone cable, and install Microsoft Workgroup Add-On for Windows 3.11 (which is also included) as your networking software.

Phone: (800) 767-4858 or (208) 336-9400.

Circle 1313 on Inquiry Card.

## EASY SOUND

The 16-bit AudioBlitz Classic sound card (\$79) from Genoa Systems (San Jose, CA) is compatible with all industry standards, such as Sound Blaster, AdLib, and Windows Sound System. You can record and play back sound in 8- or 16-bit mode, and you have a choice of compression methods. The card includes an FM synthesizer, direct line level and microphone input for recording, and an internal 4-W amplifier to enhance output.

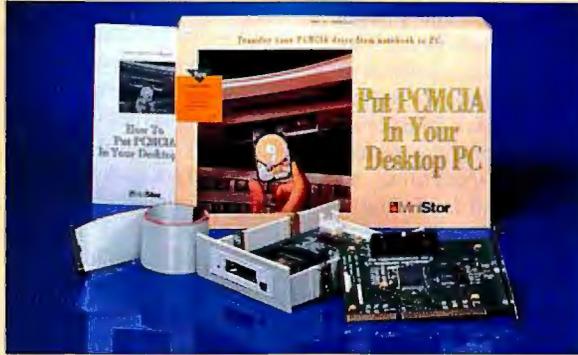
Phone: (800) 934-3662 or (408) 432-9090.

Circle 1319 on Inquiry Card.

## NETWORK PROTECTOR

The LANMax line of power-protection devices (from \$99) protects your network from power surges and spikes on your data and AC lines. The Panamax (San Rafael, CA) suppressors provide ground-reference equalization between your communications and power systems, as well as protection against ground differentials between nodes on the network. Targeted toward workstations and other equipment at the node, the devices have multiple AC outlets and RJ-11/45 (in/out) outlets. The LANMax suppressors provide protection for Ethernet 10Base-T, token ring, Apple-

## ADD A PCMCIA SLOT TO YOUR PC



The Dockit Socket lets you use PCMCIA cards with your current 386 or 486 desktop PC. You simply install the Dockit Socket in a free drive bay in your unit for access to most PCMCIA Type I, II, III, and larger peripherals. The socket reads data from the card at an average data transfer rate of 230 KBps. The unit costs \$249; with a MiniStor 128-MB PCMCIA card, the cost is \$948.

Contact: MiniStor Peripherals, San Jose, CA, (800) 943-0165 or (408) 943-0165.

Circle 1310 on Inquiry Card.

Talk, and ARCnet running on UTP cable.

Phone: (800) 472-5555 or (415) 499-3900.

Circle 1324 on Inquiry Card.

## TWO COLOR TECHNOLOGIES IN ONE PRINTER

Fargo Electronics' (Eden Prairie, MN) Photo-Realistic Upgrade Kit (\$249.95) combines dye-sublimation and thermal-transfer technology in the Primera Color Printer. After you upgrade the printer driver in your PC, Mac, or Amiga, you can use your Primera to print quick proofs via wax-thermal transfer and then replace the wax-thermal-transfer ribbon with the dye-sublimation ribbon to get high-quality prints.

Phone: (800) 258-2974 or (612) 941-9470.

Circle 1320 on Inquiry Card.

## PCMCIA ETHERNET

The NE4000T (\$299) and NE4000 (\$349) adapters connect

PCMCIA-compatible notebooks to Ethernet networks. From Microdyne (Alexandria, VA), the NE4000T supports 10Base-T UTP cable. The NE4000 includes a stainless-steel base unit and a media coupler that supports BNC 10Base-2 cable.

Phone: (703) 739-0500.

Circle 1322 on Inquiry Card.

## A FLEXIBLE, PORTABLE PLOTTER ▼

The Draftsman 100 portable plotter from Parallelex (Indialantic, FL) produces full D-size drawings. Designed with a traveling arm, the plotter uses standard Hewlett-Packard pens that move in both the x and y axes at a speed of 9½ inches per second while the paper remains stationary. The 5-pound Draftsman 100 (\$1198) can be table- or wall-mounted. Connec-



tion to your computer is via the parallel port.

Phone: (407) 952-4310.

Circle 1321 on Inquiry Card.

## BAR CODE READER WITH A VOICE

With a prerecorded custom voice prompt, the TriCoder Portable Reader (from \$799) lets you record up to 65 voice messages to be broadcast at specific data-entry steps and errors. You can program the reader or use the built-in default inventory programs, and you can upload to the host computer with the provided BASIC programs or your own communications program, such as Procomm or Q-Modem. The package is from Worthington Data Solutions (Santa Cruz, CA).

Phone: (800) 345-4220 or (408) 458-9938.

Circle 1315 on Inquiry Card.

## VL-BUS CONTROL FOR IDE

The CSA-6210 32-bit VL-Bus IDE disk controller (\$69) supports up to four IDE drives, two serial ports, and one bidirectional parallel port. From CMD Technology (Irvine, CA), the card is compatible with software features such as NetWare disk mirroring; Windows NT RAID 0, 1, and 5; Windows FastDisk; and MS-DOS driver support. Sustained transfer rates are as high as 8.2 MBps, and peak transfer rates are as high as 8.33 MBps.

Phone: (800) 426-3832 or (714) 454-0800.

Circle 1325 on Inquiry Card.

# What's New Hardware

## WORKGROUP DYE-SUBLIMATION PRINTER



**Tektronix's new Phaser 480 is a full-bleed 11- by 17-inch dye-sublimation color printer. Its built-in support for PostScript Level 2 provides raster-image processing at speeds of less than 3 minutes for a three-pass tabloid-size page and less than 4 minutes for a four-pass color page, Tek-**

**tronix says. The Phaser 480 is designed to address a wide range of graphic arts and scientific and engineering applications, and it has automatic intelligent switching among its parallel, serial, and AppleTalk ports and protocols.**

**The printer's base 32-MB memory is expandable to 64 MB in 16-MB increments. Using the Phaser Print plug-in for Adobe Photoshop software, you can print large Photoshop raster files across a network at nearly the speed of a dedicated, directly connected raster printer, according to Tektronix. The printer costs \$14,995.**

Contact: Tektronix, Wilsonville, OR, (800) 835-6100 or (503) 682-7377.

Circle 1311 on Inquiry Card.

## CD-ROM FOR YOUR NETWORK

Procom Technology's (Irvine, CA) CD Tower-7 subsystem (from \$2795) lets you share CD-ROM applications over a network. The CD Tower-7 has from two to seven double-speed CD-ROM drives with up to 4.2 GB of storage; you can simultaneously access data stored in any drive. The drives offer sustained data transfer rates of up to 330 Kbps and an average access time of 200 ms.

Phone: (714) 852-1000.

Circle 1327 on Inquiry Card.

## DISPLAY SUPER VIDEO IN WINDOWS OR DOS

Super VideoWindows-SL (\$895), from New Media Graphics (Billerica, MA), displays full-motion video in a window on your PC screen. You can infinitely scale the window from full-screen size to icon size, and you can locate it anywhere on the screen while you run other applications. Super VideoWindows-SL runs in

Windows or DOS and can grab individual frames of video in PCX, BMP, SVW, and TGA file formats for porting to other applications.

Phone: (508) 663-0666.

Circle 1326 on Inquiry Card.

## SMART SECURITY ▼

The Smart CAT (Computer-Access Authentication Terminal) from V-One (Virtual Open Network Environment, Potomac, MD) uses smart-card technology to safeguard the security of your computer network as well as your personal information. Comprising the card and a card-reader terminal that attaches to your computer, Smart CAT



(\$395) operates in Windows 3.1 and works independently of your network software. A chip on the card stores information that lets you access your passwords; you activate the card via a PIN. The card encrypts files via DES with a separate key that's randomly generated for each file. In addition to storing private information, you can store information that's open to public view.

Phone: (301) 983-8362.

Circle 1312 on Inquiry Card.

## VOICE ANNOTATION ON THE ROAD

The 2½-pound, 486SLC-based DTR-Sound System (\$2995) provides voice annotation, business audio, and multimedia functions. From Dauphin Technology (Lombard, IL), the unit lets you perform tasks such as recording voice memos or describing a spreadsheet. The mobile system includes an internal fax modem, 4 MB of RAM (expandable to 8 MB), a 40-MB hard drive, standard I/O ports, an internal microphone, two external speakers, and an external microphone.

Phone: (708) 971-3400.

Circle 1329 on Inquiry Card.

## A CELLULAR MODEM

The Collect 14.4 PCMCIA modem (\$549) from Motorola UDS (Huntsville, AL) features the company's Enhanced Cellular Control (EC<sup>2</sup>) to improve cellular data reliability while retaining compatibility with CCITT- and Bell-compliant modems. The modem connects to any data-capable Motorola MC<sup>2</sup> MicroTAC cellular phone. The modem has a maximum throughput rate of 57.6 Kbps and supports standard asynchronous speeds down to 300 bps; it also supports UUCP spoofing for high-speed Unix applications.

Phone: (205) 430-8000.

Circle 1328

on Inquiry Card.

## PLUG-IN DIAGNOSTICS

The POSTcard V2 plug-in diagnostic board (\$499.95) monitors POST routines, provides continuous burn-in testing of the pre-boot function, and supports comprehensive system-function and component diagnostics for 386, 486, and Pentium PCs. From Unicore Software (North Andover, MA), the diagnostic board tests, sources, and pinpoints IRQ and DMA conflicts and monitors any 16-bit port address.

Phone: (508) 686-6468.

Circle 1316 on Inquiry Card.

## TYPE WITH YOUR THUMBS

The Touch Edit keyboard (from \$99) adds eight extra keys below the space bar that you touch-type with your thumbs. Five of the extra keys are standard editing keys, such as the arrow and delete keys; the other three are new keys that move the cursor by an entire word in either direction or delete a word. The Key Innovations (Minnetonka, MN) keyboard reduces the number of



editing keystrokes by a factor of five, according to the company, and it eliminates right-wrist flexion by shifting the strokes to your thumbs.

Phone: (612) 724-7745.

Circle 1333 on Inquiry Card.

## TAKE YOUR MOUSE ANYWHERE

The Mouse Slide (\$24.95), from Creative Computer Accessories (Walnut Creek, CA), attaches to the bottom of most notebook computers and slides out for use as a mouse pad. You can extend the platform to either side of your notebook.

Phone: (510) 934-1930.

Circle 1330 on Inquiry Card.

The inspiration for our new Club World<sup>SM</sup> seat.



© 1993 British Airways

With an adjustable lumbar support, a newly designed footrest and the privacy of side headrests, you'll think you're flying on cloud nine. *It's the way we make you feel* that makes us the world's favourite airline.

**BRITISH AIRWAYS**

The world's favourite airline®

Circle 74 on Inquiry Card.

# What's New Software

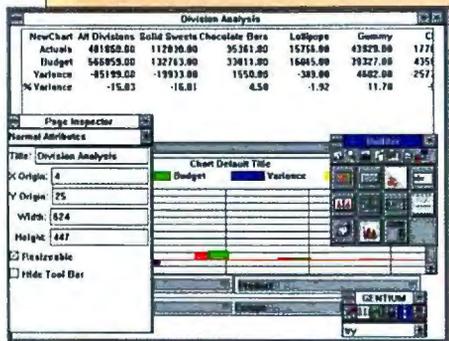
## DROP AND DRAG GROUPS ACROSS DISPARATE PLATFORMS

The Gentium eis 1.0 analytical applications development environment is a multiplatform system for use with EIS/DSS (Executive Information Systems and Decision Support Systems). According to Planning Sciences, Gentium uses open-systems design standards and features a point-and-click object-oriented interface, unlimited data access, and cross-platform portability. All EIS/DSS features, such as multidimensional databases, data modeling, matrix reporting, charts and graphs, and exception reporting, are provided as objects that you can assemble and reuse without writing code.

Gentium lets you create workgroups encompassing users across disparate platforms and networks. Users can retain the operating-system interface they are most familiar with, share information concurrently within a group, and be moved from group to group. Cost is \$2340 per user for 25 users or \$1222 per user for 100 users.

Contact: Planning Sciences, Roswell, GA, (404) 772-9767.

Circle 1271 on Inquiry Card.



## WORKGROUP DATA SHARING

The network version of askSam for Windows (\$1095 for five users) is a free-form database that combines database, word processing, text-retrieval, and OLE functions. From askSam Systems (Perry, FL), the software lets you share unstructured data such as personal notes, E-mail, marketing information, and government regulations.

Phone: (800) 800-1997 or (904) 584-6590.

Circle 1275 on Inquiry Card.

## ZANY FONTS ▶

Font-o-Matic (\$59.95), a utility from Alsys (Richardson, TX), enables you to create unusual TrueType fonts from any TrueType or PostScript Type 1 font. Via the GUI you can enlarge, rotate, or skew your fonts and then add designs such as cow spots, swiss-cheese holes, or cactus prickles to a copy of the original font. Each new font is accessible from any Windows application.

Phone: (800) 477-2131 or (214) 680-2060.

Circle 1283 on Inquiry Card.



## TCP/IP FOR DOS AND WINDOWS

A TCP/IP package, Piper/IP (\$375) uses less than 6 KB of base memory and has a data transfer rate of up to 500 KBps. From Ipswitch (Wakefield, MA), Piper/IP has a Winsock interface and is compatible with NetWare, Vines, LAN Manager, LAN Server, and Windows for Workgroups. The package has a set of TCP/IP utilities, NetBIOS, and an SNMP agent. Support is included for SQL databases, terminal emulators, the X Window System, and Internet utilities.

Phone: (617) 246-1150.

Circle 1276 on Inquiry Card.

## EASY 3-D ANIMATION

3D Choreographer (\$149.95), from AniCom (Columbia, MD), offers a no-fuss way to integrate 3-D animation into your presentation, report, or multimedia production. You select an actor by clicking on an icon and then draw a path that is divided into time points for the actor to follow. You use commands to tell the actor what to do. You can also create your own actions (or complex actions via layering multiple actions). The package supports OLE and generates animation files in Autodesk FLC format, allowing you to use 3D Choreographer as a stand-alone package.

Phone: (800) 949-4559 or (410) 799-1060.

Circle 1277 on Inquiry Card.

## ADD ZIP TO WINDOWS

The DynaZIP Data Compression Library for Microsoft Windows (\$295 per developer station) lets you incorporate into your programs the capability to read, test, create, modify, and write industry-standard ZIP files without having to shell to DOS. Compatible with any DLL-capable high-level language such as C, C++, and Visual Basic, the Inner Media (Hollis, NH) package

provides information about ZIP file items, dual-progress monitor callback capabilities, and status and error reporting.

Phone: (603) 465-3216.

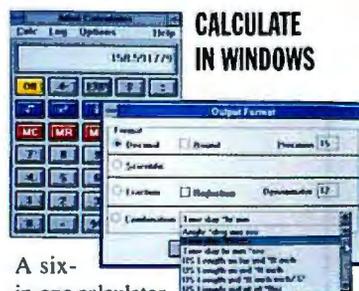
Circle 1278 on Inquiry Card.

## NETWORK DESKTOP MANAGER

An SNMP-based desktop management system for Windows, Newtwatch (\$495) from Net-Manager (Cupertino, CA) lets you manage and analyze remote desktop PCs running the company's Newt TCP/IP stack and SNMP agent or other desktop SNMP agents. You can also use the software to manage and analyze other network resources, such as bridges, hubs, and routers. The system's Newttrace software lets you capture, view, and analyze all inbound and outbound TCP/IP traffic on your Windows PC.

Phone: (408) 973-7171.

Circle 1279 on Inquiry Card.



## CALCULATE IN WINDOWS

A six-in-one calculator utility for Windows, MasterCalc (\$49) includes Mini, Math, Business, Statistical, Unit, and Programmer's calculators. From Borys (Hanover Park, IL), MasterCalc includes user-friendly graphics; a 15-digit precision rounding option; an unlimited, easy-to-access memory location; and pop-up windows. MasterCalc supports display formats, such as decimal, scientific, fractional, and combined, which you can customize. You can choose different formats for input and output and control conversions from one representation to another.

Phone: (708) 837-9680.

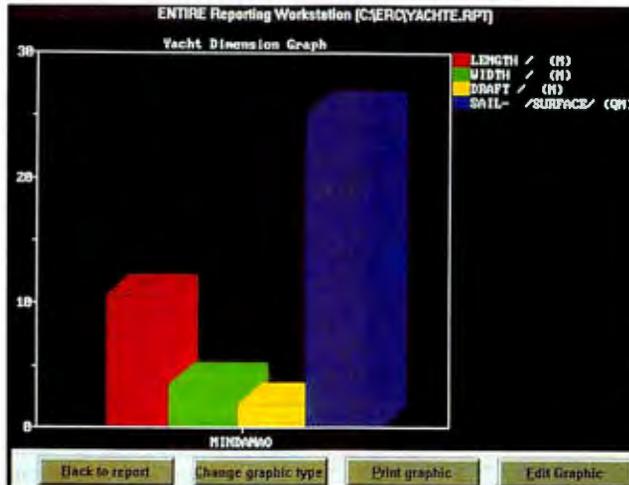
Circle 1281 on Inquiry Card.

## PUT SERVER CAPABILITY ON YOUR PC ▶

Entire Reporting Workstation for Windows (from \$270 per copy) lets you use Windows to access enterprise data from multiple files and bring it to your desktop PC for additional processing and analysis. From Software AG (Reston, VA), Entire Reporting Workstation allows you to export and import reports into other formats, letting you use the information in applications such as Excel or Word.

Phone: (703) 860-5050.

Circle 1287 on Inquiry Card.



## GET COMPUTER CLOCK ACCURACY

Clockwright (\$39), a utility from Barberry Hill Software and Engineering (Woodstock, VT), maintains the exact time on PCs running DOS, Windows, or OS/2. Able to reduce the error of the system clock to 1 second per week or less, Clockwright

calculates clock-speed error after two clock corrections are made. The program automatically corrects the clock setting during start-up or any other mandated time. You can switch among standard, daylight saving, universal, or local-mean-time modes.

Phone: (802) 457-2654.

Circle 1282 on Inquiry Card.

## NOT JUST A DOCUMENT MANAGEMENT SYSTEM

SoftSolutions 4.0 combines document management, workflow control, and a client/server architecture to create a workgroup environment that spans LANs and WANs, yet it gives individuals the capability to solve their particular needs. The document desktop is customizable, with icons representing documents, applications, file folders, and saved document searches.

OLE 2.0-compatible, SoftSolutions includes open database connectivity and is SQL compliant. The software is integrated with Reach Software's Workman and can work with word processing and spreadsheet packages such as 1-2-3, WordPerfect, and Word. E-mail, the Enterprise Administrator, and the fuzzy

logic-based Intelligent Search are included. Cost is \$495; additional workstations are \$295 each.

Contact: SoftSolutions Technology, Orem, UT, (801) 226-6000.

Circle 1272 on Inquiry Card.



## YOUR OWN LAN MECHANIC

LAN Mechanic (from \$199) is a network management utility for Artisoft LANtastic networks. From Micro Mechanic (Boulder, CO), LAN Mechanic features a repair module for network shared-resource hard drives, an unattended hard drive integrity-check module, capacity thresholds for hard drives, alerts for DOS and Windows screens as well as for the paging module, and a remote editor for workstations and file servers. A view manager for each file server and workstation shows RAM availability, resource use, and a system and memory summary.

Phone: (303) 443-0091.

Circle 1280 on Inquiry Card.

## JOB SCHEDULING MADE EASY

EcoScheduler (from \$8000) lets you schedule batch jobs for your enterprise system based on calendar events, the status of other jobs, and the level of resources required by a job. You can use the Compuware (Farmington Hills, MI) software to schedule a job or groups of jobs and specify limits on the amount of computer and database resources used by a job. EcoScheduler maintains a log of the current status of all jobs, which you can view, print, and manipulate.

Phone: (313) 737-7300.

Circle 1285 on Inquiry Card.

## Software Update

**Saber LAN Workstation 2.0**, Saber Software (Dallas, TX), adds centralized file and software distribution, an advanced programming language, remote alarm notification, a desktop launching utility, and a control panel that replaces the Windows control panel. From \$179.

Phone: (800) 338-8754 or (214) 361-8086.

Circle 1288 on Inquiry Card.

**BookWise 2.0**, Xerox Imaging Systems (Peabody, MA), includes an advanced version of the company's OCR software, editing capabilities from within the BookWise program and file management, compatibility with Hewlett-Packard's scanners, and automatic page orientation. \$1295.

Phone: (800) 248-6550 or (508) 977-2000.

Circle 1289 on Inquiry Card.

**Learn to Speak Spanish 4.0**, HyperGlot Software (Knoxville, TN), features 60 QuickTime or QuickTime for Windows movies, a 350-page workbook, and an enhanced interface. \$149.

Phone: (800) 726-5087 or (615) 558-8270.

Circle 1290 on Inquiry Card.

**Opti-Net NLM 2.0**, Online Computer Systems (Germantown, MD), is Novell certified and provides new diagnostics, improved administration functions for large database manipulation, client caching, seamless use across NetWare 3.x and 4.x operating systems, access to logical-unit-number CD-ROM drives, and support for ISA SCSI host adapters in servers that are equipped with more than 16 MB of RAM. \$1495 for a 100-workstation license.

Phone: (800) 922-9204 or (301) 428-3700.

Circle 1291 on Inquiry Card.

# What's New Software

## CREATE YOUR OWN WORLD



The Vream Virtual Reality Development System lets you draw whatever objects you want in your 3-D world using a set of 3-D drawing tools within the Vream 3D World Editor. To make your virtual world interactive, you define the logical link structures of the objects. After you've defined your world, you can enter it and interact with it in real time using the Vream Runtime System. You can walk through your creation and then grab and move objects with the virtual hand to activate the linked structures. The package costs \$795.

Contact: Vream, Chicago, IL, (312) 477-0425.

Circle 1273 on Inquiry Card.

## LONG FILENAMES PERMISSIBLE

A Windows- and DOS-compatible document manager that lets you create file and directory names up to 255 characters long, QuickFind (\$49.95) works from within your application. From View Software (Palo Alto, CA), QuickFind lets you give meaningful names to your files, offering an intuitive alternative to file-searching and indexing systems. Integrated with an application, QuickFind enhances the File Open and File Save As commands and dialog boxes; it also provides a migration path to long filenames that are native to Windows NT.

Phone: (800) 487-8439 or (415) 856-8439.

Circle 1284 on Inquiry Card.

## CROSS-PLATFORM CD-ROM

The QuickView multimedia viewer for Macs (developer's kit, \$495) emulates the functionality of Microsoft's Multimedia Viewer 2.0. From Altura Software (Pacific Grove, CA), QuickView lets you develop CD-ROM titles

that will play on Macs and in Windows. The software includes complete file compatibility with HPJ and RTF files; context-sensitive help; hypertext links; and PICT, BMP, and segmented hypergraphics support. QuickView also supports Mac sound files and Windows WAV files, embedded panes and windows, full text search and retrieval, external commands, and support for QuickTime and AVI movies. Phone: (408) 655-8005.

Circle 1286 on Inquiry Card.

## WRITE IN KANJI IN WINDOWS

A Japanese word processor for Windows, KanjiWord (\$199) has a fully configurable kana/kanji front-end processor that allows you to enter Japanese phonetically using an English keyboard. Pacific Software Publishing's (Mercer Island, WA) package comes complete with two built-in fonts: a 16-pixel Japanese

bit-map font for on-screen viewing and a 48-pixel Mincho-Japanese bit-map font that provides clean Japanese output.

Phone: (206) 232-3989.

Circle 1303 on Inquiry Card.

## SAFE PASSAGE FOR E-MAIL

MailWatch (from \$5000) alerts network administrators and mail recipients on a multiplatform LAN of blockages that prevent the delivery of E-mail. The Uniplex Enterprise Systems group (Greenwich, CT) tool monitors E-mail systems such as cc:Mail via graphical representation of the mail network and provides early warning of problems. One PC can monitor an entire mail network, or Mail Agents installed at several points throughout the network can do the monitoring. Phone: (203) 661-4404.

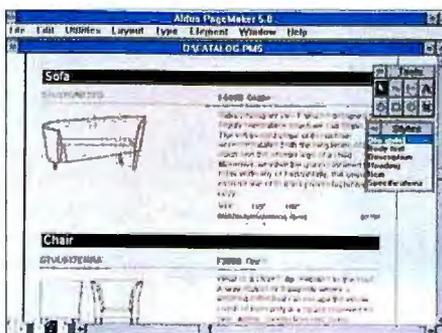
Circle 1338 on Inquiry Card.

## A FIRST ADDITION ▼

Now a stand-alone package, InfoPublisher Database Addition 2.0 (\$199) from Aldus (Seattle, WA) links PageMaker 5.0 for Windows to database management systems such as Paradox 3.5, Access, and FoxPro. The software provides improved ASCII text-file support and complies with Microsoft's ODBC protocol. Features include the ability to launch InfoPublisher as an Addition from within PageMaker and automatic updates to reflow stories based on data or format changes.

Phone: (206) 622-5500.

Circle 1305 on Inquiry Card.

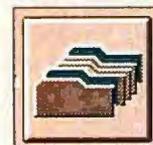


## Software Update

**Raosoft Survey 2.5**, Raosoft (Seattle, WA), offers additional options for forms design, additional capacity in analysis and reports, expanded data-entry support, and an intuitive calculation option. \$495.

Phone: (206) 525-4025.

Circle 1292 on Inquiry Card.



**Corel Ventura 4.2**, Corel (Ottawa, Ontario, Canada), combines

Ventura Publisher, DataBase Publisher, support for Adobe Acrobat, and faster font loading. \$249.

Phone: (800) 772-6735 or (613) 728-8200.

Circle 1293 on Inquiry Card.



**Insync 1.1**, Syn-ergy Solutions (Mesa, AZ), includes a two-

port version of Modem Assist Plus network modem sharing. \$495.

Phone: (602) 545-9797.

Circle 1294 on Inquiry Card.

**Rescue 5.0**, AllMicro (Clearwater, FL), gives you the ability to recover data from compressed drives, bypasses bad or destroyed partitions and root-directory damage to recover by filename, lets you choose which FAT to use, and is friendlier and quicker. \$349.

Phone: (800) 653-4933 or (813) 446-6660.

Circle 1295 on Inquiry Card.

**DeltaGraph Pro 3**, DeltaPoint (Monterey, CA), has been redesigned with a streamlined interface and now has a multiview configuration. New are 13 charts; a charting engine; a chart advisor; support for multiple documents; compatibility with Pantone ColorUP; and eyedropper, shadow, and blend tools. \$195.

Phone: (408) 648-4000.

Circle 1296 on Inquiry Card.

# Your software programs were barely speaking. Then something clicked.

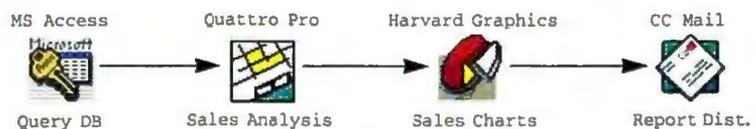


If you're tired of playing matchmaker to software applications (even ones from the same vendor), you'll be pleased to hear this. There is a product that does it for you, now. Prodea Synergy™ makes

the programs you already have, and what you've built with them, work together. A few points and clicks, and applications will exchange just about everything but valentines.

Mr. R. Lee Allen of Schering-Plough, a company already using Prodea Synergy, put it less romantically

although no less enthusiastically. "It's not like anything out



*Drag and drop the icons, connect them with arrows. Data flows automatically.*

there before. It's more than OLE or DDE. It transcends both languages and APIs."

You should also know that what you build is easy to pass on to others, without worrying about hot links, paste links or file location. Prodea Synergy runs under Windows; costs \$495 and has a 30-day money-back guarantee. For a limited time you also get a \$200 introductory cash rebate. Call us at 1-800-PRODEA-1. Your software programs will never look at one another the same way again.

**PRODEA** Synergy™

# What's New Software

## ACCESS UNIX FROM OS/2

XoftWare/32 3.0 (from \$395) is now available for OS/2 platforms in addition to Windows. From AGE Logic (San Diego, CA), XoftWare/32 lets you use your PC to access and display network-based Unix applications simultaneously with OS/2, Windows, and DOS applications. Features include a comprehensive Network File Manager utility with file transfer and local printing capabilities, an interactive Telnet client, and a Windows- and OS/2-based Trace utility. The Windows version adds a Unix print reroute utility, support for installation from a remote server, and 24-/16-bit color support.

Phone: (619) 455-8600.

Circle 1302 on Inquiry Card.

## OS/2 SCHEDULER

Sytos Scheduler (\$99) is a scheduling utility for Presentation Manager that runs automated or background events, such as command and executable files, under OS/2. Sytos Scheduler enables you to plan single or multiple scheduled events to run once or according to your specified schedule. You can specify the start and end times and dates and exclude events from running on certain dates, such as holidays. You can use the Sytron (Westborough, MA) utility as a stand-alone scheduling utility for OS/2 or as an enhanced scheduler for Sytos Plus for OS/2 procedures.

Phone: (508) 898-0100.

Circle 1337 on Inquiry Card.

## SCREEN-SAVER SELECTION

Art and photographic images are the mainstay of Second Nature Software's (Portland, OR) 30 screen-saver/wallpaper collections for Windows 3.1 (\$15 per collection). Each collection has 22 256-color images such as butterflies, national parks, impressionist paintings, classic cars,

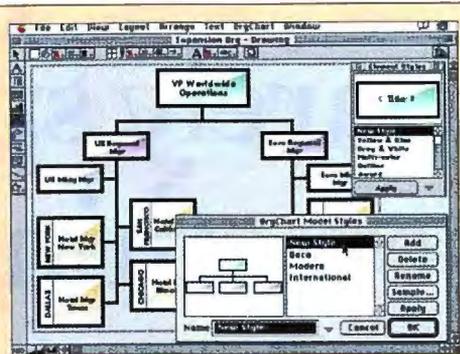
## CREATE AN IMPACT

ClarisImpact 1.0 for Macintosh automatically creates the graphics you define and updates them when you specify changes.

With its integrated word processing capability, ClarisImpact creates reports and memos with business graphics, automatically wrapping text around the graphics. The software enables you to create slide presentations with professionally designed backgrounds and special effects. The Claris graphics engine provides seamless cross-platform compatibility between Macintoshes and Windows for Claris graphics products. The package costs \$399.

Contact: Claris Corp., Santa Clara, CA, (408) 987-7000.

Circle 1274 on Inquiry Card.



and space voyages.

Phone: (503) 291-9500.

Circle 1307 on Inquiry Card.

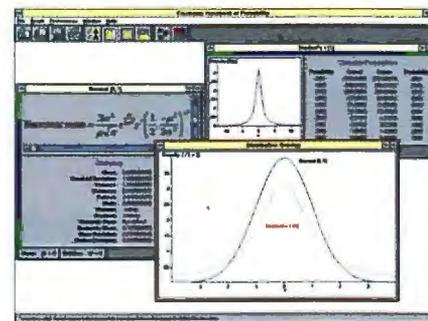
Claris Clear Choice's (Santa Clara, CA) Imaginaria (\$49) is a multimedia screen-saver collection for Windows. Images, 11 animated transition screens, and 15 surrealistic story modules come with original sounds and music.

Phone: (408) 987-7000.

Circle 1308 on Inquiry Card.

## HOP OVER TO PROBABILITY CALCULATIONS ▼

The Electronic Handbook of Probability, or eHop (\$49), calculates p values and percentage points for 28 probability distributions. The Windows 3.1 util-



ity provides distribution statistics, formulas, random samples, and graphical output for each distribution. From Crunch Software (Oakland, CA), eHop also provides information and references for each distribution.

Phone: (510) 562-9900.

Circle 1304 on Inquiry Card.

## SIMPLICITY IS A PIM

An entry-level PIM, Ecco Simplicity (\$149) has an intuitive start-up screen that lets you start working quickly. From Arabesque (Bellevue, WA), Ecco Simplicity has profession-specific templates that access Ecco Professional's dynamic information-linking abilities. Graphical calendar views display the month and week at a glance; to-do items can be in color to help distinguish them from appointments. Calendar, phone book, and outline views are integrated, so you don't have to enter your information more than once.

Phone: (206) 885-4272.

Circle 1306

on Inquiry Card.

## Software Update

**SCSI Director Professional 3.0**, Transoft (Santa Barbara, CA), features integrated driver support for major CD-ROM formats, supports Apple's SCSI Manager 4.3, and is SCSI-2 compatible. \$199.

Phone: (805) 565-5200.

Circle 1297 on Inquiry Card.

**PacketView 1.10**, Klos Technologies (Merrimack, NH), supports the Open Data-Link Interface, expands support for the NetBIOS protocol, provides enhanced data-sharing with the Network General Sniffer, adds symbolic support for SNMP Object IDs, and supports FDDI networks. \$299.

Phone: (603) 424-8300.

Circle 1298 on Inquiry Card.



**Coherent 4.2**, Mark Williams Co. (Northbrook, IL), can run over 50 third-party software packages, adds a user-interface shell and a Unix System V-style print spooler, and supports SCSI and floppy tape drives. From \$99.95.

Phone: (708) 291-6700.

Circle 1299 on Inquiry Card.

**Mirror-Fax with Voice 2.0**, Soft-Klone (Tallahassee, FL), features data, fax, and voice capabilities and supports Cirrus Logic, Rockwell, Sierra,

and ZyXel data/fax/voice chip sets. \$99.

Phone: (904) 878-8564.

Circle 1300 on Inquiry Card.

**Trak/Report 2.0**, Concord Communications (Marlborough, MA), adds group-capacity-planning capability, faster performance, enhanced database functionality, and support for token-ring and bridged networks. \$7500.

Phone: (508) 460-4646.

Circle 1301 on Inquiry Card.

# If It Were A Baseball Player, It Would Hit Home Runs, Toss No-Hitters, Steal Bases, And Sign For Under \$200.

Okay, it hasn't happened in baseball. But in the computer world, there's a major league player in the communications game that can pretty much do it all. Introducing CommWorks™ for Windows™ by

Traveling Software. The first complete communications package that gives you more flexibility than ever to do business away from the office. For starters, there's **LapLink<sup>®</sup>V**, the number one selling file transfer program. You can make unattended, regularly scheduled file transfers at anytime, from any place. And for local file transfers, use the included serial cable. CommWorks also

allows you to send

and receive a

**Fax**

from your PC quickly, easily and privately. CommWorks also features **Remote Access**, which brings remote files and printers directly to your PC wherever you are. And with

the online program, you can tap into MCI Mail<sup>®</sup>, CompuServe<sup>®</sup>, or other **Online Services**

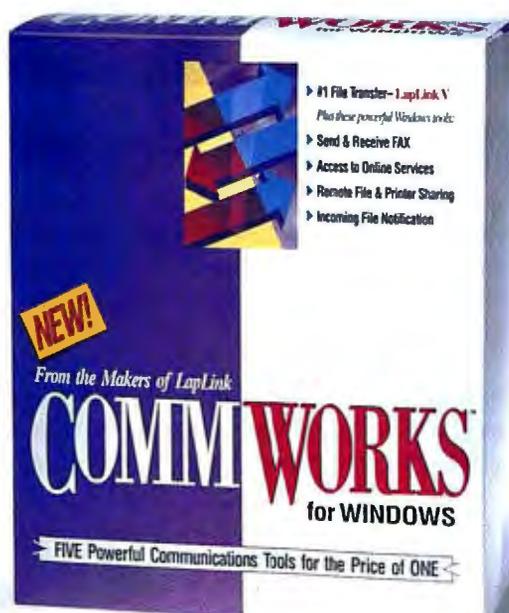
at the click of a button. What's more, the CommWorks Control Center puts all of these communications tools at your fingertips. See your local dealer or call Traveling Software for \$50 off the suggested retail price of \$199.95. And get the

one who can do it all.

Without the

overblown

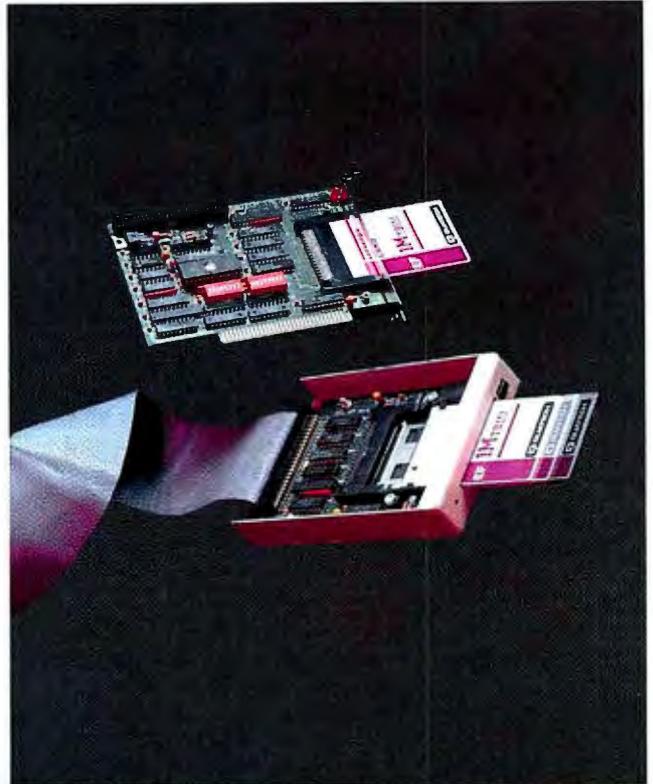
salary.



**Call for \$50 off  
(800) 472-4735**

Circle 146 on Inquiry Card (RESELLERS: 147).

# Quatech's Solid State Drives for PCMCIA



## • 100% Reliability • No Moving Parts

Quatech's line of Solid State Drives for PCMCIA (Type I and Type II) fit into any personal computer and conform to the PCMCIA/JEIDA standards thus allowing your PC to access the newest technology used in notebooks, hand-held computers and PDA's. These drives are available in three options: 3.5" front drive, rear card slot drive, or 3.5" front drive and rear card slot drive.

Quatech's line of PCMCIA FLASH Memory, SRAM and I/O Cards offer add on memory in one, two and four meg options. SRAM available in one and two meg options only. FAX/modem, Serial RS-232, RS-422, EPP Parallel Port, and Digital I/O give you maximum flexibility for your application.

