100 ETHERNET CARDS TESTED

AUGUST 1993

BYTE

THE WORLDWIDE COMPUTING AUTHORITY

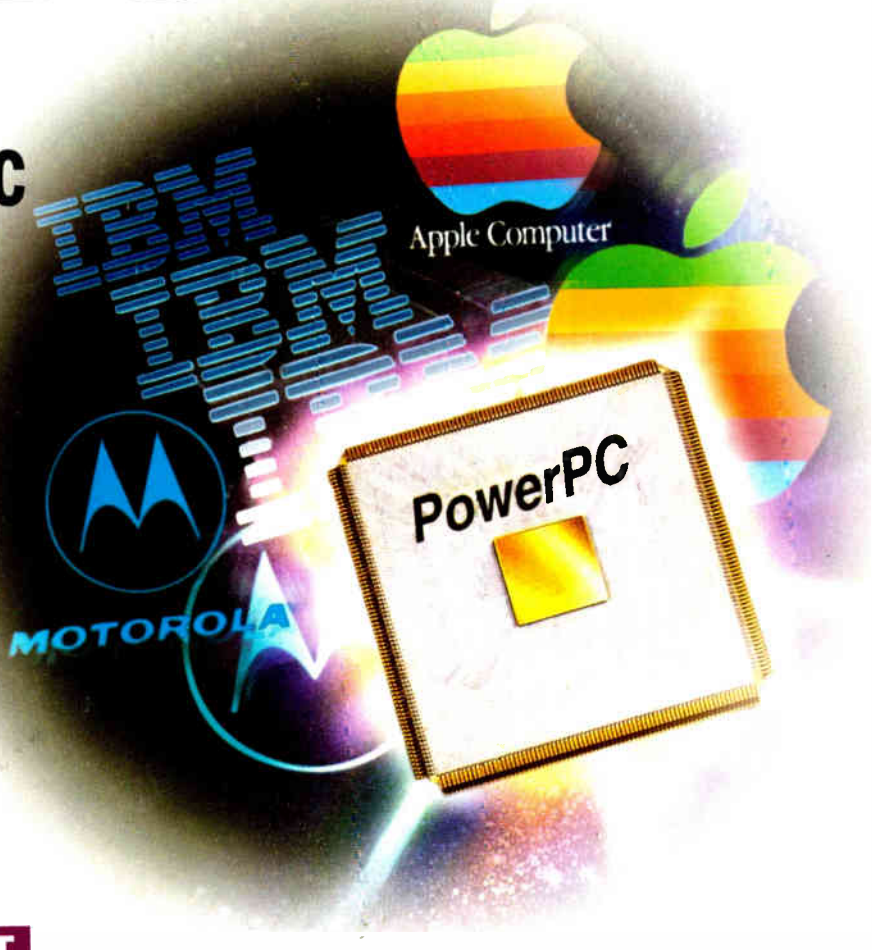
DeskStation's RISC PC Is Built to Run NT Page 145

NextStep Comes to the 486

Programming Elegant Windows Dialog Boxes

PowerPC

IBM, Apple, and Motorola's PowerPC technology promises low-cost, high-speed systems that can run Windows, Mac, OS/2, and Unix software



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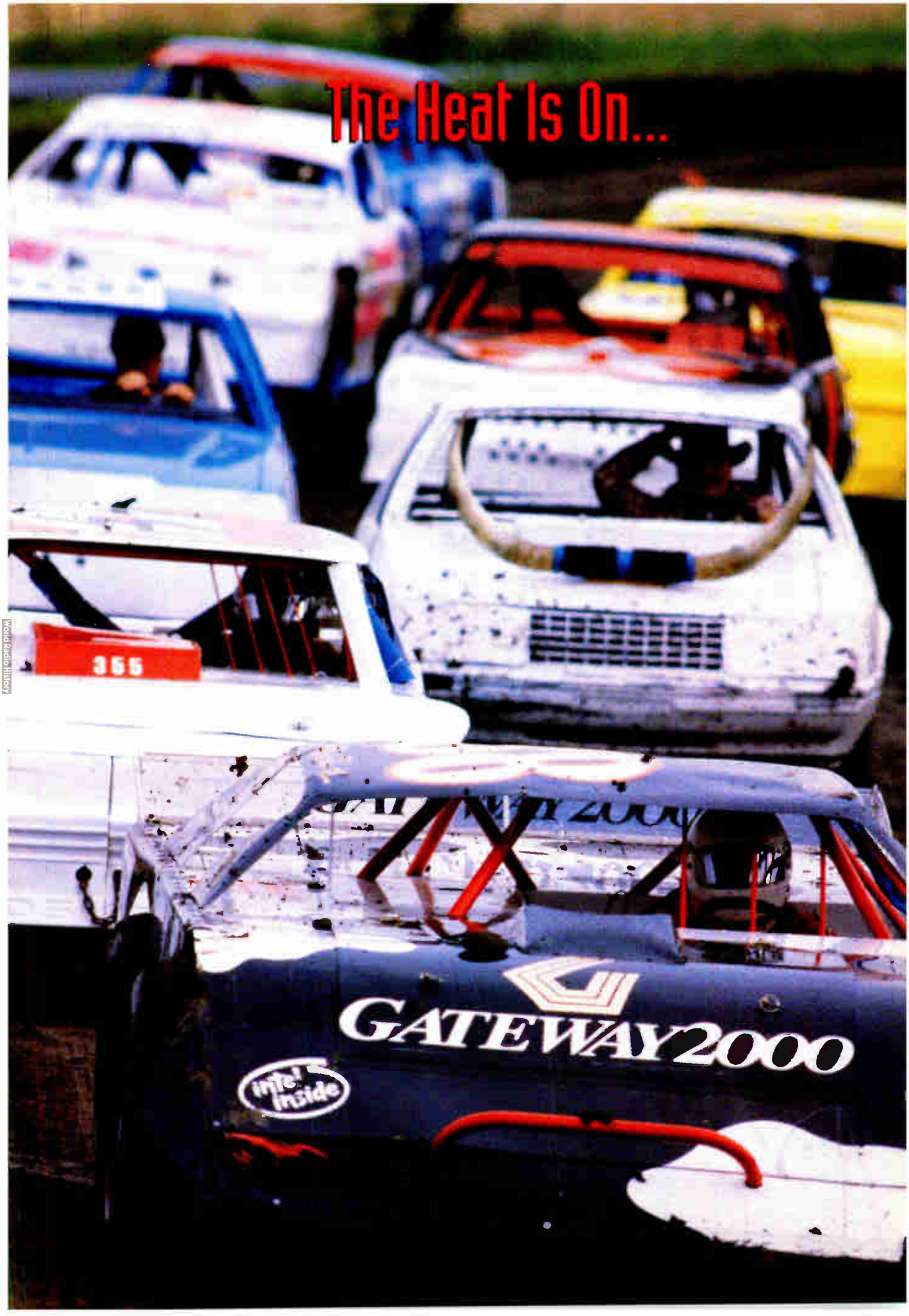
intel inside

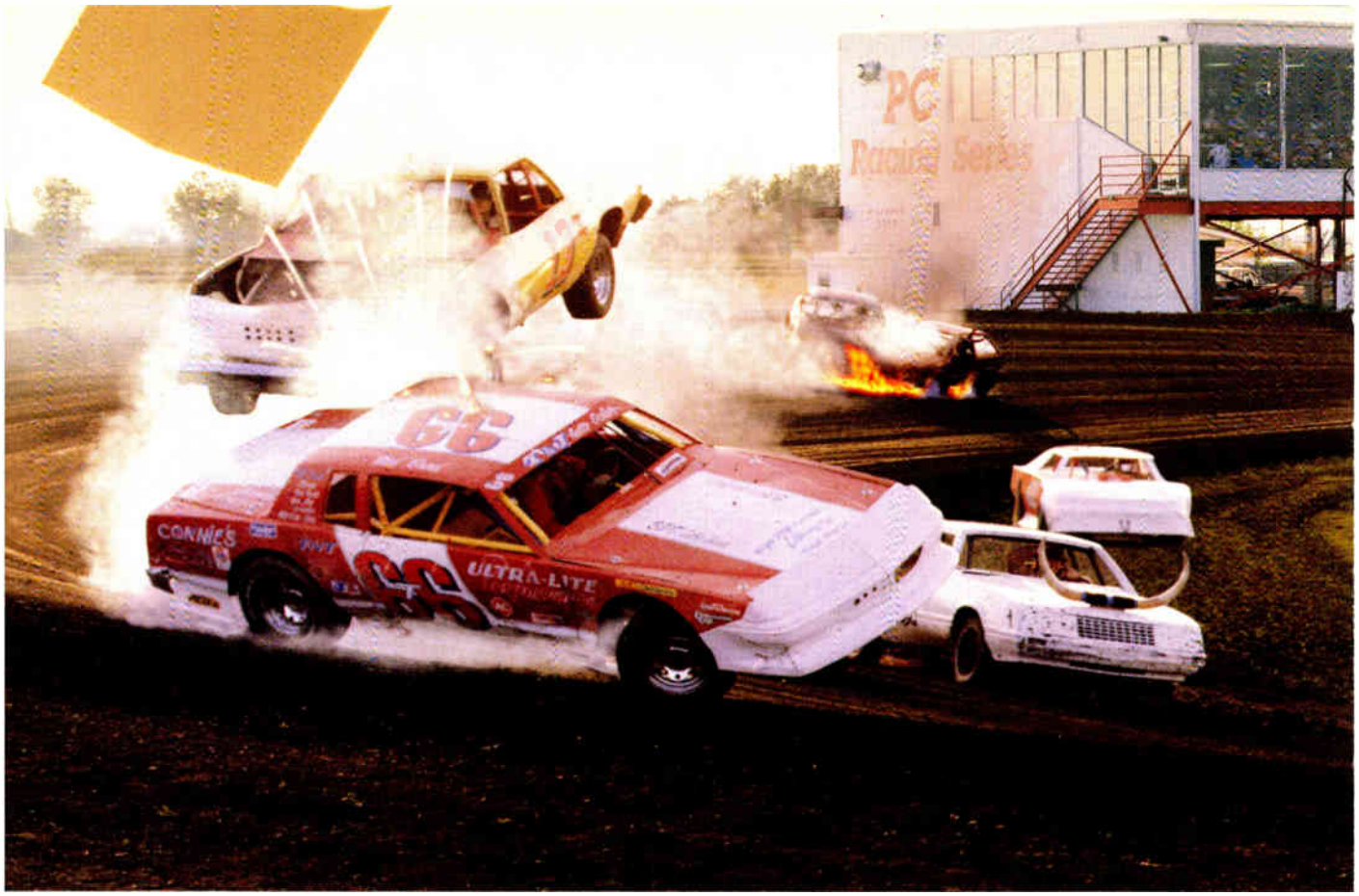
SERVICE & RELIABILITY · PC MAGAZINE · READERS' CHOICE

PC WORLD

1993 BYTE READERS' CHOICE AWARD

Service Award





Gateway 2000 Outmaneuvers The C

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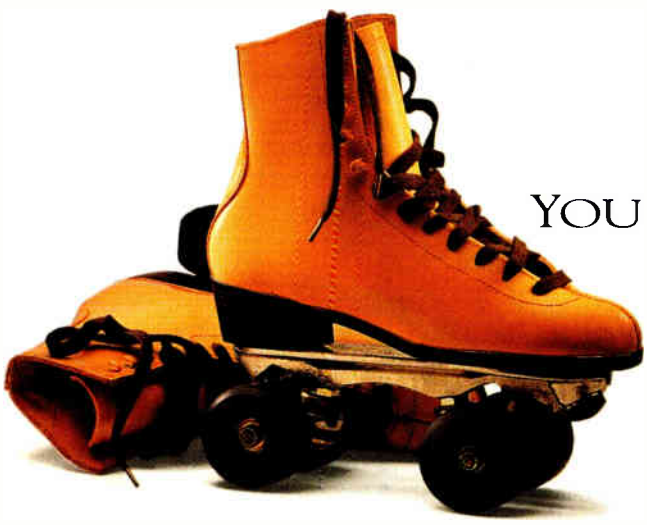

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From BIX: Join "listings/frombyte93" and select the appropriate subarea (i.e., "aug93").

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.

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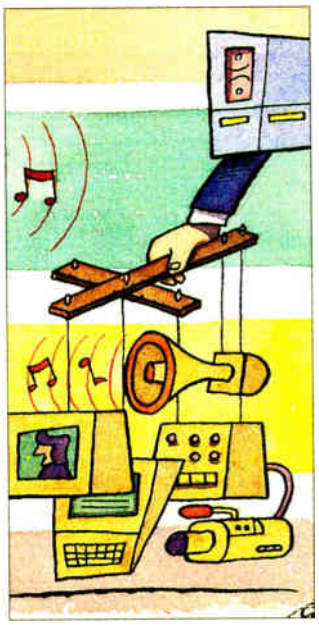

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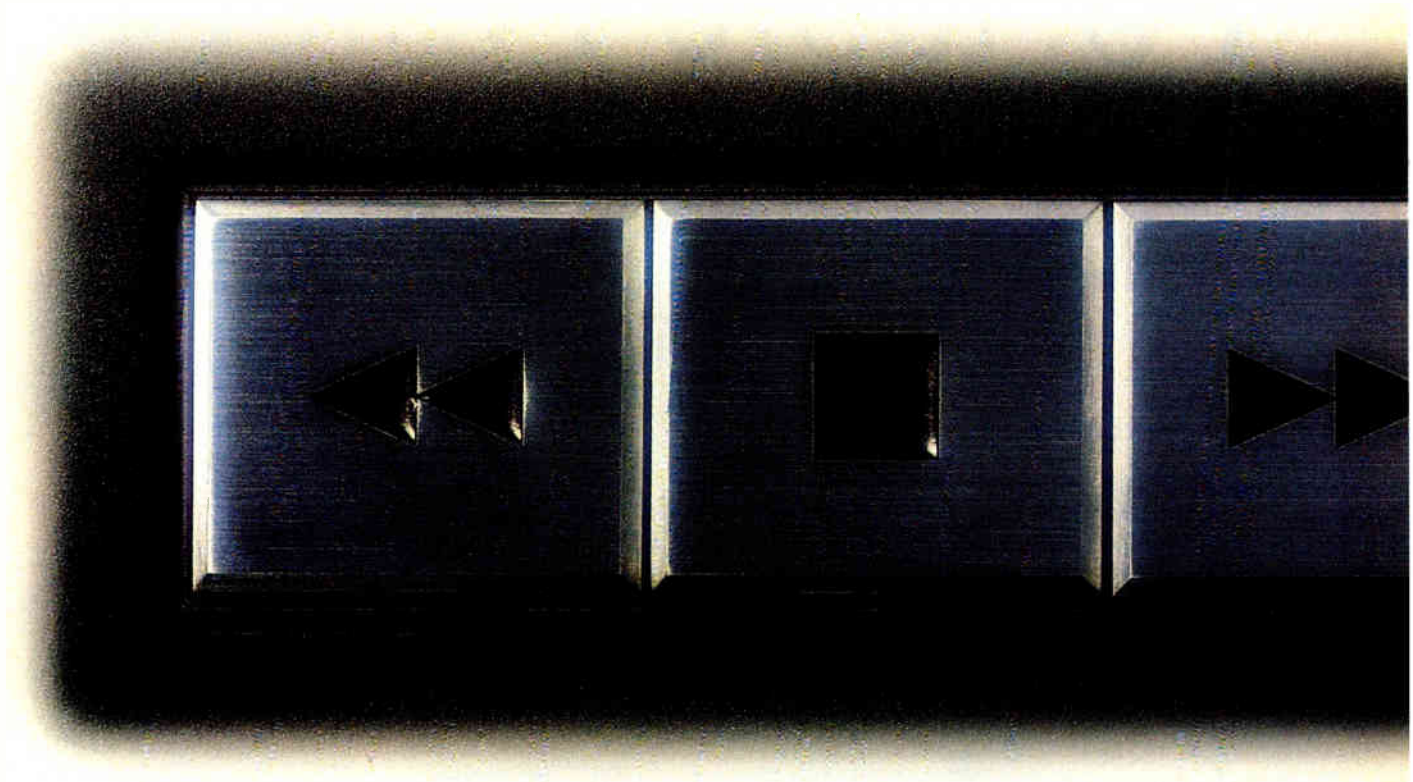