For more information on PCMCIA products or our complete line of communication, data acquisition and industrial I/O products call:

**800-553-1170**

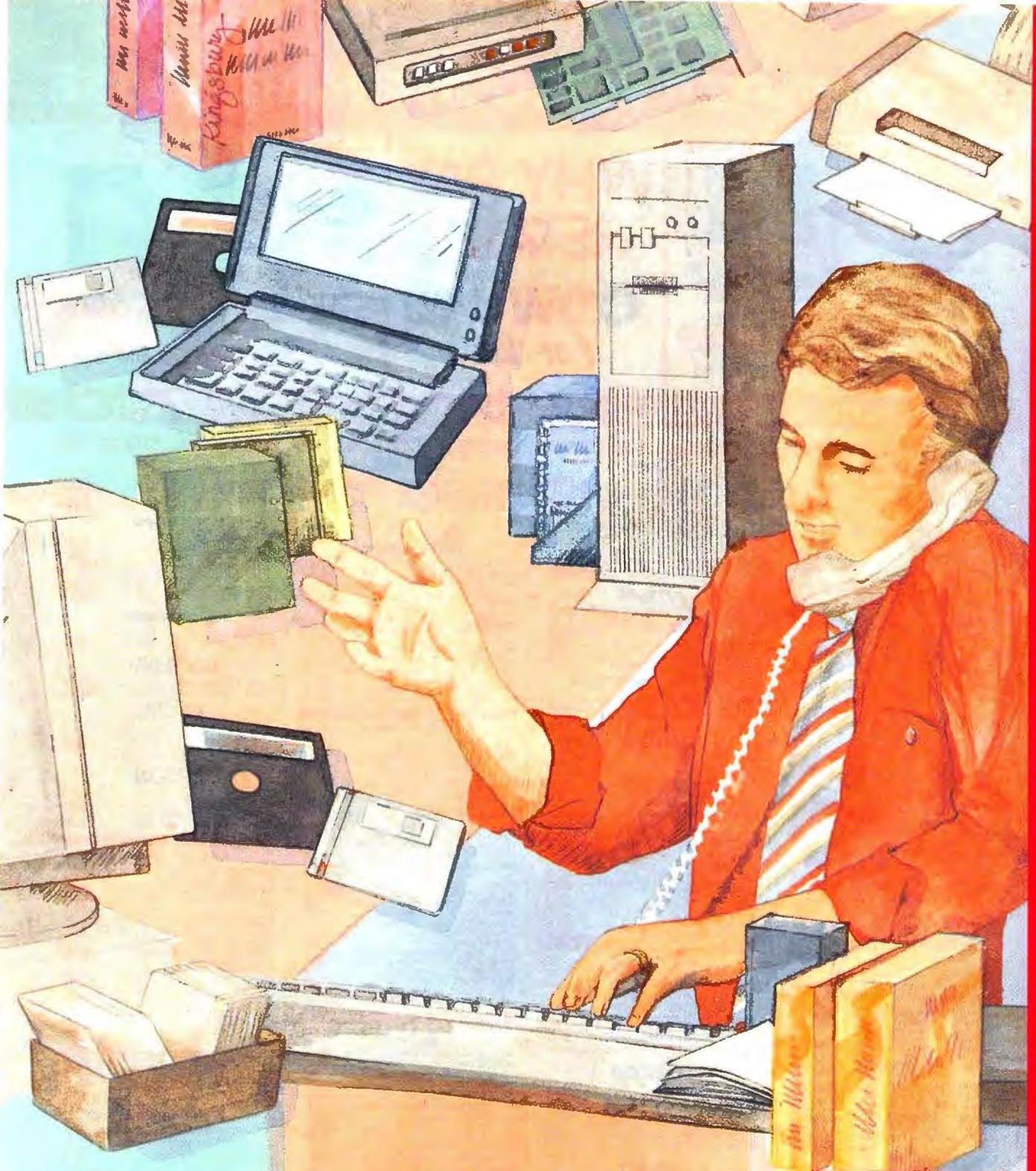


FAX: 216-434-1409

BBS: 216-434-2481

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 416-513-7027), England/Diamond Point International 634-722-390, Finland/Lab Hitech OY 358-0-804-2522, France/Elexo 33-1-69302880, Germany/Jupiter Electronic Systems 06181/75041, Israel/RCM Ltd. 972-03-5447885, Italy/N.C.S. Computer Italia 03311 770-016, Netherlands/ACAL Auriema 040-502602, Korea/Sam Boo Enterprise Co. 82-2-538-4001, Spain SANTA Barbara SA 343-4188116, Singapore Bliss Services Pte Ltd (65) 338-1300, South Africa Eagle Electronics 27 21 234943, Switzerland Amiro Tech. Engin. 37-2311-18. IBM PC-XT, AT, and Micro Channel are registered trademarks of IBM Corp. All other trademarks are of their respective companies.





**BUY IT THROUGH BYTE**

**Mail Order**

The latest offerings from vendors supplying products of all leading manufacturers at extremely competitive prices.

**216**

**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.

**243**

**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.

**251**



# COMPUTER DISCOUNT WAREHOUSE™

## MAGNAVOX CM9217 Magnascan 17" SVGA Monitor

- Maximum Display Resolution of 1280 x 1024 (Non-Interlaced)
- 72Hz Refresh Rate
- Horizontal Scan from 30 to 57 KHz
- Vertical Scan from 50 to 100 Hz
- 1 Year Limited Warranty
- Tilt & Swivel Base



**BEST VALUE 17"**

CDW Price ..... **\$599.50** CDW 23261

# WHY PAY RETAIL?

## CDW Sells For Less

## CANON BJC-600

### Color Bubblejet Printer

- ✓ 360 dpi / 240 cps
- ✓ Individual Color Cartridge System: Less Waste
- ✓ 100 Sheet Feeder
- ✓ Laser Quality Text
- ✓ Optimized for Plain Paper: Vibrant Colors Without Special Paper



**CDW TOP SELLER**

**Canon**

CDW Price ..... **\$588.50** CDW 32009

# HARDWARE, SOFTWARE & PERIPHERALS AT DISCOUNT PRICES

### NETWORKING PRODUCTS

#### NOVELL

Netware V4.01	
5 USER CD	899.00
10 USER CD	1499.00
25 USER CD	2994.00
50 USER CD	5870.00

#### Netware V3.12

V3.12 5 USER 3.5"	629.00
V3.12 10 USER 3.5"	1099.00
V3.12 25 USER 3.5"	2099.00
V3.12 50 USER 3.5"	4249.00
V3.12 100 USER 3.5"	8370.00

Call for Pricing on NetWare CD-ROM Versions and Upgrades

NETWARE LITE 1 USER	69.49
NETWARE LITE 5 STARTER KIT	339.39
NE2000 PLUS ETHERNET COAX CARD	109.90
NE3200 THIN COAX w/TPA	539.82
NE3200 THICK COAX	214.29

NEW	
COACTIVE STARTER KIT	189.99
COACTIVE ADD-ON KIT	129.99

#### TRIMMIS/UNIMU

TC5143 ETHERNET COAX	122.87
TC5143 ETHERNET COAX 6PK	699.55
TC5143 ETHERNET 10BT	95.95
TC5143 ETHERNET 10BT 6PK	483.89
TC6242 ARCNET 8 BIT COAX CARD	95.59
TC6245 ARCNET COAX CARD	179.99
TC6245 ARCNET 10BT CARD	179.99
TC6245 ARCNET ALL-IN-ONE CARD	259.84
TC640 ARCNET PASSIVE 4 PORT HUB COAX 39.50	
TC640 ARCNET SMART HUB COAX 242.22	
TC5055 ETHERNET 8 PORT COAX 10BT	97.44
TC5151 ARCNET 16 PORT SMART HUB COAX 672.12	
TC4035 TOKEN RING 4MBPS CARD	289.89
TC4045 TOKEN RING 16/4 CARD	439.57
TCNS 100MPS COAX CARD	539.84
TCNS 100MPS EISA COAX CARD	609.91
TCNS 100MPS STP CARD	457.69
TCNS 100MPS FIBER OPTIC CARD	716.60
TCNS 100MPS 8 PORT SMART HUB COAX 1365.27	
TCNS 100MPS 8 PORT SMART HUB COAX 1149.77	
TCNS 100MPS 8 PORT SMART HUB STP 1169.75	
TCNS 100MPS 8 PORT SMART HUB FIBER 1485.90	

#### ARTISOFT

AES ETHERNET COMBO CARD	199.38
NODERUNNER 2000A	210.34
NODERUNNER 2000T	176.47
NODERUNNER 2000C	176.47
NODERUNNER/SI 2000A	119.88
NODERUNNER/SI 2000T	95.44
NODERUNNER/SI 2000C	97.44
CENTRAL STATION II	269.33
10BT 5 PORT INTERNAL HUB	499.57
NODERUNNER STARTER KIT WINDOWS	78.17
LANTASTIC AI V5.0	78.19
LANTASTIC AI 4 WINDOWS	69.80
LANTASTIC SOFTWARE	69.80
LANTASTIC FOR WINDOWS SW	129.88
T-RUNNER 8 PORT 10BT	299.28
T-RUNNER 12 PORT 10BT	497.41

#### SMC

ULTRA16 ETHERNET COAX	105.25
ULTRA16 ETHERNET COAX 6PK	593.66
ULTRA16 ETHERNET 10BT	105.25
ULTRA16 ETHERNET 10BT 6PK	583.68
ULTRA16 ETHERNET COMBO	125.35
ULTRA16 ETHERNET COMBO 6PK	693.40
ETHERCARD+ ELITE 8 BIT COAX	97.82
ETHERCARD+ ELITE COAX	119.84
ETHERCARD+ ELITE COMBO 6PK	629.73
ETHERCARD+ ELITE MCA COAX	119.84
ETHERCARD+ ELITE 10BT	119.84
ETHERCARD+ ELITE 10BT 6PK	618.22
ETHERCARD+ ELITE MCA 10BT	189.55
ETHERCARD+ ELITE EISA 10BT	579.78
ETHERCARD+ ELITE COMBO	139.57
ETHERCARD+ ELITE COMBO 6PK	739.59
3608 ETHERNET 8 PORT COAX 10BT	329.61
3512 ETHERNET 12+2 PORT COAX 10BT	614.78
PC600WS ARCNET CARD TP	125.93
PC650WS ARCNET CARD TP	119.88
PC600FS ARCNET CARD COAX	199.29
PC130 ARCNET CARD COAX	65.50
ARCNET 8 PORT ACTIVE HUB COAX	229.41
TOKENCARD ELITE 16/4	389.88

### NETWORKING PRODUCTS

#### 3Com

3C503 ETHERLINK II COAX	159.84
3C508 ETHERLINK III COAX	119.50
3C508 ETHERLINK III COAX 5 PK	529.12
3C509 ETHERLINK III 10BT	119.50
3C509 ETHERLINK III 10BT 5 PK	537.37
3C509 ETHERLINK III MCA 10BT	124.45
3C529 ETHERLINK III MCA COAX 5PK	592.27
3C508 ETHERLINK III MCA 10BT 5PK	578.59
3C508 ETHERLINK III COMBO	155.88
3C509 ETHERLINK III COMBO 5 PK	578.84
3C575 ETHERLINK EISA COAX	229.91
3C575 ETHERLINK EISA 10BT	229.91
3C1627 12 PORT LINKBUILDER 10BT	628.37

#### Xircom

PE310BC POCKET ETHERNET COAX	314.89
PE310BT POCKET ETHERNET COAX	289.00
PE310BT POCKET ETHERNET 10BT	268.31
PA20286 POCKET ARCNET COAX	236.30
PT216BT POCKET TOKEN RING 16/4	229.14
PT216BT POCKET TOKEN RING 16/4	527.08
PPX03 PARALLEL PORT MULTIPLEXOR	79.90
XIRCOM 14.4K POCKET MODEM	499.30

#### IBM TOKEN RING

IBM TOKEN RING 16/4 ISA	501.40
IBM TOKEN RING 16/4 MCA	609.95
IBM TOKEN RING MAU	458.88

#### intel

ETHEREXPRESS 16 COAX	99.33
ETHEREXPRESS 16 COAX 5PK	491.12
ETHEREXPRESS 16 COAX 20PK	1699.38
ETHEREXPRESS MCA COAX	165.52
ETHEREXPRESS FLASH 10BT	39.33
ETHEREXPRESS 16 10BT 5 PK	454.13
ETHEREXPRESS 16 10BT 20PK	1698.38
ETHEREXPRESS MCA 10BT	165.52
ETHEREXPRESS 16 COMBO	116.77
ETHEREXPRESS 16 COMBO 5PK	548.08
ETHEREXPRESS 16 COMBO 20PK	2038.93
ETHEREXPRESS FLASH 10BT	111.88
ETHEREXPRESS FLASH 10BT 5PK	519.62
ETHEREXPRESS FLASH COMBO 5	131.82
ETHEREXPRESS EISA COAX 5 PK	626.84
ETHEREXPRESS EISA COAX	115.30
TOKENEXPRESS 16/4	399.53
NETPORT II COAX	358.97
NETPORT II 10BT	368.65
ETHEREXPRESS ISA HUB	519.93
ETHEREXPRESS ISA HUB EXP	449.96

### TAPE, REMOVABLE & FLOPPY DRIVES

#### COLORADO MEMORY SYSTEMS INC.

JUMBO 120MB INTERNAL	97.21
JUMBO 250MB INTERNAL	167.34
TRAKKER 120MB PARALLEL PORT	277.50
TRAKKER 250MB PARALLEL PORT	327.44
POWERTAPE 2GB SCSI INTERNAL	947.58
POWERTAPE 2GB SCSI EXTERNAL	1087.99
POWERDATA 2GB SCSI INTERNAL	1924.33

#### MEGA

TAPE 250MB INSIDER HH	187.57
FLOPTICAL 21MB INSIDER	379.27
BERNOULLI 150MB INSIDER SCSI	429.11
BERNOULLI 150MB PC POWERED	477.87
BERNOULLI 150MB TRANSPORTABLE	879.26
BERNOULLI 150MB INSIDER IDE	487.59

#### SUMMIT

SE120 120MB INT TAPE B-U	139.96
SE250 250MB INT TAPE B-U	178.63
SE305 305MB INT TAPE B-U	269.90

### MICROSOFTS

BACKPACK 3.5" 1.44MB FLOPPY PARALLEL	177.84
BACKPACK 5.25" 1.2MB FLOPPY PARALLEL	177.84
BACKPACK 170MB HD PARALLEL	369.59
BACKPACK 200MB HD PARALLEL	427.99
BACKPACK CD-ROM PARALLEL	357.91
BACKPACK 250MB TAPE B-U PARALLEL	355.05

### TAPE, REMOVABLE & FLOPPY DRIVES

#### SyDOS

PRO NOTE 42MB PARALLEL	488.17
PUMA 88MB PARALLEL	442.44
MARLIN 105MB INT IDE	498.26
88MB EXT SCSI WADPT	523.27

#### Mountain

TD-250 250MB INT IDE	189.32
FS8500 305MB INT IDE	449.50
SIDOCAR II 305MB PARALLEL TBU	358.77
TD-4 4GB EXT SCSI	201.93
750MB-1.5GB INT TBU WADPT	1036.19
750MB-1.5GB EXT TBU WADPT	1254.69

### WYSE TERMINALS

WYSE 30 AMBER OR GREEN	272.89
WYSE 50 AMBER OR GREEN	355.50
WYSE 55 AMBER, GREEN, WHITE	358.48
WYSE 60 AMBER, GREEN, WHITE	279.60
WYSE 150 AMBER, GREEN, WHITE	265.43
WYSE 160 AMBER, GREEN, WHITE	329.98
WYSE 325 COLOR.	519.40

### MULTIMEDIA, SOUND, CD

ALTEC LANSING ACS300 SPKRS/SW	274.28
CDW 5 CD BUNDLE	129.17
CDW 5 CD BUSINESS BUNDLE	119.86
CDW 5 CD ENTERTAINMENT BUNDLE	79.33
CDW 4 CD EDUCATION BUNDLE	65.16
CREATIVE LABS DISCOVERY 16 INT	418.00
CREATIVE LABS MULTIMEDIA STARTER INT	449.58
CREATIVE LABS SOUND BLASTER PRO	117.03
CREATIVE LABS SB 16	178.48
CREATIVE LABS SOUND BLASTER 16 ASP	187.78
CREATIVE LABS SB 16 SCSI	187.56
MEDIAVISION PRO AUDIO 16 BASIC	111.36
MEDIAVISION PRO AUDIO SPECTRUM 16	159.64
MEDIAVISION PRO AUDIO STUDIO 16	214.20
MEDIAVISION PRO 16 SYSTEM II BUNDLE	798.57
MEDIAVISION MEMPHIS SYS	755.17
MS MULTIMEDIA BEEHIVEN	54.88
MICROSOFT BOOKSHELP CD	119.89
MICROSOFT WIN SND SYS V2.0	111.88
MS WIN SND SYS V2.0 WBOARD	139.77
MICROSOFT CINEMA 1994	52.88
ORCHID SOUNDWAVE 32	219.72
ORCHID GAMEWAVE 32	149.90
PROCOM INT MULTIMEDIA STATION	739.16
PROCOM EXT MULTIMEDIA STATION	799.48
SONY DSKTOP LIBRARY INT	267.04
SONY DSKTOP LIB INT W/SND	459.05
SONY DSKTOP LIBRARY EXT W/SND	544.74
TURTLE BEACH MULTISOUND	513.97

### CD-ROM & OPTICAL DRIVES

CHINON CDS535 INT CD-ROM KIT	385.50
CHINON CDS535 EXT CDROM KIT	449.88
ACCULOGIC PARALLEL PORT CD-ROM	499.50
HITACHI 1900S EXT CD-ROM	499.85
HITACHI CDR1950 EXT	512.50
HITACHI 8700 INT CD-ROM	409.85
HITACHI CDR6750 INT	412.51
NEC CDR741 EXTERNAL CD-ROM	399.50
NEC 3X2 INTERNAL NEW	479.90
NEC 3XE EXTERNAL NEW	569.90
NEC 3XP Portable	499.90
ORCHID CDS310 INT	322.83
PIONEER DRM80X 6 DISC QUADRASPIN	1347.42
PROCOM 200MS INT SCSI CD-ROM	452.00
PROCOM 200MS EXT SCSI CD-ROM	557.65
SONY CDS535 INT CD-ROM	467.12
SONY CDS4191 INT SCSI CD-ROM	349.15
SONY CDD720M EXT CD-ROM	263.79
SYDOS PARALLEL PORT CD ROM	299.51
TEXEL 3028 240MS INT KIT	CALL
TEXEL 3028 W/PA SPECTRUM 16	CALL
TEXEL 5028 240MS EXT KIT	CALL
TEXEL 5028 W/PA SPECTRUM 16	CALL
TOSHIBA 3401 INT SCSI CD-ROM	397.60
TOSHIBA 3401 INT SCSI CD-ROM W/WADPT	549.14
TOSHIBA 3401 EXT SCSI CD-ROM	487.61
TOSHIBA 3401 EXT SCSI CD-ROM WADPT	649.53
TOSHIBA 3401 EXT SCSI 4 DRIVE TOWER	2535.00

### PLOTTERS, DIGITIZERS & SCANNERS

#### HURTA

IS/ONE 12 X 12 4 BUTTON	300.23
IS/ONE 12 X 12 2 BUTTON	290.82
XLP 12 X 12 4 BUTTON & STYLUS	228.80
XLP 12 X 18 16 BUTTON	454.86
IGT X 12 X 12	399.90

#### CalComp

DB III 12X12 W/STYLUS	305.90
DB III 12X12 4 BUTTON	304.84
DB III 12X12 16 BUTTON	304.84
DB III 12X18 16 BUTTON	399.86
DB III 12X18 16 BUTTON CORDLESS	399.86
12 X 12 16 BUTTON	287.80
24 X 36 16 BUTTON	1332.38

#### Summagraphics

SUMMASKETCH III 12 X 12 16 BUTTON	259.90
SUMMASKETCH III 18 X 12 4 BUTTON	524.44

#### HOLSTON INSTRUMENT

HI 7100 A-D SIZE 8 PEN	2598.78
HI 7200 A-F SIZE 8 PEN	3387.22

#### HEWLETT PACKARD

HP SCANJET IIP	733.48
HP SCANJET IIP DOCUMENT FEEDER	269.93
HP SCANJET IICX HW ISA NEW	998.50
HP SCANJET IICX DOCUMENT FEEDER	474.72

#### EPSON

ESBIONSCANNER ES800C	798.80
ES200C PARALLEL/SCSI	1089.81
ACTIONSCANNER ES800C	1077.29
ACTIONSCANNER ES900C PRO	1238.53

### VIDEO PRODUCTS

#### VGA & SUPER VGA MONITORS

ACER SVGA 14"	239.09
AST VISION 4H 14"	369.91
AST VISION 4L 14" NEW	399.95
IBM SVGA 14"	437.33
IBM 17P 17"	1043.71
MAG INNOVISION MW5F	517.15
MAG INNOVISION MK1F	599.50
MAGNAVOX CM2079 14" 29	222.20
MAGNAVOX CM2089 14" 38	275.90
MAGNAVOX CM2099 14" 28 NI	299.88
MAGNAVOX CM217 17"	599.50
MAGNAVOX 20CM64 20"	1169.88
NANAQ F340W 15"	719.83
NANAQ F5501 17"	1047.77
NANAQ F550W 17"	1199.00
NEC 3V 15"	499.82
NEC 3FE 15"	577.17
NEC 4FE 17"	722.72
NEC 5FE 17"	1099.90
NEC 5FP 17"	1357.21
NEC 6FG 21"	2368.94
PANASONIC C13811 14"	325.76
PHILIPS 1537AS 15"	479.89
PHILIPS 1764DC 17"	739.50
SONY CPD1430 14"	599.50
SONY CPD1730 17"	1049.15
SONY 17S 17"	1199.48

#### VGA & SUPER VGA DISPLAY CARDS

ACTIX ULTRA PLUS 1MB	235.90
ACTIX ULTRA PLUS 2MB	324.85
ADS VGA TO TV LITE	257.78
ATI GRAPHICS ULTRA+ 2MB	237.58
ATI GRAPHICS ULTRA PRO 2MB	357.58
ATI GRAPHICS ULTRA PRO 2MB EISA	394.92
ATI VGA WONDER XL24	119.32
CARDINAL WARPSPEED 2MB VLB	489.21
CREATIVE LABS VIDEO BLASTER	337.02
CREATIVE LABS VIDEO SPICOT	

# COMPUTER DISCOUNT WAREHOUSE™



## AST Bravo LC i486SX/25 Desktop Computer

- ✓ i486SX/25 CPU
- ✓ 120MB HD, 4MB RAM
- ✓ Local Bus Video
- ✓ 4 16-bit Slots
- ✓ Midsize Case, 3 External Bays

CDW Price... **ONLY \$997.97** CDW 30837

## WHY SETTLE FOR LESS?

# CDW® SERVICES YOU BETTER

## US Robotics Courier V.32terbo Modem

**19,200 bps  
Without  
Compression!**

- ✓ Data Transfer Protocols from 2400 bps (V.22bis) to 19.2K bps (V.32terbo), Including Popular 9600 bps (V.32) and 14.4K bps (V.32bis) Compatibility.
- ✓ V.42, V.42bis Data Compression and Error Correction
- ✓ User-upgradeable to 28.8K bps (V.34) Technology when Available

Internal..... **\$330.60** CDW 32490  
External..... **SPECIAL \$378.23** CDW 32489

CDW® CARRIES OVER 15,000 PRODUCTS. IF YOU DON'T SEE IT, **CALL!**

### COMPUTERS

#### TOSHIBA

T1950/120MB	1899.00	T4800C/200MB	3999.00
T1950/200MB	2099.00	T4800C/340MB	4399.00
T4800/120MB	2089.00	T6600C/510MB	6099.00
T4800/200MB	2299.00	T8000C/510MB	6599.00
T4800C/120MB	2069.00		
T1950CT/120MB PAS CLR	2479.00		
T1950CT/120MB ACT CLR	2799.00		
T1950CT/200MB PAS CLR	2699.00		
T1950CT/200MB ACT CLR	2999.00		
T3400/120MB NEW	2197.00		
T3400CT/120MB ACT CLR NEW	2429.00		
T4700CS/200MB PAS CLR NEW	4499.00		
T4700CS/200MB ACT CLR NEW	4239.00		
T4700CS/320MB PAS CLR NEW	4849.00		
T4700CT/320MB ACT CLR NEW	4599.00		
T6600C/510MB CD/DVI	7599.00		

### AST

LC 4/25S 120MB	997.97	LP 4/25S 340MB	1599.35
LC 4/33S 120MB	1119.97	LP 4/33D 170MB	1445.60
LC 4/33D 120MB	1257.97	LP 4/33D 340MB	1899.77
LC 4/33D 210MB	1497.97	LP 4/66D 170MB	1934.52
LC 4/50 120MB	1529.95	LP 4/66D 340MB	2394.91
LC 4/50D 120MB	1787.97	MT 4/33D 170MB	1497.97
LC 4/66D 120MB	1787.97	MT 4/33D 340MB	1936.44
LC 4/66D 210MB	2019.91	MT 4/66D 170MB	2018.15
LP 4/25S 170MB	1177.97	MT 4/66D 340MB	2467.97
NOTEBOOK BOMB MONO	1657.97		
NOTEBOOK BOMB MONO COLOR	1767.97		
NOTEBOOK 170MB MONO COLOR	1967.97		
NOTEBOOK 170MB COLOR	2397.97		
POWEREXEC 4/25 200MB	1429.97		
POWEREXEC 4/25 200MB COLOR SPECIAL	3959.97		

### Canon

NOTEJET 425 135MB	2387.97		
INNOVA 4/25 180MB	923.83		
INNOVA 4/33L SX 170MB	1025.71		
INNOVA 4/33L SX 240MB	1265.71		
INNOVA 4/55L 170MB	1445.96		
INNOVA 4/55L 240MB	1638.97		
INNOVA 4/65L 170MB	1814.88		

### NEC

#### VERSA NOTEBOOKS

4/25 120MB COLOR	3589.26	4/40 120MB COLOR	3878.60
4/25 180MB MONO	2578.38	4/40 250MB MONO	3037.39
4/25 180MB COLOR	3829.55	4/40 250MB COLOR	4286.91
4/30 180MB MONO	2854.45	4/50 200MB MONO	3299.82
4/30 180MB COLOR	4098.70	4/50 200MB COLOR	4549.28
4/30 250MB MONO	3096.07	4/50 300MB MONO	3719.11
4/30 250MB COLOR	4293.65	4/50 300MB COLOR	4974.69
4/40 120MB MONO	2618.72		
READY ES 4/25 170MB	997.97		
READY ES 4/33S 210MB	1246.68		
READY ES 4/65 250MB	1694.51		
READY 4/25S 170MB Multimedia	1447.97		
READY 4/33S 210MB Multimedia	1899.89		
POWERMATE ES 4/25 170MB	1069.79		
POWERMATE ES 4/33 170MB	1399.97		
POWERMATE ES 4/66 170MB	1699.93		

### SHARP

SHARP 486/33 200MB PAS CLR	2089.82
SHARP 486/33 200MB ACT CLR	3499.98

### TEXAS INSTRUMENTS

TM4000C 4/25D 120MB MONO	1859.55
TM4000 4/25D 200MB MONO	2249.44
TM4000C 4/25S 120MB ADV COLOR	2099.43
TM4000 4/40 200MB PASV COLOR	2959.56
TM4000 4/50 120MB MONO	2529.52
TM4000 4/50 200MB MONO	2959.78
TM4000C 4/50 200MB DUAL COLOR	3219.23
TM4000C 4/50 200MB ACTIVE COLOR	3779.16

### OKIDATA

184 TURBO	222.14	ML590	428.51
ML320	304.45	ML591	585.87
ML321	432.43	PACCEMARK 3410	1222.82
ML380	214.85	OL400E	499.58
ML390	389.20	OL810	763.59
ML395C	1038.74	OL830	1079.95
ML520	369.82	OL850	1185.20
ML521	498.18	DOC-IT 4000	2909.49

### Canon

BJ105X NEW	239.88
BL200	399.89
BL220	499.90
BL2300 COLOR	898.39
LB430 LASER	388.30

### DOT MATRIX & LASER PRINTERS

#### EPSON

AP2250	115.63	LQ870	444.91
AP2350	172.85	LQ1170	511.83
AP3250	199.15	LQ2550	998.08
LBX810	187.80	DFX5000	1327.84
FX870	287.58	DFX8000	2277.97
FX1170	385.95	STYLUS 300	229.95
LO570+	237.97	STYLUS 800	277.97
LO1070+	345.35		

#### ACTION LASER 1500

ACTION LASER 1500	648.97
ACTION LASER 1500 W/2MB	697.22

### NEC

P3200	225.78	Silentwriter 95F	867.70
Jetman 1000	267.41	Silentwriter 95FX	1085.80
SuperScript 610	628.49	Silentwriter 1097	1388.80
Silentwriter 640	NEW798.58		

### Panasonic

1150	133.49	2180	178.31
1624	265.20	2624	299.88
1695	399.44	4410 LASER	1899.88
2023	262.97	4430 LASER	1899.88
2124	318.37	4440 LASER	1899.40
2124	318.41		

### TEXAS INSTRUMENTS

MICROWRITER INKJET	277.97
MICROWRITER BASIC	517.16
MICROWRITER PS35	677.22
MICROWRITER P565	937.20
MICRO ASER PRO 800 P523	1318.62
MICROSLASER PRO 600 P565	1338.25
POWERSTEP UPGR- ml500	512.89

### HP

Deskjet Port 310	387.40	LaserJet 4L	689.97
Deskjet 500	299.03	LaserJet 4P NEW	999.99
Deskjet 500C	399.60	LaserJet 4MP NEW	1489.89
Deskjet 550C	598.12	LaserJet 4	1389.48
Deskjet 1200C	1399.88	LaserJet 4M	1948.64
Deskjet 1200C PS	1938.95	LaserJet 4SI	2988.95
HP Paintjet XL300	2249.38	LaserJet 4SI MX	4508.30

### SHARP

SHARP JX9400 300DPI 4PPM	489.87
SHARP JX9460 800DPI 6PPM	949.89

### IBM LEXMARK

4037 5E 5PPM	657.97
4029-10 10PPM	1117.97
4039-10R 10PPM	1247.97
4039-10RD 10PPM DUPLEX	1847.97
4039-12R 12PPM	1697.97
4039-12L 12PPM	2447.97
4039-16L 16PPM	2724.87

### HARD DRIVES & CONTROLLERS

#### Maxtor

7131A 131MB IDE	198.10	7345A 345MB IDE	309.18
7245A 245MB IDE	254.87	7345S 345MB SCSI	369.83
7245S 245MB SCSI	284.44	7546A 540MB IDE	637.87

### MICROPOLIS

1050MB IDE	849.23	1050GB SCSI AV	998.35
1050MB SCSI	949.31	1.765GB SCSI AV	1259.34
1.7GB SCSI	1279.29	1936 3GB SCSI	2299.38

### CONNER

210MB IDE	268.00	540MB IDE	628.25
343MB IDE	398.87	540MB SCSI	848.29
343MB SCSI	338.88	1GB SCSI	877.21
426MB IDE	418.89	1.37GB SCSI	1088.89

### Seagate

ST3243A 200MB IDE	223.75
ST3290A 261MB IDE	253.56
ST3399A 341MB IDE	323.20
ST3594A 432MB IDE	453.54
ST11200N 1.05GB SCSI	888.33

### CONTROLLERS

ACCULOGIC IDE	23.65
ACCULOGIC IDE W/1PAR, 2SER, 1GAME	38.04
ACCULOGIC IDE W/BIOS	48.80
ACCULOGIC VLB IDE	32.20
ACCULOGIC ISA SCSI-2	118.44
ACCULOGIC EISA SCSI-2	249.89
ADAPTEC 1542CF SCSI KIT	259.45

### MODEMS & COMMUNICATIONS

#### US Robotics SPORTSTER MODEMS

14.4 INT.	139.50
14.4 INT W/FAX	148.50
14.4 EXT.	169.50
14.4 EXT W/FAX	177.50
WORLDPORT 14.4	148.00

#### COURIER MODEMS

V.32TERBO INT	333.60
V.32TERBO INT W/FAX	348.60
V.32TERBO EXT	379.23
V.32TERBO EXT W/FAX	394.07
16.8 HST EXT	177.50
DUAL STD INT W/FAX	632.63
DUAL STD TERBO INT/EXT W/FAX	679.91/732.63

#### Hayes

ACCUFA 2400B INT 59.10	OPTIMA 24 FAX	119.34
ACCUFA 2400 EXT 89.25	OPTIMA 9000 EXT	338.50
ACCUFA 24EC FAX 99.49	ACCUFA 96 FAX 175.12	109.33
ACCUFA 96 FAX 175.12	ACCUFA 14.4 EXT 383.80	109.33
ACCUFA 96 EXT 189.68	OPTIMA 14.4 FAX 378.30	109.33
ACCUFA 14.4 FAX 189.68	OPTIMA 14.4 Fax/Ext 295.93	109.33
ACCUFA 14.4 EXT 219.45	ULTRA 9600 EXT	569.18
OPTIMA 2400	ULTRA 14.4 EXT 629.56	439.13
OPTIMA 28 KB V.F.C. EXT W/FAX	ESPACADELATERAL SINGLE DUAL SERIAL	79.50/116.94

### ALICORP

2400B INT	61.68
2400 EXT	89.95
PM2400EFX 2400 V.42 BIT W/FAX	89.65
PM2400EF 2400 V.42 EXT W/FAX	109.33
PM2400EP 2400 POCKET W/FAX	109.33
PM5600FX 9600 INT W/FAX	174.30
PM5600FMT 9600 EXT W/FAX	182.20
PM1440FX 14.4 INT W/FAX	174.30
PM1440FXMT 14.4 EXT W/FAX	197.28
PM1440FP XBA 14.4 EXT W/FAX, LCD	374.45
PM1440FPX 14.4 POCKET W/FAX	339.95

### int'l

#### SATISFACTION MODEMS

100 INT.	98.66	350 INT.	257.23
200 INT.	209.50	400 INT.	273.65
300 INT.	229.70	400 EXT.	309.59

#### BOCA

2400 V.42BIS INT	179.70
2400 V.42BIS EXT	112.52
9600 INT/EXT W/FAX	154.76/165.25
14.4 INT/EXT W/FAX	168.45/197.28

### BATTERY BACKUP AND UPS

BC250	99.11	BC900 LAN	359.67
BC400	143.77	BC1250 LAN	449.39
BC500	191.42	OMNI 500 LAN	299.31
BC500 LAN	199.40	OMNI 600 LAN	309.89
BC800 LAN	239.50	OMNI 750 LAN	369.82
BC750 LAN	313.90	OMNI 1250 LAN	599.03

### AMERICAN POWER

BACK UPS 250	99.34	SMART UPS 400	299.95
BACK UPS 400	159.83	SMART UPS 600	363.38
BACK UPS 450	189.81	SMART UPS 900	569.53
BACK UPS 600	264.84	SMART UPS 1250	709.87
BACK UPS 800	374.4		
BACK UPS 1250	498.77		
SURGEARREST PLUS	29.97		
SURGEARREST PLUS W/TEL LINE-R 600	54.88		
	119.89		

### MICE

LOGITECH DEXXA SERIAL MOUSE	27.37
LOGITECH MOUSEMAN COMBO	66.85
LOGITECH MOUSEMAN CONTROL	89.93
LOGITECH TRACKMAN PORTABLE	72.50
LOG FOTOMAN - W/FREE MOUSE	549.76
MICROSOFT MOUSE V2 SERIAL	59.00
MICROSOFT MOUSE V2 0 PS-2	39.00
MICROSOFT BALLPOINT V2.0	152.77

\* SPECIAL THROUGH 11 30 93

### PCMCIA

DATARACE PCMCIA 2400 W/FAX	178.70
DATARACE PCMCIA 14.4K W/FAX	248.24
DLINK PCMCIA ETHERNET 10BT	217.12
HAYES PCMCIA OPTIMA 2400 W/FAX	235.85
HAYES PCMCIA OPTIMA 14.4 W/FAX	315.00
IBM PCMCIA TOKEN RING 16/4	409.79
INTEL PCMCIA 2400 W/FAX	180.00
INTEL PCMCIA 9600 W/FAX	248.00
INTEL PCMCIA 14.4 W/FAX	299.00
LINKSYS PCMCIA ETHERNET COAX	197.91
LINKSYS PCMCIA ETHERNET 10BT	197.91
MEGAHERTZ PCMCIA 2400 W/FAX	189.85
MEGAHERTZ PCMCIA 2400 XJACK W/FAX	197.82
MEGAHERTZ PCMCIA 9600 W/FAX	259.90
MEGAHERTZ PCMCIA 9600 XJACK W/FAX	277.07
MEGAHERTZ PCMCIA 14.4 W/FAX	248.00
MEGAHERTZ PCMCIA 14.4 XJACK W/FAX	309.31
NOVELLEAGLE PCMCIA ETHERNET COAX	242.80
PRACTICAL PCMCIA 14.4 W/FAX	319.00
T. CONRAD PCMCIA ETHERNET COAX	289.88
USR WORLDPORT PCMCIA 2400 W/FAX	284.60
USR WORLDPORT PCMCIA 14.4 W/FAX	308.48
XIRCOM PCMCIA ETHERNET COAX	276.80
XIRCOM PCMCIA ETHERNET 10BT	269.32
XIRCOM PCMCIA ETHERNET COMBO	309.59

### 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 SMM	CALL
AST PREMIUM 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 4 1MB MEM UPG	CALL
HP LASERJET 2P/III 2MB	CALL
HP LASERJET 2SI 4MB	CALL

The World's First Photorealistic Interactive CD Sci-Fi Adventure.



# THE JOURNEYMAN PROJECT



9 Jun 2318, 0651Z.

## Attention Temporal Protectorate:

A rip has been detected in the fabric of time. Only moments remain until all that mankind has accomplished is laid waste. Your objective - journey through time... from prehistoric lands to the distant future, to prevent any compromise in the established continuum. But before the game is over, you must discover who... or what... is the source of this mayhem, and bring it to a halt.

- Photorealistic 3D modeled worlds to explore
- Integrated arcade action and puzzles to challenge any player
- Intuitive interface featuring easy-to-use inventory and movement controls
- Original soundtrack
- Over 30 minutes of full motion video
- No set order in which the goals must be accomplished
- More than one solution to each problem you encounter
- Available on MPC and Macintosh CD

**Take a ride through time on the CD Adventure that will alter history.**

Available at retailers throughout the continuum or by contacting:  
Quadra Interactive, Inc., P.O. Box 188033, Carlsbad, CA 92009-9793  
(619) 431-9530

Circle 220 on Inquiry Card.