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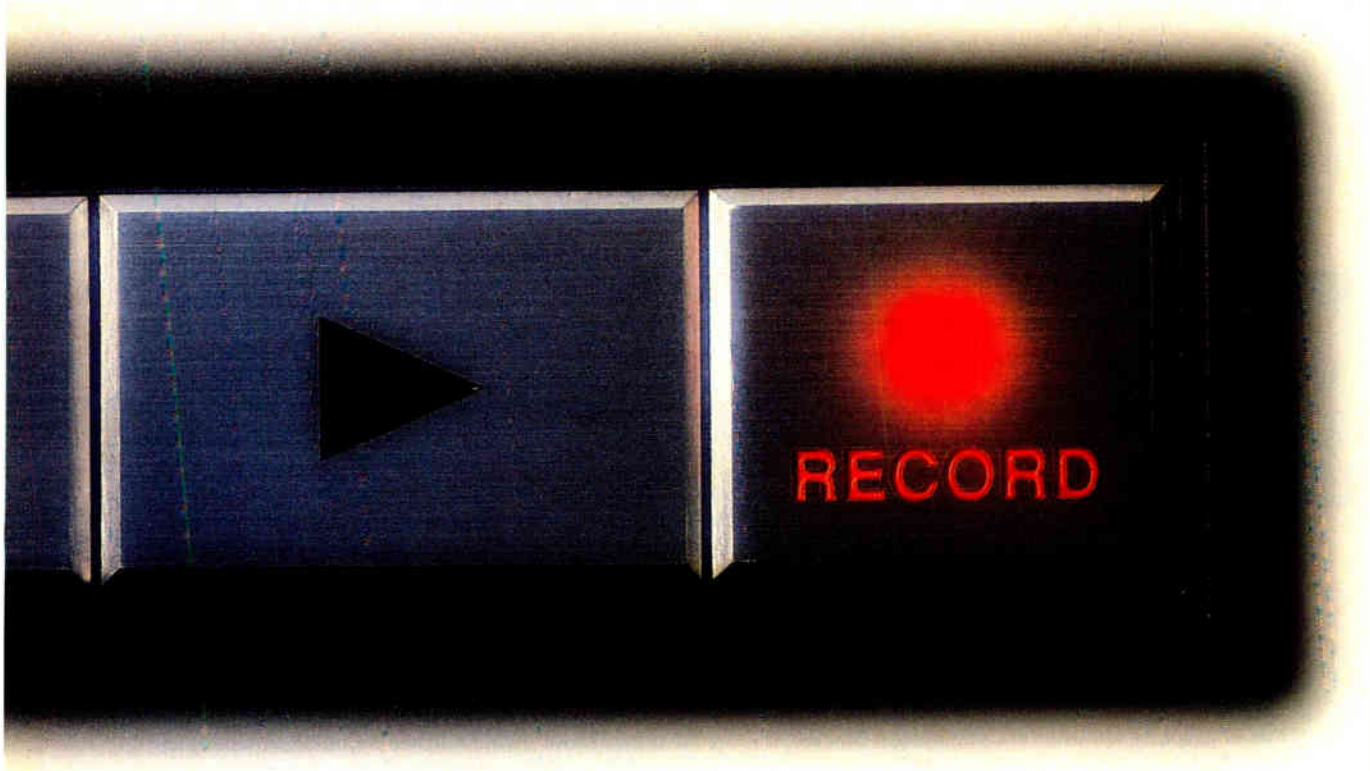
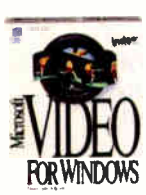


technology concept to your PC.



Video for Windows lets you capture, edit and incorporate video into Windows applications.*

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It's the Technology, Stupid

The 1990s is definitely not a time for the faint of heart or the technically impaired.

Want proof that computers are not commodities? Then look no further than IBM's, Apple's, and Motorola's baby, the PowerPC. This microprocessor raises a lot of questions that most folks haven't had to consider until now. Fact is, since the mid-1980s it's been a pretty simple world. If you wanted easy-to-use software or access to lots of graphics applications, you bought Macintoshes with Motorola CPUs. If you wanted compatibility with a larger number of systems and access to a greater number of software packages, you bought DOS or Windows-based PCs with Intel CPUs. And if you wanted high-speed workstations for design or engineering work, you bought workstations with RISC CPUs.

Once you chose the hardware platform, your operating system and applications choices were made automatically. Or to put it another way, once you chose the hardware, you really had no further choices. Mind you, the idea on which this industry was founded is not one of limited choices, but that has been the state of the industry for the past several years. The choices have been so narrowed that the only difference in most DOS-based PCs recently has been price. For a while it seemed as though the industry leaders must have had a secret meeting and agreed to stop improving PCs and to start selling them like pork bellies—strictly on price.

Oh, sure, we all benefited by the resulting price war. It certainly made the bean counters in the financial department ecstatic—why, even *they* could decide which computers to buy. (Of course I make an exception to that derogatory remark for Claudia Flowers, BYTE's financial director, who holds the purse strings to my budget.) The point is, it didn't take a lot of smarts to buy computers, because beyond price, the pickings in differentiation were slim.

Innovations like the PowerPC, though, may send the bean counters back to counting beans. Why? The technology ante just got raised to a level at which only experts can play. Think about it: PowerPC systems that can run Windows, Mac, OS/2, or even Unix software. But how do you decide if a PowerPC system is better than, say, a Pentium system? Or how does a system with multiple 486 processors compare? You can make that decision only if you are fully equipped with a thorough understanding of the underlying technology.

Let's not just focus on the PowerPC, either—it's merely representative of many other new quandaries. Suddenly the horizon is filled with competing CPUs—namely, Pentium, PowerPC, Alpha, R4000, and more are on the way. Each offers unique benefits based on sometimes radically different technologies. Next, consider the emerging operating-system war between Windows NT, OS/2, Solaris, Taligent, Unix, and NetWare. Now, allow me to pose a few of the questions we all face:

Is it a CPU based on CISC, RISC, or a hybrid of the two that's right for you? How will differences in microkernel architectures among operating systems affect portability? To run any application on all platforms in your organization, what software-emulation strategies are best? For what applications does symmetric processing pay off? How can you make it all work together?

Once, the common-wisdom advice for computer-illiterate folks when they asked which computer to buy was to select the applications software first, and the hardware and operating-system platform were automatically dictated, leaving folks to then fixate on price. Now, the best advice for those folks is to select the applications software first—then find a BYTE reader to figure out the rest for them. It's best that they not try to do it on their own, because they might hurt themselves while playing in the technology jungle.

What's happening in this industry is exciting and messy. We are on the verge of breaking through incompatibilities and underpowered solutions, and this is not a time for the faint of heart or technically impaired. The 1990s is the era of expertise, and the winners of this decade are the folks who know their stuff. For those of us who deal with computers, it's knowing and understanding the technical details. And for anyone else who doesn't get it, just tell them this: It's the technology, stupid.

DENNIS ALLEN, EDITOR IN CHIEF

A New BYTE

On another note, I'd like to formally acknowledge our colleagues at the newest BYTE *publication,* BYTE Argentina. *They join our family of 13 local-language editions of* BYTE, *and we welcome them aboard.*

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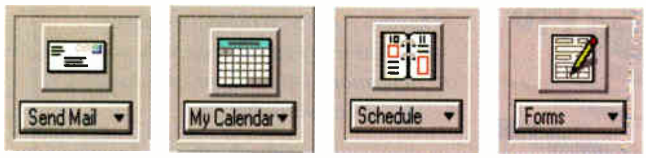

E-mail isn't enough anymore.

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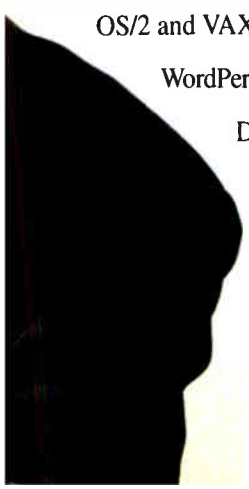

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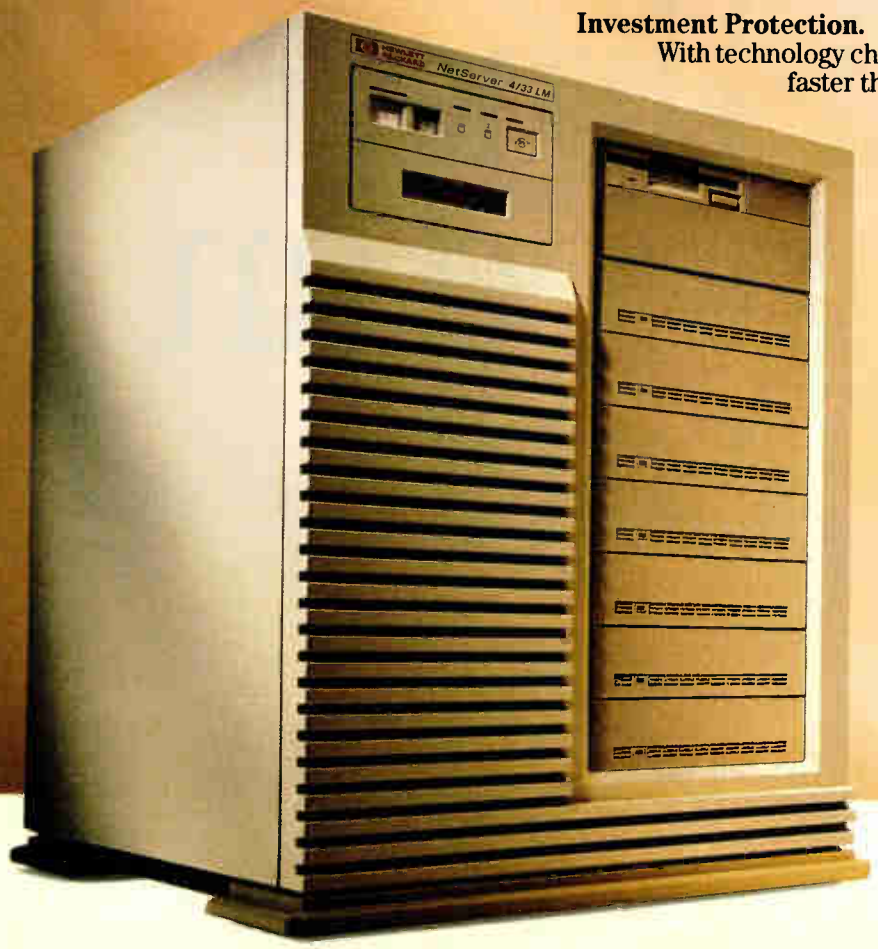

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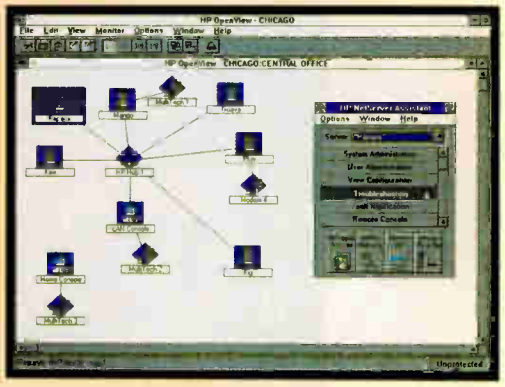

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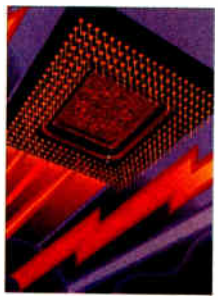
*U.S. list price for HP NetServer LM Model 530, including 486/33DX processor, 16-MB RAM and 535-MB SCSI hard drive.**U.S. list price for HP NetServer LE Model 240, including 486/33SX processor, 4-MB RAM and 240-MB IDE hard drive. Prices subject to change without notice. Pentium and the Intel Inside logo are U.S. trademarks of Intel Corporation.

HEWLETT PACKARD

Letters

Pentium

I found Tom R. Halfhill's article on the Pentium ("Intel Launches Rocket in a Socket," May) very informative but a little biased. Halfhill apparently considers Windows NT the only operating system that will run on the Pentium. However, Next has been working closely with Intel in developing a Pentium version of NextStep.



In my opinion, NextStep is the most advanced operating system at the moment. Not only does it have a great GUI, but it was designed from the ground up with objects in mind, and it provides the best tools for developing applications and working in groups.

Diego Martin Zamboni
Mexico City, Mexico

The May cover story poses the question: Does Intel offer the best engine for Windows NT? This question disregards all other operating systems. A better question is: Does Intel offer the best engine for GUI systems?

William L. Hartzell
Garland, TX

Printers in Review

Three days after I bought a new printer, the May BYTE arrived with umpteen pages of printer tests ("126 Printers"). The printer I bought was not included in the Lab Report, much less recommended. But guess what? The printer I bought works fine, does what I want it to, does it well, and does it at a price well below those of the printers you tested and recommended.

The average person doesn't need to invest thousands of dollars in a system that works at the speed of light and could be used to counterfeit $20 bills. Try reviewing software and hardware combinations that let the average person be more productive without going broke.

Victor W. Briggs
Fisher, PA

Matrix Clarification

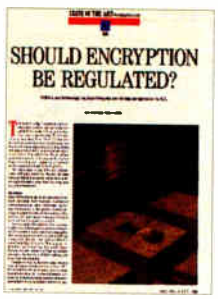
In "Windows NT Gaining Momentum" (BYTE's Essential Guide to Windows, Spring 1993, page 30), the pricing for Matrix for Unix is incorrect. An eight-user configuration is available for $9000, not $900.

As you mentioned, Ampersand is porting Matrix to Windows NT. The product, called Matrics, provides CICS transaction processing on Windows NT. Scheduled for release this month, the Matrics server will be in the $5000 to $8000 range; the client will sell for $700 to $1200.

Surekha Shetty
Vice President, Marketing
Ampersand Corp.
Glendale, CA

Regulating Encryption

Peter Wayner's "Should Encryption Be Regulated?" (May) lists two reasons for not regulating encryption technology. First, business data is protected by encryption. Second, criminals are stymied by encryption. I must add a third reason, which far overrides these: my right to privacy.



The government does not have an inherent right to snoop in my private data. It's not enough to say that the government will always act benignly. The greatest proof is the McCarthy era, when the government "benignly" ruined the lives of hundreds of people by snooping in their private affairs. If we regulate encryption, Big Brother could be (benignly, of course) watching you.

I hope we don't become seduced by the Micali methodology and miss the main point: We have a basic right to privacy.

Timothy Blancke
Concord, MA

The Clinton administration has come out in support of the Clipper chip as a standard for data encryption. The government would keep the two interlocking keys that, when used, would open anyone's mail.

However, other encryption schemes, such as the Vernam cipher, require no more technology than a piece of paper and a pencil. They are essentially uncrackable, provided the key does not fall into the wrong hands. With such methods available to anyone, and considering that the retention of the keys to the government's Clipper encryption scheme is a well-publicized fact, I can't help but wonder if this system is a threat to anyone except users of the government-endorsed encryption system—who are basically honest.

Patrick Bryant
Marietta, GA

The Human Edge

In "Losing the Human Edge" (May), Hans Berliner points out that in most games, computer programs "are near the forefront or have already surpassed the best humans." I agree. However, go poses a much richer and more challenging problem than does chess. To date, the best go programs have been easily beaten by humans.

While sophisticated tree searches have essentially solved the problem of computer chess, the game tree of go is too large for such a single-minded approach. Successful go programs use many different aspects of human and machine intelligence. Computer go deals with tree searches, but also with machine learning, pattern recognition, strategic (i.e., humanlike) reasoning, rule-based knowledge representation, simulated annealing, dedicated VLSI design, and other areas of research that might be of interest to BYTE's audience.

Bernd Bruegmann
Syracuse, NY

Fixes

In the May Lab Report ("126 Printers"), the Roll Call on page 175 contains errors. The microLaser Turbo does not have a PS35 option, and its correct price is $1967. The correct price of the microLaser XL PS35 is $3366. The "Low Cost" chart on page 168 incorrectly lists the Epson Stylus 800 as accepting 11- by 17-inch paper.

In the June issue, the illustration on page 109 was incorrectly credited. Art watchers will have realized it was done by the same person who did the other illustrations for that section: Nigel Buchanan. And the uncredited illustrations for Jerry Pournelle's column were done by Bethany Gully. Our apologies to both artists.