**Winner!**

INVISION 1993 Multimedia Awards **Award of Excellence**

plus

- **Gold-Best Animation/Graphics**
- **Bronze-Best Production Design**
- **Bronze-Adult Games**

**"...the world of interactive gaming is never going to be the same."**

Mark Rhodes, Multimedia Editor,  
Micropublishing News



*Travel through time.*



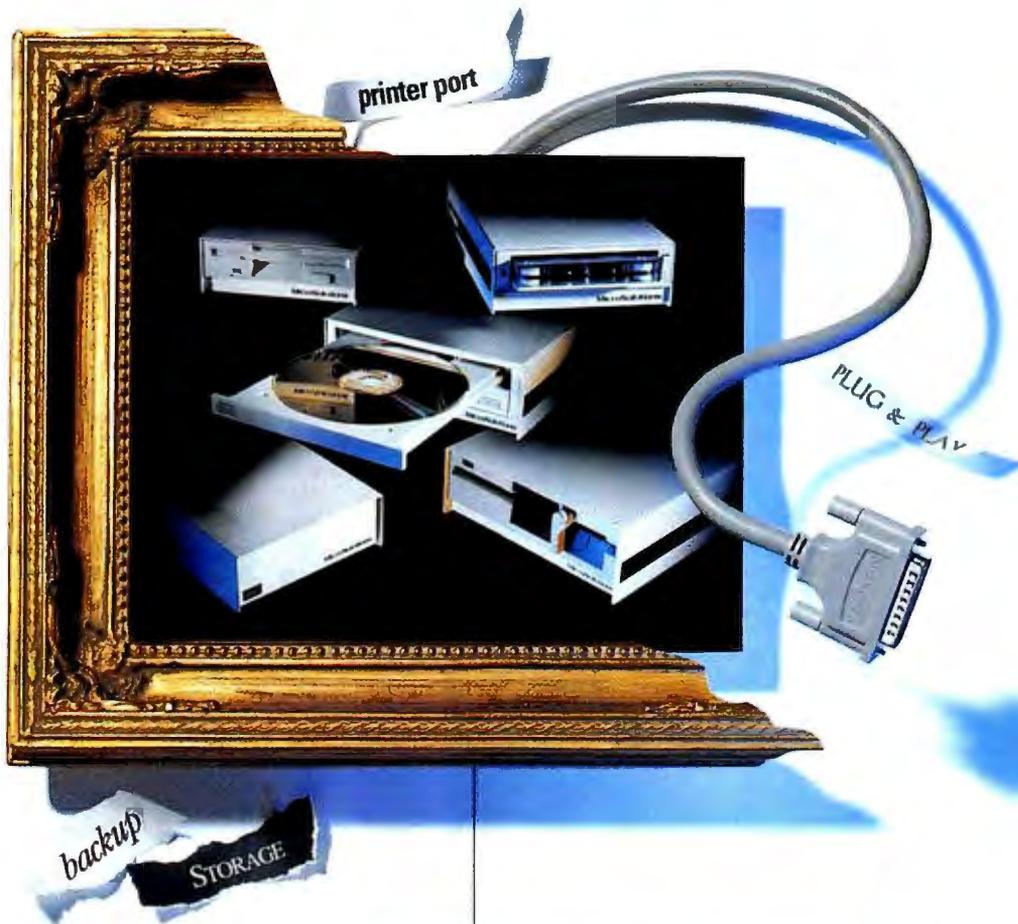
*Arcade action.*



*Multi-level challenges.*

© Copyright 1992, 1993 Presto Studios, Inc.  
MPC version by Quadra Interactive, Inc.





**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 196 on Inquiry Card (RESELLERS: 197).



EPP Aware  
Backpack® does Windows™

## THE SIMPLE CONNECTION BEHIND COMPUTERS AND BACKPACK TAPE DRIVES.



### **It's fast. It's small. It's reliable. It's incredibly compatible.**

Backpack is the best selling parallel port tape drive on the market. We'd like to tell you why.

With Backpack, tape backup is quick and simple. Just plug it into your printer port and it's ready to use. No hardware conflicts, no slots required. One model fits all IBM PCs, compatibles and portables, regardless of CPU speed.

Backpack can store up to 250MB on a tape using data compression, is completely QIC80 compatible, and reads QIC40 tapes. With its compact size

and 1Mbps transfer rate, Backpack is the smallest and fastest parallel port tape drive you can buy.

Micro Solutions is dedicated to the perfection of backup technology.

CD-ROM, hard drive, and diskette Backpack drives are also available. Call today for ordering information and a dealer nearest you.

Telephone 815.756.3411 FAX 815.756.2928

**MicroSolutions** 132 West Lincoln Highway DeKalb, IL 60115

**Call toll free: 800-295-1214**

Circle 198 on Inquiry Card (RESELLERS: 199).

YOUR ONE-STOP SOURCE FOR

# RACKMOUNT

COMPUTER SYSTEMS



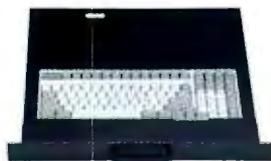
### Rackmount Monitors

- 9" to 20" Diagonal Sizes
- Monochrome or Color SVGA Monitor
- Monitor Kit for Desktop Monitors Available



### Rackmount Enclosures

- 20 Different Models
- Designed for 8,12,14,20 Slot Board
- Up to 8 Drive Bay & 600W Power Supply
- Redundant Power Supply (Optional)



### Rackmount Keyboard

- Full Travel Drawer Mounted 101 Keyboard with Mouse Holder
- Membrane 101 Keyboard
- Keyboard Drawer for Full Size 101 Keyboard



### CPU Cards

- Designed for the 16 bit 32 bit VESA Local Bus
- Upgradeable from 386DX to 486DX2 66MHz.
- 1MB to 64MB On-board Memory
- ISA/EISA/VL Bus Backplane - 3 slot to 20 slots
- Segmented Backplane (Optional)



### Redundant Power Supply

- Designed to provide continual AC Power Source
- Zero System Down-time



### Hard Drive Enclosure

- Designed for 4 Full Height or 8 1/2 H Drives
- Up to 600W Power Supply (Two x 300W PS)
- Redundant Power Supply (Optional)



### Industrial Rackmount System

- 286, 386, 486 ISA/EISA/VESA System
- 9" Monochrome or 10" VGA Color Monitor
- 3 External and 2 Internal Drives

Appro International, Inc. is dedicated in providing our customers with top quality products, unsurpassed service and support at an extremely attractive price. With extensive experience in the rackmount industry, our representatives can offer a wide range of products to fit a variety of customers' needs.

We provide a wide range of rackmount enclosures, monitors, keyboards, Single Board Computer (SBC), and backplanes. Whether your need is to ruggedize a current system or acquire a completed rackmount system, APPRO has the solution. Call our representatives for more information on our rackmount products.

**APPRO**  
INTERNATIONAL, INC.

**800-927-5464**



3687 ENOCHS ST. SANTA CLARA, CA. 95051 • TEL. (408) 732-6091 • FAX (408) 732-6095

Circle 202 on Inquiry Card.

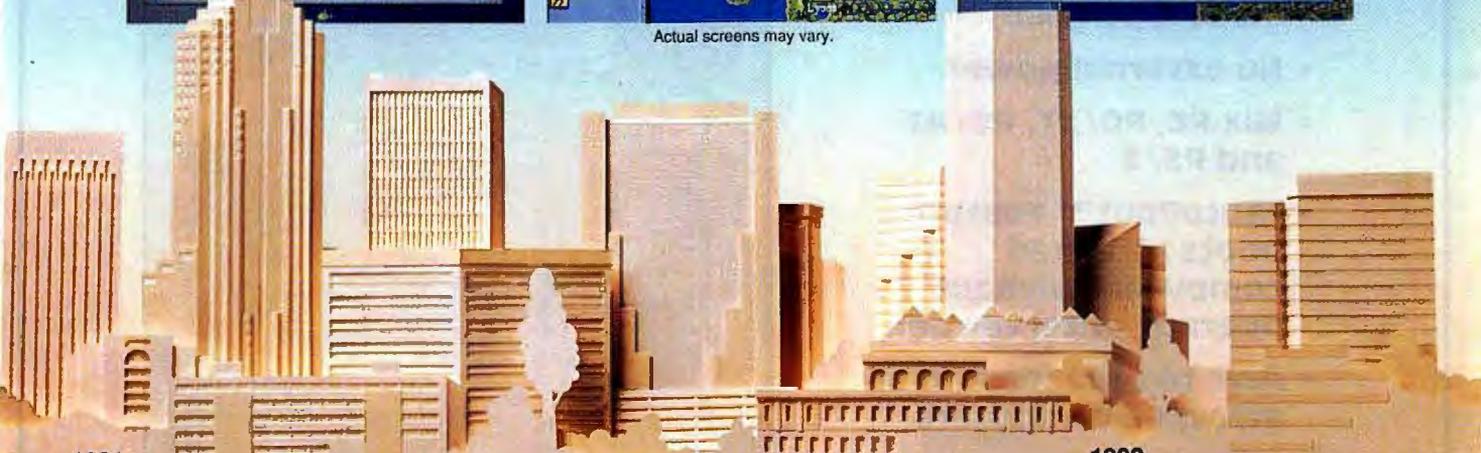
# Build An Empire To Stand The Test Of Time

Now available for Windows™

...With Sid Meier's CIVILIZATION™



Actual screens may vary.



- 1991**
- Best Consumer Entertainment Program
  - Best Strategy program
  - Critic's Choice

*Software Publishers Association*

**Game of the Year**

*Tilt*

**Game of the Year**

*Byte*



**1992**  
**Game of the Year**

*Computer Gaming World*

**PC Special Achievement Award**

*Game Players PC Entertainment*

**Game of the Year**

*Byte*

**Best Simulation**

*PCM*

**Strategy Game of the Year**

*PC Games Plus*

**Rout Ramses... Outwit Alexander... Knockout Napoleon...**

History is littered with the bones of great men who thought their achievements would live forever. Now you can succeed where they failed as MicroProse brings you Sid Meier's **Civilization**. Guide a culture from its earliest stages, through agricultural and industrial revolutions, all the way to your own Space Age. Survive and dominate by outmaneuvering mankind's most legendary leaders. Carve your name indelibly in the pages of history. With Sid Meier's **Civilization**, you really can build a brave new world.

**MICRO PROSE**  
ENTERTAINMENT • SOFTWARE

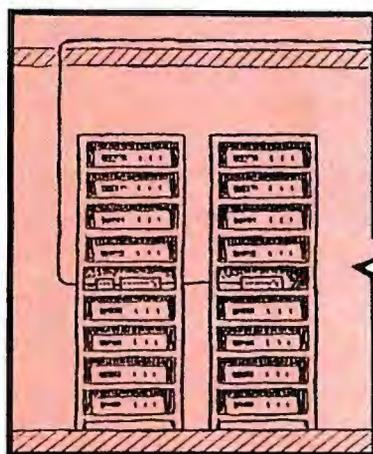
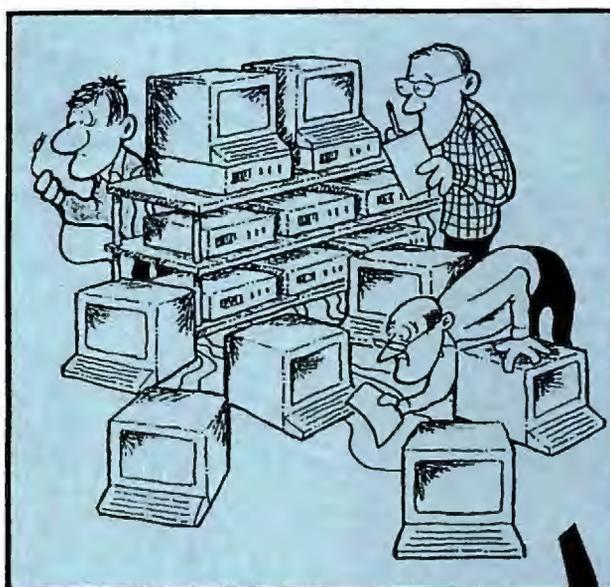
© 1993 MicroProse Software, Inc., 180 Lakefront Drive, Hunt Valley, MD 21030-2245.  
For Macintosh, IBM-PC compatibles, and Commodore Amiga personal computers.  
To get our free catalog, call 1-800-879-PLAY, 8:30 am to 5:00 pm EST.

Circle 195 on Inquiry Card.

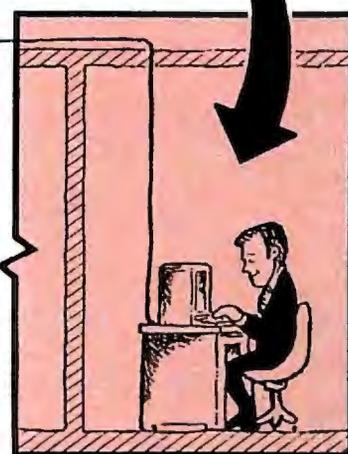
# CONTROL UP TO 96 PC FILE SERVERS WITH 1 KEYBOARD AND MONITOR USING... **COMMANDER™**



- Select via Keyboard
- Dual access up to 250 feet away (optional)
- No external power
- Mix PC, PC/XT, PC/AT and PS/2
- "AutoBoot™" Feature boots attached computers without operator intervention
- Able to Broadcast to all attached computers



- PS/2 and Serial Mouse support available
- Each unit accommodates from 2 to 8 PCs
- Up to 12 units can be cascaded
- Mounting kit available for 19" and 24" rack installation



4912 Research Drive  
Huntsville, AL 35805 U.S.A.  
(205) 430-4000  
FAX (205) 430-4030

Dealer Program Available

PC, PC/XT, PC/AT and PS/2 are trademarks of International Business Machines Corp.

# Arnet's SurgeBlock™ Protection Keeps Our I/O Boards From Frying Like the Rest

## Tests Prove Our Boards Withstand Surges That Make Other Boards Fail

Direct buyers want the best products. The best performance for the price, and — above all — *reliability*.

That's why Arnet uses a unique feature called SurgeBlock to protect every port on its I/O boards from power surges. They're the leading cause of I/O board failures because they're caused by countless sources — from lightning storms to simply walking across the floor.

SurgeBlock gives our I/O boards unbeatable reliability. It was the first onboard surge protection, and independent tests prove it's still the best. Call us and we'll send you the results that prove it.

### The Best I/O Boards to Buy Direct

Not only are our boards the most reliable — with a field failure rate of *less than 1%* — they're also the best direct buy around. Here's why:

### Unmatched Price/Performance

Our I/O solutions support from two to 512 users and operate at speeds from 2400 to 115K baud — with prices starting at less than \$70 per port!

### Compatibility

Our I/O boards are compatible with more than 30 operating systems, including UNIX, Windows, DOS, Multiuser DOS and NetWare.™

### 30-Day Money-Back Guarantee Plus a Lifetime Warranty

We back our reliability with a 30-day, hassle-free money-back guarantee plus a Lifetime Warranty.

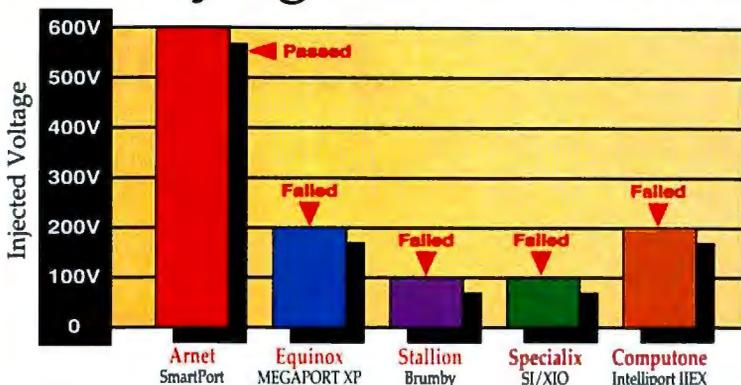
### 24-Hour Hot Swaps

If your board does fail, you can have a replacement at your site within 24 hours.

### Attractive Terms

Qualified customers can buy with our convenient Arnet Gold credit card or other major credit cards. And we offer next day delivery!

### Reseller Discounts Available



CS06 test by Wyle Laboratories. Call for your copy.

## Cost-Effective, Expandable Intelligent Serial I/O



### SmartPort and SmartPort Plus

Create PC systems that can grow as you do with SmartPort and SmartPort Plus. SmartPort is best suited for systems supporting up to 8 users per slot. SmartPort Plus is most cost-effective for systems requiring 16 to 32 users per slot. A powerful onboard processor offloads serial I/O from the host PC to dramatically improve data throughput.

- Supports I/O speeds up to 38.4K baud per port
- Up to 64 Kb of dual ported RAM
- Full signal support for modems and other devices
- RS-422 support on SmartPort Plus for longer distances
- SimulPort terminal paging software
- SimulPrint transparent printing utility

From **\$446**

## Intelligent I/O Communications Subsystem for PCs



### COMStax

Add a COMStax host card to your PC to support up to 128 users per slot. An onboard high performance 20 MHz RISC processor enables transmission rates up to 115.2K baud per port.

- Desktop stackable modules for asynchronous, synchronous and high-speed parallel printing
- Up to 8 stackable communication modules per host card
- RS-423 support for longer distances

Host Adapter From **\$596**  
Modules From **\$371**

## Workgroup Concentrator for Local and Remote Users



### ClusterPort

Build large systems that can support remote users with ClusterPort. A host adapter card with two high-speed synchronous links connects to multiple 16-port Cluster Boxes or to modems for remote locations. Remote users can be connected without using costly multiplexers.

- Supports 128 ports per slot, 512 ports per system
- Supports local users thousands of feet from the host without modems (miles with optional Fiber Link Kit)
- 1.2 Mbps RS-422 synchronous link between host adapter and local Cluster Boxes; Up to 64Kbps synchronous for remotely-attached Cluster Boxes.

Host Adapter From **\$1721**  
Cluster Boxes From **\$1121**

Ask for Your FREE Catalog of Arnet PC Connectivity Solutions!

800-377-5515

FAX: 800-377-8848



**ARNET**

Rock Solid Connections from Digi International

618 Grassmere Park Drive

Nashville, TN 37211

(615) 834-8000, (615) 834-5399 FAX

Arnet and the Arnet logo are registered trademarks of Arnet Corporation. All other trademarks are the property of their respective corporations. Test conducted by Wyle Laboratories, September 1993.

Circle 213 on Inquiry Card (RESELLERS: 214).

Buy six boards—now or one at a time—and get the next one **FREE!**

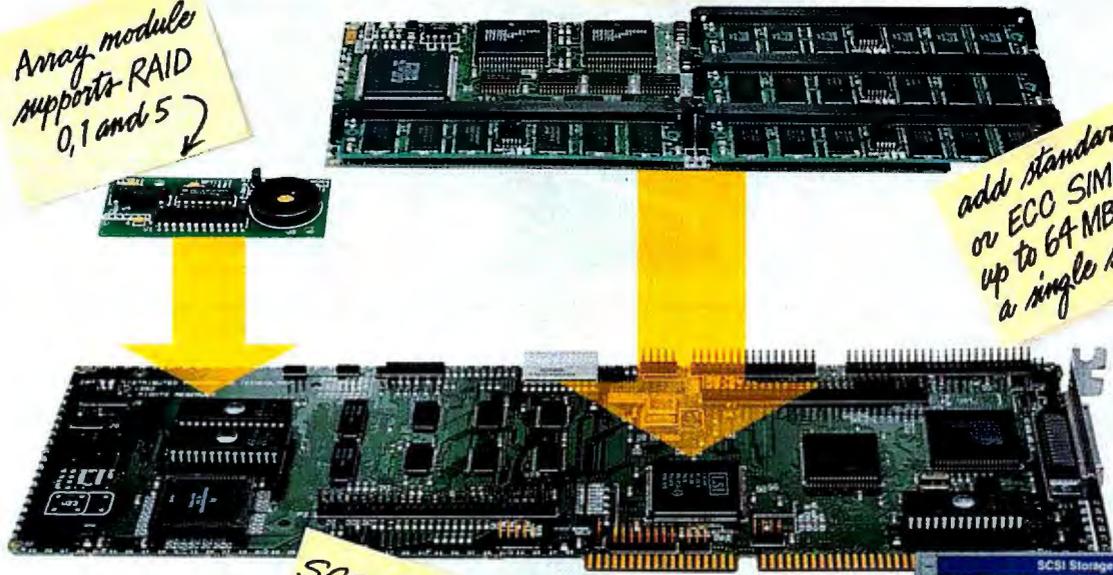
# Take Note: The World's Best SCSI Adapter Just Got Better

*and cheaper!  
\$285\**

*Caching module  
adds blinding  
disk speed!*

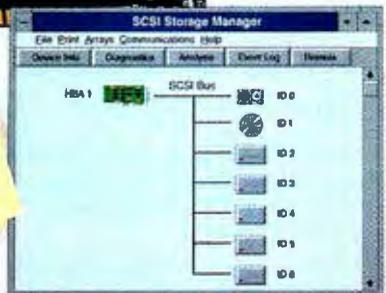
*Array module  
supports RAID  
0, 1 and 5*

*add standard  
or ECC SIMMs—  
up to 64 MB in  
a single slot*



*SCSI adapter—  
for ISA and  
EISA models*

*Storage Manager  
GUI for easy set-up,  
diagnostics, etc.*



## SmartCache III is the total, growable SCSI solution!

The world's best SCSI adapter is now the world's greatest bargain—priced lower than any major competitor. An unprecedented value, SmartCache III offers top performance and universal connectivity with all major SCSI-1, SCSI-2 and Fast SCSI devices, including hard drives, tape, CD-ROM and WORM.

It also comes with built-in support from all major operating systems, including DOS, Windows, OS/2, NetWare, Windows NT, NextStep and all versions of Unix.

And only SmartCache III gives you a growth path. Optional plug-on modules let you migrate easily to caching (with up to 64Mb cache), as well as full RAID capability. *Storage Manager*, our GUI utility, makes installation quick, easy and automatic. Plus, it gives you on-line and remote control over subsystem management, diagnostics, performance monitoring, and disk array configuration and control.

Distributed Processing Technology, Inc.  
140 Candace Dr. Maitland, FL 32751 USA



\*List price for ISA model PM2021/90 SCSI Adapter Board

Circle 189 on Inquiry Card (RESELLERS: 190).

Call DPT, today!  
800-322-4DPT  
FAX 407-260-5366



# Your One Stop Component & Computer Source

Since 1973

## Jameco Motherboards



- Motherboards now available without CPU! Call for details
- Diagnostic and operating system software available
- One-year warranty

95231	80486DX 50MHz w/CPU	..\$799.95
93534	80486SLC 50MHz w/CPU	..\$399.95
95222	80486DX 33MHz w/CPU	..\$49.95
79214	80486SX 25MHz w/CPU	..\$289.95
82333	80386DX 40MHz w/CPU	..\$239.95
82350	80386DX 33MHz w/CPU	..\$219.95
101821	80386SX 33MHz w/CPU	..\$124.95
84945	XT 10MHz w/CPU	..\$79.95

## RAM Memory



41371	41256-100	..256KBx1	..\$1.75
41398	41256-120	..256KBx1	..\$1.99
42251	51100P-80	..1MBx1	..5.95
42219	51100P-10	..1MBx1	..5.75

## SIPPS



41700	421000A9A-70	..1MBx9	..\$60.95
41718	421000A9A-80	..1MBx9	..49.95
41697	421000A9A-10	..1MBx9	..49.95

## SIMMS



41523	41256A9B-80	..256KBx9	..\$14.95
41486	41256A9B-10	..256KBx9	..14.95
41689	421000A8B-80	..1MBx8	..49.95
41742	421000A9B-60	..1MBx9	..59.95
41751	421000A9B-70	..1MBx9	..54.95
41769	421000A9B-80	..1MBx9	..48.95

## SIPP to SIMM Converter

- Use SIPP's in place of SIMM's
- Upgrade from a SIPP Motherboard to a new SIMM Motherboard without buying new RAM
- Fits into standard 30 pin SIMM socket

93382	SIPP Module Converter	.....\$9.95
-------	-----------------------	-------------



## Keyboards & Keypad

78271	32-key keypad	.....\$59.95
20431	84-key keyboard	.....39.95
17128	101-key enhanced	.....74.95
17136	130-key enhanced	.....99.95

## Computer Power Supplies

- Fits most popular desktop mini vertical, and vertical cases • One-year warranty
  - 8088/80286/80386 and compatible • Built-in fan
- |       |                 |              |
|-------|-----------------|--------------|
| 19455 | 150 Watt (8088) | .....\$69.95 |
| 67467 | 200 Watt        | .....89.95   |
| 18545 | 200 Watt        | .....89.95   |
| 19553 | 200 Watt mini   | .....89.95   |
| 65728 | 300 Watt        | .....139.95  |

## Graphics/Memory Cards

- 8088/80286/80386 and compatible
- One-year warranty
- Expand your memory or enhance your graphics capabilities

93542	VGA Hi-color card	.....\$139.95
67459	VGA card	.....59.95
91230	Monochrome Graphics	.....39.95
29313	32MB Memory Card	.....144.95
19975	(8088) Memory Card	.....49.95

## Parallel Printer Cables and Adapter

28695	PPC Adapter - straight	.....\$5.95
28716	PPC6 6' - straight	.....4.95
28708	PPC12 12' - straight	.....8.95
28741	PPR6 6' - right angle Centronics	6.95

## 9-Pin Serial Cable

31721	SAT6 9-pin serial cable	.....\$4.95
-------	-------------------------	-------------

## DB25-Pin Extension Cable

39538	25M10M Male to male	.....\$8.95
-------	---------------------	-------------

## Floppy Disk Drives



- 8088/80286/80386 and compatible
  - One-year warranty
- |       |                    |               |
|-------|--------------------|---------------|
| 74392 | FD505 3.5"/5.25"   | .....\$149.95 |
| 74384 | FD235J 2.88MB 3.5" | .....119.95   |
| 40774 | 356KU 1.44MB 3.5"  | .....79.95    |
| 17099 | FD55B 360KB 5.25"  | .....89.95    |
| 17101 | FD55G 1.2MB 5.25"  | .....99.95    |
| 79396 | SD540 360KB 5.25"  | .....99.95    |

## Floppy Controllers and I/O Cards



- One-year warranty
- 8088/80286/80386 and compatible

## Multi I/O with Floppy Controller

19895	8088 Multi I/O	.....\$69.95
19908	286/386 Multi I/O	.....59.95

## Floppy Disk Drive Controller Cards

19617	Two-drive controller	.....\$34.95
19668	Four-drive controller	.....44.95

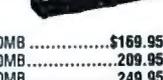
## RS232 Card (4 ports)

76726	4 Port RS232 Card	.....\$59.95
-------	-------------------	--------------

## RS232 Serial Cards

78713	16450 UART	.....\$29.95
-------	------------	--------------

## Conner IDE Hard Drives



- One-year warranty
- |       |                |               |
|-------|----------------|---------------|
| 14058 | CP3000 40MB    | .....\$169.95 |
| 14068 | CP3008A 80MB   | .....209.95   |
| 93286 | CP30174E 170MB | .....249.95   |
| 93294 | CP30254 250MB  | .....299.95   |
| 93307 | CP30544 545MB  | .....749.95   |

## Silicon Valley IDE Disk Drive Adapter Cards



- One-year warranty

10233	ADP20 16-bit hard	.....\$22.95
10250	ADP20F 16-bit hard/floppy	.....29.95
10268	ADP50 8-bit hard	.....59.95
10276	ADP60 16-bit hard w/ BIOS	.....69.95
10284	ADP60F 16-bit hard/floppy w/ BIOS	.....74.95
74114	AOP65F 16-bit hard/quad floppy drive adapter	.....99.95
101670	ADP90VL Super I/O Card (VESA)	.....99.95

## D-Subminiature Connectors

- Compatible with 24 AWG Cable • Metal shell
- Solder cups for 22 AWG wire • Male connectors with grounding tangs

Part No.	Product No.	Gender	1-9	10-99
15747	DE9P	M	.....\$4.43	.....\$3.35
15771	DE9S	F	......47	......39
15034	DA15P	M	......53	......45
15051	DA15S	F	......57	......49
15114	DB25P	M	......63	......55
15157	DB25S	F	......73	......63
15472	DC37P	M	.....1.15	......95
15499	DC37S	F	.....1.25	......99
15675	DD50P	M	.....1.79	.....1.49
15691	DD50S	F	.....2.25	.....1.69

## D-Subminiature Slim Line Gender Changers

18497	Interfaces two D-sub 9-pin F	.....\$3.95
18489	Interfaces two D-sub 9-pin M	.....3.95
56071	Interfaces two D-sub 15-pin F	.....4.19
56063	Interfaces two D-sub 15-pin M	.....4.19
18446	Interfaces two D-sub 25-pin F	.....4.29
18420	Interfaces two D-sub 25-pin M	.....4.29



Call 1-800-831-4242 to order today!

## EPROMS

39909	2708	.....\$4.95
33611	TMS2716	.....6.95
40002	2716	.....3.95
40125	2732A-25	.....4.19
140230	2764A-20	.....4.49
39829	27C64-15	.....3.75
39833	27128-25	.....7.75
39868	27128A-20	.....4.95
39984	27128A-25	.....4.49
39677	27C128-15	.....5.39
40037	27256-15	.....5.39
40061	27256-25	.....4.75
39714	27C256-15	.....5.49
39722	27C256-20	.....5.25
39781	27C512-15	.....6.49
65699	27C020-15	.....10.95
43692	68766-35	.....4.95

## UVP EPROM Eraser



- Erases all EPROM's
- Erases 1 chip in 15 minutes
- Erases 8 chips in 21 minutes
- UV Intensity: 6800 UW/CM<sup>2</sup>
- Size: 9.0"L x 3.7"W x 2.6"H
- One-year warranty

15712	DE4 8-Chip eraser	.....\$89.95
-------	-------------------	--------------

## 1 Socket 16K-2MB E(E)PROM Programmer



- Programs EPROM's, EEPROM's, and Flash memories
- Programs 16KB to 2MB EPROM's
- Programming speeds/algorithms: Normal, Intelligent, and Quick pulse
- Menu driven software • Full screen buffer editor
- File formats supported: Intel Hex, Motorola S Hex, Tektronix Hex, and Binary
- 2 & 4-way Binary file splitting programs
- 2 & 4-way Binary file shuffler programs
- Includes adapter card, software and manual
- Size: 7"L x 5.5"W x 1.75"H • One-year warranty

78457	1 Socket 16K-2MB (above)	.....\$199.95
101400	1 Socket 16K-512KB	.....129.95
78465	4 Socket 16K-2MB Programmer	.....269.95
78473	8 Socket 16K-2MB Programmer	.....469.95
78481	1 Socket 16K-8MB Universal	.....679.95

## Portable IC Tester



Our hand-held IC tester is an easy-to-operate, cost effective unit that includes excellent functions.

- Supports TTL, CMOS, DRAM 41, and DRAM 44 Series
- Size: 7"L x 3.625"W • One-year warranty

73525	Portable IC Tester	.....\$144.95
-------	--------------------	---------------

## Microprocessors



26147	MM54104N	.....\$24.95
26227	MM58274N	.....7.49
43158	6402	.....4.95
43166	65C02	.....5.95
43254	6522	.....3.75
43596	6821	.....1.95
61844	8031	.....3.59
51676	80C31	.....6.95
52003	8052AH	.....6.95
52142	8088	.....3.95
52652	8251A	.....2.95
52724	8255	.....2.75
52732	8255A-5	.....2.95
52417	82C55A	.....3.95
53022	8748	.....8.75
53057	8749H	.....9.75
53081	8751H	.....24.49
52978	87C51	.....32.95

## Waber Surge Protectors



- Electrical Rating: 15 Amp, 120 VAC, 60Hz
- Protection devices: Metal oxide varistors • OEM pricing
- EMI/RFI noise rejection: up to 15dB • Easily installs into wall outlet
- UL 1449 suppressed voltage rating: 400volts
- Clamping response time: <5 nsec

99291	EP6 6 Outlet Wall Plug-in	.....\$6.95
99979	EP6M 6 Outlet Wall Plug-in	.....9.95
99987	EP6M 6 Outlet Wall Plug-in	.....9.95
	with telephone protection	
	with cable TV protection	

## 7 Outlet Power Strip



- Audible alarm sound for surge protection
- Master power switch • 4' Power cord
- Push-to-reset 15 Amp circuit breaker
- High-impact thermoplastic case
- Size: 3.25"L x 2.125"W x 1.125"H
- One-year warranty

98749	LR69225 Power Strip	.....\$9.95
-------	---------------------	-------------

## Apple II, II+ and IIe Switching Power Supply



- Can drive four floppy disk drives and up eight expansion cards
- Short circuit and over load protection inside the Apple II, II+, IIe • 60 Watt
- Fully regulated +5V @5A, +12V @ 2.5A, -5V @5A, -12V @ 5A • One-year warranty
- Same size as original power supply
- Apple type plug-in power cord included
- 110V/220V switchable
- Size: 9.875"L x 3.5"W x 2.25"H
- Data included • Weight: 2.8 lbs.

22269	KHP4007 Power supply	.....\$49.95
-------	----------------------	--------------

## Apple IIGS Switching Power Supply

- Fully regulated +5VDC @ 6A, +12VDC @ 2A, -5VDC @ 0.5A, -12VDC @ 0.5A • 60 Watt
- Input Voltage: 115VAC • One-year warranty

85518	Switching power supply	.....\$69.95
-------	------------------------	--------------

## Metex Digital Multimeters



- Handheld high accuracy
  - Measures AC/DC voltage, AC/DC current, resistance, diodes, audible continuity test, transistor hFE
  - Manual ranging w/overload protection
  - Comes with probes, batteries, case and manual • One-year warranty
- |       |                                                        |              |
|-------|--------------------------------------------------------|--------------|
| 27078 | 3.5 digit multimeter                                   | .....\$59.95 |
| 27086 | 3.5 digit multimeter with frequency & capacitance      | .....69.95   |
| 27115 | 3.5 digit multimeter                                   | .....39.95   |
| 27140 | 4.5 digit multimeter with tach and dwell               | .....69.95   |
| 27158 | 4.5 digit w/frequency and capacitance/data hold switch | 99.95        |

## AC and DC Wall Transformers



- Male Plug - 3.5 mm
- Female Plug - 2.1 mm
- UL listed
- Current rating to 1 Amp

Part No.	Voltage	Current	Plug	Price
10129	9VAC	500mA	Male	.....\$4.95
10073	12VAC	500mA	Male	.....5.49
10081	12VAC	1000mA	Female	.....5.95
101266	6VDC	500mA	Female	.....6.25
15561	9VDC	500mA	Male	.....5.49
15368	12VDC	500mA	Female	.....5.95
15392	12VDC	1000mA	Male	.....7.95

Wireless Information Delivery from Motorola



**EMBARC puts  
wireless power  
in the palm  
of your hand!**

## EMBARC Unlocks the Potential of Your Personal Digital Assistant

At EMBARC, we've expanded our wireless reach to include today's newest, most portable class of computer — the personal digital assistant! Now, a wealth of wireless news and information comes straight to your PDA over the EMBARC wireless network. All you need is the EMBARC Motorola NewsCard wireless data receiver.

Virtually anywhere you travel in the U.S. and Canada, the EMBARC wireless network keeps you sharp and productive with a broad array of subscription news and information services. Dozens of subject options from such leading sources as USA TODAY, REUTERS and INDIVIDUAL, Inc. keep you up to speed with everything from financial market updates, to industry-specific news, to sports and weather. Plus, you'll be on top of business with full-text wireless E-mail and file transfers from your office.

The EMBARC Motorola NewsCard fits many of today's popular PDAs, including the Casio Z-7000, Tandy Z-PDA and GRiD 2390, and operates for a full month on one AAA battery. For a mere \$249, it turns your personal digital assistant into a wireless wonder! To learn more about EMBARC wireless service for PDAs, and to ask about EMBARC compatibility with other platforms, call 800-EMBARC4, Ext. 330.

EMBARC and NewsCard are registered trademarks of Motorola, Inc.  
All other names and products mentioned are the property of their respective organizations.

**EMBARC**<sup>SM</sup>

by Motorola

Circle 207 on Inquiry Card (RESELLERS: 208).

**CALL NOW FOR FREE CATALOG!**

# EXXUS

**OVERNIGHT DELIVERY!**  
Available On All Systems Standard!

Your Single Resource For All Your Computer Needs!  
**800-557-1000**

## Diskettes



**\$0.36**  
50+ Quantity  
Premium Grade IBM-Formatted  
disk color may vary

**HD \$0.25**  
50+  
IBM-Formatted

**5 1/4" HD**

**DD \$0.18**  
50+  
IBM-Formatted

**5 1/4" DD**

**FREE**  
50+ Quantity  
IBM-Formatted  
disk color may vary

**\$0.30**  
50+ Quantity  
IBM-Formatted  
disk color may vary

IBM-Formatted \$0.36  
Non-Formatted \$0.36  
MAC-Formatted \$0.52

PROMOTE ENVIRONMENTAL AWARENESS  
PRE-LABELED RECYCLED DISKETTES  
No Supplies Lost CALL NOW!

## Data Cartridges

Model	Price	Brand
DC170	\$11.49	Premiere
DC170	\$12.95	Generic
DC2000	\$ 9.89	Brand
DC300XLP	\$12.89	
DC400A	\$12.99	
DC4150	\$13.49	
DC6250	\$16.49	

**3M**  
90M (2.0 GB) \$13.99  
40M (1.3 GB) \$11.99  
Cleaning Cart. \$14.99

**8 Data Grade**  
112M (3.0 GB) \$11.99  
Cleaning Cart. \$19.99

**Optical Disks**  
5 1/4" REWRITABLE 512K/650MB \$89.00  
5 1/4" REWRITABLE 1024K/650MB \$89.00  
5 1/4" REWRITABLE 512K/128MB \$45.00  
3 1/2" FLOPTICAL 21MB \$16.79  
5 1/4" CD-R 74 MIN. RECORDABLE CD \$21.99  
5 1/4" CD-R 63 MIN. RECORDABLE CD \$19.50

**3.5" Cartridges**  
44 MEG \$ 65.00  
85 MEG \$ 95.00

## SUPPLIES

**HP HEWLETT PACKARD**

2225A LABELJET II, INK, INK, SERIES II	\$77.99
22715A LABELJET II, INK, HP	\$81.99
22296A LABELJET IV, INK	\$95.99
22255A LABELJET, LASERJET, 300, SERIES I	\$74.99
22291A LABELJET III, INK, INK, MK	\$108.99

5108A DESKJET / DESKWRITER	\$15.99
51028A DESKWRITER, FAX 800/300, DESKJET	\$23.99
51604A THINKJET / QUIETSET	\$9.99
51025A DESKJET 300C / DESKWRITER 300	\$25.99

8020029 STYLUS 800	\$14.99
7753 LB870/870	\$9.00
8015032 ACTION PRINTER	\$9.00

## EPSON

5051011 ACTION LASER 1000/1500	\$118.00
5051099 EPL 8000	\$148.00
5050002 ACTION LASER 8	\$78.00

8020029 STYLUS 800	\$14.99
7753 LB870/870	\$9.00
8015032 ACTION PRINTER	\$9.00

## CD ROM SOFTWARE

WORLD ATLAS	\$13.75	VOYAGE/STARS I	\$35.00	GREAT CITIES	\$20.00
CIA WORLD FACT BOOK	\$16.25	VOYAGE/STARS II	\$35.00	GUINNESS	\$22.50
CLASSIC COLLECTION	\$47.50	VOYAGE/STARS III	\$35.00	HAWAII	\$13.75
FAMILY DOCTOR	\$22.50	VOYAGE/STARS IV	\$35.00	INTERACTIVE STORY II	\$10.75
VOYAGE /PLANETS I	\$35.00	ENCYCLOPEDIA	\$37.50	LOOM	\$17.50
VOYAGE/PLANETS II	\$35.00	FOOD ANALYST	\$22.50	MAGAZINE PACK	\$18.75
VOYAGE/PLANETS III	\$35.00	GAME PACK I	\$13.75	MAMMALS	\$16.25
VOYAGE/PLANETS IV	\$35.00	GAME PACK II	\$15.00	MARIO DELUXE	\$16.25

## PACKARD BELL MULTI-MEDIA DESKTOPS

THE COMPUTER THAT'S A TV!



THE ULTIMATE WINDOWS EXPERIENCE!  
CABLE-TV READY AND VIDEO CAMERA COMPATIBLE!  
NEW! MULTI-SESSION CD-ROM DRIVE COMES INSTALLED!  
HIGH-FIDELITY STEREO SPEAKER CONSOLE WITH SOUND CARD!  
CAPTURE SCREEN IMAGES AND SIZE TO YOUR NEEDS, THEN PASTE INTO YOUR CHOICE OF DOCUMENTS!  
ON-SCREEN REMOTE CONTROL!  
ENTIRE MULTI-MEDIA SYSTEM WITH MULTIMEDIA SOFTWARE LOADED AND USE-READY!  
AUDIO CD PLAYER INCLUDED!

486SX/25MHz + 210MB HARD DISK + 4MB RAM + LOCAL BUS VIDEO MODEM + DUAL FLOPPY DRIVES + 4 BUS SLOTS + 4 DRIVE CAVITIES  
2P SOCKET + 1280 X 1024 EXT. VGA VIDEO CARD + HIGHRES MOUSE  
ENHANCED 101-KEY KEYBOARD  
SATELLITE SPEAKERS

**23" MONITOR INCLUDED! \$1,999!**

**EXTRA-HIGH POWER MINITOWERS**  
F2010 \$1,499  
486SX 25MHz  
170MB HARD DISK  
4MB RAM  
MODEM  
2P SOCKET  
4 BUS SLOTS  
4 DRIVE CAVITIES  
3 1/2" HD FLOPPY DRIVE  
1280 X 1024 EXT. VGA VIDEO CARD  
VESA LOCAL BUS VIDEO CONTROLLER  
ENHANCED 101-KEY KEYBOARD  
SATELLITE SPEAKERS  
MULTI-SESSION CD ROM DRIVE

**STEREO OFFICE DESKTOP**  
F250 \$1,499  
486SX 33MHz  
250MB HARD DISK  
4MB RAM  
FAX/MODEM  
2P SOCKET  
4 BUS SLOTS  
4 DRIVE CAVITIES  
3 1/2" HD + 5 1/4" HD FLOPPY DRIVES  
1280 X 1024 EXT. VGA VIDEO CARD  
VESA LOCAL BUS VIDEO CONTROLLER  
ENHANCED 101-KEY KEYBOARD  
SATELLITE SPEAKERS + AUDIO CARD

**TOP VALUE PRODUCTIVITY DESKTOPS**  
F715 \$1,499  
486SX 33MHz  
250MB HARD DISK  
4MB RAM  
FAX/MODEM  
2P SOCKET  
4 BUS SLOTS  
4 DRIVE CAVITIES

**TOP VALUE PRODUCTIVITY DESKTOPS**  
F1177 \$1,999  
486SX 33MHz  
245MB HARD DISK  
4MB RAM  
MODEM  
2P SOCKET  
4 BUS SLOTS  
4 DRIVE CAVITIES

**FREE! PRE-LOADED SOFTWARE FREE WITH ALL ABOVE SYSTEMS!**  
Microsoft Windows 3.1, Productivity Pack, MS DOS 6.0 with MS DOS Shell and GBasic, Microsoft Works for Windows, Packard Bell Navigator, Microsoft Money, Best of MS Windows Entertainment Pack with 8 games (for Packard Bell), Prodigy Start-Up Kit. **ALSO!** FREE ON ALL MULTI-MEDIA SYSTEMS: Toolworks Pack including The Animals, Chessmaster 3000, Mavis Beacon Teaches Typing, World Atlas, U.S. Atlas, and Toolworks (Croler's) Encyclopedia.

## NOTEBOOKS

**PACKARD BELL**  
Statesman  
9.5" DUAL SCAN COLOR  
486SLC/33 4 MB RAM  
250MB HARD DISK  
9000/3400 FLOPPY MODEM  
3.5" 1.44MB FLOPPY  
J. MOUSE  
\$2,299.00  
\$1,000.00

## EPSON

**ActionNote**  
486SLC/33  
150MB HARD DISK  
9000/3400 FAX MODEM  
5.5 LBS.  
10" SCREEN  
LOCKTECH TRACKMAN  
MS DOS / WINDOWS  
\$1,649.00  
150MB HARD DISK  
\$1,999.00

## MONITORS

9005 14" 60Hz	\$289.00
1000 14" 70Hz	\$299.00
1500 14" EDGE TO EDGE 76Hz	\$379.00
2000DX 15" FLAT SCREEN 72Hz	\$439.00
4000CX 17" FLAT SCREEN, EDGE TO EDGE, 76Hz	\$799.00

## PRINTERS

8020029 STYLUS 800	\$14.99
7753 LB870/870	\$9.00
8015032 ACTION PRINTER	\$9.00

## RAM MEMORY

1X3X70 - 1MB	\$ 47.00	72 Pin Simm 1X36X70 - 4MB	\$187.00
1X9X70 - 1MB	\$ 61.00	2X36X70 - 8MB	\$373.00
4X9X70 - 4MB	\$174.00	4X36X70 - 16MB	\$669.00
		8X36X70 - 32MB	\$1,499.00

**EXXUS**  
800-557-1000  
800-557-9000 - FAX

ALL MAJOR CREDIT CARDS WELCOME. SATISFACTION GUARANTEED!  
YOUR SATISFACTION IS OUR UTMOST CONCERN. IF, WITHIN 30-DAYS, FOR ANY REASON YOU ARE NOT SATISFIED WITH YOUR PRODUCTS, WE WILL REPLACE THEM OR REFUND YOUR MONEY. HOTEL: ALL RETURNING MUST BE ACCOMPANIED BY EXXUS PMA NUMBER. RETURNS NOT ACCOMPANIED BY PMA WILL BE REFUSED.

COD'S: COP'S WILL BE EVALUATED ON A PER-CASE BASIS.

CORPORATE DEPARTMENT 800-557-2000  
GOVERNMENT & EDUCATION DEPARTMENT 800-557-4000

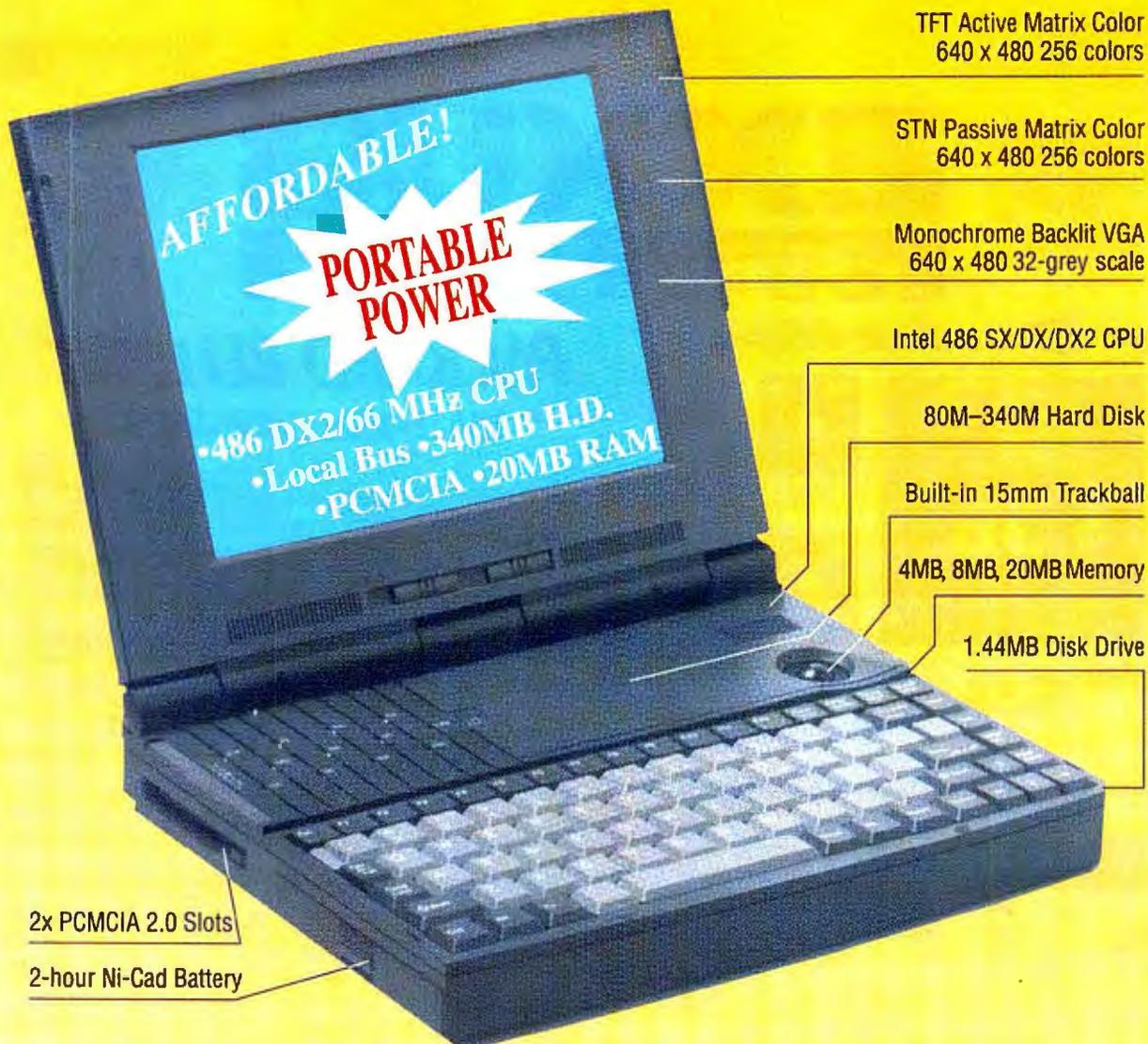
INTERNATIONAL DEPARTMENT 213-457-7097 - PHONE  
213-457-7098 - FAX  
CUSTOMER SERVICE & TECH SUPPORT 800-557-8000

**SHIPPING INFORMATION**  
SPECIALS THIS MONTH INCLUDE:

**FEDERAL EXPRESS**  
NEXT-DAY AIR! 2ND-DAY AIR!  
\$19.99 1-10 lbs.  
\$9.99 11-30 lbs.  
\$6.99 31-50 lbs.  
FOR OTHER SHIPPING DETAILS PLEASE CALL!

1645 N. VINE ST., SUITE 705, HOLLYWOOD, CA 90028

Circle 215 on Inquiry Card.



TFT Active Matrix Color  
640 x 480 256 colors

STN Passive Matrix Color  
640 x 480 256 colors

Monochrome Backlit VGA  
640 x 480 32-grey scale

Intel 486 SX/DX/DX2 CPU

80M-340M Hard Disk

Built-in 15mm Trackball

4MB, 8MB, 20MB Memory

1.44MB Disk Drive

2x PCMCIA 2.0 Slots

2-hour Ni-Cad Battery

# Need the **fastest** Windows performer?

## High Performance **Micro-International HCP Model 65681M**

"If you need a notebook with processing power for massive spreadsheets and databases, to perform gray-scale imaging, or for other demanding tasks, the HCP 65681M is for you. It ran our Windows performance test twice as fast as the Compaq LTE lite 4/25E, . . . In fact, this was the fastest monochrome notebook in our entire test sample. The HCP 65681M's monochrome screen quality is the best we saw from passive-matrix monochrome displays. . . and an excellent keyboard."

October 1993 BYTE/NSTL LAB REPORT

MICRO-INTERNATIONAL, INC. 10850 Seaboard Loop, Houston, Texas 77099  
National Sales:(800) 967-5667•Local Sales:(713) 495-9096•FAX:(713) 495-7791

\$2740 for a monochrome 486/66M 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



# LEAVE IT TO US TO RACK THINGS UP

RECORTEC's Rack Mount PC compatible computers, monitors, keyboards and printer continue the tradition of manufacturing excellence RECORTEC started in 1969. With our broad product line, fast delivery, excellent pre and post sale service, it's no wonder more and more people "leave it to us to rack things up".



## QUALITY

All products 100% tested and verified prior to shipment.

## RELIABILITY

Field proven components backed by a comprehensive warranty.

## SERVICE

Large stock for fast delivery plus assistance by knowledgeable sales and support personnel.

## SOLUTIONS

Choose from many models which offer a wide range of solutions for a variety of rack mount needs. We also offer custom designs when a standard product just won't do.



**CALL OR FAX FOR MORE INFORMATION.**

**1-800-729-7654**

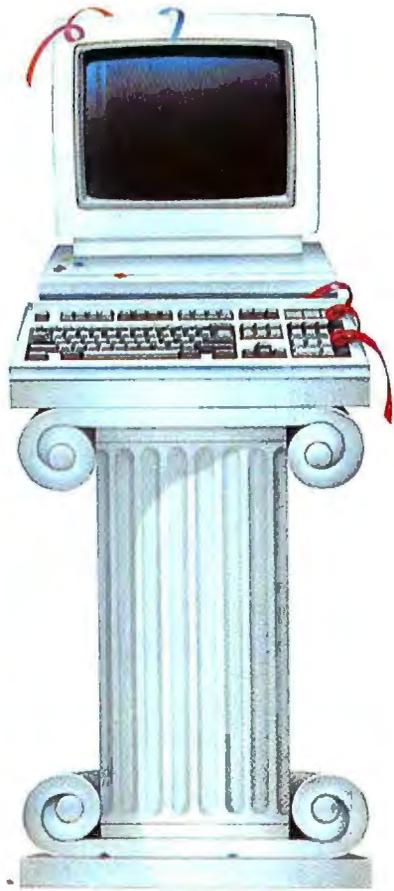
**RECORTEC, INC.**

1290 Lawrence Station Road Sunnyvale, CA 94089

Tel: (408) 734-1290

Fax: (408) 734-2140

Circle 201 on Inquiry Card.



# Everyone makes claims. We make sure.

**When the industry wants product testing taken to the nth degree, they take it to NSTL.**

In every field, one name sets the standard. In microcomputer testing, the name is NSTL, the leading independent testing lab.

The NSTL compatibility certification seal on a product says that it withstood the toughest lab in the industry — and it's ready for your business.

The seal saves you a lot of comparison and guesswork. It says you'll find the product compatible with a wide range of business applications and hardware. It helps you make the right choice.

**Real-world testing for real-world use.**

Beyond compatibility testing, we access nearly every conceivable

problem — from engineering-level hardware bugs to the everyday usability of business software.

And we test with the end-user in mind, in a real-world environment, just the way your staff uses equipment. Except our trials are more punishing.

**Our publications, and others that publish our work.**

In a separate facility we also do comparison testing for our own Ratings Reports: *Software Digest*®, *PC Digest*® and *LAN Reporter*®. They're read by people who purchase an average of more than \$500,000 in microcomputer hardware and software annually.

And because of the respect we've earned, some of the industry's leading publications, like *Data Communications*,

*LAN Times*, *Unix World* and *Datapro Research Group* publish our test results.

**Look for the NSTL seal and be sure.**

Experts rely on the NSTL name: now you can, too. The final test of a product is its compatibility in a business environment. The NSTL mark tells you it's already met that test. Look for it when you compare products.

Plymouth Corporate Center  
Box 1000, Plymouth Meeting, PA 19462  
215-941-9600

Micro Channel™ and OS/2™ are trademarks of the IBM Corporation.

# SILICON VALLEY COMPUTER VESA LB TO 66 MHZ

YOU CAN'T BUY MORE PERFORMANCE FOR LESS

NOW, FACTORY DIRECT



Pylon I

Desktop

Pylon II

Designed, built, tested and warranted in the USA

Total compatibility: SVC systems accept all 8 and 16-bit ISA cards. VESA systems accept both ISA and VESA Local Bus cards. 8/7 ISA slots. All systems are software compatible with MS-DOS, Windows 3.1, Windows for Workgroups, Windows NT, Unix, Novell, Interactive, Theos, Mach and Next operating systems.

**ALL SYSTEMS INCLUDE:**

- 4 MB 70ns zero wait state DRAM
- 1.44 MB Teac FDD
- 210 Megabyte 14 ms IDE Hard Drive
- 20 MBPS HD Interface
- (2) Serial, (1) Parallel, (1) Game Port
- Real time clock & battery backup/Audio speaker
- 15,000V static discharge drains, venting fan
- 104-key enhanced (Alps click) keyboard
- Complete technical manuals
- MS-DOS, Windows 3.1, Works & Anti-Virus
- 72-hour dynamic burn-in.

MTBF: 300,000 Hours. Three-year limited warranty

**World Leadership in ultra-fast Systems and I/O**

Since 1982, SVC has shipped over 1,000,000 units. Worldwide. SVC is a world leader in design and integration of high-speed motherboards and IDE drive controllers. All controllers carry a 5-year warranty. SVC offers a wide variety of controllers for all IBM-compatible ISA and VESA systems: 8088, 286, 386, 486 and Pentium. 5 times faster than other interfaces. Control for hard disks to 8 Gigabytes.

**Fast, fail-safe Mirroring Hard Drive Controllers**

- |                                    |                                |
|------------------------------------|--------------------------------|
| 100% Fail-safe for Programs & Data | 100% Software transparent      |
| 100% Data integrity at all times   | 100% of the speed of the drive |
| 100% Automatic data backup         | 100% Automatic backup          |
| 100% Compatible with all OSs       | 100% FCC Compliant             |
| 100% Compatible with all Apps.     | 100% Self-installing BIOS      |

**400% faster than software solutions**

NEVER requires a user interface, software or expensive software upgrades

**ISA 16-bit Mirroring IDE Drive Controllers:**

- ADP104 - Controls 2 sets of 2 hard drives to 8GB \$99
- ADP108 - Controls 2 sets of 2 hard drives to 8GB plus 4 mixed capacity floppy drives \$139

**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 (hard drive, tape or CD-ROM) and 2 mixed floppy drives. Provides 2 serial, 1 parallel and 1 game port \$185

**VESA 32-bit Super I/O Controller**

- ADP90VL - Controls 4 independent IDE hard drives of any capacity to 8GB, plus 2 mixed floppy drives. Provides 2 serial, 1 parallel and 1 game port \$59

**Universal IDE Controllers**

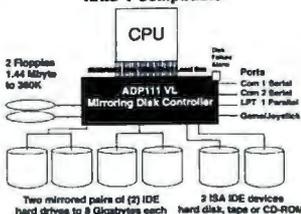
- ADP60F 16-bit IDE Controller. Works with all 16-bit ISA systems. Controls 2 IDE drives to 1.6 Gigabytes. Controls 2 floppies of any capacity. On-board intelligent BIOS is relocatable.

- ADP50 8-bit IDE Controller. Interfaces 2 16-bit IDE hard drives to 8-bit bus. Works with all XT compatibles including IBM, Compaq, Tandy and ATT.

- 85 MB IDE Drive, cable & either controller \$179
- 210 MB IDE Drive, cable & either controller \$259

Volume pricing is available on motherboards, I/O and systems  
Circle 274 on Inquiry Card.

**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

**How Hardware Mirroring works:**

All data written to the primary drive is "mirrored" on the second drive. Should the primary drive fail, an alarm is sounded and the system is automatically shifted to the "mirrored" drive until the primary drive can be repaired or replaced. Backup is automatic, continuous and totally transparent to the Operating System and applications software.



**SAMPLE SYSTEMS:**

**66 MHz Pentium DXC VESA LB System**

- Pentium™ Processor
- On-board DRAM to 128 MBytes
- 50 MHz VESA Local Bus/256K cache **\$2195\***

**66 MHz 486DX2 VESA LB System**

- i486DX2 Processor EISA/VESA systems
- 64K cache (expandable to 256K)
- EISA/VESA/ISA Motherboard add: \$195 **\$1099\***

**33 or 40 MHz 486DXC VESA LB Systems**

- 486DXC Processor
- 64K Cache (expandable to 256K) **\$995\***

**33MHz 486SXC VESA LB System**

- 486SXC Processor
- 64K Cache (expandable to 256K) **\$775\***

**Drives \***

- |                                             |                  |
|---------------------------------------------|------------------|
| ■ VESA Mirror Board and 2nd 210 MB MD       | <b>Add \$289</b> |
| ■ Conner 340 MB IDE 12 ms Access Hard Drive | <b>\$ 85</b>     |
| ■ Conner 540 MB IDE 10 ms Access Hard Drive | <b>\$315</b>     |
| ■ 1 Gigabyte IDE 10 ms Access Hard Drive    | <b>\$765</b>     |
| ■ 250 MB Tape Drive and backup software     | <b>\$149</b>     |
| ■ Dual-speed CD-ROM, controller & software  | <b>\$239</b>     |

**Monitors & Accelerators**

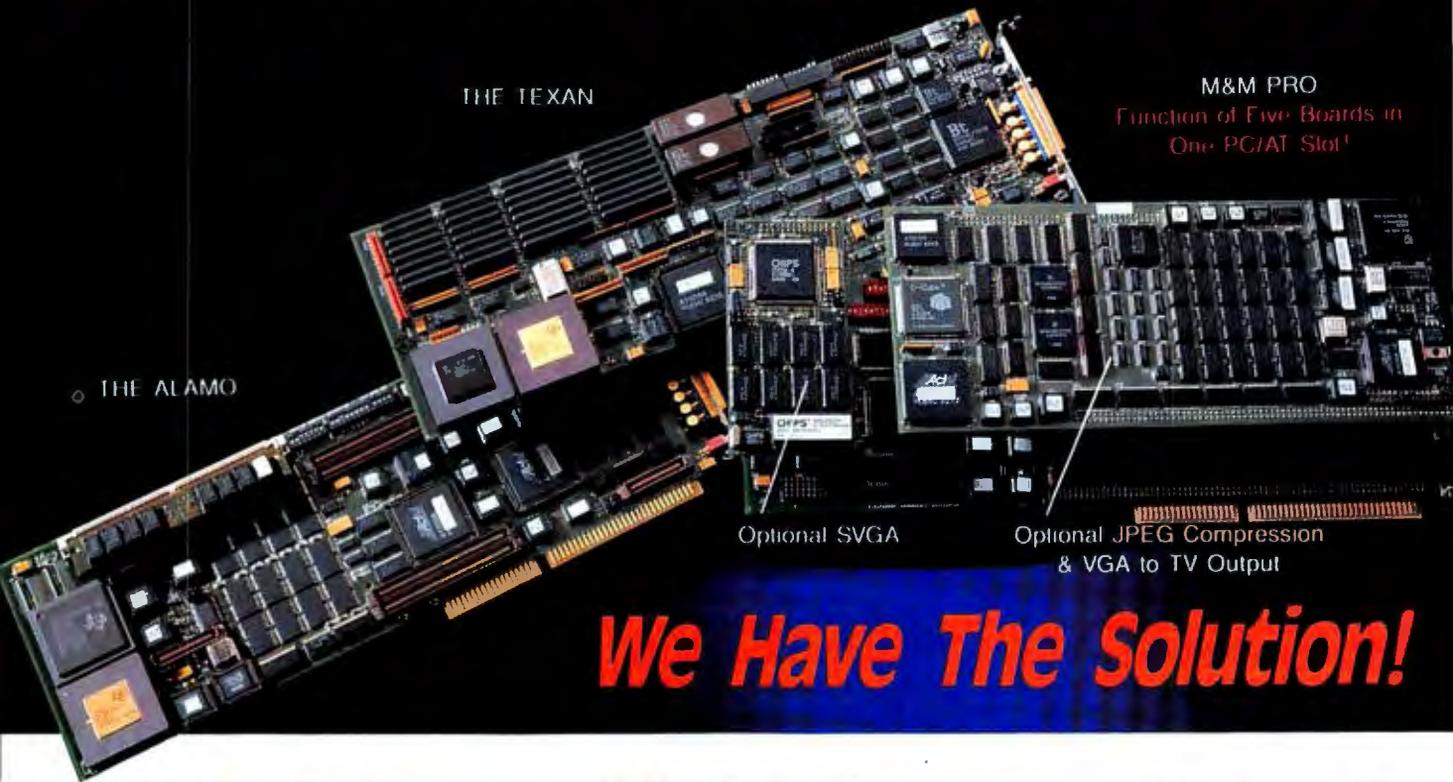
- |                                            |              |
|--------------------------------------------|--------------|
| 14" SVGA Interlaced (Hitachi tube)         | <b>\$289</b> |
| 14" SVGA .28 Non-int. VESA-ready (Hitachi) | <b>\$349</b> |
| 15" SVGA .28 Non-int. VESA-ready (Hitachi) | <b>\$445</b> |
| 17" SVGA .26 Non-int. VESA-ready (NEC)     | <b>\$845</b> |
| VESA 32-bit accelerator (Cirrus processor) | <b>\$ 99</b> |
| VESA 32-bit accelerator (S3 processor)     | <b>\$169</b> |
| VESA 32-bit accelerator (Weitec processor) | <b>\$389</b> |

**SILICON VALLEY**  
C O M P U T E R

**1-800-600-8111**

441 North Whisman Road, Bldg. 13, Mountain View, CA 94043  
Phone: 415-967-1100, Fax: 415-967-0770

# CAD or Multimedia



THE TEXAN

M&M PRO

Function of Five Boards in One PC/AT Slot!

THE ALAMO

Optional SVGA

Optional JPEG Compression & VGA to TV Output

## We Have The Solution!

### Ultra High Resolution Graphics Display Controllers from the World's first TMS34020 Manufacturer

Our PC/AT boards provide programmable display resolutions up to 1600 x 1280, and provide 72Hz or higher refresh rate for 1280 x 1024 and lower resolutions. 40 MHz TMS34020 Graphics Processor, VGA pass-through and RGB cable set are included. Software drivers are provided for TIGA, MS-Windows, and AutoCAD®. Drivers for the X Window System for Interactive and SCO UNIX are optional.

**THE ALAMO \$2,995**  
24-BIT TRUE-COLOR at 1600 x 1200  
6 MByte VRAM + 1 MByte DRAM

**THE TEXAN 1600 \$1,450**  
256 Colors at 1600 x 1280, 60 Hz  
2 MBytes VRAM + 1 MByte DRAM

**THE TEXAN 1280 \$1,250**  
256 Colors at 1280 x 1024, 72 Hz  
2 MBytes VRAM + 1 MByte DRAM

**THE TEXAN 1024 \$995**  
256 Colors at 1024 x 768, 72 Hz  
1 MByte VRAM + 1 MByte DRAM

Omnicomp has been providing graphics hardware solutions for Systems Integrators, OEMs, and Resellers in domestic and international markets for over 10 years.

Our products cover a wide range of popular computer platforms and operating systems including PC/AT, VME, Micro Channel®, DOS, Windows, UNIX and others.

Omnicomp, THE TEXAN, THE ALAMO, M&M PRO, M&M Basic, VIVA, VIVA Basic and VIVA HC are trademarks of Omnicomp Graphics Corporation. All other trademarks or registered trademarks are property of their respective owners. Specifications subject to change without notice.

### Multimedia Graphics: Everything you need to get video into or out of the PC

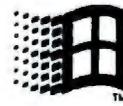
**M&M PRO \$995 +**  
24-bit TRUE-COLOR NTSC/PAL/SECAM video window frame grabber. Optional 12-bit per channel digital stereo audio, hardware JPEG compression, on-board 1024 x 768 SVGA, composite and S-Video NTSC/PAL output with flicker filters.

**M&M Basic (composite video) \$500**  
**(composite & S-Video) \$600**  
NTSC/PAL frame grabber displays live video window on VGA screen.

**VIVA Basic (NTSC or PAL) \$300**  
Internal or External VGA to Video converter outputs VGA to composite and S-Video with flicker filters. No TSR required for 640 x 480 modes.

### NEW PRODUCTS AVAILABLE!

Call or fax for the latest information on our growing range of computer graphics hardware. We also specialize in services such as custom hardware and software design.



MICROSOFT WINDOWS



AUTODESK

Windows drivers provide 1600 x 1200, 24-bit TRUE COLOR on the ALAMO, 1600 x 1280, 256 color on THE TEXAN, and HI-COLOR on the VIVA HC.

Video for Windows compatible MCI/AVI Multimedia Windows drivers for the M&M PRO and M&M Basic.

DL-Xpress (included) and Soft Engine (optional) from Vibrant Graphics allow 24-bit TRUE-COLOR display on THE ALAMO and 256 color display on THE TEXAN for AutoCAD®, 3D Studio™, etc.

**Monitors . . . IDEK 21" flat screen multiscan monitors 30-80 KHz . . . others available.**  
MF 5421A 1600 x 1280, .26 Dot Pitch **\$2,525**  
MF 5321A 1280 x 1024, .31 Dot Pitch **\$2,125**

**Phone 713-464-2990**

**Fax 713-827-7540**

For more information, call or fax our Systems Engineering Department, M-F, 8:30-5:30 CST.

We accept VISA, MASTERCARD and AMERICAN EXPRESS



Direct from Manufacturer  
12-Month Warranty  
F.O.B. Houston

# Omnicomp Graphics Corporation™

. . . The Texas Graphics Company  
1734 W. Sam Houston Pkwy, N.  
Houston, Texas 77043

Circle 280 on Inquiry Card.

# MEMORY MEMORY MEMORY

## PERSONAL COMPUTER MEMORY

IBM	
AMBRA Enterprise 386, Hurdle 386, Sprinto 386 (all models)	
2MB N/A.....594	8MB N/A.....5329
AMBRA Enterprise 486, Hurdle 486, Sprinto 486 (all models)	
4MB N/A.....5195	16MB N/A.....5639
PS/1 286, 386SX	
2MB 9279935.....582	4MB 9279694.....5168
PS/1 Consultant, Essential, Expert models 433, 444	
PS/Valuepoint all models except Cxx series	
4MB 96F9290.....5199	16MB 96F9291.....5639
PS/1 Consultant, Essential, Expert models 276	
16MB Kit 96F9291.....5639	
PS/2 25/286, 30/286, memory adapter 1497259	
2MB Kit 30F5360.....581	
PS/2 335X; LS, 405X, 50Z, 555X; LS, 655X; LS, 70, XStation	
1MB 6450603.....539	2MB 6450604.....576
PS/2 70-A21; A61; B21; B61, PS/1 Consultant, Essential, Expert models x11, x13, x14, PS/Valuepoint Cxx series	
2MB 6450608.....576	
PS/2 335X; LS, 405X, 555X; LS, 655X; LS, XStation, PS/Valuepoint Cxx series, adapter board 34F3011 or 34F3077	
4MB 34F2933 or 87F977.....5181	
PS/2 335X; LS, 405X, PS/Valuepoint Cxx series	
8MB 6450129.....5354	
Z 90 XP, 95 XP, P75 (mini), 56, 57 (all), PS/1 Pro M1213	
4MB 6450902.....576	
PS/2 90 XP, 95 XP, P75 (pairs), 56, 57 (all), PS/1 Consultant, Essential, Expert models x11, x13, x14, PS/1 Pro M1213	
4MB 6450128.....5181	8MB 6450130.....5354
Expansion boards for 50, 50Z, 555X, 60, 655X	
2.8MB w/2MB 1497259.....5199	
Expansion boards for all models 70, 80	
4.16MB w/4MB 34F3011.....5317	

AST	
Premira	
4MB 501159-001.....5129	8MB 501159-002.....5369
Mosbello SWP	
16MB 501143-001.....5735	
Bravo 3/25i	
2MB 500710-004.....596	8MB 500824-002.....5319
Advantage! 386SX/20; 33; 35; Advantego PC SX/25; Bravo 3/33i	
2MB 500967-001.....584	8MB 500962-002.....5289
Advantage! Pro 486DX/33; SX/25; Bravo LC 4/25; 33; 33i; 504; 4/66d	
2MB 500987-001.....559	4MB 500987-002.....5159
Premium 386/25; 33; 33T, Premium II 386SX/16; 20; 25	
1MB 500780-003.....533	
Advantage! 486/25; 33; 33T, Bravo 4/33; 486/25; Premium 4/25; 33TE, Server SE 4/33	
2MB 500718-004, 780 005.....569	
Advantage! 486/25; 33; 33T, Premium 3/33, 4/33; 33i; 504; 66d, Premium 386/33TE, 486/25; 33; 33i; 33TE, Premium II 386/25; 33; 486/33, 486SX/20	
Premium Server SE 4/33	
4MB 500780-004.....5179	8MB 500780-001.....5349

Compaq	
ProLinea 3/25s; 3/25ss	
2MB 141738-001.....589	8MB 141742-001.....5319
ProLinea 4/25s; 4/23, 4/30, 4/50	
1MB 141687-001.....539	2MB 141683-001.....576
4MB 141684-001.....5181	8MB 141685-001.....5354
DeskPro 386-20; 20s; 25	
4MB 113137-001.....5180	4MB 113645-001.....5244
DeskPro 386s/16	
4MB 112534-001.....5180	4MB 113634-001.....5255
20H, SystemPro LT Series, Portable 486c, M Series	
1MB 118688-001.....539	2MB 118689-001.....576
4MB 118690-001.....5181	8MB 112877-001.....5354
ProSignia PC Server 486/33; DX2/66	
16MB 149320-001.....5649	32MB 149147-001.....51280
DeskPro 386-33, 486-33, SystemPro	
2MB 115144-001.....599	8MB 116561-001.....5379

Hewlett-Packard	
Vectra QS/16s; 20P, RS/20; 20C; 25, 25C	
4MB Kit D1542 or 1642A.....5189	
Vectra 386/16M, 386/20N, 386/25N PC	
2MB 02404A.....592	8MB 02404A.....6310
Vectra 486PC; 25T; 33T; 486s/20; 4/25H; 33H; 50N; 66H	
2MB 02381A.....576	8MB 02157A.....5354
Vectra 386/25s; 486/25U; 486/33U; 486/50U; 486/66H	
4MB 02381A.....576	8MB 02157A.....5354
Vectra 486/25H; 486/33H; 486/50H; 486/66H	
16MB 02676A.....5640	
Vectra 386/33M; 33HM	
2MB 02714A.....592	8MB 02715A.....5310

NEC	
Image 425, 433, 466	
4MB 41012007.....5181	16MB 41012003.....5647
Ready 425, 433	
4MB N/A.....5195	16MB N/A.....5649
PowerMate 286/12; SX/16, SX/20	
2MB Kit OP-410-8103.....596	
PowerMate SX/20	
2MB CPU Upgrade OP-410-8101.....5159	
2MB Exp. Board OP-410-8102-8103.....5180	
PowerMate 386/33; Express Te, e series	
4MB OP-410-8205.....5181	16MB OP-410-8206.....5640

IBM	
UltraLite Verso (all models)	
4MB.....5229	8MB.....5449
UltraLite & Cellular Workstation SX/20	
2MB.....5147	8MB.....5309
UltraLite III, SL/25C	
4MB.....5129	8MB.....5159
UltraLite SL/20, SL/20P	
2MB.....589	8MB.....5259
ProSpeed 286, 386SX/16	
4MB.....5219	8MB.....5119

IBM	
AMBRA Treks	
2MB.....5112	2MB.....5112
ThinkPad 300	
2MB.....5119	8MB.....5369
PS/2 CL575X and ThinkPad 700, 700c, 720, 720c	
4MB.....5209	4MB.....5389
ThinkPad 710T	
4MB.....5189	8MB.....5319
NSI Notebook (All)	
2MB.....569	4MB.....5189
4MB.....5185	8MB.....5359
2MB.....5359	8MB.....591

Texas Instruments	
TravelMate 3000 (all models)	
2MB.....5179	2MB.....5179
TravelMate 4000 (all models)	
4MB.....589	2MB.....5129
TravelMate WinSLC/25	
2MB.....5129	

Zenith	
Z-Lite 320L	
2MB.....5139	2MB.....5108
Z-Note 320L, 320LH, 325L, 325Lc	
8MB.....5384	4MB.....5188
Z-Sport 4205, 4255	
2.4MB.....5106	2.4MB.....5194
Z-Sport 3255	
4MB.....5184	2MB.....589
MastersPort 386SL, SLc, Sle	
MastersPort 386SX	
SuperPort SX, 286c, SilesPort	
SuperPort 286; 286c	
1MB.....599	4MB.....5279

## ADI



**"Mainstream Choices!"**  
**MicroScan/ADI**

- MicroScan 3E+, 14", 0.28mm, 1024x768 NI @ 72Hz
- Microprocessor-based digital controls, 30K-60KHz.....\$359
- MicroScan 4G, 15.75", 0.28mm, 1280x1024 NI @ 60Hz
- Microprocessor-based digital controls, 30K-64KHz.....\$449
- MicroScan 5A, 17.5", 0.26mm, 1280x1024 NI @ 60Hz
- Microprocessor-based digital controls, 30K-64KHz.....\$869

## SIMMS

**1x9.....\$43**

1MB x 9-70s (9 chips).....543

4MB x 9-70s.....5155

16MB x 9-70s.....5795

512K x 36-70 (2MB).....576

1MB x 36-70 (4MB).....5181

2MB x 36-70 (8MB).....5354

## MEGAHERTZ



**NEW PRICES!**

For Laptop and Notebook Systems.

PCMCIA 2.0 Data/Fax with XJACK

14,400bps FAX/Modem.....\$329

24,960bps FAX/Modem.....\$299

Internal Data/Fax/Modem

14,400bps FAX/Modem.....\$419

96,960bps FAX/Modem.....\$399

24,960bps FAX/Modem.....\$299

Packet Modems for any serial port

14,400bps FAX/Modem.....\$319

96,960bps FAX/Modem.....\$275

## CPU UPGRADES

SX/Now! 386 CPU Upgrade

25MHz (SX).....\$169

33MHz (SX).....\$199

SLC/Now! 486 CPU Upgrade

25MHz (SLC).....\$219

50MHz (SLC).....\$299

4.86/Now! 486 CPU Upgrade

25MHz (SL).....\$399

33MHz (DX).....\$579

MCMaster 486 CPU Upgrade

25MHz (SL).....\$699

33MHz (DX).....\$899

With 4MB add.....\$181

With 8MB add.....\$354

## LASER MEMORY

Canon LBP-4, 4Lte, 4Plus

1MB \$63-2220.....\$106

2MB N/A.....N/A

Canon LBP-11 & 81H Plus

7MB \$63-2350.....\$145

3MB \$63-2360.....\$299

Epson EPL 6000

2MB \$5401.....\$120

4MB N/A.....N/A

Epson ArtisanLaser II, EPL-8000

2MB N/A.....\$135

4MB N/A.....\$213

HP LaserJet IIIi, 4, 4M, 451, 451MX, X1300, InkJet 600

4MB \$2053A.....\$181

8MB \$2064A.....\$354

HP LaserJet HP II, HP, IID

2MB \$2475B.....\$97

4MB \$2477B.....\$170

HP LaserJet II & IID

2MB \$3444B.....\$110

4MB \$3445B.....\$195

IBM Laser 4029 all models

2MB \$18533A.....\$96

4MB \$18333B.....\$157

Ohlsson 4000

1MB 70014701.....\$67

2MB N/A.....\$104

Panasonic 4410 & 4430

2MB \$X-F444.....\$113

4MB N/A.....\$191

Panasonic 4450I & 4420

2MB \$X-R411.....\$129

4MB N/A.....\$189

Texas Instruments MicroLaser and XL

1MB 2553731-001.....\$46

4MB 2560052-0002.....\$99



**30 DAY GUARANTEE**

## WE SET THE STANDARD:

- 100% COMPATIBLE IN FORM, FIT, AND FUNCTION
- ALL PRODUCTS USER INSTALLABLE
- INSTALLATION INSTRUCTIONS INCLUDED
- TOLL-FREE TECHNICAL SUPPORT
- MANUFACTURER'S WARRANTIES
- CORPORATE PO'S, APO/FPO'S WELCOME
- GOVERNMENT AND EDUCATIONAL PRICING
- INTERNATIONAL ORDERS WELCOME
- SPECIAL VOLUME PRICING
- SAME DAY SHIPPING
- OVERNIGHT DELIVERY AVAILABLE
- VISA, MASTERCARD, AMERICAN EXPRESS, AND DISCOVER ACCEPTED
- NO SURCHARGE ON CREDIT CARDS

## DON'T SETTLE FOR LESS!



**CALL FOR ANY MEMORY UPGRADE NOT LISTED**

WE STOCK MEMORY UPGRADES FOR OVER 1500 COMPUTERS AND PRINTERS

**TOLL FREE FROM USA & CANADA**

**800-261-9866**

**INTERNATIONAL ORDERS**

**714-448-7750**

**FAX ORDERS**

**714-448-7760**

Business hours:  
Monday - Friday, 8am-5pm, P.S.T.  
Saturday, 9am-3pm, Orders Only



**First Source International**

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 members are for your convenience. Freight charges are non-refundable. A RMA number is required for all returns. All non-defective returns, unopened, sealed, or cancelled orders, will be subject to a 20% restocking fee. Due to L.L.C. units placed on some manufacturers, summary 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 typographic or photographic. We will not sell educational price valid only on domestic orders, offer not good for SIMMs or DRAMs. Trade marks and registered trademarks are of their respective companies.