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.*

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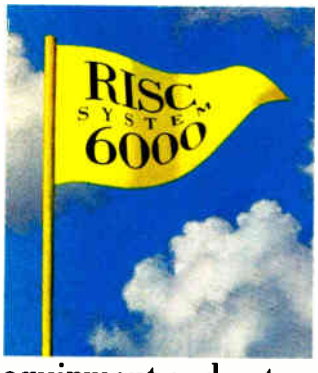

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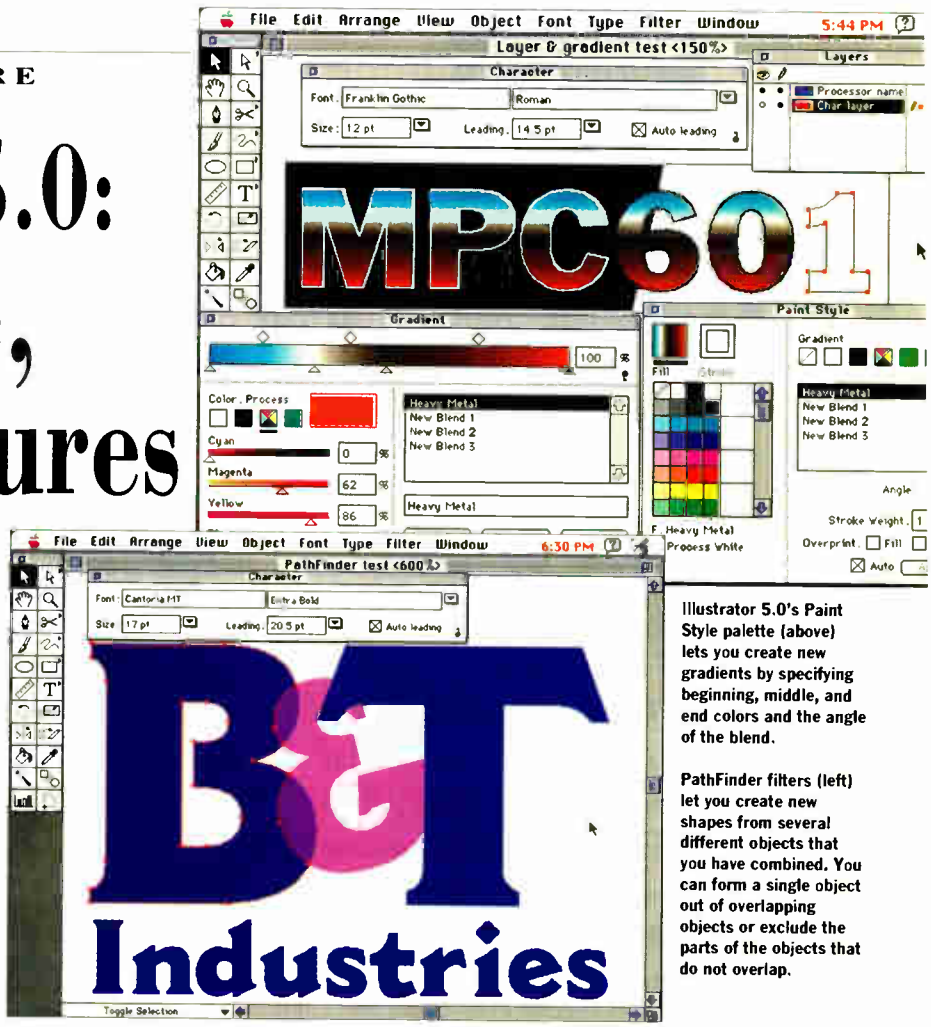
GRAPHICS SOFTWARE

Illustrator 5.0: New Face, New Features

New gradient fill, layer control, and preview editing features bring sophisticated drawing capabilities to Adobe's new Illustrator for the Mac

TOM THOMPSON



Illustrator 5.0's Paint Style palette (above) lets you create new gradients by specifying beginning, middle, and end colors and the angle of the blend.

PathFinder filters (left) let you create new shapes from several different objects that you have combined. You can form a single object out of overlapping objects or exclude the parts of the objects that do not overlap.

As object-based drawing applications go, Adobe Illustrator 3.2 made it easy to turn out simple drawings. For more sophisticated artwork, however, there were a few things *not* to like about Illustrator, such as the lack of layer control or ability to do gradient fills. All this has changed in Illustrator 5.0 for the Mac. An advanced look at a beta version of 5.0 showed me that the program adds significant features and a revised, easier-to-use interface.

You can now edit previews in Illustrator—no more flipping back and forth between the full-color preview and the artwork view to make a change to your work. This feature is available in Aldus FreeHand and the Next and Windows versions of Illustrator, and it is overdue on the Mac.

Next, there's layer control. You can assign objects to layers, name the layer with a descriptive title, and change certain attributes of objects within the layer. For example, hiding a layer makes its objects disappear, which is handy for uncluttering complicated artwork. Or you can lock a layer, which makes it visible but uneditable, so that you can position other objects or layers with respect to the locked layer. Finally, you can specify whether or not the layer prints. This is handy for adding invisible notes to the artwork, or for constructing a single advertisement whose artwork creates different output targeted for different audiences, depending on the layers you choose to print.

At long last, Illustrator does gradient fills. A gradient palette lets you assign the number and types of colors to use and the fill mode (i.e., linear or radial) you want, and a gradient tool lets you select an object and assign the fill direction. A few clicks of the mouse set up a multicolored gradient fill, instead of clogging up the artwork using intermediate objects made with the Blend tool, as in the past.

Speaking of palettes, you'll notice that most of Illustrator 5.0's interface has undergone a makeover. Many of those complex dialog boxes for assigning a paint style or selecting a text typeface and its attributes have become floating palettes. This allows ready access to these frequently used functions.

You can still make CYMK

color selections by typing and tabbing in the various color values, or you can move sliders instead, which makes it easier for artists who prefer to set the color by eye. Besides interface improvements, the addition of some handy commands such as Align Objects (which lets you horizontally or vertically align the sides or centers of selected objects) makes precision work a snap.

Finally, Illustrator has introduced PathFinder plug-in modules. These little gizmos let you combine or exclude the Bézier curves and paths of selected objects (see the screen). In other words, you can unite overlapping objects into one object or exclude the portions of objects that don't overlap. Other filters let you blend, mix, and invert colors; smooth or distort paths; or add special effects.

For example, to make a pharmacy logo, you'd type in *R* and *X* characters, convert them to outlines, drag the *X*'s outline to the tail of the *R*'s outline, and then select the Unite operation in the PathFinder plug-in. All the nonoverlapping Bézier curves are discarded, while the rest of the paths are combined into one object. Presto—instant pharmacy logo. This ability to readily unite or discard combinations of objects and paths will liberate professional artists: They can be more spontaneous in drawing their artwork. The PathFinder feature alone makes Illustrator 5.0 a major win.

Illustrator 5.0 does make more demands on your Mac. Whereas version 3.2 used only 2 MB of RAM and occupied 1.2 MB on your hard drive, version 5.0 requires 4.5 MB of RAM and 3.3 MB of storage (this includes 1.5 MB of plug-in and pattern files). However, based on what I've seen, the extra bulk is muscle, not fat: The additional code implements useful features. Illustrator 5.0 will ship for $595, and upgrades are available on floppy disk for $199 or on CD-ROM for $249.

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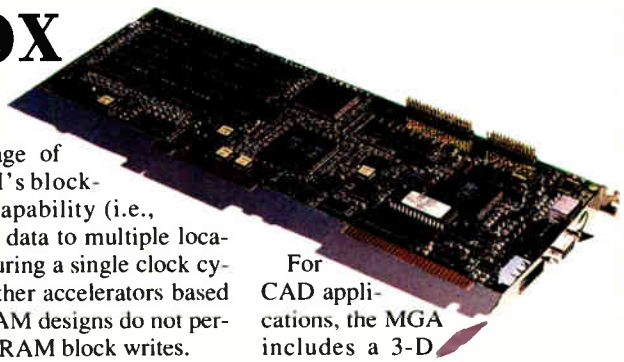

Just as the popularity of Windows spawned a flourishing market for graphics accelerators, the arrival of Pentium processors will require a revamped graphics architecture to meet the new PC performance standard. Matrox leads the next wave of graphics acceleration with its MGA (Multimedia Graphics Architecture).