# CALL THE UPGRADE EXPERTS 800-261-9866

Circle 191 on Inquiry Card (RESELLERS: 192).

# CAD Warehouse

VALUE ADDED DIRECT MARKETING  
One Of The Nations Largest Authorized Dealers Of Digitizers & Plotters

## 1-800-487-0485

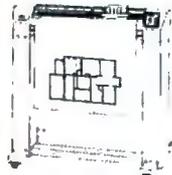
Customer Service 216-487-0590 - Tech Support 216-487-0511 - 1929 E. Aurora Road, Twinsburg, Ohio 44097

**Hewlett-Packard**  
Call For Pricing



**DMP161**  
Just \$2100  
512K

**Houston Instruments**



HIPlot 7100 Plotter

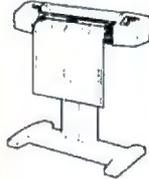
**DMP 160 Series/Hi-Plot**

- DMP 162R - 512K ..... Lowest
  - Hi-Plot 7100 - 1MB ..... Lowest
  - Hi-Plot 7200 - 1MB ..... Lowest
- DMP 60 Series**
- DMP 61 - 8 Pen ..... 1995.00
  - DMP 62 - 8 Pen ..... 2750.00

**Roland**

- GRX 350 ..... 3250.00
- GRX 450 ..... 3925.00
- G SX 3000 Pen/Pencil ..... 4495.00
- G SX 4000 Pen/Pencil ..... 5495.00

**Calcomp**



- Pacesetter™  
2024 A-D ..... 1995.00
- 2036 A-E ..... 2595.00

- Design Mate™  
Priced At ..... 1992.00
- Stand & Cable Extra!
- Classic™  
Special Offer ..... 4195.00
- 4 MB Buffer Free!

**DrawingMaster™**

**Autodesk Genericad**  
Only \$259.00

Scanners	
Ideal / Calcomp	Call
300 DPI, 500 DPI, 800 DPI, 1000 DPI (A-E)	Call
GTX Raster CAD	Call
Laser & PaintJet Printers	
CalComp 600 DPI 16MB	3995.00
HP Paint Jet XL300	2370.00
Data Products LZR 1555 2 tray	2695.00
Data Products LZR 1560 2 tray	2695.00
Data Products LZR 1580	Call
Calcomp 513 XF	Call
Houston Instruments	
JetPro V50	1310.00
JetPro V100	1875.00
Ioline	
Studio 7 36" & 24"	Call
Roland Digital	
PNC 1000A 20"	2450.00
PNC 1100 24"	3150.00
PNC 1800 48"	7895.00
Letter Art 7.5	Call
ENGAD	
SP 1800 A-D	2019.00
SP 2800 A-E	2530.00
Pacific Data Protracer II	
512K	1230.00
2MB/HPGL	1725.00
JDL	
Express Plotter II A-E 52MB HD	8250.00
Graphics Cards	
Artist XJ1000 50MHz	1050.00
ATI Ultra Pro 2MB	365.00
ATI Ultra Plus 2MB	335.00
Bravado 8	720.00
Diamond Stealth	175.00
Diamond Viper	425.00
Matheus Premier VL2	340.00
Matheus Premier VL4	555.00
Matheus Premier S3	325.00
Matrox	Call
Nih Edge	875.00
Targa *64	1695.00
TrueVision VVGA8	890.00
#9 Level 12	418.00
#9 Level 23	965.00
#9 Level 29 Tricolor	1339.00

### February Savings!

Drawing Board III 12x12 \$252.00

(Ask about cordless option)

Summa Sketch III \$252.00

12 x 12 Digitizer W/ Cursor

- CalComp 12x18 ..... \$565
  - CalComp 24x36 ..... \$1325
  - CalComp 36x48 ..... \$1495
  - Summa III 12x18 ..... \$499
  - Hitachi 12x12 ..... 295.00
  - Kurta XLP ..... 219.00
  - Kurta IS1 ..... 309.00
  - Calcomp Esti-Mat ..... 1175.00
- All 12x12 Digitizers  
(Except Kurta & Hitachi)  
Include Free Autocad Templates

### Monitors

Hitachi elite 17"	1235.00
Hitachi 2088 20"	1625.00
Hitachi 2095 20"	1335.00
Hitachi 2187 21"	2050.00
Hitachi 2188XL 21" 28DP	2290.00
Hitachi Accuview PS21AM	2590.00
Mitsubishi Diamond Pro 17"	1059.00
Mitsubishi 6955 20"	1795.00
Mitsubishi 7955 20"	2039.00
Mitsubishi 7165 21" Flat Scr	2130.00
Nanao F340W	705.00
Nanao F550 17"	1029.00
Nanao F550W 17"	1179.00
Nanao T560 17"	1695.00
Nanao T660 20"	2395.00
Nanao F760W	2275.00
NEC 5FGP 17"	1550.00
NEC 6FGP 21"	2475.00
Panasonic C795 17"	1145.00
Viewsonic 17	1025.00
Viewsonic 21	1975.00
Idek / Mag	Call

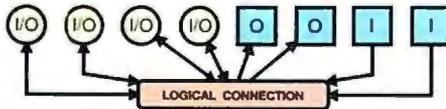
**SONY**  
Authorized Dealer

1730 17" ..... 1025.00  
New GDM 2038 - 1280 72Hz ..... 2150.00

When Checking Our Competitions Ads For Prices Please Check The Fine Print For Handling Charges And Credit Card Surcharges

# 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 & HP III Si
- PCMCIA
- TOSHIBA
- MAC SIMMs
- POWERBOOK

**LOGICAL CONNECTION**, 4660 Portland Road NE #108 Salem, OR 97305-1658 Tech.: (503) 390-9375 FAX: (503) 390-9372

# Recognized as the two best PC-diagnostic tools on the market.

## NOW AVAILABLE IN ONE GREAT PACKAGE...

ALL NEW

VER. 5.0

### Micro-Scope™

UNIVERSAL DIAGNOSTICS SOFTWARE

Fully operating system independent diagnostic software.

**PCUPGRADE**  
UTILITY OF THE MONTH

Recently named as PC Upgrade Magazine's Utility of the Month.

FULLY OPERATING SYSTEM INDEPENDENT, BIOS INDEPENDENT, AND CMOS INDEPENDENT.

MICRO-SCOPE Universal Computer Diagnostics was developed to satisfy the expanding need for accurate system diagnosis in the rapidly growing desktop computer market.

- **CACHE MEMORY** – "Micro-Scope" Ver. 5.0 now fully tests cache memory and the cache controller subsystem.
- **LOW LEVEL FORMAT** – Ability to do factory style initialization of all IDE drives, together with the ability to do factory style low level formatting on all drives, including MFM, RLL, ESDI, SCSI, and all IDE drives.
- **O/S, BIOS and CMOS INDEPENDENT** – Does not rely on O/S for diagnostics. Talks to PC on a hardware level regardless of the O/S, BIOS or CMOS setting.
- **TRUE HARDWARE DIAGNOSTICS** – Accurate testing of CPU, IRQs, DMA, memory, hard drive, floppy drive, video cards, etc.
- **DISPLAY DRIVE TYPE** – Reads and displays the actual drive parameters for any drive type automatically.
- **CPU DETERMINATION** – This capability is necessary for accurate system diagnosis on 386SX, 386DX, 486DX and 387 and 487 chip implementations. Because each of these specific chips has its own unique instruction set, and therefore cannot be accurately diagnosed with any program which cannot recognize these differences!
- **MEMORY TEST** – "Micro-Scope" 5.0 has no limitations as to the size of memory it can accurately test. Micro-Scope now also tests up to 2 meg of video memory!
- **MEMORY EXAMINE** – Displays any physical bit of memory. Very useful for determining memory conflicts. Very useful for determining available memory space.
- **BATCH CONTROL** – All tests, even destructive, may be selected for testing.
- **ERROR LOGGING** – Automatically inputs errors during testing to an error log.
- **AUTOMAPPING** – Automatically bad sector maps errors found on hard disks.
- **IRQ DISPLAY** – Show bits enabled in IRQ chip for finding cards that are software driven. (Network, etc.)
- **IRQ CHECK** – Talks directly to hardware and shows I/O address and IRQ of devices that respond.
- **SECTOR EDITOR** – Allows the editing of any sector of floppy or hard disk media (even track 0).
- **AND MUCH MORE...** We don't have enough space here for everything this software can do!

### POST-PROBE™

1ST EVER UNIVERSAL POST CARD FOR ALL PCs!

The only Power-On Self-Test card you need to debug any "dead" PC!

**SERVICE NEWS**  
PRODUCT OF THE MONTH

Named as Product of the Month in the July issue of Service News.

"This is the only card that will function in every system on the market. The documentation is extensive, and not only covers the expected POST Codes for different BIOS versions, but also includes a detailed reference to the bus signals monitored by the card."

— Scott Mueller from his globally recognized book, 'Upgrading & Repairing PCs, Second Edition'



- Includes pads for voltmeter to attach for actual voltage testing under load.
- 4 LEDs monitor +5vdc -5vdc +12vdc -12vdc.
- Monitors Hi & Lo clock and OSC cycles to distinguish between clock chip or crystal failure.
- Monitors I/O Write and I/O Read to distinguish between write and read errors.
- Monitors memory write/read to distinguish between address line failures and memory chip failures.
- Monitors ALE for proper CPU/DMA operation.
- Monitors Reset to determine if reset is occurring during POST, indicating short.
- Monitors progress of POST without POST codes.
- Reads POST codes from any IBM or compatible that emits POST codes. ISA/EISA/MCA.
- Compatible with Micro Channel computers.

- Dip switch allows easy selection of I/O ports to read.
- Includes tri-state LOGIC PROBE to determine actual chip failures.
- Manual includes chip layouts and detailed POST procedures for all major BIOS's.

This is the perfect package for all repair technicians and self-maintainers.

Call MICRO 2000, Inc. for volume discounts and after sales service!

800-864-8008

1100 E. Broadway, Suite 301

Glendale, California 91205

818-547-0125 • Fax 818-547-0397

**MICRO**

Circle 203 on Inquiry Card.

- **AUSTRALIA** – MICRO 2000 Australia, P.O. Box 1777, Wollongong, NSW 2500. Tel: (042) 564446.
- **UK** – MICRO 2000 Europe, P.O. Box 2000, Latchworth, Herts, S661 TG., England. Tel: +44 462 483483, Fax: +44 462 481484.
- **CANADA** – Business Data Systems, 169 Burnside Drive, London, Ontario, Canada N5W 5V5. Tel: (416) 777-2479 Fax: (519) 249-5420.

It's FREE! Absolutely, positively, totally FREE!  
No strings! No commitment! No shipping! No  
handling! No nothing! FREE! FREE! FREE! **FREE!**  
It's your FREE introductory issue of

**Metatec's**  
**NautilusCD**<sup>sm</sup>

The Multimedia Magazine<sup>sm</sup>  
on CD ROM

This is not a misprint. It's an honest-to-gosh offer for a FREE introductory issue of NautilusCD, The Multimedia Magazine on CD ROM.

NautilusCD is the premier showcase of multimedia creativity. Our contributors are multimedia's superstars, wizards who can make your computer screen flash to life with moving pictures...play music or sing for you...dazzle your eyes with 3-D graphics...and even talk to you! It's an experience not to be missed.

Yeah, you'll get a subscription offer with your FREE issue of NautilusCD, but no more will come—and neither will any bills—until you tell us “OK, I've gotta have it!” You've got hours of thrilling multimedia entertainment to gain and nothing to lose. So call the number and ask for your FREE issue now!

To order your absolutely,  
positively, totally FREE issue,  
call toll-free  
1-800-448-2323.

Available in Macintosh and Windows versions. CD ROM drive required.  
Limited Time Offer. Only 1 CD ROM per inquiry. International orders 1-614-760-4165

**NautilusCD** The Multimedia Magazine  
7001 Discovery Boulevard, Dublin, Ohio 43017



## How to make powerful new connections in 10 seconds. Or less.

The new Adaptec<sup>®</sup> SlimSCSI<sup>™</sup> host adapter instantly connects your PCMCIA-ready notebook or PDA to SCSI-based peripherals, including the latest CD-ROMs, tape drives, and scanners. It's the quickest way to tap into your database or add some pizzazz to your presentations, no matter where you are.

Getting started is just as quick. SlimSCSI comes bundled with SCSIworks!<sup>™</sup>, the DOS/Windows software that makes it easy to load drivers for the peripherals you're using.

Ask your dealer for Adaptec's latest IOWare<sup>™</sup> product, the new SlimSCSI host adapter. Or, for PDAs and notebooks with parallel port connections, ask for Adaptec's MiniSCSI. For more information about either product, call 1-800-934-2766 (1-408-957-7150 for information by fax).

They're great ways to make new connections. Fast.

**adaptec**<sup>®</sup>

NOW MORE IMPORTANT THAN EVER.

Copyright © 1994 Adaptec, Inc. All rights reserved. Adaptec, the Adaptec logo, SlimSCSI, and IOWare are trademarks of Adaptec, Inc., and SCSIworks! and MiniSCSI are trademarks of Trantor Systems Limited, an Adaptec company, all of which may be registered in some jurisdictions.



# IntegrAda™ for Windows™



For More Information Call:

**(619) 431-7714**

**AETECH**

Ada Software Development & Tools

IntegrAda is a registered trademark of AETECH, Inc.  
Windows is a registered trademark of Microsoft Corporation.



## Ada Programming for Windows!



IntegrAda for Windows is a Professional  
Ada Programming Support Environment

- Develop Windows, DOS or POSIX Applications
- Validated Ada Compiler
- Microsoft C Compatible Interface
- Windows Linker, Resource and Help Compiler
- Complete Set of Windows Ada Libraries
- Easy\_Ada Libraries for Fast GUI Development
- Powerful Design and Programming Tools
- Applications are True Executables
- SDK Not Required
- No Royalties

5841 Edison Place, Suite 110, Carlsbad, California 92008 (619) 431-7714 FAX (619) 431-0860

## Serious Speed For Serious Modem Users

*Nothing Else Comes Close!*



Serious PC users demand serious speed from their modems. 14.4 Kbps? You must be joking! Waiting for a large file transfer is like watching corn grow.

METACOMP's **COMMPORTER™/56** is a 56 Kbps digital modem card that offers performance no other modem can touch.

**Fast and Reliable**  
COMMPORTER uses 56 Kbps digital telephone circuits, either switched or dedicated. Because they're digital end-to-end, you can accurately transfer files four times faster than a V.42 modem and six times faster than V.32!

**Software and System Compatible**  
DOS, Windows, OS/2, Unix, PROCOMM, Crosstalk, HyperAccess – it makes no difference. COMMPORTER works with any OS or communications software. It configures easily, emulating a standard COM port with a Hayes-compatible modem attached to your ISA/EISA system.

### 56 Kbps – It's Cheap and It's Everywhere

Switched 56 is priced similar to analog phone lines, and is widely available. Since your actual connect times will be a fraction of those with an analog modem, you could save the \$995\* price of the COMMPORTER in the first month of use.

Now you have a choice: watch the corn grow while waiting on your slow analog modem, or call METACOMP. Get serious. Get the COMMPORTER/56.

**METACOMP**

10989 Via Frontera  
San Diego, CA 92127  
Tel: (619) 674-5000  
Fax: (619) 674-5005

COMMPORTER is a trademark of METACOMP, Inc. All rights reserved. DOS, Windows, OS/2, Unix, PROCOMM, Crosstalk, and HyperAccess are trademarks of their respective companies. \*Quantity one, end user price.

Serving you since 1979



# JDR Microdevices®

2233 SAMARITAN DRIVE, SAN JOSE, CA 95124

BUY WITH CONFIDENCE FROM JDR!

30-DAY MONEY BACK GUARANTEE

1 YEAR WARRANTY

TOLL-FREE TECH SUPPORT



## INTERFACE CARDS

### Fast Multi I/O Card

- Includes two NS16550 serial ports, one parallel port and one game port
- 8-bit 286/386/486 compatible card



MCT-AIO+	As above with one NS16450	\$89.95
MCT-AIO	As above with one NS16450	\$49.95
MCT-IDEIO+	IDE w/NS16550 compatible serial	\$99.95
MCT-IDEIO	IDE w/NS16450 compatible serial	\$69.95
MCT-VIO	V.L. Bus IDE and Multi I/O card	\$99.95
MCT-IDEFH	16-bit IDE floppy card	\$29.95
MCT-VCFH	VESA Local Bus cache IDE controller	\$229.95
MCT-VSCSI	VESA Local Bus SCSI-2 controller	\$299.95

## VIDEO PRODUCTS

### VGA Package with Accelerator Card

- 1024 x 768 in 16/256 colors, 800 x 600 in 16/256/64K colors, 640 x 480 in 16/256/64K/16M colors
- 14" diagonal screen; 0.28mm
- 16-bit 286/386/486 PC compatible Windows accelerator card, interlaced and non-interlaced modes



### VGA-PKG-1024N

VGA-PKG-1024	0.39mm, 1024 x 768 VGA package	\$459.95
VGA-MONITOR	0.39mm, 1024 x 768 int. monitor	\$349.95
VGA-MON-1024N	0.28mm, 1024 x 768 non-int. mon.	\$269.95
VGA-MON-17N 17"	0.26mm 1280 x 1024 non-int. mon.	\$379.95
VGA-MON-17N 17"	0.26mm 1280 x 1024 non-int. mon.	\$799.00

### Low Cost Windows Accelerator

- 16-bit 286/386/486 PC compatible; supports interlaced and non-interlaced, analog or multisynch monitors; VESA software compatible
- Up to 1280 x 1024 resolution in 16 colors



MCT-VGA-5000	16-bit Windows accelerator	\$99.95
SPEEDSTAR-PRD	16-bit Windows accelerator	\$129.95
MCT-VGA-4000	16-bit 1024 x 768/256 color card	\$129.95
MCT-VGA-1000	16-bit 640 x 480 VGA card	\$49.95

## DEVELOPERS TOOLS

### POST Code Display Card \$79<sup>95</sup>

- 286/386/486 compatible
- Displays Power On Self-Test codes
- Works when software won't boot computer
- Includes AMI Diagnostics software



PCODE+	Above without AMI Diagnostics	\$79.95
PCODE	Above without AMI Diagnostics	\$49.95

### Wire-Wrap Prototype Cards

JDR-PR2	8-bit with I/O decode layout	\$29.95
JDR-PR2-PK	Parts kit for JDR-PR2 decode	\$8.95
JDR-PR10	16-bit with I/O decode layout	\$34.95
JDR-PR10-PK	Parts kit for JDR-PR10 decode	\$12.95
PDS-601	8-bit breadboard with decode	\$79.95
PDS-611	16-bit breadboard with decode	\$89.95

### EPROM Eraser \$39<sup>95</sup>

- Quickly and simultaneously erase up to 4 standard EPROMs
- Includes wall plug power supply



### DATARASE II \$39.95

- Programs devices up to 512K bits, plus 27C100, 27C101, 27C301, 27C1000, 27C1001, 27C2001, 27C4001 & more

With 8-bit 8088 & 286/386/486 PC compatible card		
ZIF socket accepts 0.6" wide DIP IC's to 32 pins		
MOD-MEP-1A	As above with 4 ZIF sockets	\$199.95
MOD-MEP-4A	As above with 4 ZIF sockets	\$269.95

## SYSTEM BASICS

### 3-Button Mouse \$14<sup>95</sup>

- Accuracy 290-1450 DPI
- Opto-mechanical design



JDR-MOUSE-3	Keeps mouse ball free of dirt	\$14.95
MOUSE-PAD	Dual port game card	\$4.95
MCT-GAME	Joystick	\$29.95
JSTK-300	Pilot-style joystick	\$9.95
JSTK-500		\$19.95

## MULTIMEDIA

### Low Cost Internal CD-ROM Drive

- 5-1/4" half-height internal drive with 1/2 length interface card
- 150Kb-175Kb per second, 350ms average access time
- Includes drive, interface card, cables and manual



CDROM-I	NEC internal dual speed CD-ROM drive	\$199.95
CDR-84	SoundBlaster 8-bit sound card	\$49.95
MCT-SOUND	SoundBlaster 8-bit sound card	\$89.95
SB-OLX	16-bit video card with software	\$329.95
VIDEODR-1		

## STORAGE DEVICES

### 5-1/4" & 3-1/2" Combination Drive

- 5-1/4" half-height beige drive
- Supports 1.44Mb, 1.2Mb, 720Kb & 360Kb diskettes



FD-505	2.88Mb 3-1/2", Beige	\$149.95
FDD-2.88A	1.44Mb 3-1/2", Beige	\$99.95
FDD-1.44A	1.44Mb 3-1/2", Black	\$59.95
FDD-1.44X	1.44Mb 3-1/2", Black	\$59.95
FDD-1.2	1.2Mb, 5-1/4", Beige	\$59.95
FDD-360	360Kb, 5-1/4", Black	\$59.95

### Preformatted Bulk Diskettes in Quantities of 250

MD20-BULK	5-1/4" 360Kb DS/DD disks w/labels & tabs	\$ .25 ea
MD2H-BULK	5-1/4" 1.2Mb DS/HD disks w/labels & tabs	\$ .45 ea
3.5D-BULK	3-1/2" 720Kb DS/DD disks w/labels & tabs	\$ .39 ea
3.5HD-BULK	3-1/2" 1.44Mb DS/HD disks w/labels & tabs	\$ .59 ea

### 250Mb Tape Drive \$169<sup>95</sup>

- 286/386/486 PC compatible
- QIC-40 read and QIC-80 read/write compatible
- Up to 3.5Mb/minute transfer rate
- 5-1/4" internal half-height drive
- Includes DOS backup software and manual



## IDE Hard Drives

PART #	BRAND	CAP.	SPEED	TYPE	PRICE
CP-30084	Conner	84Mb	19ms	3-1/2" IDE	\$189.95
ST-3096A	Seagate	89Mb	16ms	3-1/2" IDE	\$189.95
ST-3144A	Seagate	131Mb	16ms	3-1/2" IDE	\$209.95
CP-30174	Conner	170Mb	17ms	3-1/2" IDE	\$229.95
CP-30254	Conner	250Mb	14ms	3-1/2" IDE	\$269.95

### Seagate IDE Drive Kits

- 16-bit 286/386/486 PC compatible card
- Includes hard drive
- 16-bit controller interfaces two hard and two floppy drives



HDKIT-80	Kit with 89Mb ST-3096A drive	\$209.95
HDKIT-130	Kit with 131Mb ST-3144A drive	\$229.95
HDKIT-210	Kit with 214Mb ST-3243A drive	\$269.95

## UPGRADE COMPONENTS

### Dynamic RAM

PART #	SIZE	SPEED	TYPE	PRICE
41256-80	256K x 1	80ns	DIP	\$2.39
1M8-80	1M x 1	80ns	DIP	\$4.99
41256A98-80	256K x 9	80ns	SIMM	\$14.95
41256A98-60	256K x 9	60ns	SIMM	\$16.95
421000A98-80	1M x 9	80ns	SIMM	\$49.95
421000A98-60	1M x 9	60ns	SIMM	\$59.95
424000A98-80	4M x 9	80ns	SIMM	\$159.95
424000A98-60	4M x 9	60ns	SIMM	\$179.95

DUE TO CURRENT MARKET CONDITIONS, CALL FOR CURRENT DRAM PRICES

### Math Co-Processors



PART #	SPEED	PRICE	PART #	SPEED	PRICE
8087-2	8MHz	129.95	80387-SXP	≤25MHz	74.95
8087	5MHz	89.95	80387-DXP	≤33MHz	79.95
80287-XL	12MHz	74.95	80487-SX	≤25MHz	369.95

### OverDrive Processors

ODP486-SX20	For 20MHz 486SX OverDrive socket	\$299.95
ODP486-SX25	For 25MHz 486SX OverDrive socket	\$359.95
ODP486R-DX25	Replace 25MHz 486DX w/50MHz DX2	\$359.95
ODP486R-DX33	Replace 33MHz 486DX w/66MHz DX2	\$529.00
ODP486-DX33	66MHz 486DX2 for OverDrive socket	\$529.00

## MODEMS & FAX

### 14,400 Baud Internal Fax/Modem

- 14,400/12,000/9600/4800/2400 baud modem & fax
- Full Hayes command set compatibility
- QuickLink II communications software



MCT-144IF+	14,400 baud internal fax/modem	\$149.95
MCT-24I	2400 baud internal modem with s/w	\$49.95
FAXM-SWITCH	Connect fax/modem/phone on 1 line	\$89.95
FAX-SWITCH	Above without modem connection	\$59.95

## MOTHERBOARDS

### VESA Local Bus 486DX Motherboard \$599

- 33MHz Intel 80486DX or 66MHz Intel 80486DX2 CPU
- Uses 256K x 9, 1M & 4M x 9 60ns SIMMs (8K installed)
- ZIF CPU socket for upgrades
- Eight 16-bit expansion slots
- MS-DOS, Windows 3.1, DESQview 386, Novell NetWare and OS/2 compatible



MCT-M486VL-33	33MHz 486DX VESA local bus	\$599.00
MCT-M486VL-66	66MHz 486DX VESA local bus	\$899.00
MCT-M486EV-66	66MHz DX2 w/VESA & EISA bus	\$999.00
MCT-M386SX-33	33MHz 386SX	\$129.95
MCT-C386-33	33MHz cache 386	\$249.95
MCT-C386-40	40MHz cache 386	\$299.95
MCT-M486SX-33	33MHz cache 486SX	\$449.95
MCT-M486-33	33MHz cache 486DX	\$549.00
MCT-M486-50	50MHz cache 486DX	\$799.00
MCT-M486-66	66MHz cache 486DX2	\$849.00
LITHIUM-6V	6 volt lithium battery	\$10.95

FREE JDR CATALOGS!

PC EDITION AND COMPONENTS EDITION AVAILABLE NOW!

800-538-5000



800-538-5000

Toll-Free Fax Ordering 800-538-5005

Local 408-559-1200 BBS 408-559-0253



TERMS: For shipping & handling include \$5.00 for ground & \$7.50 for air. Orders over 1 lb. and foreign orders may require additional shipping charges—contact our Sales Dept. for the amount. CA residents must include applicable sales tax. Prices subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sales. A full copy of our terms is available upon request. Items pictured may only be representative. JDR, the JDR logo, JDR Microdevices, and the MCT logo are registered trademarks of JDR Microdevices, Inc. Medatarr Circuit Technology is a trademark of JDR Microdevices, Inc. Copyright 1993 JDR MICRODEVICES.

# 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 (N) Rear CRT cover.  
Optional Touch Screen  
17" & 20" models available



**\$785**

### Rack Mount Disk Array



- Hot Plug Per Supply
- Hot Plug Drives
- Each Drive has own Power supply
- Fault Tolerant
- Diagnostic LEDs
- Audible Alarms
- Variable Speed Fans

### 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 Rolls



**\$525**

### 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.

## Complete Interactive Kiosks

- ▶ Point of Purchase Displays
- ▶ Demonstration Console
- ▶ Data Collections Terminal
- ▶ Training Center

### Features Include:

Touchscreen monitors (14" & 17") - 19" Rack Base Unit - Stylish & Modular Design - Credit Card Reader - Telephone / Videophone - Printers - Custom Programming

5 Models Available!



### Digital Video Editing

- 30 fps Frame Capture Full Screen!
- Full Array of Transition Effects!
- Editing Software Included
- Capture Video up to 16.7 Million Colors!
- Complete Non-Linear Solution!
- Supports all video Standards!
- Text and Graphic Overlay

**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
- ALDUS PHOTOSTYLER
- Image @ 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



**Pentium and MIPS Available!**

**EISA 12-Slot Available!**

- Video Options**  
ATI SB WinTX, Diamond Viper, 2 The Max Hi Color Number 9, Metrowin Matrix
- Monitor Options**  
Sampo, Nec, Isak, Hitachi, ViewSonic, CXTX, MAG, KFC
- Hard Drive Options** 120 Meg to 70.0 Gg  
Conner, Fujitsu, Maxtor, Micropolis, Seagate, Quantum, Hewlett Packard Western Digital. Call about CD-ROM and optical 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.  
Programmable 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 (Upgradeable 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

## 486 EISA System

- CCSI 486-33-\$1198
- CCSI 486-50-\$1374
- CCSI 486-66-\$1497

Configured As Above 256K Cache On MB, 8 EISA and 1 VLB Slots



### 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

Now Celebrating  
**2 Year**  
Limited Warranty  
On All Custom  
Configured  
Computers  
**10**  
10th ANNIVERSARY

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.

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.

## Portable Bar Code Readers



TimeWand® I    DuraWand®    TimeWand II

Data collection is fast, easy, and extremely accurate when using Videx portable bar code readers. Cordless operation, compact size, and light weight allow you to take the wands wherever the work needs to be done. Call Videx today for your free information kit: 503-758-0521. Prices starting at:



- TimeWand I ..... \$298
- DuraWand ..... \$495
- TimeWand II ..... \$698

See us at MacWorld Expo, booth #4261  
1105 NE Circle Blvd., Corvallis, OR 97330-4285  
503-758-0521 • FAX 503-752-5285

TimeWand, DuraWand, and Videx are registered trademarks of Videx, Inc. GCO355

Circle 241 on Inquiry Card.

## CENTRAL SERVER CONTROL FROM ONE KEYBOARD & MONITOR

with MasterConsole®

"No other solution stacks up."



- COMPARE QUALITY AND PRICE PERFORMANCE!**
- "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
  - Add Mouse Control  
Add Remote Access up to 150 Feet
  - Thousands in Use Worldwide  
GSA Schedule for US Fed. Govt.

**CALL TODAY!**  
**(908) 874-4072 X 71**

MasterConsole saves space, eliminates clutter, cuts cost, simplifies network server control with 100% reliability.

RARITAN COMPUTER, INC.  
10-1 Ilene Court, Belle Mead, NJ 08502  
Fax (908) 874-5274



**CeBir'94 Booth #014B09**  
Germany - Elsner Computertechnik, Tel: 49-521-889877 Fax: 49-521-889925  
Japan - Proside Corp., Tel: 81-3-3254-6131 Fax: 81-3-3254-6134  
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

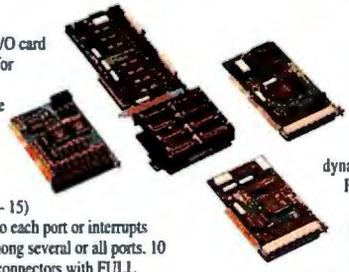
30-DAY MONEY BACK GUARANTEE FULL 1-YEAR WARRANTY

Circle 265 on Inquiry Card (RESELLERS: 266).

## Four more reasons why great Sysops choose Gtek for their multi-line BBS...

### BBS550

Eight port Serial I/O card especially suited for BBS systems. 16550 UARTS are standard. Ports are individually addressable. Individual interrupts (IRQ 2 - 15) may be assigned to each port or interrupts may be shared among several or all ports. 10 conductor RJ-45 connectors with FULL modem support. Up to eight cards may be installed in a single PC for up to 64 ports. DigiBoard & Galacticom compatible. RS-232, 422 & 485 interfaces available. Call for a list of supported BBS software.



### PCSS-8F

Eight channel Intelligent Serial card. Unit has eight RJ-12 connectors, up to 128K of dynamically allocated FIFO memory and its 24 MHz processor handles input speeds up to 115,200 Kbps. DOS, UNIX, XENIX and FOSSIL drivers included. RS-232, 422 & 485 interfaces available.

### PCSS-8X

Ultra high speed Intelligent Octal Serial Card. Unit has eight RJ-12 connectors, up to 512K of dynamically allocated FIFO memory and a 24 MHz processor. Custom gate array provides DMA transfer rates to 1 Megabyte across the PC bus. I/O Mapped registers so no host memory is used. Input speeds up to 115,200 Kbps. DOS, UNIX, XENIX, and FOSSIL drivers included. RS-232, 422 & 485 interfaces available.

All products or company names are trademarks of their respective holders.

OEM & DEALER INQUIRIES INVITED



800-282-4835 (GTEK)

P.O. Box 2310 • Bay St. Louis, MS 39521-2310 USA • Mississippi & Technical Support 601-467-8048 • Fax 601-467-0935

Circle 226 on Inquiry Card (RESELLERS: 227).

## 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, Plika, TTI and Intel voice and fax hardware. Supports up to 32 voice lines and up to 8 fax lines. **Hardware + Software Kits \$650** 2 voice lines kit starts at Fax-on-Demand lines: 818-368-4566 or 818-368-8848

### SigmaTech Software

Tel: (818) 368-6132 Fax: (818) 368-7859  
10801 Bismarck Ave., Northridge, CA 91326 USA  
(Resellers/Dealers/OEMs/Private labels are welcome)

- Automated Attendant
- Unlimited Audiotex
- Voice Mail
- Talking Yellow pages
- Telemarketing
- Fax Mail
- Fax-on-Demand
- Fax Broadcasting
- Date/Party lines
- Int'l Call Back

Circle 250 on Inquiry Card (RESELLERS: 251).

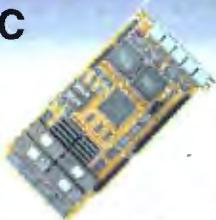
**SHUT YOUR MOUTH!**  
Let our ...  
**Voice Mail  
Call Processing  
Fax-on-Demand**  
Systems do your talking. Complete voice processing systems start under \$300.  
**CALL 1-800-685-4884**  
Demo (510) 522-3800 • FAX (510) 522-5556  
TALKING TECHNOLOGY, INC.  
1122 Alhambra Avenue, Alhambra, CA 91801  
Prices subject to change without notice.

Circle 238 on Inquiry Card.

Computer Systems • Data Acquisition

# PC Systems in ROM

Develop code on PC  
Burn DOS in ROM  
PC Compatible



KS-2 XT equivalent V40 CPU card \$139 - q1  
Options: PCMCIA, 1M ram 512K rom, 256k NV sram,  
3 serial, 2 parallel, clock, modem, A/D, LCD, keypad.  
KS-7 AT equivalent V53 CPU card \$269 - q1  
Options: PCMCIA, 4M ram, 2M rom, 512K NV sram,  
5 serial, 3 par, clock VGA, keyboard, flop, modem, A/D.

**\$139 up**

**KILA**

303-444-7737 Fax 303-786-9983

Boulder Colorado 80301-2842 U.S.A.

Circle 231 on Inquiry Card.

## Rackmount Solutions

### RACKMOUNT COMPONENTS - QTY 25 PRICING

Rackmount Chassis 19"x7"x17" \$183  
Rackmount VGA Monitors \$531  
Rackmount Monitor Shelf \$113  
Rackmount Keyboard Shell \$88

### RACKMOUNT PLATFORMS - Qty 1 Pricing

RMS486-33EISA \$1799 RMS386-40 \$814  
RMS486-33 \$1443 RMS386SX-25 \$693

System Platforms include 7" Rackmount Chassis,  
200W Power Supply, Motherboard, 1.0MB Memory,  
IDE, FDC, 2-Ser, Par, 1.2MB or 1.44MB Floppy Disk  
Drive, 1 Year Warranty

### RACKMOUNT CHASSIS - 15 Models up to 20 Board Slots

SLOT CPU BOARDS - 486, 386, 386SX  
RACKMOUNT MONITORS - Super VGA and Monochrome  
RACKMOUNT CABINET - Modular from 21" to 96" high

**VALLEY TECHNOLOGY INC.**

2468 Armstrong Street, Livermore CA 94550  
(510) 447-2030 FAX: (510) 447-4559



Circle 246 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 221 on Inquiry Card.

## 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** the smart approach to instrumentation™

IOtech, Inc. - 25971 Cannon Rd. - Cleveland, OH 44146  
(216) 439-4091 • Fax (216) 439-4093

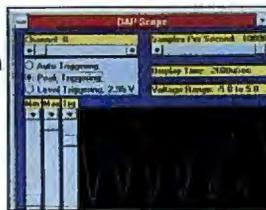
**DaqBook/100™**

Circle 228 on Inquiry Card.

Data Acquisition

## INTELLIGENT DATA ACQUISITION

Now you can run high speed data acquisition under Windows™. A Data Acquisition Processor™ with on-board intelligence\* handles the critical part of an application: the tasks that run in real time. The DAP can be controlled from any Windows language or application that can make DLL calls. The one shown here is written in Visual Basic™ and uses only seven DLL functions. \*1486



**MICROSTAR LABORATORIES™**

Phone: (206) 453-2345  
or fax: (206) 453-3199

### TP208 8 bits 20 MHz COMPUTER-CONTROLLED MEASURING INSTRUMENT

8 BIT RESOLUTION

8 BIT CONVERSION RATE

- STORAGE OSCILLOSCOPE
- SPECTRUM ANALYZER
- VOLTMETER
- TRANSIENT RECORDER

TiePie engineering

The TP208 high-speed data acquisition card, has to be placed in a free ISA slot of the computer. Now you have a complete measuring instrument!

**HARDWARE:** 8 bits 2x20 MHz input range 20 mVolt...80 Volt, signal generator, two switchable probes (1 - 1 - 10), Data acquisition SOFTWARE: two channel storage oscilloscope, spectrum analyzer, voltmeter, transient recorder

**CALL for FREE demo diskette and information NOW**

**COMPLETE SYSTEM \$998!**

**TIEPIE engineering**

Tel: (31) 5106 9238 Fax: (31) 5106 9704  
Ballensersreed 2, 9023 AR Jorwerd  
The NETHERLANDS

Circle 247 on Inquiry Card.