I plugged the MGA Impression into a Gateway 486/66 with 16 MB of RAM and a Viewsonic 17-inch monitor—and never looked back. The Impression represents the current high end of the MGA line, with 3 MB of VRAM (video RAM) and a $1299 price tag (prices for MGA will range from $599 to $1499). The performance, especially when working with large 24-bit images, is remarkable.

MGA doubles the bandwidth of the current stock of 32-bit graphics chips, accessing onboard video memory via a full 64-bit data path. The MGA also takes advantage of VRAM's block-write capability (i.e., writing data to multiple locations during a single clock cycle). Other accelerators based on DRAM designs do not perform VRAM block writes.

The MGA turned in impressive results in the BYTE video benchmark test, even though the MGA drivers were still in beta form. I pitted the Impression against one of the fastest accelerators we've tested so far, Diamond's Viper VLB (with Weitek's P9000 accelerator). The MGA consistently outperformed the Viper: Text performance was twice as fast, and the MGA executed line draws and graphics primitives 60 percent faster. The MGA really shone when I was working with 24-bit images in Adobe Photoshop. Scrolling and panning was noticeably snappier, and zooming was almost instantaneous.

For CAD applications, the MGA includes a 3-D graphics engine and ships with enhanced drivers for AutoCAD release 12. Video and animations are improved by a double-buffering scheme: while one image is being displayed, the next image is being built in video memory. MGA hardware assists character antialiasing (to sharpen on-screen text), Video for Windows decompression, video pan and zoom, and true-color emulation. MGA raises the bar in VL-Bus graphics acceleration. Others will be scrambling to catch up.

—Stanford Diehl

Matrox Electronic Systems, Ltd., Dorval, Quebec, Canada, (514) 685-2630.

FINLAND TURNS TO ATM TO LINK TWO CITIES

HELSINKI—A new pilot project in Finland that links two cities over an ATM (Asynchronous Transfer Mode) connection is the first step in creating a network that will eventually deliver a wide range of computer services across the country.

The long-distance ATM link, which is the first in Europe, went into service in Finland at the beginning of May. Telecom Finland, a telecommunications common carrier/public network operator, is providing this pilot link between the cities of Helsinki and Tampere, which are 200 km apart.

Initially, the link will be used to connect high-speed LANs operated by the FUNET (Finnish University Research Network) and Tampere University of Technology. The service will keep its pilot status for about a year, while it evolves into an ATM production platform for advanced data communications applications.

FUNET is using the ATM pilot for various multimedia applications, such as high-definition displays and workstation-based videoconferencing. According to Markus Sadeniemi, director of FUNET, "We believe that ATM is the next generation of technology for research networks. We want to implement, eventually, a system known as Meta-Computer Finland, whereby consistent computer-based services can be provided all over the country, regardless of the computers' physical location."

The ATM technique allows simultaneous switched digital transmission of widely differing bit rates for applications ranging from low-speed telemetry to interactive exchanges of digitized, fully animated, high-definition video signals. Live applications such as video transmission cannot use conventional X.25 packet switching because of its time delay. Furthermore, non-switched solutions based on leased lines would be far too expensive for most small- to medium-size enterprises or individual users. Lastly, narrowband (synchronous) ISDN, whose Primary Rate Access mode operates at 2 Mbps, cannot be easily upgraded to handle throughputs in the hundreds-of-Mbps range, because of the problem—solved through the use of ATM—of simultaneously managing different bit rates.

—Raymond Boult

ARCHITECTURES

PCI: Apple's New Bus

PCI, the Peripheral Component Interconnect local-bus architecture endorsed by more than 150 companies, received a powerful new supporter recently when Apple Computer announced that it plans to support it in future computers.

Apple's announcement that future PowerPC systems (see "PowerPC Performs for Less," page 56) will include PCI expansion capabilities adds credence to statements already made by officials of PCI Special Interest Group member companies that PCI will eventually supplant the VESA (Video Electronics Standards Association) VL-Bus standard. Apple's endorsement of PCI makes it the second vendor of non-80x86 computers to support the architecture. DEC, which is supporting PCI in its Alpha processor–based workstations, was the first such vendor. Prior to Apple's announcement, industry heavyweights like IBM, Adaptec, S3, ATI Technologies, Compaq, Intel, and DEC were already members of PCI.

"We believe PCI will be the next standard," said Steve Manser, director of Apple's Modular Systems Desktop Group. Manser said that because the PCI design isolates peripheral products and add-in boards from the CPU, customers will be able to choose from a broader set of peripheral products and purchasing channels.

Manser's statement regarding PCI's processor independence was echoed by other officials of system and peripheral companies. A common thread in the opinions of product managers who spoke to BYTE is that PCI's processor independence means companies can focus on extending their products' capabilities without having to redesign their products to support new processor technologies.

As PCI becomes widely accepted, this should reduce the cost for peripheral vendors who want to release products for multiple hardware platforms such as the 80x86, the Mac, and the Alpha. Instead of having to use different bus-interface chips and bus-interface logic on each platform version of their peripherals, vendors will be able to introduce peripherals that support multiple hardware architectures. Glenn Schuster, senior hardware applications engineer for S3, said the PCI specification provides a mechansim that allows a board's ROM to contain several different images to accommodate different machine and processor architectures. S3 plans to deliver a PCI version of its 86C928 graphics-accelerator chip this summer.

Other advantages of PCI espoused by PCI backers include its support for auto-configuration, full multimaster capability, and low pin count (under 50) required to handle data and addressing, interface control, arbitration, and system functions. Support for multimaster concurrency means peripherals on the PCI bus can communicate with each other while the CPU handles other instructions. And, because the PCI Steering Committee established tight guidelines regarding PCI compliance, add-in cards will be compatible with a higher percentage of systems than VL-Bus cards, Schuster said. However, many PCI products announced at Spring Comdex will not be available until the fourth quarter of this year.

continued

A SAMPLING OF PCI 2.0 PRODUCTS AND COMPONENTS

Company	Product	Availability
Weitek	Power 9000 graphics accelerator	August
VLSI	VL82C580 chip set: 1000-set quantities, $65 each	Samples: Third quarter Volume: Fourth quarter
AMI	Super Voyager PCI motherboard	Volume: June
Brooktree	Bt885 Video Cache DAC: 100-set quantities, $42.65 each	Volume: June
Diamond	Viper PCI accelerator card: $649	Third quarter
Matrox MGA	Windows accelerator	Fourth quarter
SiS	SiS85C49X chip set with power management for 486, P24T Overdrive CPUs	Not specified
ATI	Four graphics accelerators based on mach32AX	Later this year
Buslogic	SCSI-2 BT-94C host adapter: list price, $499; OEM single-unit price, $340	Fourth quarter
Logic Modeling	PCI model for design verification, $15,000	June 10
NEC	Image Series Desktop PC, Express/II servers	Servers in June; Image P60 in August
DEC	Peripheral chips: single-chip Ethernet controller for PCI to be announced in June. Also, graphics, multimedia, and system-logic chip sets to interface Alpha to system memory, cache memory, and PCI local bus.	1993
STB	Pegasus video accelerator	August

PCI AND VL-BUS AT A GLANCE

FEATURE	VL-BUS	PCI
Maximum number of loads	8	10
Concurrent CPU/bus operation?	Rarely	Yes
Auto-configuring?	No	Yes
Here now?	Yes	No
Direct connection of peripherals to CPU signals?[1]	Yes	No
Local bus isolated from processor?[2]	Rarely	Yes

[1] Direct connection of peripheral devices to the CPU's signals lowers the complexity and pin count for system-logic chip sets for 486 systems and lets VL-Bus support higher frequencies than PCI's maximum 33 MHz.

[2] Isolating the CPU from the local bus lets PC manufacturers design a motherboard to work with several generations of PCs without having to redesign the motherboard's I/O subsystem for each new processor.

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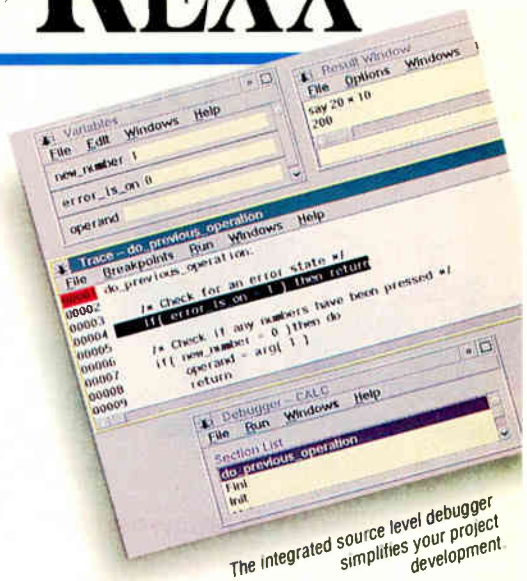
WATCOM VX•REXX is an easy to use visual development environment for creating applications that leverage the capabilities of OS/2 2.x and exploit the Presentation Manager graphical user interface. VX•REXX combines a project management facility, visual designer and an interactive source-level debugger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



The integrated source level debugger simplifies your project development

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 to the objects.

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 DB Manager, because VX•Rexx is based on the OS/2 2.x standard system REXX.

Highlights

- Easy to use visual development environment
- 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 DB Manager
- 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
- Autosizing and alignment of objects
- Integrated console window support for existing REXX programs
- Royalty-free run-time available
- Multiple modeless window support
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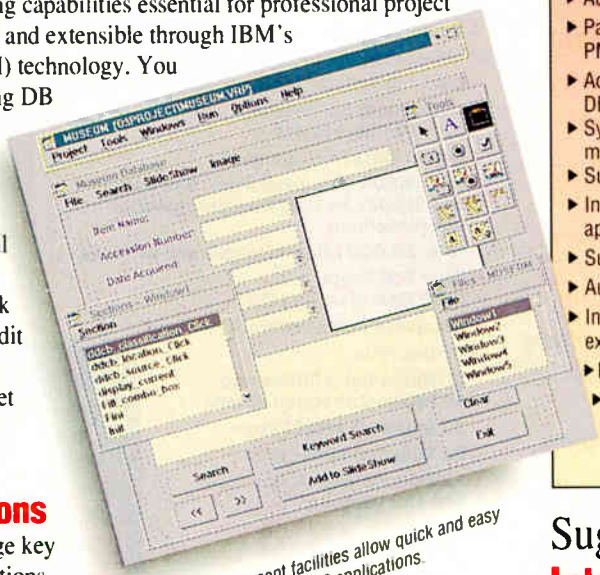

Project management facilities allow quick and easy development of your OS/2 applications.

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.

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As for QuickRing, Apple's high-speed local-bus technology, Apple officials said board vendors will be able to release cards that are both PCI and QuickRing compatible (see "QuickRing Gets Closer, Expands to Networking"). Apple's current midrange and high-end computers use the NuBus expansion-bus technology. Apple says it will continue to support and build systems based on NuBus. The first PowerPC systems, slated for release in the first half of 1994, will also be NuBus-based. But Apple's goal is to support PCI in all its computers, says Ross Ely, Apple's product manager for the PowerPC.

How Apple will phase PCI into its line of Macs and PowerPCs has not been finalized. "I don't know exactly how we're going to transition from NuBus to PCI," Ely said. He did say that Apple expects there will be a time period in which the company ships some systems that support NuBus and some that support PCI, and possibly systems that support both. But the future mainstream local bus for Apple is clearly PCI. "We expect to transition fully to PCI over a period of time," he said. "So obviously we don't want to have to support NuBus forever." —Dave Andrews

CONNECTIVITY

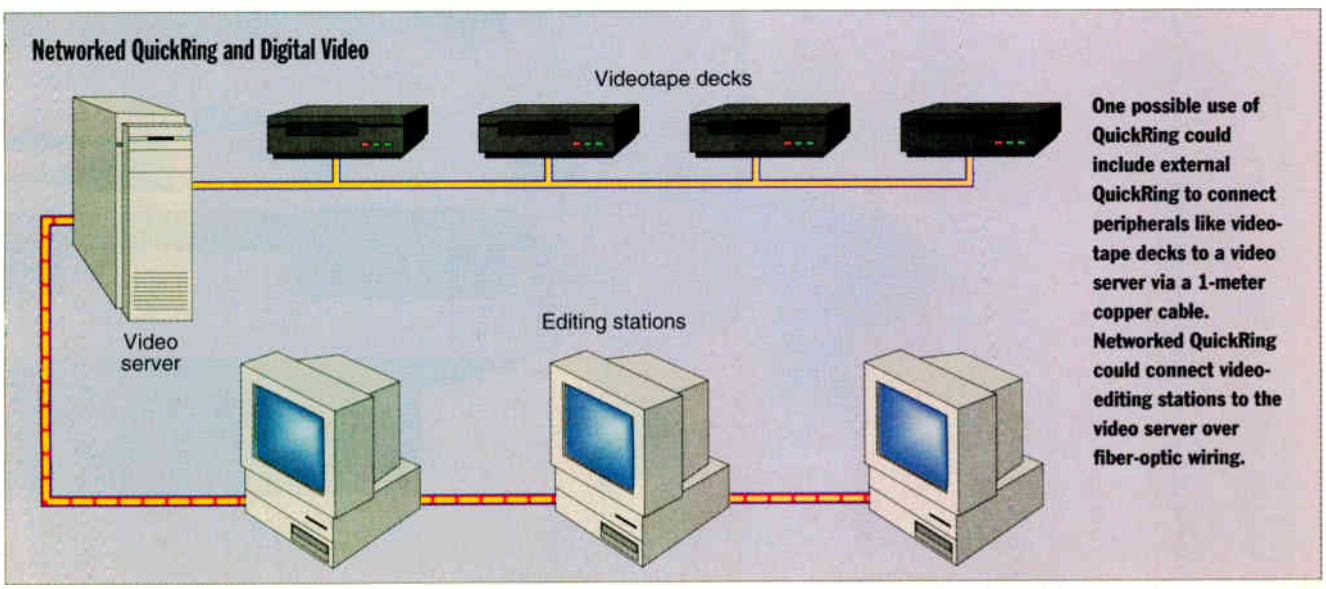
QuickRing Gets Closer, Expands to Networking

At next January's MacWorld Expo, the first products based on Apple's high-speed QuickRing local-bus technology should be introduced. According to Rod Williams, an independent consultant working for National Semiconductor, which is developing the QuickRing interface chip, the company expects to release hardware development kits in August or September for vendors who want to build QuickRing products. The first QuickRing silicon was due to begin sampling this month.

The core QuickRing technology consists of technology developed at Apple's Advanced Technology Group, Santa Clara–based National Semiconductor's controller chip, and a special connector manufactured by Beta Phase (Menlo Park, CA). A primary application of QuickRing is as a card-to-card auxiliary bus and not as a replacement for NuBus, PCI, ISA, Micro Channel, or any other PC expansion bus: QuickRing cards are connected within a system through dedicated cables attached at the top of the card. A group of QuickRing nodes can achieve multiple simultaneous and continuous data transfer rates of 180 MBps—much faster than the typical 450 KBps or so that you get from 10-Mb Ethernet networks.

Because QuickRing supports concurrent transactions, two cards can talk to each other through the dedicated cable and work on a heavy-duty processing task without consuming any cycles of the system's CPU. QuickRing's point-to-point ring-topology connection is well suited for prepress, digital video, and multimedia applications.

According to National Semiconductor, QuickRing will support three types of connections: internal connections for card-to-card applications; external connections to support linking of external peripherals, such as a printer to a QuickRing-based computer via a 1-meter-long copper cable; and networked connections, a future extension that will use fiber-optic media and hub technology to deliver QuickRing performance over enterprise-wide distances. Ideal applications for a QuickRing network would include delivery of digitized video from a media server to a QuickRing display card, Williams said. Companies are even looking at QuickRing as a vehicle for carrying ATM traffic, Williams said. Apple plans to promote QuickRing as a solution for the DOS/Windows market as well. —D. A.



One possible use of QuickRing could include external QuickRing to connect peripherals like videotape decks to a video server via a 1-meter copper cable. Networked QuickRing could connect video-editing stations to the video server over fiber-optic wiring.