## The Classic Color Transportable PC

- Available in 486-33/50/66 system or in a SKD enclosure
- Build-in 10" color SVGA SONY Trinitron monitor
- 6 Slots with 3 full 3 half arrangement
- 2 x 5.25" DD and 1 x 3.5" HDD bay



**Trans 2000, Inc.**  
11558 E. Washington Blvd. Suite A, Whittier, CA 90606  
Tel: 310-908-6814 • Fax: 310-908-6819

Circle 261 on Inquiry Card.

## PS/2 Hard Drives

**PS/2 50 50z 55sx 60 70 80 P70**

INTERNAL DRIVES - May be used as a high performance replacement or to co-exist with original IBM drive. Compatible with DOS 3.3 to 6.2, OS/2 2.0, 2.1 and Novell. Includes IDE or SCSI-2 microchannel controller, hard drive, mounting kit, ribbon & power cable, manual, hardware, and free technical support.

106mb, 15ms, Internal Seagate IDE Drive Kit	\$383
125mb, 15ms, Internal Maxtor IDE	\$414
245mb, 15ms, Internal Maxtor IDE / SCSI Drive Kit	\$479/\$499
340mb, 13ms, Internal Maxtor IDE / SCSI Drive Kit	\$549/\$626
540mb, 8.5ms, Internal Maxtor SCSI Drive Kit	\$943
1.06gb, 9ms, Internal Connor SCSI Drive Kit	\$1,368

**PS/2 Model 25, 30, 30-286**

External SCSI drives available from 245 mb to 2.9 gb. Includes SCSI-2 controller, external case with drive installed and configured, # SCSI cable. Free drivers for CD-ROM drives. OS/2 Novell 2.2 to 4.01 and Windows NT.

42mb/106mb Hard Drive Kit	\$189/\$253
125mb/245mb Hard Drive Kit	\$284/\$349

**General Technics** 1 Year Warranty - 10 Day Money Back Guarantee

**1-800-GT-SALE-8**

Call for your FREE Catalog today!

Tel: (516) 981-9473 Fax: (516) 981-5038

38 Ryeover Ave Rockville Centre, NY 11779

Open 9am to 5pm EST, Mon-Fri

Circle 254 on Inquiry Card.

### DISC DRIVE REPAIR • NOTEBOOK REPAIR

### DATA RECOVERY • BUY & SELL HARD DRIVES & NOTEBOOKS

**NOTEBOOKS • NOTEBOOKS • NOTEBOOKS**

**COMPUADD EXPRESS**

- 386SX, 25MHz
- 4mb RAM, 80mb Hard Drive
- Built in Trackball
- 9600/2400bps Fax/Modem
- DOS 5.0 - Windows 3.1, Caring Case

**\$1195**

**COMPUADD EXPRESS**

- 486SX, 25MHz
- 4mb RAM, 120mb Hard Drive
- Built in Trackball
- 9600/2400bps Fax/Modem
- DOS 5.0 - Windows 3.1, Caring Case

**\$1495**

**PS/2 HARD DRIVE KITS**

INTERNAL/EXTERNAL KITS FOR MODELS 50-80	Internal	External
120mb/10ms	\$305	\$430
213mb/16ms	395	490
340mb/14ms	559	680
510mb/15ms	865	930
1.03gb/10ms	1229	1345

**INTERNAL KITS FOR MODELS 25, 25-286, 30, 30-286**

20mb/65ms	\$165
30mb/40ms	175
40mb/28ms	195
80mb/19ms	229
120mb/15ms	239
213mb/10ms	295

All internal kits include Drive Controller Cables and Mounting Kit

**HARD DRIVES**

Seagate ST3144A	130mb/16ms	IDE	\$169
Conner CP30170	170mb/17ms	SCSI	205
Maxtor MK7245A	245mb/15ms	IDE	225
Quantum G2405	245mb/16ms	SCSI	239
Maxtor MK7345A	340mb/15ms	IDE	290
Maxtor MK7345S	340mb/14ms	SCSI	330
Conner CP30544	545mb/10ms	IDE	585
Conner CP30540	645mb/10ms	SCSI	585
Maxtor XT12405	1.2gb/8.5ms	SCSI	1105

**HARD DRIVE CARDS**

40mb/28ms	\$150
120mb/19ms	225
210mb/15ms	290
340mb/15ms	399

MANY BRANDS AND HARD TO FIND DRIVES IN STOCK

**DISC DRIVE REPAIR PRICES**

**180 DAY WARRANTY ON ALL HD REPAIRS**  
MFM, RLL, SCSI, IDE & ESDI INTERFACES

20-39mb	\$32	161-299mb	\$135
40-59mb	48	300-399mb	175
60-99mb	80	400+	275
100-160mb	90	TEST & EVALUATION	10

**DATA RECOVERY**

\$75 Evaluation Charge. Additional Charges for Successful Recovery. Call For Pricing

**SYSTEM / NOTEBOOK REPAIR**

System Board Repair	From \$55
Notebooks	From \$75
VGA Monitor Repair	From \$55

VISA, MASTERCARD, AMEX, DISCOVER, PO'S WELCOMED

**jb TECHNOLOGIES, INC.**

5105 Maureen Lane  
Moorpark, CA 93021

ORDER DESK & TECH SUPPORT **800-688-0908** FAX: (805) 828-7712  
PHONE: (805) 828-0908

Circle 230 on Inquiry Card.

## Take SCSI To It's Speed Limit!

# SCSI Vue Terminator

High-Performance Active Diagnostic

**\$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**



**Diagnostic Indicator** **SCSI 1/2/3**

**Granite The Ultimate SCSI Cables**

**D•I•C•I•T•A•L**

**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

3101 Whipple Rd. Union City, CA. 94587

Ph: 510-471-6442 Fax 510-471-6267

Circle 252 on Inquiry Card (RESELLERS: 253).

## Victory Printing Disk Factory

800-727-DISK (3475)



**Victory Enterprises**

223 West Anderson Ln, Suite B-300  
Austin, TX 78752  
(512) 450-0880 Fax (512) 450-0869

- Automatically loads, formats, copies, verifies and PRINTS THE LABEL on 3.5 & 5.25 diskettes!
- Designed for use with a network or any application for distributing data.
- Perfect for serializing or otherwise identifying specific diskettes.

Circle 240 on Inquiry Card.

# BYTE

Breaks the 4-Color Price Barrier with the Hardware/Software Showcase

See how affordable it is to advertise to BYTE's 300,000 computer professionals in this section!

Call for more advertising information:  
(603) 924-2695 or (603) 924-2598

## Money Back Guarantee & 1 Yr. Warranty

### Popular Space-Saver Keyboard \$98.00



Saves 60% desk space. Footprint 27.3 x 15.2 cm. 100 full-travel tactically responsive keys. Standard left-right spacing for easy touch typing. IBM XT/AT PS 2 compatible. Many language versions available.

**Call Toll Free To Order: 1-800-DATALUX**

**DATALUX**

155 Aviation Dr. • Winchester, VA 22602  
Tel 1-703-662-1500 • FAX 1-703-662-1682  
Auto-FAXed Specs FAX 1-703-662-1675

Circle 223 on Inquiry Card.

Laptops & Notebooks

# INTRODUCING AMREL'S 486 COLOR WORKSTATION



- Active-Matrix Color LCD
- Built-in PS/2 Trackball
- Power Management
- Password Security
- Removable HDD
- Docking Station

### Total Expandability

Optional PCMCIA 2.0 Slots, Internal 1.44K Data/Fax Modem, and Docking Station delivers unlimited expandability to the SLT486DX notebook. The PCMCIA option adds two industry-standard Type II slots and lets you plug-in expansion cards—Data/Fax Modem, Flash memory, LAN adapter, or even wireless communication. The Docking Stations features four 16-bit ISA expansion slots, two 5.25" drive bays, built-in Ethernet adapter, and an electronic security system to protect both your notebook and your data.

### Total Upgradability

Unique tri-speed motherboard design supports CPUs from 486DX/33 to 486DX2/66 and beyond so you will never outgrow your SLT notebook. RAM is upgradable from 4MB to 52MB to satisfy the most memory-demanding applications and a removable hard drive allows for easy storage expansion.



**1-800-88 AMREL**

**AMREL TECHNOLOGY INC.**  
11801 Goldring Road, Arcadio, CA 91006  
Tel: (818) 303-6688 • Fax: (818) 303-8538

Circle 244 on Inquiry Card.

## Most Cost-effective Pen Based Personal Information Processor Meets Your Specific Needs.



### Infoman

- Model J:  
For project design
- Model CFX:  
Universal Fax computer

- Programmability**
  - Very easy-to-use 4GL for different information processing
  - Development System on VGA PC for downloading the applications
- Data Compatibility**
  - DOS file system compatible
  - dbf, wk1, pcx, bmp, txt, etc. compatible
- Communication**
  - RS232, Modem, Fax, Infrared, Radio frequency links available
- Cost**
  - Very reasonable

### DIALOGUE TECHNOLOGY CORP.

2nd Fl., 38, Ching Shing Rd., Wen Shan District, 117,  
Taipei, Taiwan, R.O.C.  
TEL: 886-2-9327680  
FAX: 886-2-9317814



Circle 259 on Inquiry Card.

Laptops & Notebooks • Memory/Chips/Upgrades



# Universal Keypad for Portable Computers

Available in Ivory or Black

Boost data entry speed, accuracy and convenience with Genovation's Micropad,™ the innovative numeric keypad for portable computers.

### TO COMPUTER



### TO PRINTER

17741 Mitchell, North  
Irvine, CA 92714 USA  
TEL (714) 833-3355  
FAX (714) 833-0322  
(800) 822-4333

Is the unhandy numeric section of your portable computer's keyboard dragging you down?...Give your productivity a boost by using our Micropad. The ergonomically designed Micropad is ideal for spreadsheet and accounting applications that require fast and accurate entry of numeric data.

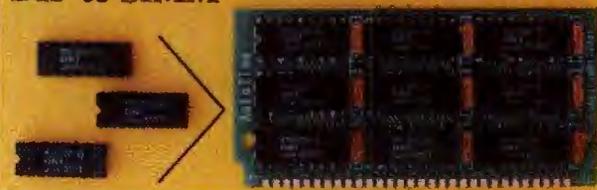
The Micropad attaches to the parallel port of any MS-DOS computer while providing a clean pass through connection to the printer. Power usage is negligible. Lightweight and compact, the Micropad is fully compatible with and programmable under both DOS and Windows. It is also available with connectors to fit keyboard and serial ports.

**GENOVATION**

Circle 225 on Inquiry Card.

## DIP to SIMM

Call on Other RAM Conversions



### Convert obsolete RAM into useful RAM

NEW BOARD retrofits surplus memory into a SIMM module format

#### DIP to SIMM

Board Only (You Solder) \$ 8.50  
Send your Chips (We Solder) \$ 13.50

#### SIP to SIMM

Send Your SIP Modules  
& We Retrofit to SIMM \$13.50

**AUTOTIME**  
24 Hr Fuxbak (503)452-0208

6605 SW Macadam - Portland, OR 97201  
Ph: (503)452-8577 Fax: (503)452-8495

Circle 260 on Inquiry Card.

Let your "true colors shine through" when you advertise your computer products in BYTE's  
**HARDWARE/SOFTWARE SHOWCASE**

our newest, affordable, 4-color  
advertising section!

Call for more details:

**(603) 924-2695 or (603) 924-2598**

## Our New Contribution, Your New Partner

V.32turbo 19200bps  
Available

Main products:  
14400bps+V.42bis+FAX(G3)  
9600bps+V.42bis  
9600bps+MNP5  
2400bps+V.42bis+FAX(G3)  
2400bps+MNP5  
Stand alone  
Internal card  
Rack mounted

Branch office.U.S.A.  
TEL : 818-2811826  
FAX : 818-2879825



14400bps+V.42bis+FAX



Rack Mounted  
Network Management  
System



10F,14L ANE609,SEC.5,CHUNG HSIN RD.,SAN CHUNG  
CITY,TAIPEI,TAIWAN,R.O.C.  
TEL : 886-2-9993155 FAX : 886-2-9994960

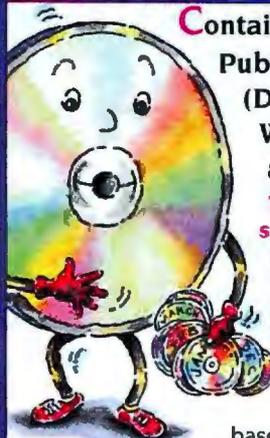
16 - 23 - 03 - 1994



HALL 13- STAND C21

Circle 258 on Inquiry Card.

## Receive ONE CD-ROM A MONTH



Containing **new** Shareware,  
Public domain & Commercial  
(Demo) software for DOS,  
Windows, OS/2, Linux  
and Macintosh.

These CD's contain every  
software imaginable  
including Games, Business,  
Programming, Graphics, Sounds,  
Databases, New Drivers, BBS,  
Utilities, Communication, etc.

Costs less than \$10.00 a CD

Powerful Windows and DOS  
based viewing software for fast  
retrieval and easy installation. Ready to be used on a  
BBS with files.bbs support. (Sysop discount available)  
Dealer Inquiries and International Orders welcome.

**1 year (12 issues) only \$99.95 - SAVE 58%\***  
**2 years (24 issues) only \$149.95 - SAVE 69%\***  
**Sample (One issue) only \$19.95**

\*Off annual cover price - \$239.40. Monthly payment plans available.

Jana Technology Group Inc., 908 Niagara Falls Blvd., Suit 479,  
North Tonawanda, NY, USA, 14120-2060. Phone (416) 633-2007  
Fax (416) 922-5597, BBS (416) 633-3527, E-Mail : info@jana.com

Orders, Call Toll Free.

**1-800-363-2083**



Circle 267 on Inquiry Card (RESELLERS: 268).

## STAND-ALONE LCD MONITORS STN Color or Monochrome



New  
Dual-  
Scan!

**\$1595** | DATALUX introduces its new high quality, high brightness color  
LCD monitor in the same case as the popular Monochrome version.

- 640 X 480, 256 Colors, VGA compatible, 2 CCFT backlights
- Driven by ISA Bus Controller Card, no external power supply, optional CRT output
- Adjustable desk stand, folds for wall mounting or portability, 1.75Kg weight
- 197 X 147mm display (9.4 inch diag), non-reflective glass face
- Contrast ratio of 15:1, 200ms Rise and 150ms Fall time

**\$795** | Monochrome version 640 X 480, 64 gray shades.  
Wide viewing angle.

Also Available

- Mobile/Industrial model sealed against spills and splashes in rugged drawn aluminum housing with optional swivel mount.
- Touch Screen Version. Capacitive technology. Provides high resolution, fast response, all glass scratch proof optically clear sensor. Complete with built-in controller and software.

To Order Call Toll-Free: **1-800-DATALUX**

**DATALUX**

155 Aviation Drive • Winchester, VA 22602

Tel: 1-703-662-1500

FAX: 1-703-662-1682

AutoFAXed Specs: 1-703-662-1675

Circle 222 on Inquiry Card.



NEW

**ChipLab**

- Programs PLDs, PROMs, and EPROMs and microcontrollers up to 48 pins
- Algorithm updates available via electronic bulletin board

Special Introductory Price  
**32-pin version: \$895**  
**48-pin version: \$1495**

To order, call:  
**1-800-3-DataIO,**  
Ext. 911  
(1-800-332-8246)

Also distributed by:  
**Promark Technology West**  
(1-800-227-3345)

**JDR Microdevices**  
(1-800-538-5000)

**DATA I/O**

Circle 245 on Inquiry Card.

## UNIVERSAL/GANG PROGRAMMERS ALL-07

Fill ALL of your EPROM, PLD, GAL, FGPA, MPU, TTL ...  
programming and testing needs with one unit!

- Supports virtually ALL programmable devices.
- Supports DIP, PLCC, QFP, SOP, PGA ... up to 256 pins.
- Gang programming option for production.
- Free software updates via BBS.
- Algorithms approved by IC manufacturers.



**HI-LO Systems**

44388 S. GRIMMER BLVD., FREMONT, CA 94538

TEL (510) 623-8860

FAX (510) 623-7260

Circle 239 on Inquiry Card.

**Programmable Hardware • Scanners/OCR/Digitizers**

# IEEE 488/Serial Converters & Controllers

Connect IEEE 488 (HP-IB/GPIB) and serial (RS-232 or RS-422) computers, plotters, and instruments



**Iotech** *the smart approach to instrumentation*  
 Iotech, Inc. • 25971 Cannon Road • Cleveland, Ohio 44146  
 (216) 439-4091 • Fax (216) 439-4093

Circle 229 on Inquiry Card.

## LOW COST MINIATURE CONTROLLERS

**Save time. Save money.**

Our wide range of C-programmable miniature controllers are ideal for control applications, data acquisition, and test and measurement. Compact and low in price (the Little PLC™ above is 2"x3" and \$195), these controllers are programmed with our easy-to-use Dynamic C™ development system. Our controllers feature digital I/O, ADCs and DACs, relays and solenoid drivers, RS232/RS485 serial ports, battery-backed memory and time/date clock, LCDs, keypads, enclosures and more!



1724 Picasso Avenue Davis, CA 95616  
 916.757.3737  
 916.753.5141 FAX

24-Hour Information Service 916.753.0618.  
 Call from **your** FAX and follow the instructions.

Circle 243 on Inquiry Card.

SPECIAL DEALS ON **SCANNERS**



	REG.	SALE.
AV100 - AVISION Gray, Desk/Laptop Scanner 600 DPI, Built-in ADF, Direct print to Printer iPhoto Plus & OCR (Laptop adapter additional)	<del>\$839.00</del>	\$556.67
AV680C - AVISION 256 Gray, flatbed scanner max. 1,600x1,600 DPI, Legal Size, OCR	<del>\$1399.00</del>	\$780.99
AV660C - AVISION 24-Bit, True Color Flatbed Scanner Max. 1,200 DPI, Legal Size, iPhoto Plus & OCR	<del>\$1,799.00</del>	\$890.99
AV680C - AVISION 24-Bit, True Color Flatbed Scanner Max. 1,600 DPI, Legal size, Image Pal & OCR	<del>\$1,999.00</del>	\$1,140.00
AV800 - AVISION High-speed (10ppm) Scanner 24 Bit, 1,200 DPI in Flatbed Image Fast & OCR	<del>\$2,699.00</del>	\$1,855.99
Flatbed Transparency Scanning Adapter	<del>\$459.00</del>	\$325.00

MOTHERBOARDS WITH CPU STARTING FROM \$89.99 UP

## COMPUTERS -N- MORE

A DIVISION OF LITECH CORPORATION  
**1-800-548-3246**  
 LITECH CORP. • 614 N. MAIN STR., LOUISBURG, N.C. 27549

TECHNICAL SUPPORT: 1-800-LITECH-6  
 VAR and Dealers welcome • PHONE (919) 496-2669 FAX: (919) 496-7111  
 AVISION IS THE REGISTERED TRADE NAME OF AVISION INC. • PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

Circle 262 on Inquiry Card.

**Scanners/OCR/Digitizers • Tape Drives**

### P.C. Compatible Camera:

Captures images and displays on VGA Equipped PC.

- Utilizes CCD image sensor technology
- Resolution 192 (H) x 165 (V) pixels



P.C. Control Software has the following features:

- Snap shot image or quasi-video image acquisition
- Auto exposure control
- Electronic shutter
- Image pixel-by-pixel editing
- Variety of image output formats
- Flexible camera set up under menu control

Package includes:

- Camera complete with optics
- Image acquisition board for P.C.
- 6 foot cable
- PC control software
- Instruction manual

Price: \$495.00 U.S. VISA accepted  
 For more information or to order:  
 Call Smart-Tech, Inc. at 1-800-267-9263  
 1051 Clinton Street, Buffalo, NY 14206

Circle 263 on Inquiry Card (RESELLERS: 264).

### 3480/3490 & 9-Track Tape Subsystems 1/4" DAT 8mm Optical

Windows Software Now Available

- Tape Backup and Restore
- Make Your Own CD ROM with our CD ROM Maker
- Optical Storage from \$995.00
- Fujitsu Quality Drives



**CALL 1-800-938-TAPE**

Get The Very Best For Less



**Laguna Data Systems**

7340 Smoke Ranch Road, Suite C, Las Vegas, NV 89128  
 Tel: (702) 254-2648 • Fax: (702) 254-0910

Circle 232 on Inquiry Card.

## 9-TRACK FOR PCs

Mainframe To PC Data Interchange

Rock solid solutions, rock bottom prices.

Direct from the manufacturer. 1600/3200/6250 bpi.

- The most trusted name in 9-track, since 1980
- Powerful, easy-to-use software tools included

**Overland Data Inc.**  
**800-729-8725**  
 7 AM - 5 PM Pacific Time

TEL: 619-571-5555  
 FAX: 619-571-0982  
**EUROPE:**  
 TEL: (+44) 734-891891  
 FAX: (+44) 734-891897

Ask about 3480 with IDRC.

Circle 234 on Inquiry Card.

### Desktop 9-Track Tape Subsystem #1-selling 9-track system on desktop.



Qualstar's low cost 1/2-inch 9-track Streaming tape systems bring full ANSI data interchange to IBM AT, PS/2 or Macintosh, giving your micro the freedom to exchange data files with nearly any mainframe or minicomputer in the world.

Systems include DOS or Xenix compatible software, coupler card and cables. High reliability 1600 or 6250 BPI capability may be used for disk backup as well as data interchange.

**Call us today! For details and to order: Fax (818) 882-4081 Phone (818) 882-5822**



9621 Iroindale Ave., Chatsworth CA 91311

©1989 Qualstar Corp.  
 All product and company names and trademarks are the exclusive property of their respective owners.

Circle 235 on Inquiry Card.

**PC/Mainframe/Mini Information Exchange**

- Tape Transfer and Format Conversion
- EBCDIC ↔ ASCII Data Manipulation
- AS/400, TK50, and 14" OIC Drives
- UNIX Tar and DEC Save Set Options
- Reseller Inquiries Invited

**QuickCopy™ Tape Duplication**

**READ/WRITE 9-TRACK  
3480 • 8MM • DAT on  
YOUR PC NOW!**

Call Us ... (317) 842-2077 or  
**1-800-248-3475**

**SHAFFSTALL CORPORATION**  
FAX: (317) 842-8294  
*Media Conversion Systems Since 1973*

Circle 256 on Inquiry Card (RESELLERS: 257).

**HiWIRE® II Schematic and PCB Software**

With support for expanded and extended memory, HiWIRE II can handle your most demanding schematic and PCB designs. The unique HiWIRE II editor allows you to display and edit schematics and PCBs simultaneously, using the same commands for each. HiWIRE II is \$995, and is guaranteed.

Call (800) 742-6809 or (317) 448-1903

**WINTERK**®  
Wintek Corporation  
1801 South Street  
Lafayette, IN 47904  
(800) 742-6809

Circle 242 on Inquiry Card.

**Free Data Acquisition Software Tool**



DAQ Designer is a free software tool that helps determine which hardware and software combinations are best for your PC-based data acquisition system. DAQ Designer will (1) ask questions about your application, (2) analyze your answers to determine your system needs, and (3) describe what hardware and software you need to develop your data acquisition system.

**National Instruments**  
6504 Bridge Point Parkway  
Austin, TX 78730  
(512) 794-0100 • (800) 433-3488

Circle 233 on Inquiry Card.

**Only One Peer-to-Peer LAN Gives You Four Connectivity Options At One Low Price -- \$99 Per Node!**

Only one peer-to-peer local area network offers you a solution that reflects the reality of business automation: a mix of different cabling and connectivity options on one LAN.

**Modem Networking** LANLink Professional gives you your choice of remote modem, or local ethernet, parallel and/or serial connections *in any combination on the same network*. And you can connect PCs running DOS, Windows or PC-MOS® operating systems seamlessly.

**Ethernet Networking** All this flexibility in one product from one company at one price: **\$99 per node**. Plus you get rich networking features like print spooling, NetBIOS compatibility and more. Call The Software Link today.

**Parallel Networking**

**Serial Networking**

Call (404) 512-0600  
Fax (404) 396-6628

**LANLINK™**  
PROFESSIONAL

Dealer Inquiries Welcome

Policies and specifications subject to change without notice. PC-MOS is a registered trademark and LANLink is a trademark of The Software Link.

Circle 237 on Inquiry Card.

**For Engineers who Excel!**



**DADiSP**

- Collect, analyze, and display data in a multi-window graphical environment
- Point and Click menu driven operation
- Data reduction and editing
- Series and scalar math
- Matrix math
- Statistics
- Peak analysis
- FFTs and Convolutions
- Digital filtering
- XY plots
- 3-D/4-D graphics
- Spreadsheet environment

DADiSP is currently in use in engineering, laboratory data collection, matrix processing, manufacturing, science, signal processing, chemical and mechanical applications in automotive, aerospace, defense, medical, and other industries.

**CALL 1-800-777-5151**

for your free DADiSP Trial Kit for SUN, HP, IBM, NeXT, DEC, Concurrent, and Silicon Graphics workstations, and of course, PCs under Windows™.

**DSP**  
Development Corporation

One Kendall Square  
Cambridge, MA 02139  
tel: 617-577-1133  
fax: 617-577-8211

Circle 224 on Inquiry Card.

**Utilities • Windows**

# FAST LOAD

## FILE-WISE DISK SPEED UP

**BEYOND DISK CACHE! BEYOND RAM-DISK!**

- Keeps files you specify in E/XMS for ultrafast access
- Works alone or to speed up existent cache/RAM disk
- Unlike cache, your files do not get needlessly flushed out of XMS, but are always ready for instant access
- Unlike RAM disk, no need to copy files / reconfigure applications, no E/XMS wasted on granularity slack
- Reduce LAN traffic. Speed up DOS / WIN. Uses < 5k
- Price: \$49 VISA, MC, AMEX

**OMEGA POINT, Inc.**  
25 Birch Rd. Framingham, MA 01701  
TEL (508) 877-1819  
FAX (508) 877-0915



Circle 249 on Inquiry Card.

**Windows**

Circle 236 on Inquiry Card.

**TCP/IP**

- Windows Developer's Kit
- Binary TCP/IP Transport
  - PDS for DOS
  - Windows Sockets API



**Development Components**

**winsock.dll** is a dynamic link library (DLL) which allows windows applications to dynamically bind for TCP/IP services. The winsock.h, .lib, .def files are also provided for the C/C++ developer.

**/build** contains the source and executables for Windows Sockets finger client. This is useful for testing winsock, configuring the build environment, and as an example of both message-based and synchronous Windows Sockets programming.

**winsock.HLP** provides on line help for Windows Sockets version 1.1.

For More Information Call  
1 (800) 541-9508  
{805} 484-2128 • Fax {805} 484-3929

Circle 248 on Inquiry Card.

**International Marketers:**

Sell your computer products in one of the fastest growing markets today!

**REACH 78,000 LATIN AMERICAN BYTE READERS**

Now you can advertise in 1, 2, or all 3 Latin editions of BYTE:

- BYTE Mexico
- BYTE Brazil
- BYTE Argentina

Give Liz at Global Ad-Net a call today for more info: 603-876-4311.



4901 Morena Blvd., #903  
San Diego, CA  
92112

# WEST COAST MICRO INCORPORATED

P.O.'s accepted from  
Universities and  
Qualified Firms

**WE WILL BEAT ANY ADVERTISED PRICE**



FAX  
(619) 581-0125

**(800) 581-6040**

(619) 581-6040



**IDE HARD DRIVES**

CONNER		MAXTOR	
CP30174	170mb \$180	7213A	213mb \$230
CP30254	250mb \$240	7245A	245mb \$250
CP30344	340mb \$310	7345A	345mb \$279
CP30544	540mb \$570	MXT540SL	540mb \$720
Seagate		Western Digital	
ST1239A	112mb \$230	WD2200	200mb \$220
ST3290A	285mb \$260	WD2250	250mb \$260
ST3390A	340mb \$300	WD2340	340mb \$300
ST3550A	450mb \$460	WD2420	420mb \$450

**MEMORY**

CALL FOR BEST PRICE - ALL SPEEDS - OTHERS AVAILABLE

IBM-PS/2	72 PIN SIMMS	SIMMS/SIPPS
6450804	512X36-70 \$84	1X3-70 \$42
6450808	1X36 \$173	1X9-70 \$53
6450902	2X36-70 \$375	4X3-70 \$143
30F5360	4X36-70 \$659	4X9-70 \$150
34F2933	Call For Best Price	16X9-70 \$910

**CYRIX-(MATH CO's & CPU's)**

83D87-33	\$45	83D87-40	\$49	83S87-33	\$45
486DLC-33	\$75	486DLC-40	\$85		

**MOTHERBOARDS**

ISA BUS	VESA LB	INTEL VESA LB			
486DLC33	\$229	486DLC33 VLB	\$249	486DX2/66 VLB	\$629
486DLC40	\$239	486DLC40 VLB	\$259	486DX33 VLB	\$399
				486DX VLB W/O cpu	\$119
486SLC2/66 - IBM	486SLC2/66 VLB	MINI EISA			
ISA 5-16bit, 2-8bit	8 Slots; 2-VL, 6-ISA	486DX2/66 VLB	\$709		
Landmark 153.21	Landmark 153.07	486DX33 VLB	\$459		
\$275	\$329	486MB	\$189		

**SPECIALS**

CONNER	MONITOR	HARD DRIVE
250 Tape Drive with tape	14" SVGA, .28 D.P. 1024 x 768	Toshiba - 1 Gigabyte MK537EB
\$152	\$239	\$719

**NOTE BOOKS**

IBM Thinkpad	Toshiba	PCMCIA
700 700C 720	4500	14.4 Fax/Modem
4mg \$229	4mg \$259	\$269
8mg \$459	8mg \$449	SCSI Adapter
		\$279
750	4600	Ethernet
16mg \$999	16mg \$969	\$199
20% restocking fee on all non-defective returns		

# 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 1/4" ads can include headline (23 characters maximum), descriptive text (300 characters is the maximum recommended) plus company name, address, tele-

phone and fax number. 2"x2 1/4" 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 Gnade at 603-924-2656. FAX: 603-924-2683.

### RATES (Jan. 1994)

	3-5 Issues	6-11 Issues	12 Issues	13 Issues
<b>2"x1 1/4"</b>				
1 ad	\$696	\$668	\$585	\$557
2 ads/issue	-	-	557	529
3 ads/issue	-	-	529	501
<b>2"x2 1/4"</b>				
1 ad	\$1,392	\$1,336	\$1,170	\$1,114
2 ads/issue	-	-	1,114	1,058
3 ads/issue	-	-	1,058	1,002

## ACCESSORIES

### RADIOACTIVE?

Plot it on your PC with The RM-60 RADIATION MONITOR Serial or printer port. Detects: ALPHA • BETA • GAMMA • X-RAY MicroR, 1000 times the resolution of standard geiger counters. Excellent for tracking RADON GAS. Find sources. New. Version 3.1 • WINDOWS, Plot: • Background • Cosmic Rays • Clouds • Foods Call/Writes for PC MAGAZINE review. • TSR • GM Tube VISA/MC/EURO Phone orders. Not satisfied? Full refund.

**800-729-5397 or Tel/Fax: (302) 655-3800**

**Aware Electronics Corp.**  
P.O. Box 4299, Wilmington, DE 19807 **\$149.50**

### How's your MonKeyMouse™?!!!

Your **MON**itor, **KEY**board, and **MOU**se can be much more effective!!! Control more than one PC/Server with a single **MonKeyMouse™**!!! Use two, 4, or even 8 **MonKeyMouse™** units on a single PC/Server!!! Locate your **MonKeyMouse™** up to 80m (250ft.) from your PC/Server!!! 220V and 110V available.

**CR International, ALABAMA, USA**

FAX: 1 (205) 461-9762

Inquiry 651.

### KEYBOARD, VIDEO, MOUSE, AUDIO

Extend signals from PC with **EXTENDER** Split signals with **COMPANION/PC EXPANDER** Switch signals among PCs with **COMMANDER** Boosts signals up to 600 feet. Control up to 96 PCs with one keyboard, monitor and mouse.

### CYBEX CORPORATION

4912 Research Dr., Huntsville, AL 35805

Phone: 205-430-4000 Fax: 205-430-4030

Inquiry 652.

### VGA Splitters

- Connect 2, 4, or more monitors to your computer
- Bright and crisp presentation simultaneously on all monitors - Guaranteed
- Works with all VGA, SVGA, and RGB monitors
- Small durable metal case. **MADE IN USA**
- Extension cables available

**H&R TECHNOLOGY** **800-959-6439**  
Santa Ana, CA (714) 641-8607

Inquiry 653.

## BAR CODE

### Labeling Software

On EPSON, IBM, OKI, or LaserJet. Easy WYSIWYG design. Any format/size. Up to 120 fields per label. 18 text sizes to 3" - readable at 100'. AIAG, KMart, Sears, MIL-STD, Pennys, 2of5, 128, UPC/EAN, Code 39. File Input & Scanned PCX graphics - \$279. Other programs from \$129.

**Worthington Data Solutions**

(408) 458-9938 **800-345-4220**

## BAR CODE

### Portable Reader

- \* AA Battery Operated, 64K or 256K
- \* **Prompt Operator with your prerecorded voice messages for data entry and error messages.**
- \* 4x20 Supertwist LCD Display, 36 Rubber Keys
- \* Real-time Clock Built-In for Date/Time Stamps
- \* 2 Built-In Inventory Programs
- \* 3 User Defined Programs, & 3 User Data Files
- \* Wand, CCD, or Laser Scanner Input
- \* Doubles as Non-Portable Reader
- \* Serial Interface and Keyboard Interface
- \* Reads 2of5, UPC/EAN, 128, Code 39, etc.
- \* Uploads with furnished Programs or Xmodem
- \* 2 year Warranty on Reader & Wand
- \* 30 Day Money Back Guarantee
- \* 64K Complete with Wand and Voice - \$799
- \* **New Smaller Size - weighs only 12.5 oz**

### Worthington Data Solutions

3004 Mission Street, Santa Cruz, CA 95060

408-458-9938 FAX 408-458-9964 **800-345-4220**

## BAR CODE

### Portable Bar Code Reader

- Use as a **PORTABLE, WEDGE, or SERIAL**
- **9V Battery Operation with Lithium Backup**
- **2x16 Supertwist LCD Display**
- **54 Key Keyboard with Separate Numeric Keys**
- **Real-time Clock Supports Date & Time Stamps**
- **Reads all Popular Bar Codes (16 types)**
- **Wand, CCD, Laser, or Serial Input Devices**
- **Built-In Program Generator**
- **Create Your Own Custom Programs**
- **6 Built-In Inventory Programs**
- **Up to 250 Programs Can Reside in Memory**
- **Create up to 250 Data Files per Program**
- **Up to 250 Look-Up Files in Memory**
- **Built-In Calculator**
- **Supports Hayes Compatible Modems**
- **64K Memory with Data Compression**
- **30-day \$\$ Back Guarantee - 1 Year Warranty**
- **Complete Unit with WAND Scanner - \$795**

### AMERICAN MICROSYSTEMS

2190 Regal Parkway, Euless, TX 76040

(800) 648-4452 (817) 571-9015 FAX (817) 685-6232

### Bar Code Readers

#### For PC, XT, AT, PS/2, Macintosh and Serial Terminals

- \* Attaches as 2nd Keyboard or to any ADB port
- \* Reads 2of5, 128, UPC/EAN, Code 39, etc.
- \* External or Internal attachment on PC
- \* Wand, CCD, Slot Badge, Magstripe or Laser
- \* Two Scanners per Reader
- \* 100+ Configurable Options
- \* 2 Year Warranty, 30 Day S Back Guarantee
- \* Direct From Manufacturer
- \* Top Rated by Independent Review
- \* Complete with Laser Scanner - \$1250
- \* Complete with Stainless Steel Wand - \$399

### Worthington Data Solutions

Swiss Office

Rütistrasse 6

CH 9050, Appenzell Switzerland

071 87 51 17 FAX

071 87 51 15 Phone

3004 Mission Street

Santa Cruz, CA 95060

408-458-9938

**800-345-4220**

### BAR CODE READERS

#### For PC, XT, AT, PS/2, & Serial Terminals

- Emulates Keyboard: Works With Any Software
- Data Appears as Keyboard Input
- Uses Enhanced Decoding Algorithms
- Accepts Wand, Slot/Badge, CCD, Laser, Magnetic Stripe Reader, & RS232 Serial Input
- Reads All Popular Bar Codes (16 types)
- Reads HIGH, MEDIUM, & LOW density codes
- Auto-Discriminates Between Bar Code Types
- Easily Programmed with a Bar Code Menu
- Over 140 User Configurable Options
- Daisy Chain Up to 96 Readers
- Supports NOVELL Networks
- Supports US & INTERNATIONAL Keyboards
- Direct From Manufacturer
- 30-day \$\$ Back Guarantee, 1 Year Warranty
- Complete Unit with LASER Scanner - \$1095
- Complete Unit with WAND Scanner - \$395

### AMERICAN MICROSYSTEMS

2190 Regal Parkway, Euless, TX 76040

(800) 648-4452 (817) 571-9015 FAX (817) 685-6232

### Bar Code Printer & Software

Allegro Thermal Transfer Printer-2" per sec speed. Up to 4" label width-Only 20 lbs. weight-Prints UPC/EAN, 2of5, UCC-128, Code 39, 128 - Prints scalable text and PCX graphics with bar codes - Packaged with LabelRIGHT Software, serial cable, ribbon and labels-Complete-\$1895

### Worthington Data Solutions

(408) 458-9938 (800) 345-4220

### SCANNER SALE

- WELCH ALLYN Steel Wand w/decoder \$249
- SYMBOL Laser LS2000, LT1700 or SP400 widecoder \$699+
- Software Wedge (DOS/Windows) WHP Wand or PSC Laser \$125+
- Mag Stripe Encoder/Reader (2 or 3 tracks) \$1099+
- Printing Software (DOS/Windows) \$149+
- POS Products • VAR Discounts • USA Made
- 2-5 YR WARRANTY • SPANISH Dept. Avail.

### BARCODE INTERNATIONAL SYSTEMS (BIS)

12140 Severn Way, Riverside, CA 92503

(909) 270-0016 • (800) 653-4252 • FAX (909) 270-0920

Inquiry 654.

# THE BUYER'S MART

## 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, GIF, 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

## BBS INCOME

### Free Report on how to go from \$0 to \$3,000 per month in BBS Income in as little as 90 days!

This valuable report outlines powerful marketing secrets to help you - find new subscribers, collect top dollar fees, get free publicity, take credit cards, plus much more. Limited quantity.

**InfoLink** - 1 (619) 228-9653, FAX 1 (619) 369-1165  
56089 29 Palms Hwy, Ste. 254-BY  
Yucca Valley, CA 92284

Inquiry 658.

## 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

Harding Way, ST. IVES, Camba, UK, PE17 4WR  
Tel: 011-44-480-461778 Fax: 011-44-480-494042

Inquiry 659.

## CAD/CAM

### CONTOURING MOTION CONTROL

FROM A PRINTER PORT!

NEW INDEXER LPT™ software \$249  
VERSION 3 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 660.

## CAD/G.I.S.

### Digital Quad Maps

Local Street Maps, State Maps, and World  
Maps in DXF, PCX, PICT, PIC or TIF  
Formats. Gigabytes of Map data available.

### Micro Map & CAD™

(303) 988-4940

Inquiry 661.

## 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 662.

## CD-ROM

- \* TOSHIBA \* TEXEL \* TEAC \*
- \* SCSI INTERFACE: TRANTOR \*
- \* MEDIA VISION \*

\* WIDE SELECTION OF CD-ROM TITLES  
\* CD-ROM CADDIES AND 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 663.

## CD-ROM

### OPTI-CDcache™

Improve CD-ROM workstation performance!  
Only \$89!

OPTI-CDcache™ takes advantage of Extended Memory (XMS) to cache CD-ROM data. Retrieve data from a high speed cache instead of directly from the CD-ROM drive and significantly improve your CD-ROM workstation performance!  
Ask for our free catalog of exciting CD-ROM products including the market-leading OPTI-NET™ CD-ROM networking software!

### ONLINE COMPUTER SYSTEMS, INC.

A member of the Reed Elsevier group  
FlashFAX Info Hotline 301-601-2120  
301-428-3700 or FAX us at 301-428-3700.

Inquiry 664.

### New and Updated CDROM Titles

Cica MS Windows CDROM, Thousands of Windows programs.....\$29.95  
Giga Games CDROM, Games for DOS/Windows.....\$39.95  
Space and Astronomy, Thousands of NASA images/data.....\$39.95  
C Users Group Library, C source code.....\$49.95  
Simtel MSDOS CDROM, DOS Shareware/Freeware.....\$29.95  
QRZ Ham Radio CDROM, FCC Callsign Db & Shrwir.....\$29.95  
Gifs Galore CDROM, Over 6000 GIF Images.....\$39.95  
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  
Libns Britannia, MSDOS Tech/Sci/Engineer.....\$69.95  
X11RS/Gnu CDROM, Full src, SPARC binaries.....\$39.95  
Nebula for NeXTSTEP, Programs 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-211, Concord, CA 94520  
1-800-786-9907 Visa/MC AMEX, Fax: +1-510-674-0821

Inquiry 665.

## CELLULAR PHONES

### TWO CELLULAR PHONES WITH ONLY ONE NUMBER

Our cellular software will allow you to  
change phone numbers and elec-  
tronic 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 666.

## 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 Systems Corp.

572 W. Market St. #5, Akron, OH 44303  
(216) 253-8787 • (216) 762-6050 Demo

Inquiry 667.

### 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-PACK-  
ARD SCANNERS • MAGNETIC STRIPE READERS. Our  
readers plug and play with your existing system without addi-  
tional software. CALL ABOUT OUR 30 DAY GUARANTEE •  
TECHNICAL SUPPORT • OEM/VAR DISCOUNTS.

**INTERNATIONAL TECHNOLOGIES & SYSTEMS**  
Eastern USA (800) 828-1688 804-272-0138 Intl.  
Western USA (800) 228-9487 804-272-0357 Fax

Inquiry 655.

### PC BAR CODE SPECIALISTS

Bar code readers designed for fast, reliable, cost-  
effective data entry. They emulate your keyboard, so  
data looks just like it was typed in! Choose from  
stainless steel wand, laser gun, CCD, and magnetic  
stripe scanners. Also, powerful label printing  
software. Great warranty. Generous reseller  
discounts. 30-DAY MONEY-BACK GUARANTEE.

### Seagull Scientific Systems

15127 N.E. 24th, Suite 333, Redmond, WA 98052  
1-800-758-2001 206-451-8966

### 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 656.

### 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 657.

## COMPUTER BOOKS

### ADVANCED COMPUTER BOOKS at a discount

- We specialize in ADVANCED books for developers, programmers, computer professionals, engineers, and academics
- Windows, C++, OS/2, UNIX, Mac, OOP, Analysis/Design, AI, Neural Nets
- 15% discount on any quantity on most books
- Computer literate order processing staff
- Audio/Video training tapes, CD-ROM software
- MIT Journal subscriptions
- Special orders, hard-to-find books
- Latest books from over 100 publishers
- Free 16-page catalog
- UPS domestic & international shipping
- CompuServe® 70007, 1333, GO CBK
- Nifty-Serve, GO WSN
- Internet 70007.1333@compuserve.com

**CompuBooks** 800-880-6818  
Route 1, Box 271D 512-321-9652  
Cedar Creek TX 78612 Fax 321-4525  
USA MC/Visa/AmEx/Disc/JCB

Inquiry 668.

## COMPUTER INSURANCE

### INSURES YOUR COMPUTER

SAFWARE 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**

SAFWARE, The Insurance Agency Inc.  
PO Box 02211, 2929 N. High St., Columbus, OH 43202  
Now available in Ontario!!!

Inquiry 669.

## 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 670.

### Cross Assemblers Simulators Disassemblers

## PseudoCorp

716 Thimble Shoals Blvd. Newport News, VA 23606  
(804) 873-1947 Fax (804) 873-2154  
BBS (804) 873-4838

Inquiry 671.

## DATA RECOVERY

### 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 672.

## DATA RECOVERY

### Data Recovery & Repair

- High Success Rate/Fast Turnaround
- 24 Hour Service Available
- Lowest Prices on Disk Drive Repair
- Clean Room

We Repair MFM/RLL/SCSI/ESDI/IDE  
**AA Computech, Inc.**

28170 Avenue Crocker Ste#105, Valencia, CA 91355  
(800) 360-6801 (805) 257-6801 Fax (805) 257-6805

Inquiry 673.

## 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 Busy Drive, Eden Prairie, MN 55346

Inquiry 674.

## 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 675.

## CONVERSION SERVICES

Convert any 9-track magnetic tape to or from over 5000 formats including 3 1/2", 5 1/4", 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

Inquiry 676.

## 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 676.

## E-MAIL

### WEEMAIL and Tickle!

Simple and inexpensive E-Mail and personal planning "Tickler"

- One Price for any size network — \$149.00
- Unique screen handling — quicker and easier than even a mouse!
- Works on any Netbios network
- Call for a FREE sample disk

**W.E. INC.** (800) 900-9064

Inquiry 677.

## 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 license 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 678.

## 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 679.

### WINDOWS FLOWCHARTER \$129

RFFlow 2.0 is a professional drawing tool for flowcharts & org. charts. Requires Microsoft Windows. 100 shapes auto adjust in size. Diagonal lines and curves. Auto line routing and re-routing. Click on a shape to bring up a sub-chart. Move charts to other apps. via the Clipboard. Call for free trial disk.

#### RFF ELECTRONICS

1053 Banyan Court, Loveland, CO 80538  
Phone: (303) 663-5767 FAX: (303) 669-4889

## HARDWARE

### 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 680.

# THE BUYER'S MART

## 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 681.

## HARDWARE/COMPUTERS

### NEW! 20MHz 16-bit FORTH Single Board Controller with 8ch 10-bit A/D, 3ch 8-bit D/A

**TD52020** FORTH CONTROLLER AND DATA-LOGGER—A 3" board uses Hitachi 16-bit H5-S32 CMOS µP. Screens 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 PRGM. Attach keyboard, lcd, 1°C 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 (25¢) STARTER PACK \$499.

CALL NOW FOR DETAILS!

**Saelig Company**

European Technology

Sale-or-return

tel: (716) 425-3753

fax: (713) 425-3835

## NOTEBOOK PERIPHERALS

### Second Serial Ports

Texas Instruments, Toshiba, Everex/Sanyo  
• RS232 • RS422/485 • High-speed buffered UART  
• \$199 - \$249 • NEW for PCMCIA-RS422/485  
• Custom I/O ports for Toshiba 150 pin connector:  
RS232, 422/485, IEEE 488

Custom design capability. Also Auto/car adapters for portable laptops, notebooks, and printers.

Designed and made in USA!!

#### Empire Engineering

California USA

tel 805/543-2816

fax 805/543-2820

Inquiry 685.

## SCIENTIFIC SOFTWARE

### Scientific & Technical Software

Free catalog

Call 1.800.622.3345

SciTech is your source for the best value in scientific and technical software. More than 750 products.

1.312.472.0444

FAX 1.312.472.0472

2231 N. Chyboom Ave.

Chicago, IL 60614

Inquiry 686.

## HARDWARE/EMBEDDED

### SC/FOX™ EMBEDDED COMPUTERS

PC Parallel Coprocessor Plug-In Boards: 15 MIPS avg 50 MIPS burst, using the SC32 32-bit CPU or the 16-bit Harris RTX 2000™

**VME Master/Slave System Controller SBC:** 18 MIPS avg 70 MIPS burst, uses RTX 2000 cpu, SCSI, 2 ser, 1 prt ports, to 640K bytes.

**Stand-Alone Single Board Computers:** 18 MIPS avg 60 MIPS burst, 3U or 100x100mm Eurocard-size using either SC32 or RTX 2000.

Ideal for embedded real-time control, data acquisition, robotics, and signal processing. OEM software development system included.

**SILICON COMPOSERS INC** (415) 961-8778

American Technology

Inquiry 682.

## SECURITY

### FIGHT PIRACY!

★ EVERLOCK 3.0 ★

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 687.

## LANS

### The \$25 Network Try the 1st truly low-cost LAN

- Connect 2 or 3 XT's, AT's, 386's, 486's
- 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 Arcnet
- Link via Ethernet or Modems soon
- Mixed mode routing
- Typically only 35K 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 683.

## MEMORY CHIPS

### 64-bit co-processor chip

ANUGO is an ultra-high performance mathematical co-processor chip (FPU). Up to 6 times (!) faster than comparable products. 0.75 Linpack performance at 33 MHz clock speed, 64-bit internal chip architecture. IEEE 754 single and double precision. For use on motherboards with 32-bit CPUs, on graphics cards, in printers, photocopiers, scanners, cameras, etc.

#### SWABIAN

Unter den Linden 15, D-72762 Reutlingen, Germany  
+49-172-7123777 • Fax: +49-7121-370411 • MCI: 523-2219

Inquiry 684.

254 BYTE FEBRUARY 1994

## 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 690.

## 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 Monicello Dr., West Chester, OH 45069

Phone/Fax: 513-777-8586

Inquiry 691.

## 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 692.

## 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 Tel: 206/776/6443

21929 Mahak Rd., Fax: 206/776-7210

Woodway, WA 98020 USA: 800/356-0203

## 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 693.

## 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. Also, access control system and diskette drive locks.

### MICROCOMPUTER APPLICATIONS

3167 E. Otero Circle, Littleton, CO 80122

(303) 770-1917 FAX: (303) 770-1863

Inquiry 689.

### Cop's CopyLock II

The professional software protection with TRUE Machine Install. Option Board safe. OS/2, Networks, Windows, and CD-ROMs.

### LINK Data Security

Int'l: + 45 31232350 Fax: + 45 31238448

New: Access Control by DialCops

Inquiry 688.

## 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 688.

## SOFTWARE/ENGINEERING

### SpiceAge\*4W

#### Windows Analog Circuit Simulator

The following and MORE at under \$1000:

- AC, DC, Transient, Fourier, Temperature analysis • Fully expandable library • Analog & digital components
- Transmission line primitive • Real signal node names
- Graphical real time • Group delay • Component sweeping

#### Tatum Labs, Inc.

1287 N. Silo Ridge, Ann Arbor, MI 48108  
313-663-8810

Inquiry 694.

## 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, and others.

#### AccuSoft Corporation

160 E. Main St., P.O. Box 1261, Westboro, MA 01581  
(800) 525-3577 (508) 898-2770 FAX (508) 898-9662

Inquiry 695.

## Windows Graphics Library

Easy to use library for image manipulation.

- > read/write: BMP, FLC, FLI, GIF, JPG, PCX, TGA, TIFF
- > effects: brightness, blur, edge detection, flip, rotate, scale, etc.
- > image compression up to 100:1.

Available as DLL or MS/Borland C library. \$199  
Distributors welcome.

#### AiM Inc.

LJ.Sram 8, 41000 Zagreb, Croatia  
Fax/phone: +385 41 811 126 E-mail: CompuServe 73423.3143

Inquiry 696.

## 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 697.

## 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!
- systems specified by natural mathematical relationships
- automated design, optimization, editing & verification
- ideal for engineering, business/financial & scientific applications
- create stand-alone applications and influential presentations

Full System still only \$495. Call for \$99 intro offer!  
**Probots, Inc. 413-586-8929**  
80 Damon Road, Ste. 3307  
Northampton, MA 01060 **800-Sim-Easy**

Inquiry 698.

## SOFTWARE/PHOTOGRAPHY

The Photographer's DataGuide contains many useful tables for the amateur and professional. Sun/moon almanacs available for UK, USA, Aus/NZ and Canada also CineGuide option. The Photographer's DataBase is for the storage of shot details and includes label printing and an image display option. Reviewed U.K. photo mags. From E60.

#### Douglas Software

14 North Drive, Littleton, Winchester  
Hampshire, United Kingdom, SO22 6QA  
Tel: (44) 962 880495 Fax: (44) 962 776671

## SOFTWARE/SCIENTIFIC

### VT<sub>E</sub>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

"TeX 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 699.

## 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 with 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. Nonparametric. 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 700.

## TRANSLATORS

### software TRANSLATORS

FORTRAN IV to C  
CMS-2M to Ada  
METAMORPHOSIS  
(User-defined)

PL/I (Subset G) to C  
ASSEMBLY (PAL-11) to C  
CUSTOM Translators

Call or write for product brochure to:

**J. H. Shannon Associates, Inc.**

P.O. Box 597, Chapel Hill, NC 27514

(919) 929-6863

Inquiry 701.

## 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 702.

## 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 703.

## 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 Steinyway St., Suite 605, Astoria, NY 11103  
**718-545-3505**

Inquiry 704.

## WINDOWS

### 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 310-394-8622 Fax 310-395-4214  
710 Wilshire Blvd, #609, Santa Monica, CA 90401

Inquiry 705.

### 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 706.

## International Marketers:

Sell your computer products in one of  
the fastest growing markets today!

**Reach 78,000 LATIN AMERICAN**

**BYTE READERS**

Now you can advertise in  
1, 2, or all 3 Latin editions of **BYTE**

**BYTE Mexico**

**BYTE Brasil**

**BYTE Argentina**

Give Liz at Global Ad-Net

a call today for more info:

**603-876-4311**

Inquiry 707.

# 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.	Inquiry No.	Page No.	Phone No.	Inquiry No.	Page No.	Phone No.
<b>A</b>								
61-62			507-508			156-157		
ABACUS SOFTWARE	190	800-451-4319 ext. B2	CYBEX CORP (INT'L)		CIV 205-430-4030**	ITERATED SYSTEMS	134	800-437-2285
* ADAPTEC / TRANTOR	238	800-934-2766	545		143 +886-2-725-1111**	<b>J</b>		
63-84			<b>D</b>			J B TECHNOLOGIES	245	800-688-0908
ADVANCED LOGIC RESEARCH	191	714-581-6770	245		247 800-332-8246	JAMECO ELECTRONICS	227	800-831-4242
185			223		245 800-DATALUX	267-268		800-363-2083
AETECH	240	619-431-7714	222		247 800-DATALUX	* JDR MICRODEVICES	241	800-538-5000
539			* DATAPRO		102-103 609-764-0100 ext. 2777	<b>K</b>		
A-FOUR TECH CO LTD	48IS 22	+886-2-218-9908**	91		117 314-443-3282	KEA SYSTEMS LTD	96	800-663-8702
162-163			509		48IS 20 +886-2-782-0305**	112		800-253-2872
AGE LOGIC (N.A.)	173	619-455-8600	88-89		109 800-348-3221 ext. 46DD**	231		303-444-7737
66			90		187 800-348-3221 ext. 63DD**	113-114		714-435-2600
AITECH INTERNATIONAL	167	800-882-8184	* DELL COMPUTER CORP (N.A.)		CIII 800-626-8260	518		+886-2-754-8498**
ALADDIN KNOWLEDGE SYSTEMS	75	800-223-4277	* DELL COMPUTER CORP (N.A.)		CIV 800-626-8260	<b>L</b>		
* AMBRA COMPUTER CORP (N.A.)	32A-D	800-239-5731	281		199 617-491-3393	210-211		220 800-433-3726
* AMBRA COMPUTER CORP (N.A.)	33	800-239-5731	536		48IS 12 +32-2-725-4275**	232		248 800-938-TAPE
* AMBRA COMPUTER CORP (N.A.)	44-45	800-239-5740	259		246 +886-2-9317814**	546		48IS 14 +44-223-237758
221			530		61 +886-2-917-9099**	519		48IS 6 +972-2-513395**
AMERICAN MEGAVANTECH	244	800-800-6889	93		2-3 800-332-2717	262		248 800-LITECH5
67-68			276		142 800-346-0090	206		800-238-9415
AMERICAN POWER CONVERSION	193	800-892-6843	189-190		226 800-322-4DPT	176		LOGICIELS ET SERVICES DUHEM 184 +33149700455
273			510-511		48IS 10 +49-241-403117**	<b>M</b>		
AMERICAN SMALL BUSINESS COMP	88	918-825-4844	224		249 800-777-5151	544		48IS 21 +972-3-751-1901**
244			<b>E</b>			547		MANCHESTER EQUIPMENT CO (N.E.) 240NE 1 516-435-1199
AMREL TECHNOLOGY, INC	246	800-88AMREL	534-535		48IS 23 415-325-8071	179-180		116 +49-8403-1555
* ANGOSS SOFTWARE INT'L	85		94-95		42 +972-4-528613**	116-117		160 716-873-0906**
* ANGOSS SOFTWARE INT'L	121		207-208		228 800-EMBARCA ext. 330	118		160 514-685-0174**
* ANGOSS SOFTWARE INT'L	133		512-513		48IS 8 +39-35-692-229**	* MCGRAW HILL NRI (N.A.)	40A-B	
275			215		229 800-557-1000	159		7 800-845-5870
ANGOSS SOFTWARE INT'L	175	416-593-5077**	<b>F</b>			218-219		240 619-874-5000
202			514-515		7 +49-89-53880020	212		238 800-448-2323
APPRO INTERNATIONAL INC	222	800-927-5464	96-97		157 +49-89-20506-199**	203		237 800-864-8008
172-173			96-97		157 800-248 FAST	543		44 407-677-8333
ARISTO GRAPHIC SYSTEMS (EUROPE)	39	+49-40-8500425**	529		48IS 2 +886-2-717-4500**	196-197		219 800-295-1214
172-173			181-192		235 714-588-9666	198-199		221 800-295-1214
ARISTO GRAPHIC SYSTEMS (U.S.)	39	800-631-7646	98		196 713-496-9400	538		48IS 18 +39 1 87 988 460
213-214			<b>G</b>			204-205		230 800-967-5667
ARNET CORP	225	800-377-5515	* GATEWAY 2000		88A-N 800-846-2058	195		223 800-879-PLAY
174			* GATEWAY 2000		89 800-846-2058	* MICROSOFT CORP	11	
ASK ME MULTIMEDIA CENTER	42	612-531-0603	254		245 800-487-2538	* MICROSTAR LABORATORIES	244	206-453-2345
258			225		246 800-822-4333	* MICROWAY	132	508-746-4678**
ATRIE TECHNOLOGY INC	247		516		48IS 11 +49-40-231-789**	520		48IS 5 +49-511-77000
177-178			99-100		131 800-562-2543	524		48IS 9 214-446-7363
AT&T MULTIMEDIA S/W SOLU	135	800-448-6727	252-253		245 510-471-6442	269		30-31
71			517		48IS 17 +44-0364-53071**	<b>N</b>		
AT&T - MODEMS	59	800-372-2447 ext. 920	226-227		243 800-282-4835	119-120		71 310-325-5202
260			<b>H</b>			233		249 800-433-3488
AUTOTIME	246	503-452-8577	* HEWLETT PACKARD		35 800-443-1254 ext. 785	521		48IS 19 512-794-0100
533			239		247 510-623-8860	181		182 800-800-5600
AXIS COMMUNICATIONS	261	+46-46136130**	278-279		203 619-292-8331	121		112-114 800-NEC-INFO
<b>B</b>			101		84 905-470-1207**	194		239 800-854-7782
450			<b>I</b>			122		29 805-964-6767
BIX	261	800-695-4775	102		96A-D 800-426-7731	* NSTL	232	215-941-9800
72-73			103		69 800-IBM-CALL ext. 583	123		240NE 2 215-941-9600
BRITISH AIRWAYS	207		105		87 800-342-6672	75		197 800-257-8402
* BYTE BACK ISSUES (INT'L)	173		104		15 800-3-IBM-052	<b>O</b>		
* BYTE BACK ISSUES (N.E.)	240NE 4		283		26-27 800-IBM-4FAX**	522-523		48IS 12 508-393-5780
* BYTE DECK	188		540		69	124		151 800-OKI-TEAM ext. 264
* BYTE READERS' CHOICE QUEST	184A-D		541		71	249		250 508-877-1819
* BYTE SUB MESSAGE	194		106		192 209-651-1203	280		234 713-464-2990
* BYTE SUB MESSAGE	48IS 24		107		16-17 800-538-3373	531		48IS 24 +49-40-437472
* BYTE SUB SERVICES	184		108		16A-B 800-538-3373	182		194 800-454-4426
<b>C</b>			109-110		102-103 800-345-4856	234		248 800-729-8725
209			228		244 216-439-4091	<b>P</b>		
CAD WAREHOUSE	236	800-487-0485	229		248 216-439-4091	* PACIFIC DATA PRODUCTS	163	619-625-3671
501			<b>J</b>			248		800-541-9508
CERRY MIKROSCHALTER GMBH (INT'L)	200-201	+49-964-3180	<b>K</b>			125-126		800-722-6555
504-505			<b>L</b>					
COBALT BLUE	48IS 18	404-518-1116	<b>M</b>					
76-77			<b>N</b>					
COLORADO MEMORY SYSTEMS	19	800-451-0897	<b>O</b>					
78			<b>P</b>					
COMPAQ DESKTOPS (N.A.)	8-9	800-345-1518	<b>Q</b>					
284			<b>R</b>					
COMPAQ SYSTEMS (N.A.)	60-61	800-345-1518	<b>S</b>					
502-503			<b>T</b>					
COMPEX INC (INT'L)	33	714-630-7302	<b>U</b>					
* COMPUSERVE	152A-B	800-848-8199	<b>V</b>					
80			<b>W</b>					
COMPUSERVE	153	800-848-8199	<b>X</b>					
81			<b>Y</b>					
COMPUTER ASSOCIATES	127	800-531-5236	<b>Z</b>					
82								
COMPUTER ASSOCIATES	139	800-225-5224 Dept. 20500						
186								
COMPUTER DISC WAREHSE	216-217	800-959-4CDW						
* COMPUTER PROF BOOK SOCIETY (N.A.)	200	717-794-2191						
* COMPUTER PROF BOOK SOCIETY (N.A.)	200A-B							
506								
COMPUTER QUICK (INT'L)	144	415-861-8330						
277								
COMPUTER & CONTROLS SOLU	242	800-775-3525						
542								
COMPUTERLANE UNLIMITED (PC)	234	818-884-8844						
* COPIA INTERNATIONAL LTD	182	708-682-8898						
83								
COREL SOFTWARE	48	800-772-6735 ext. 28						
158								
CREATIVE LABS INC	95	800-998-LABS						
183-184								
CRYSTALOGIC, INC	120	615-391-4412						
84-85								
CTX INTERNATIONAL INC	55	909-595-6146						
86-87								
CURTIS INC	202	612-631-9512						
187-188								
CYBEX CORP	224	205-430-4030**						

# YOUR DIRECT LINK

## ADVERTISER CONTACT INFORMATION

Inquiry No.	Page No.	Phone No.	Inquiry No.	Page No.	Phone No.	Inquiry No.	Page No.	Phone No.
127		800-368-5283	<b>S</b>			246		510-447-2030
525	193	800-368-5283	139	170	403-437-2410	148-149	186	312-755-8741
526	481S 13	617-661-1510	256-257	249	800-248-3475	548	240NE 3	805-966-7631
*	B-9	+31-40-73-39-83**	250-251	243	818-368-6132			
128-129	72A-B	714-727-3300	*	136	415-940-4343**	<b>V</b>		
130	73	714-727-3300			ext. B23	240	245	800-727-3475
130	128	414-354-8699		136	800-431-4331	241	243	503-758-0521
131	43	212-571-3434			ext. B23	150-151	63	909-869-7976
532	60	+886-2-8835582**	274	233	415-967-1100	169-171	90	415-325-2113
*	211	800-PRODEA 1	236	250	800-969-4411	537	145	+972-3-6964065
115	36-37	800-445-7899	263-264	248	800-267-9263	<b>W</b>		
160-181	159	619-457-5500	166	118	416-754-1856**	549	164	206-324-0407
			237	249	404-512-0600	152	25	519-886-3700
<b>Q</b>			140	124	203-329-7428**	216	250	619-581-6040
220	218	619-431-9530	282	164	201-476-8199	242	249	800-742-6909
235	248	818-882-5822	141	79	918-583-4149	*	12-13	800-526-2615
132	53	310-392-9851	528	481S 7	800-453-1077	<b>X</b>		
133	214	800-553-1170	142-143	195	708-864-5670	153-154	189	800-678-7988
			<b>T</b>			<b>Z</b>		
134-135	65	800-852-8569	238	243	800-685-4884	155	122-123	800-554-5226
265-266	243	908-874-4072	144	67	800-835-6100	243	248	916-757-3737
		ext. 71	247	244	+31-5106-704**	164-165	111	714-693-0808
527	CI11	+36-1-2018925	145	20-21	800-457-7777			
201	231	800-729-7654	251	244	310-908-6814			
136-137	110	800-535-7876	146-147	213	800-472-4735			
138	198	800-333-9343						

\* 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. Fish (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  
 Karl Kelley (312) 616-3328  
 Ed Ware (603) 924-2664  
 McGraw-Hill Publications  
 Two Prudential Plaza  
 180 North Sletson 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  
 Barry Echavaria (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. Kope (415) 513-6861  
 James Ball (603) 924-2662  
 SILICON VALLEY, HI, WA, AK,  
 W. CANADA  
 Bill McAtee (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 Duda (714) 753-8140  
 Barry Echavaria (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 Potham (603) 924-2598  
 BYTE Publications  
 One Phoenix Mill Lane  
 Peterborough, NH 03458

**The Buyer's Mart/Classifieds**  
 Mangel L. Swanson (603) 924-2656  
 BYTE Publications  
 One Phoenix Mill Lane  
 Peterborough, NH 03458

**BYTE Deck**  
 Brad Dixon (603) 924-2596  
 BYTE Publications  
 One Phoenix Mill Lane  
 Peterborough, NH 03458

**EURO-DECK**  
 Joseph Hebe (603) 924-2533  
 BYTE Publications  
 One Phoenix Mill Lane  
 Peterborough, NH 03458

**The Buyer's Guide/Regional Advertising Sections**  
 Ed Ware (603) 924-2664  
 Fax: (603) 924-2663

### INTERNATIONAL ADVERTISING SALES STAFF

**UNITED KINGDOM, FRANCE, BENELUX**  
 Gary Lucas (+44 71 495 6790)  
 Jonathan McGowan  
 (+44 71 495 6781)  
 McGraw-Hill Publishing Co.  
 24 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 Chaik Farm Road  
 London NW1 8AN  
 England  
 Tel: +44 71 2843171  
 Fax: +44 71 2843174

**TAIWAN**  
 Sheng Shun Gou  
 Third Wave Publishing Corp.  
 2nd Fl., No. 19-2, Lane 231  
 Fu Hsing North Road  
 Taipei 105  
 Taiwan R.O.C.  
 Tel: +886 2 7136899  
 Fax: +886 2 7189467

**JAPAN**  
 Masaki Mori  
 Transworld Media Inc.  
 702, 2-26-3 Nishigotanda  
 Shinagawa-ku,  
 Tokyo 141  
 Japan  
 Tel: +81 3 33887466  
 Fax: +81 3 37880674

**AUSTRALIA**  
 Phil Bush  
 National Advertising Services  
 7-13 Parraween Street  
 Cremorne NSW 2090,  
 Australia  
 Tel: +61 2 906 9329  
 Fax: +61 2 953 8274

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

**ISRAEL**  
 Dan Ehrlich  
 Ehrlich Communication Intl.  
 P.O. Box 99  
 Herzliya 46101  
 Israel  
 Tel: +972 9 586245  
 Tel: +972 9 586246  
 Fax: +972 9 585685

**HONG KONG**  
 Zoe Yen  
 Third Wave Publishing Corp.  
 Unit 2, 6F Hing Wah Center  
 82-84 To Kwa Wan Road  
 Kowloon, Hong Kong  
 Tel: +852 784 3830  
 Fax: +852 784 3857

**A. Suzuki**  
 Nexus, Inc.  
 2-35-8, Unoki, Ota-ku  
 Tokyo 145  
 Japan  
 Tel: +81 3 37573721  
 Fax: +81 3 37572266

**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

**KOREA**  
 Young-Seoh Chinn  
 JES Media International  
 Rm. 704, Northyun Bldg.  
 37-12, Chumwon-Dong  
 Seocho-Gu  
 Seoul 137-030, Korea  
 Tel: +82 2 5458001  
 Tel: +82 2 5458002  
 Fax: +82 2 5408881

**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

**MALAYSIA**  
 H.K. Lin  
 Sarxex (Malaysia) Sdn Bhd.  
 8th Floor, Bena Tower  
 160, Jalan Ampang  
 50450 Kuala Lumpur  
 Malaysia  
 Tel: +60 3 2624592  
 Fax: +60 3 2624591

# 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!

Category No. Inquiry No.	Page No.	Category No. Inquiry No.	Page No.	Category No. Inquiry No.	Page No.
<b>HARDWARE</b>					
<b>1 ACCESSORIES/SUPPLIES</b>					
282		SONY (N.A.)	164		
247		TIEPIE ENGINEERING	244		
<b>2 ADD-IN BOARDS</b>					
67-68		AMERICAN MEGATRENDS	183		
277		COMPUTER & CONTROLS SOLUTIONS	242		
86-87		CURTIS INC	202		
530		DIGICOM INC	61		
189-190		DISTRIBUTED PROCESSING TECH	226		
516		GFK HAMBURG	48IS 11		
193		JAMECO ELECTRONICS	227		
118		MATROX ELECTRONIC SYSTEMS LTD	160		
159		MEDIA VISION (N.A.)	7		
*		PACIFIC DATA PRODUCTS	163		
133		QUATECH INC	214		
238		TALKING TECHNOLOGY INC	243		
<b>3 BAR CODING</b>					
241		VIDEX, INC	243		
<b>4 COMMUNICATIONS/ NETWORKING</b>					
533		AXIS COMMUNICATIONS	261		
88-89		DCA	109		
90		DCA	187		
207-208		EMBARC / MOTOROLA	228		
226-227		GTEK INC	243		
216-219		METACOMP	240		
265-266		RCI	243		
138		ROSE ELECTRONICS	198		
250-251		SIGMA TECH SOFTWARE	243		
238		TALKING TECHNOLOGY INC	243		
<b>5 COMPUTER SYSTEMS</b>					
83-84		ADVANCED LOGIC RESEARCH	191		
*		AMBRA COMPUTER CORP (N.A.)	32A-D,33		
*		AMBRA COMPUTER CORP (N.A.)	44-45		
202		APPRO INTERNATIONAL INC	222		
284		COMPAQ DESKTOPS (N.A.)	60-61		
78		COMPAQ SYSTEMS (N.A.)	8-9		
277		COMPUTER & CONTROLS SOLUTIONS	242		
*		DELL COMPUTER CORP (N.A.)	CIII		
*		DELL COMPUTER CORP (N.A.)	CIV		
93		DIGITAL EQUIPMENT CORP	2-3		
*		GATEWAY 2000	88A-N		
*		GATEWAY 2000	89		
102		IBM DIRECT (N.A.)	96A-D		
283		IBM WORKSTATIONS	26-27		
540		IBM (INT'L)	69		
541		IBM (INT'L)	71		
107		INTEL CORP	16-17		
109-110		INTERGRAPH	102-103		
231		KILA	244		
547		MANCHESTER EQUIPMENT CO (N.A.)	240NE 1		
121		NEC - SYSTEMS	112-114		
*		NSTL	232		
123		NSTL (N.E.)	240NE 2		
125-126		PC POWER & COOLING	51		
201		RECORTEC INC	231		
*		SILICON GRAPHICS (INT'L)	136		
*		SILICON GRAPHICS (N.A.)	136		
274		SILICON VALLEY COMPUTER	233		
246		TRI VALLEY TECHNOLOGY INC	244		
216		WEST COAST MICRO	250		
155		ZEOS INTERNATIONAL	122-123		
<b>6 DATA ACQUISITION</b>					
221		AMERICAN ADVANTECH	244		
228		IO TECH	244		
*		MICROSTAR LABORATORIES	244		
233		NATIONAL INSTRUMENTS	249		
133		QUATECH INC	214		
236		SILICONSOFT, INC	250		
247		TIEPIE ENGINEERING	244		
261		TRANS 2000	244		
<b>7 DISK &amp; OPTICAL DRIVES</b>					
*		ADAPTEC / TRANTOR	238		
67-68		AMERICAN MEGATRENDS	183		
86-87		CURTIS INC	202		
254		GENERAL TECHNICS	245		
252-253		GRANITE DIGITAL	245		
230		J B TECHNOLOGIES	245		
543		MICRO DESIGN INT'L (INT'L)	44		
196-197		MICRO SOLUTIONS COMP PROD	219		
198-199		MICRO SOLUTIONS COMP PROD	221		
*		PINNACLE MICRO	72A-B		
128-129		PINNACLE MICRO	73		
<b>8 DISKETTES/DUPLICATORS</b>					
240		VICTORY ENTERPRISES TECHNOLOGY	245		
<b>9 FAX BOARDS/MACHINES</b>					
532		PORA CORP (INT'L)	60		
<b>10 GRAPHICS TABLETS/MICE/ PEN INPUT</b>					
172-173		ARISTO GRAPHIC SYSTEMS (EUROPE)	39		
172-173		ARISTO GRAPHIC SYSTEMS (U.S.)	39		
276		DIGITAL VISION	142		
<b>11 KEYBOARDS</b>					
501		CHERRY MIKROSCHALTER GMBH (INT'L)	200-201		
223		DATALUX CORP	245		
<b>12 LAN HARDWARE</b>					
502-503		COMPEX INC (INT'L)	33		
167-188		CYBEX CORP	224		
507-508		CYBEX CORP (INT'L)	CIV		
88-89		DCA	109		
206		LOGICAL CONNECTION	236		
125-126		PC POWER & COOLING	51		
<b>13 LAPTOPS &amp; NOTEBOOKS</b>					
*		AMBRA COMPUTER CORP (N.A.)	32A-D,33		
*		AMBRA COMPUTER CORP (N.A.)	44-45		
244		AMREL TECHNOLOGY, INC	246		
259		DIALOGUE TECHNOLOGY	246		
529		FIRST INTERNATIONAL COMPUTER	48IS 2		
225		GENOVATION, INC	246		
*		HEWLETT PACKARD	35		
230		J B TECHNOLOGIES	245		
*		JDR MICRODEVICES	241		
204-205		MICRO-INTERNATIONAL, INC	230		
145		TOSHIBA AMERICA INC	20-21		
155		ZEOS INTERNATIONAL	122-123		
<b>14 MAIL ORDER</b>					
*		AMBRA COMPUTER CORP (N.A.)	32A-D,33		
*		AMBRA COMPUTER CORP (N.A.)	44-45		
186		COMPUTER DISCOUNT WAREHOUSE	216-217		
542		COMPUTERLANE UNLIMITED (PC)	234		
534-535		ELEX INFORMATION SYSTEMS INC	48IS 23		
215		EXXUS	229		
102		IBM PC DIRECT (N.A.)	96A-D		
193		JAMECO ELECTRONICS	227		
204-205		MICRO-INTERNATIONAL, INC	230		
194		NEVADA COMPUTER	239		
75		NSTL / PC DIGEST	197		
115		PROGRAMMER'S PARADISE	36-37		
263-264		SMART-TECH, INC	248		
247		TIEPIE ENGINEERING	244		
<b>15 MEMORY/CHIPS/UPGRADES</b>					
260		AUTOTIME	246		
191-192		FIRST SOURCE INTL	235		
107		INTEL CORP	16-17		
193		JAMECO ELECTRONICS	227		
113-114		KINGSTON TECHNOLOGY	119		
210-211		L A TRADE	220		
206		LOGICAL CONNECTION	236		
269		MOTOROLA RISC DIVISION	30-31		
<b>16 MISCELLANEOUS HARDWARE</b>					
106		INTEGRAND RESEARCH	192		
160-161		PROXIMA CORP	159		
216		WEST COAST MICRO	250		
<b>17 MODEMS/MULTIPLEXORS</b>					
258		ATRIE TECHNOLOGY INC	247		
71		AT&T - MODEMS	59		
509		DATATRONICS TECHNOLOGY	48IS 20		
*		JDR MICRODEVICES	241		
216-219		METACOMP	240		
164-165		ZYXEL USA	111		
<b>18 MONITORS &amp; TERMINALS</b>					
84-85		CTX INTERNATIONAL INC	55		
222		DATALUX CORP	247		
112		KFC (N.A.)	145		
518		KUO FENG CORP (INT'L)	45		
119-120		NANAO USA CORP (N.A.)	71		
526		PHILIPS MONITORS	8-9		
150-151		VIEWSONIC	63		
<b>19 MULTIMEDIA</b>					
277		COMPUTER & CONTROLS SOLUTIONS	242		
158		CREATIVE LABS INC	95		
96-97		FAST (MULTIMEDIA)	157		
267-268		JANA TECHNOLOGY GROUP, INC	247		
159		MEDIA VISION (N.A.)	7		
280		OMNICOMP GRAPHICS CORP	234		
160-161		PROXIMA CORP	159		
*		SILICON GRAPHICS (INT'L)	136		
*		SILICON GRAPHICS (N.A.)	136		
236		SILICONSOFT, INC	250		
263-264		SMART-TECH, INC	248		
537		VOCALTEC LTD (INT'L)	145		
<b>20 PRINTERS/PLOTTERS</b>					
209		CAD WAREHOUSE	236		
206		LOGICAL CONNECTION	236		
520		MINOLTA GMBH	48IS 5		
124		OKIDATA	151		
*		PACIFIC DATA PRODUCTS	163		
144		TEKTRONIX	67		
<b>21 PROGRAMMABLE HARDWARE</b>					
245		DATA I/O	247		
94-95		ELIASHIM MICROCOMPUTERS	42		
514-515		FAST HARDLOCK (INT'L)	7		
239		HI-LQ SYSTEMS	247		
229		IO TECH	248		
*		JDR MICRODEVICES	241		
179-180		MARX DATENTECHNIK GmbH	116		
124		OKIDATA	151		
243		Z-WORLD ENGINEERING	248		
<b>22 SCANNERS/OCR/DIGITIZERS</b>					
209		CAD WAREHOUSE	236		
534-535		ELEX INFORMATION SYSTEMS INC	48IS 23		

# 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!

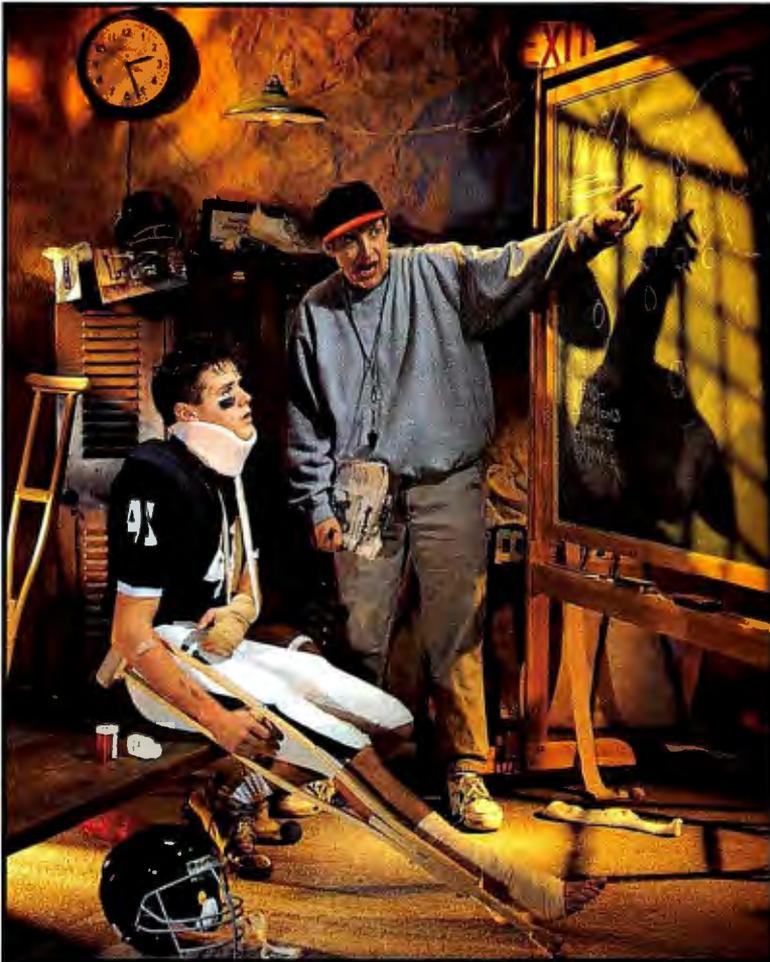
Category No. Inquiry No.		Page No.	Category No. Inquiry No.		Page No.	Category No. Inquiry No.		Page No.
94-95	ELIASHIM MICROCOMPUTERS	42	<b>30</b>	<b>EDUCATIONAL</b>		139	SEQUIER SOFTWARE INC	170
519	LIGATURE LTD	48IS 6	61-62	ABACUS SOFTWARE	190	528	SYMANTEC	48IS 7
262	LITECH CORP	248	185	AETECH	240	548	TYPHOON SOFTWARE (N.E.)	240NE 3
124	OKIDATA	151	*	MCGRAW HILL NRI (N.A.)	40A-B	152	WATCOM	25
160-161	PROXIMA CORP	159				153-154	XVT SOFTWARE INC	189
527	RECOGNITA (INT'L)	CIII	<b>31</b>	<b>ENGINEERING/SCIENTIFIC</b>		<b>41</b>	<b>SECURITY</b>	
263-264	SMART-TECH, INC	248	510-511	DR HUGGLE & PARTNER GMBH	48IS 10	65	ALADDIN KNOWLEDGE SYSTEMS	75
<b>23</b>	<b>TAPE DRIVES</b>		224	DSP DEVELOPMENT CORP	249	501	CHERRY MIKROSCHALTER GMBH (INT'L)	200-201
67-88	AMERICAN MEGATRENDS	183	278-279	HORIZONS TECHNOLOGY	203	94-95	ELIASHIM MICROCOMPUTERS	42
78-77	COLORADO MEMORY SYSTEMS	19	109-110	INTERGRAPH	102-103	512-513	EUTRON	48IS 8
232	LAGUNA DATA SYSTEMS	248	156-157	ITERATED SYSTEMS	134	514-515	FAST HARDLOCK (INT'L)	7
196-197	MICRO SOLUTIONS COMP PROD	219	118-117	MATHSOFT INC	140	99-100	GLENCO ENGINEERING	131
198-199	MICRO SOLUTIONS COMP PROD	221	<b>32</b>	<b>ENTERTAINMENT</b>		179-180	MARX DATENTECHNIK GmbH	116
234	OVERLAND DATA INC	248	212	METATEC SYSTEMS	238	134-135	RAINBOW TECHNOLOGIES	65
235	QUALSTAR CORP	248	195	MICROPROSE SOFTWARE	223	140	SOFTWARE SECURITY	124
256-257	SHAFFSTALL CORP	249	220	QUADRA INTERACTIVE	218	<b>45</b>	<b>UNIX</b>	
<b>24</b>	<b>UPS</b>		<b>33</b>	<b>GRAPHICS</b>		*	COPIA INTERNATIONAL LTD	182
273	AMERICAN POWER CONVERSION	94	66	AITECH INTERNATIONAL	167	101	HUMMINGBIRD COMMUNICATIONS	84
524	MINUTEMAN	48IS 9	172-173	ARISTO GRAPHIC SYSTEMS (EUROPE)	39	522-523	ODYSSEY TECHNOLOGIES	48IS 12
125-126	PC POWER & COOLING	51	172-173	ARISTO GRAPHIC SYSTEMS (U.S.)	39	169-171	VISIONWARE	90
148-149	TRIPP LITE	186	177-178	AT&T MULTIMEDIA S/W SOLUT	135	<b>46</b>	<b>UTILITIES</b>	
<b>SOFTWARE</b>			83	COREL SOFTWARE	46	183-184	CRYSTALOGIC, INC	120
<b>25</b>	<b>BUSINESS</b>		119-120	NANAO USA CORP (N.A.)	71	176	LOGICIELS ET SERVICES DUHEM	184
278-279	HORIZONS TECHNOLOGY	203	136-137	RGB COMPUTER & VIDEO INC	110	203	MICRO 2000	237
*	PRODEA SOFTWARE CORP	211	<b>35</b>	<b>MAIL ORDER</b>		249	OMEGA POINT, INC	250
<b>26</b>	<b>CAD/CAM</b>		186	COMPUTER DISCOUNT WAREHOUSE	216-217	130	PKWARE INC	128
69	AMERICAN SMALL BUSINESS COMP	88	506	COMPUTER QUICK (INT'L)	144	<b>47</b>	<b>WINDOWS</b>	
172-173	ARISTO GRAPHIC SYSTEMS (EUROPE)	39	517	GREY MATTER LTD	48IS 17	61-62	ABACUS SOFTWARE	190
172-173	ARISTO GRAPHIC SYSTEMS (U.S.)	39	<b>36</b>	<b>MATHEMATICAL/STATISTICAL</b>		539	A-FOUR TECH CO LTD	48IS 22
109-110	INTERGRAPH	102-103	141	STATSOFT	79	174	ASK ME MULTIMEDIA CENTER	42
538	MICRODATA SYSTEM SRI	48IS 18	142-143	SYSTAT INC	195	177-178	AT&T MULTIMEDIA S/W SOLU	135
280	OMNICOOMP GRAPHICS CORP	234	<b>37</b>	<b>MISCELLANEOUS SOFTWARE</b>		*	COPIA INTERNATIONAL LTD	182
242	WINTEK CORP	249	531	ON TIME MARKETING	48IS 24	91	DASTASTOR TECHNOLOGIES	117
<b>27</b>	<b>COMMUNICATIONS/ NETWORKING</b>		548	TYPHOON SOFTWARE (N.E.)	240NE 3	90	DCA	187
162-163	AGE LOGIC (N.A.)	173	<b>38</b>	<b>ON-LINE SERVICES</b>		101	HUMMINGBIRD COMMUNICATIONS	84
213-214	ARNET CORP	225	450	BIX	261	111	KEA SYSTEMS LTD	96
91	DATASTORM TECHNOLOGIES	117	*	COMPUSERVE	152A-B	195	MICROPROSE SOFTWARE	223
88-89	DCA	109	80	COMPUSERVE	153	*	MICROSOFT CORP	11
90	DCA	187	281	DELPHI INTERNET SERVICES	199	119-120	NANAO USA CORP (N.A.)	71
98	FUTURESOFT ENGINEERING	196	<b>39</b>	<b>OPERATING SYSTEMS</b>		182	ON TOP SYSTEMS	194
548	LANSOURCE	48IS 14	104	IBM PERSONAL S/W SYSTEMS	15	248	PACIFIC SOFTWARE	250
218-219	METACOMP	240	132	QUARTERDECK OFFICE SYSTEMS	53	127	PERSOFT INC	193
122	NORTON-LAMBERT	29	<b>40</b>	<b>PROGRAMMING LANGUAGES/ TOOLS</b>		220	QUADRA INTERACTIVE	218
522-523	ODYSSEY TECHNOLOGIES	48IS 12	185	AETECH	240	236	SILICONSOF, INC	250
127	PERSOFT INC	193	*	ANGOSS SOFTWARE INT'L	85	548	TYPHOON SOFTWARE (N.E.)	240NE 3
166	SOFTARC	118	*	ANGOSS SOFTWARE INT'L	121	<b>48</b>	<b>WORD PROCESSING/DTP</b>	
237	SOFTWARE LINK, THE	249	*	ANGOSS SOFTWARE INT'L	133	519	LIGATURE LTD	48IS 6
146-147	TRAVELING SOFTWARE	213	275	ANGOSS SOFTWARE INT'L	175	<b>GENERAL</b>		
169-171	VISIONWARE	90	72-73	BORLAND INT'L	CII-1	<b>49</b>	<b>BOOKS/PUBLICATIONS</b>	
549	WALKER, RICHER & QUINN (INT'L)	164	504-505	COBALT BLUE	48IS 18	61-62	ABACUS SOFTWARE	190
<b>28</b>	<b>DATA ACQUISITION</b>		183-184	COPIA INTERNATIONAL LTD	182	*	COMPUTER PROF BOOK SOCIETY (N.A.)	200
233	NATIONAL INSTRUMENTS	249	183-184	CRYSTALOGIC, INC	120	<b>51</b>	<b>MISCELLANEOUS</b>	
521	NATIONAL INSTRUMENTS	48IS 19	510-511	DR HUGGLE & PARTNER GMBH	48IS 10	74	BRITISH AIRWAYS	207
<b>29</b>	<b>DATABASE</b>		103	IBM NETWORKING SYSTEMS (N.A.)	69	*	BYTE BACK ISSUES (INT'L)	173
81	COMPUTER ASSOCIATES	127	105	IBM PERSONAL S/W SYSTEMS	87	*	BYTE BACK ISSUES (N.E.)	240NE 4
82	COMPUTER ASSOCIATES	139	544	MAGIC / MSE	48IS 21	*	BYTE READERS' CHOICE SURVEY	184A-D
510-511	DR HUGGLE & PARTNER GMBH	48IS 10	*	MICROWAY	132	*	BYTE SUB MESSAGE	194
278-279	HORIZONS TECHNOLOGY	203	531	ON TIME MARKETING	48IS 24	*	BYTE SUB MESSAGE	48IS 24
544	MAGIC / MSE	48IS 21	525	PHAR LAP SOFTWARE INC	48IS 13	545	C.E.T.R.A.	143
182	ON TOP SYSTEMS	194	131	POPKIN S/W & SYSTEMS INC	43	*	DATAPRC	102-103
*	WORDPERFECT CORP	12-13	115	PROGRAMMER'S PARADISE	36-37	536	DIALOGIC TELECOM EUROPE	48IS 12
						181	NATIONAL PRODUCTIONS INC	182

# 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.

Inquiry No.	Page No.	Inquiry No.	Page No.	Inquiry No.	Page No.	Inquiry No.	Page No.	
<b>A</b>								
1346, Aclix Systems	146	1330 Creative Computer Accessories	204	Lewis Research Center	22	1292 Raosoft	208	
1347, 1348		1304 Crunch Software	208	1314 Lexmark International	204	1398, Raster Ops	146	
1349 Advanced Integration Research	146	1451 CIC	40IS-15	Lotus Development	22	1414		
1080 Advanced Logic Research	129, 181	<b>D</b>		1462 Lotus Development Russia	40IS-15	1454 Richmond Systems	40IS-15	
1450 Advanced Micro Peripherals	40IS-3	1436 Datapath	40IS-3	<b>S</b>				
1302 AGE Logic	208	1085 Datastorm Technologies	104	1149 S&S International	185	1288 Saber Software	208	
1309 Air Communications	204	1329 Dauphin Technology	204	1307 Second Nature Software	208	1433, Seikosha	40IS-3	
1350 Alaris	146	DEC	22, 76, 81, 177	1440		1447 Sharp Electronics	40IS-3	
1077, Aldus	47, 137, 208	1075 Delrina Technology	22, 141	1375, Sigma Designs	146	1399		
1305		1086 deltaComm Development	104	Silicon Graphics				81
1295 AllMicro	208	1296 DeltaPoint	208	1376, SixGraph Computing	146	1400		
1283 Allsys	208	1357, Diamond Computer Systems	146	1300 Soft Klone	208	1300 Soft Klone	208	
1286 Altura Software	208	1358, 1359		1272 SoftSolutions	208	1277 SoftSolutions	208	
1081 Ambra Computer	129	1083 Digital Communications Associates	104	1287 Software AG	208	1287 Software AG	208	
1153 American Business Concepts	185	<b>E</b>		1084 Software Ventures	104	1084 Software Ventures	104	
1351, American Megatrends	146	1360, Eisa	146	Softflower Computer	22	Softflower Computer	22	
1406		1410		Sony	22	Sony	22	
America Online	22	1456 Elektroson	40IS-15	1377, STB Systems	146	1377, STB Systems	146	
1468 Andersen Consulting	40IS-15	1472 European Software Publishing	40IS-15	1378, 1379, 1401, 1402		1378, 1379, 1401, 1402		
1277 AniCom	208	<b>F</b>		1459 Straco	40IS-15	Stylus Innovation	22	
1313 Apexx Technology	204	1320 Fargo Electronics	204	Stylus Innovation	22	Sun Microsystems	76, 81	
1352, Applan Technology	146	Fast Electronic	22	Superconductor Technologies	22	Superconductor Technologies	22	
1382		1361, Focus Information Systems	146	1105, SuperMac Technology	146	1105, SuperMac Technology	146	
Apple Computer	22, 41, 47, 76, 125	1362, 1363		1380, 1403, 1411, 1415, 1416, 1417, 1418, 1419, 1420		1380, 1403, 1411, 1415, 1416, 1417, 1418, 1419, 1420		
1306 Arabesque	208	1458 Formula	40IS-15	1155 Symantec	56, 76, 185	1155 Symantec	56, 76, 185	
1438 Arcom Control Systems	40IS-3	1088 Freesoft		1294 Synergy Solutions	208	1294 Synergy Solutions	208	
Artisoft	22	<b>G</b>		1337 Sytron	208	1337 Sytron	208	
1275 askSam Systems	208	1082 Gateway 2000	129	<b>T</b>				
Asymetrix	22	General Magic	22	1311 Tektronix	204	Texas Instruments	22	
1148, ATI Technologies	146, 185	1429 Genius LAN	40IS-3	TLX Computer	22	TLX Computer	22	
1353, 1383, 1407		1319, Genoa Systems	146, 204	Toshiba	56	Toshiba	56	
1441 Aydin Controls	40IS-3	1364, 1365		Toustone Software	56	Toustone Software	56	
<b>B</b>								
1282 Barberry Hill Software and Engineering	208	1467 Guidsoft	40IS-15	Transoft	208	Transoft	208	
1457 Basic	40IS-15	<b>H</b>		1077 Trio Information Systems	141	1077 Trio Information Systems	141	
1332 Belkin Components	204	1473 HebreWare	40IS-15	1154 Turtle Beach Systems	185	1154 Turtle Beach Systems	185	
1146 Binar Graphics	185	1460 Helsinki School of Economics	40IS-15	<b>U</b>				
Blossom Software	56	1366, Hercules Computer	146	1316 Unicore Software	204	1316 Unicore Software	204	
1354, Boca Research	146	1367, Technology		1338 Uniplex Enterprise Systems	208	1338 Uniplex Enterprise Systems	208	
1384, 1385		1389		<b>V</b>				
Borland International	76	Hewlett-Packard	81, 125	Vertisoft Systems	56	Vertisoft Systems	56	
1281 Borys	208	HSC Software	22	1284 View Software	208	1284 View Software	208	
1156 Bureau of Electronic Publishing	185	1455 HumanWare	40IS-15	1381, Volante	146	1381, Volante	146	
<b>C</b>								
1355, Cardinal Technologies	146	1290 HyperGlot Software	208	1404, 1405		1404, 1405		
1356, 1386		<b>I</b>		1312 V-One	204	1312 V-One	204	
1087 Century Software	104	IBM	22, 47, 56, 129, 177, 181	1273 Vream	208	1273 Vream	208	
1421 Chaplet Systems	40IS-3	Image Smith	22	VFlex	22	VFlex	22	
1475 Cherwell	40IS-15	1443 IME	40IS-3	<b>W</b>				
Scientific Publishing		1278 Inner Media	208	Watcom International	76, 81	Watcom International	76, 81	
Chips & Technologies	129	1444 Inpace	40IS-3	1331 Wearnes Technology	204	1331 Wearnes Technology	204	
1428 CIC Computers	40IS-3	Intel	76, 81, 129, 177	Westem Digital	22, 129	Westem Digital	22, 129	
1308 Claris	208	1318 IntelliMedia	204	1445 Workstation Source	40IS-3	1445 Workstation Source	40IS-3	
1325 CMD Technology	204	Intergraph	76	1150 World Library	185	1150 World Library	185	
1387 Colorgraphic Communications	146	1276 Ipswitch	208	1315 Worthington Data Solutions	204	1315 Worthington Data Solutions	204	
1388, Compaq Computer	146, 177	1078 Ithaca Software	125	<b>X</b>				
1408, 1409		<b>J</b>		Xerox	41, 47	Xerox	41, 47	
CompuServe	22, 56	1425 Jaguar Communications	40IS-3	1289 Xerox Imaging Systems	208	1289 Xerox Imaging Systems	208	
1449, Computers	40IS-3, 40IS-15	<b>K</b>		<b>Z</b>				
1452 Unlimited		1333 Key Innovations	204	Zedcor	47	Zedcor	47	
Computer Technology	22	1298 Klos Technologies	208					
1285 Compuware	208	1431 Klughammer	40IS-3					
1301 Concord Communications	208	<b>L</b>						
Conductus	22	LaserMaster	22					
1293 Corel	208							
Cray Research	22							

# BIX: Your Coach to the Internet!



The Internet connects you with more than 10 million people, at universities, companies, and other online services. Now, get full access to the Internet free of charge when you subscribe to BIX! You'll also get expert assistance from BIX moderators who can help you find your way around the Internet.

These experts can guide you through the many services and features available, and help you find the information you're looking for. Anytime you need help, just join our special 'internet' conference and get fast answers to your questions.

As you become more familiar with the Internet, you'll be able to download files from all over the world using FTP, connect to other sites and services through telnet, read and reply to Usenet Newsgroups, access utilities like finger and whois, and much more! BIX and the Internet together provide the largest and most effective technical resource for computing professionals.

And with over 600 local access numbers in the U.S., plus telnet access via the Internet, BIX makes it easy to connect. Try BIX today through our special 5 for Free offer - and become part of the top technical team!

## **BIX**

**If you can hack it**

New Member  
**5 hours for Free**  
Introductory Offer

Give BIX a try with our new 5 for Free Offer! Join BIX today and get 5 hours of evening and weekend access for free! Take the rest of the calendar month to explore BIX, and then continue for our standard \$13 monthly membership fee. Further details and complete rate information are provided during registration. Using any communications program, dial 1-800-695-4882. At the "logon" prompt enter bix. Then at the "name?" prompt enter bix.byte39. If you have any questions, call us at 1-800-695-4775 (voice). Or fax us at 617-491-6642.

Send Internet mail to [info@bix.com](mailto:info@bix.com). Windows users can order BIXnav, our graphical interface for BIX, for easy point and click access. Details are available during registration.

Under the 5 for Free plan, daytime rates (\$9/hr.) apply for access during prime time hours. The 5 for Free offer is valid for first-time members only.

Circle 450 on Inquiry Card.

# Layoff Software

**A program concept whose time has unfortunately come**

**F**or the computer industry, the *l*-word (*lay-off*) is the crazy aunt down in the basement—there's no way to get rid of her, and you know she's going to pop her head up sooner or later. Sure, a company can scare off some people by freezing salaries and canceling the Friday beer bust. Or they can try early-retirement incentives, and risk losing their best employees. But sooner or later, it always seems to get back to the *l*-word.

In an industry that offers 17 different desktop organizers, you'd expect someone to be working on new approaches to this problem, and you'd be right. One software company has instituted an Employee Departure Bonus Program. Instead of paying a bonus for getting a friend to join the firm, the EDBP offers a sliding scale of payments for each employee hounded into leaving the company. Demoralizing a vice president of marketing into jumping ship earns a \$1000 reward, which is a lot cheaper than a golden parachute. In fact, the EDBP has been so successful there is hardly anyone left to depart.

Even more promising are a bunch of new layoff programs that are filling an ever-expanding market niche. Layoff software is any program used to minimize personnel costs or otherwise smooth the process of laying off employees. These programs won't make layoffs go away, but they can make them a lot easier to deal with. Consider the following marketing literature for Layoff Pro, coming soon from Belly Up Software of Novato, California.

**Customer Profile:** Layoff Pro is aimed at the following group: employees.

**Multiple résumé formats:** Layoff Pro has more than 20 editable résumé formats, each designed to be both eye-catching and impressive, giving new luster to the same old job experience. Popular formats include:

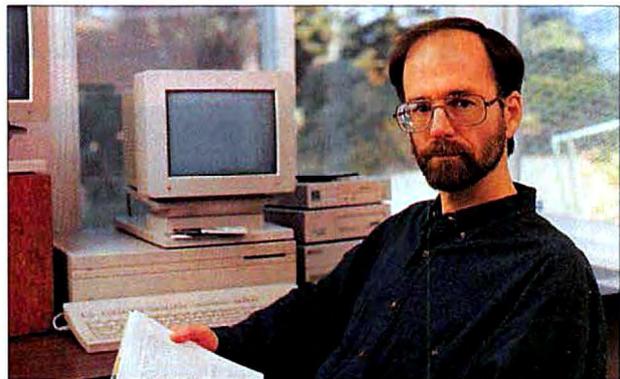
*Senior Software Engineer:* Regardless of where it is printed, your résumé will look like it came from a dot-matrix printer. It includes Acronimm Generator (AC) and Random Misspeller (RM) (we're using both on this document) for genuine techie feel.

*Technical Writer:* Your capabilities are explained in words and phrases so simple even a user could understand them. Correct grammar, spelling, and punctuation guaranteed.

*Project Manager:* Using the special thesaurus with only positive adjectives, you can turn *termination* into *career adjustment opportunity* with the touch of a key! Jargon Expander algorithm makes you sound like an expert without knowing anything.

**Job prospect database:** Updated quarterly to remove any companies that have had recent layoffs of their own.

**Cover-letter generator:** Uses our patented auto-brag tech-



MITCHELL RICE © 1994

nology, which enables you to claim sole responsibility for any project you were even remotely involved with.

**Letters of reference:** Choose from Bill Gates, John Sculley, Scott McNealy, Hillary Clinton, and other heavyweights. Includes imitation letterhead.

**Layoff etiquette:** Layoff Pro includes an on-line guide to correct office behavior under the stress of layoffs, either real or impending. Topics include: spotting the next lay-off, exit interview do's and don'ts, investment opportunities for severance pay, and inexpensive disguises for the unemployment office.

**Quick erase:** This feature lets you quickly and permanently erase any embarrassing personal letters or game software from your hard disk or any disk accessible through a network connection. (Not to be used for important company data.)

Belly Up Software plans to release the following related products in the near future:

**Layoff Pro II:** This release will address additional market segments, including doctors, lawyers, Indian chiefs, rich men, poor men, beggars, and thieves.

**Expense Slasher:** This utility randomly deletes items from your current home budget; works with most popular spreadsheets and finance programs.

**Let's Make a Deal:** Set up like the familiar TV game show, this program dispenses helpful negotiating tips for dealing with banks, utility companies, car dealerships, and collection agencies.

**Best Offer:** An on-line guide to running a successful garage sale.

**Bankruptcy Pro:** Everything you need to know about filing for Chapter 11.

Layoff Pro is not vaporware—my boss left a beta copy in my in-box the other day. My only question is, am I supposed to review it, or is this his idea of a subtle hint? Let's see now, how does that spotting-the-next-layoff feature work? ■

*Steve Evangelou works for himself as a freelance writer in Oakland, California. You can contact him on BIX c/o "editors."*

# WHAT PRICE PENTIUM?



DELL DIMENSION™ XPS P60

**\$2,999**

Business Lease<sup>†</sup>: \$111/MO.

Pentium™ performance doesn't have to mean premium price. As the Dell Dimension XPS P60 clearly proves.

Powered by a 60MHz Pentium chip with 8MB of RAM, a 256KB external cache, and a 450MB hard drive, the Dell Dimension XPS P60 is built for raw speed and performance.

The Pentium processor inside the Dell XPS P60 delivers nearly twice the performance of an Intel 486.<sup>†</sup> And unlike lesser machines that are trying to jump on the Pentium bandwagon with yesterday's tired, old architecture, the XPS P60 features a PCI bus that delivers every ounce of the processing power of the Pentium chip. But



Pentium power is just the beginning of a long list of innovative features found on the Dell XPS P60.

There's a double-spin, multi-session Photo CD drive that transfers data at 300KB/sec vs. the 153.6KB/sec transfer speed of single-spin CD ROM drives.

Our PCI #9GXE video card creates a virtual screen that effectively doubles the viewing area on the Dell XPS P60's UltraScan™ 14C monitor, provides three levels of magnification, and gives you on-the-fly resolution switching.

Of course, the XPS P60 comes fully loaded with DOS, Windows™, a 3.5 inch disk drive and a mouse.

To make your XPS P60 sound even better, add our Multimedia Upgrade Kit (\$199) with its 16-bit Sound Blaster

audio card and Dell's exclusive Peavey® 200 speakers.

The Dell Dimension XPS P60. Pure power. Pure speed. Pure Dell. The company that ranked highest in the J.D. Power and Associates 1993 Customer Satisfaction Study of Desktop Personal Computers among business users.<sup>†</sup>

Call today. Because now you know what price Pentium.

**DELL™**

TO ORDER, CALL  
**800-433-8093**

HOURS: MON-FRI 7AM-9PM CT SAT 10AM-6PM CT SUN 12PM-5PM CT

IN CANADA: CALL 800-668-3021. PLEASE REFERENCE #11EB4

Order Code #5000294

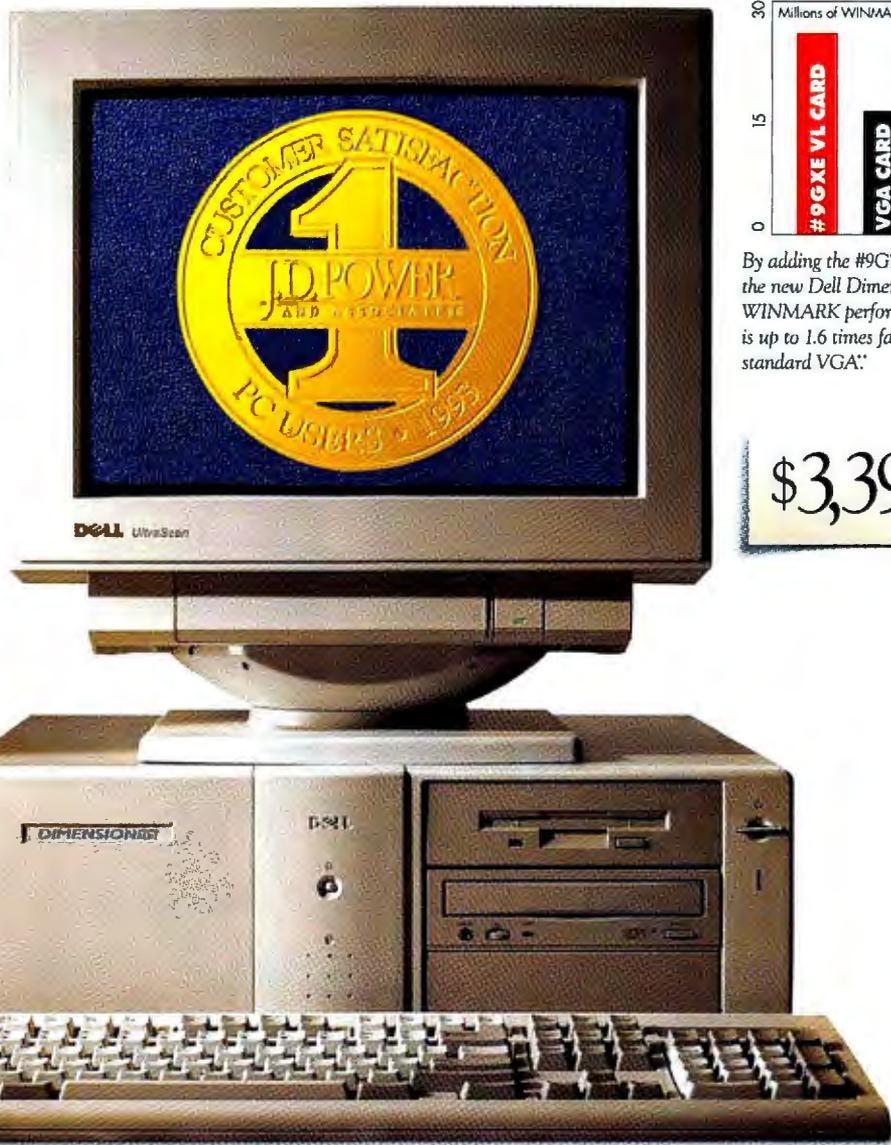
# HIT THE TOP OF THE POWER CURVE HITTING THE BOTTOM OF THE PRICE CURVE



Upgrade to virtual screen technology by adding our optional 1MB VRAM and 1MB DRAM upgrade. It's like having two monitors in one.



Our multi-session, double-spin, CD ROM drives come with a special edition of Aldus PhotoStyler and are Kodak Photo CD compatible.



DELL DIMENSION XPS 466V  
(Other systems featured are not pictured.)



By adding the #9GXE card, the new Dell Dimension XPS WINMARK performance is up to 1.6 times faster than standard VGA.\*\*

\$3,397

This is the very top of the power curve. Each and every Dell Dimension XPS system on this page features accelerated local bus video. The XPS P60 systems are Pentium processor based, and every other i486 based system can be upgraded to Pentium Overdrive™ for more power and performance.

Built for raw speed and power, the Dell Dimension XPS PCs' specs read like a power user's wish list of technological desktop PC innovations.



Take the CD ROM drive as an example. Its double-spin technology delivers nearly twice the data transfer rate of single-spin drives (300KB per second as opposed to 153.6KB per second). It's multi-session, which means it's Photo CD compatible and you can have your CD disk printed on up to four different occasions. Even its motorized loading tray is state-of-the-art.

Video on the XPS systems is supplied by a #9GXE video card that delivers 26 million WINMARKS,\*\* provides three

©1993 J.D. Power and Associates Desktop Personal Computer Satisfaction Study conducted among 1,956 user respondents. \*Prices valid in the U.S. only. Some products and promotions not available in all areas. \*\*WINMARKS test results obtained using a standard VGA card. Intel, the Intel logo, and Microsoft are registered trademarks and Windows is a trademark of Microsoft Corporation. Peavey is a registered trademark of Peavey Electronics Corp.

# POWER CURVE WITHOUT YOUR BANK ACCOUNT.

## PICTURED SYSTEM DELL DIMENSION XPS 466V i486 DX2 66MHz SYSTEM

**\$3,397**

Business Lease: \$125/Mo.

- 16MB RAM • 64MB Max RAM
- 256KB External Cache
- 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
- 3MB RAM (2MB VRAM, 1MB DRAM)
- VS15 Monitor (15", 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- SpaceSaver Keyboard
- Sound Blaster 16 Sound Card
- Peavey Speakers • Microphone
- MS-DOS\* 6.0/Microsoft\* Windows 3.1 /Mouse
- Sound Effects Library
- Special Edition Aldus Photo Styler

Order Code #5000241

## DELL DIMENSION 425SV i486 SX 25MHz SYSTEM

**\$1,399**

Business Lease: \$52/Mo.

- 4MB RAM • 64MB Max RAM
- 270MB Hard Drive
- Upgradeable to Pentium Overdrive
- 5 ISA Expansion Slots Total (3 ISA, 2 VL/ISA Available)
- Accelerated Local Bus Video
- VS14 Monitor (14", 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.0/Microsoft Windows 3.1/ Mouse

Order Code #5000237

## DELL DIMENSION DIRECTOR 433SV i486 SX 33MHz SYSTEM

**\$1,999**

Business Lease: \$74/Mo.

- 4MB RAM • 64MB Max RAM
- 170MB Hard Drive
- Multi-session, Double-spin CD ROM Drive
- Upgradeable to Pentium Overdrive
- 5 Expansion Slots Total (2 ISA, 2 VL/ISA Available)
- Accelerated Local Bus Video
- SVGA 10241 Monitor (14", 1024 x 768, .28mm)
- 3.5" 1.44MB Diskette Drive
- Sound Blaster 16 Sound Card
- Peavey Speakers
- MS-DOS 6.0/Microsoft Windows 3.1/ Mouse
- Microsoft Office, Microsoft Bookshelf, Quicken, Microsoft Home Sampler, Windows CBT

Order Code #5000238

## DELL DIMENSION XPS 466V i486 DX2 66MHz SYSTEM

**\$2,699**

Business Lease: \$100/Mo.

- 8MB RAM • 64MB Max RAM
- 528MB Hard Drive
- 256KB External Cache
- Upgradeable to Pentium Overdrive
- 7 Expansion Slots Total (5 ISA, 1 VL/ISA Available)
- VL #9GXE Video Accelerator Card with Video Control Panel Software
- 1MB Video RAM
- VS15 Monitor (15", 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.0/Microsoft Windows 3.1/ Mouse

Order Code #5000239

## DELL DIMENSION XPS 466V i486 DX2 66MHz SYSTEM

**\$2,999**

Business Lease: \$111/Mo.

- 16MB RAM • 64MB Max RAM
- 256KB External Cache
- 450MB Hard 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
- 1MB Video RAM
- VS15 Monitor (15", 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- Multi-session, Double-spin CD ROM Drive
- MS-DOS 6.0/Microsoft Windows 3.1/ Mouse

Order Code #5000240

## 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 #9GXE Video Accelerator Card with Video Control Panel Software
- 1MB Video RAM
- VS14 Monitor (14", 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.0/Microsoft Windows 3.1/ Mouse

Order Code #5000242

## DELL DIMENSION XPS P60 PENTIUM 60MHz SYSTEM

**\$3,599**

Business Lease: \$130/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 Monitor (15", 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- MS-DOS 6.0/Microsoft Windows 3.1/ Mouse

Order Code #5000243

## DELL DIMENSION XPS P60 PENTIUM 60MHz SYSTEM

**\$4,699**

Business Lease: \$169/Mo.

- 16MB RAM • 128MB Max RAM
- 256KB External Cache
- 1GB SCSI Hard Drive
- Multi-session, Double-spin CD ROM Drive
- 7 Expansion Slots Total (2 ISA, 1 PCI, 1 PCI/ISA Available)
- PCI #9GXE Video Accelerator Card with Video Control Panel Software
- 1MB Video RAM
- VS17 Monitor (17", 1024 x 768, .28mm, NI)
- 3.5" 1.44MB Diskette Drive
- SpaceSaver Keyboard
- MS-DOS 6.0/Microsoft Windows 3.1/ Mouse

Order Code #5000244

levels of magnification and gives you on-the-fly resolution switching.

And when you buy, you have the security of knowing your purchase is backed by the computer company that ranks highest in customer satisfaction according to J.D. Power and Associates 1993 Desktop Personal Computer Customer Satisfaction Study among business users.<sup>1</sup>

So if you want to hit the top of the power curve without hitting the bottom of your bank account, call Dell.

TO ORDER, CALL

**800-433-8099**

HOURS: MON-FRI 7AM-9PM CT SAT 10AM-6PM CT SUN 12PM-5PM CT  
IN CANADA\* CALL 800-668-3021. PLEASE REFERENCE #1TEAY

# WHO SAYS YOU CAN'T WIN 'EM ALL?



*"The Dell OptiPlex MXV is the closest thing we've seen to a personal computer without compromises."*

—PC Magazine, December 1993

DELL OPTIPLEX 466/MXV i486 DX2  
66MHz BUSINESS SYSTEM

**New Low Price: \$3,678**

Business Lease: \$132/MO.

- 16MB RAM
- 450MB (17ms) Hard Drive
- 15" UltraScan Monitor
- Local Bus Video with 2MB Video RAM
- Modular OptiFrame™ Chassis
- Dell Instant-Touch Embedded Diagnostics
- And More...

Order Code #5000305



*"Is there a clear winner? You bet. Five systems made the cut, Dell changed the game. We want one."*

—PC Computing, October 1993

DELL DIMENSION XPS 466V i486 DX2  
66MHz MULTIMEDIA SYSTEM

**\$3,397**

Business Lease: \$125/MO.

- 16MB RAM
- 450MB (17ms) Hard Drive
- 15" UltraScan Monitor
- Double-Speed CD ROM
- Sound Blaster 16 Sound Card
- And More...

Order Code #5000306

When you buy computers, do you have time to navigate the maze of vendors, systems, configurations, prices, manuals, service options, etc., etc., etc.?

Fortunately for you, there are people who compare computers for a living. Fortunately for us, they've singled Dell out as the best.

For business-critical applications, PC Magazine editors chose Dell® OptiPlex™

For Multimedia,



**DELL**

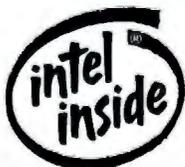
TO ORDER, CALL

**800-433-8094**

HOURS: MON-FRI 7AM-9PM CT SAT 10AM-6PM CT SUN 12PM-5PM CT  
IN CANADA: CALL 800-668-3021 IN MEXICO CITY: 228-7811 #11EAX

PC Computing chose the Dell Dimension XPS. And in the 1993 J.D. Power and Associates' study of 1,956 business users in the U.S., Dell was ranked "Highest in Customer Satisfaction Among Desktop Personal Computer Users." Ahead of every computer company in the study.<sup>†</sup>

So the next time you're ready to buy some computers, do yourself a big favor. Call Dell. Because life's a whole lot easier when you go with a winner.



<sup>†</sup>1993 J.D. Power and Associates Desktop Personal Computer Satisfaction Study. Study conducted among business users in the U.S. and based on 1,956 user respondents.