Wake up and smell

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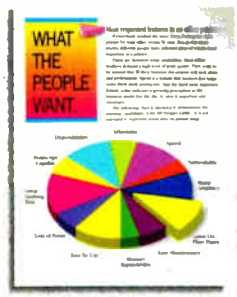
the future.



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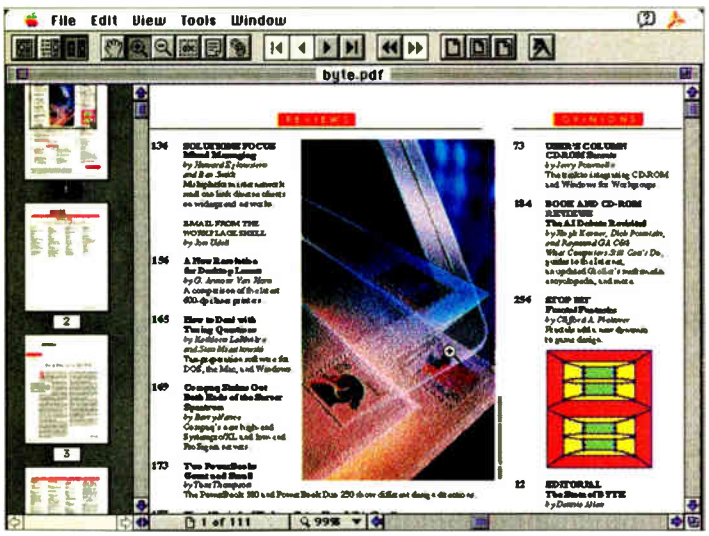

Acrobat will let publishers distribute electronic versions of their magazines. One potential problem: Designers optimize their pages for printing on paper, not computer screens.

You've heard it before: Instead of the magazine you are now holding, one day you may be reading an article like this on your computer screen. And if you do, it may be with the help of PostScript inventor Adobe Systems. With its recently released Acrobat software, Adobe promises us electronic publishing, a laudable intention in this age of shrinking global resources. But to succeed, Acrobat will have to perform a precarious balancing act: to optimize itself not only for printing on paper but also for displaying text on screens.

It is hard to avoid falling under the spell of Adobe's promise. BYTE was so impressed with a very early version at last November's Comdex that we awarded Acrobat the Best of Show award. To get your material into Acrobat format, all you have to do is print your document or publication to an EPS (Encapsulated PostScript) file. You then run this file through a Distiller program that compresses it, join the file to a 1.5-MB Acrobat reader program for either the Mac or a Windows PC, and distribute it to your audience. Your readers can then either read the documents on their computer screens or print them on their laser printers.

A recent beta version of the software, however, revealed that the execution may fall short of the intention. With its many years of experience with PostScript, Adobe appears to have focused on document printing at the expense of document display. Acrobat indeed does a superb job of printing. On the screen, however, the situation changes. Vector graphical images such as maps look impressive, but reading text on a typical screen with a resolution of 72 dpi strains the eyes. To read a document comfortably, you need to zoom in on it and then pan up and down the page—a laborious procedure for a two- or three-column document. For this reason, Acrobat may be better suited for in-house publishing of data like telephone lists and procedure manuals where the format is simple and readers can take advantage of its searching and hypertext capabilities.

Acrobat is available now for Windows and Macintosh systems at an attractive price of $195. Reader programs are priced at $50. Both these prices should decrease with increased volume. Adobe promises a DOS version later this year.

With the appearance of Acrobat, paperless publishing is a more crowded field. Folio (Provo, UT) has come out with a Windows version of its software that greatly enhances its ease of use. And NoHands Software (Belmont, CA) has just released a Mac program called Common Ground, with a Windows version scheduled for introduction soon. Both of these programs offer similar capabilities, albeit based on different technologies.

—Rich Malloy

PAPERLESS PUBLISHING PROGRAMS

COMPANY	PROGRAM	PLATFORM	PRICE
Adobe Systems	Acrobat	Windows, Mac, DOS	$195
Folio	Folio Views 3.0	DOS, Windows, Mac	$495
NoHands Software	Common Ground	Mac, Windows	$189

DOCUMENT IMAGING

Document imaging—the use of bit-mapped replicas of paper documents—was once a viable option only to large companies. Proprietary image-processing solutions are now seldom seen, and Microsoft Windows 3.1 and PC LANs have set the stage for open, and affordable, document-imaging systems. Even IBM's ImagePlus and former lone rangers Wang and Filenet tout open platforms and interoperability.

Today's single-user and small network systems from companies such as Westbrook Technologies (Westbrook, CT), Keyfile (Nashua, NH), Watermark Software (Burlington, MA), ImageFast Software Systems (McLean, VA), and Imara Research (Toronto, Ontario, Canada) have capabilities beyond those of the original enterprise systems. Price competition has become fierce—network versions can cost as little as $100 per seat, and stand-alone products are available for less than $200. Document-imaging systems are now attractive for companies of all sizes.

As enticing as the concept of the paperless office is, there are hurdles: Scanned documents take up storage space fast, and many images, particularly forms, are a challenge for an OCR package. A product called FormsOut from T.i.S. (Ramat Gan, Israel) lets you take the "form" out of form processing; that is, you can train the software to recognize certain forms and remove everything but the data.

The company's newest product, LineOut, removes lines from a form without training. According to Paz Kahana, vice president, marketing and sales, at T.i.S., a document with lines has an OCR accuracy rate of about 12 percent; without lines, the OCR rate is more than 90 percent. Also, the T.i.S. software turns a 50-KB form into a 2-KB document, according to Kahana. That may not seem substantial until you consider the billions of forms generated by organizations like the IRS. In such a scenario as the IRS, compression is an absolute necessity.

—Gordon E. J. Hoke and Dan Muse

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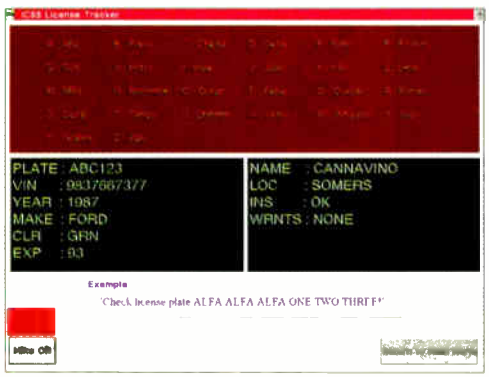
VOICE PROCESSING

IBM and Apple Work to Perfect Voice Input

Computers that can flawlessly process and understand a wide variety of spoken commands, no matter who the speaker or how heavy the accent, remain an elusive goal for PC manufacturers. However, companies such as IBM, Apple, and others are hard at work perfecting technologies that let users interact with their PCs through natural, conversational spoken commands instead of the keyboard.



Instead of typing in a license plate number, a police officer could query a remote database by talking to a computer running an ICSS-based program.

IBM recently disclosed progress it has made on its ISSS (IBM Speech Server Series), which lets you have a true working dialogue with your PC after you've "trained" it to recognize your specific accent and style of pronunciation. IBM has already begun shipping a product in the ISSS family called TangOra that requires a powerful RS/6000 workstation as a server. But thanks to better algorithms and other programming improvements, IBM has been able to bring the ISSS technology down to a standalone 50-MHz 486 system with a supporting DSP (digital signal processor).

In a recent technology demonstration, IBM showed a PS/2 running an OS/2-based program called TangLite that opened applications, accurately transcribed speech into text, and dragged windows across the system's screen, all through spoken commands. Once you have trained TangLite, it can take dictation at about 70 words per minute with 97 percent accuracy, IBM claims. TangLite is not yet a shipping product, however, and IBM officials say they haven't determined when TangLite will be available commercially.

The company is closer to shipping another product, called ICSS (IBM Continuous Speech Series), for developers who want to speech-enable their OS/2 and AIX applications. Unlike ISSS, ICSS is a speaker-independent technology, which means you don't have to train it to recognize your voice or accent. Because applications using ICSS technology can hold only a 1000-word dictionary in memory at a given time, ICSS is not suitable for developing applications that transcribe spoken dictation. However, developers can program ICSS-based applications to rapidly switch word contexts on the fly so that a speaker-independent application can recognize several thousand spoken words.

Versions of ICSS for developers should ship this summer on OS/2 and AIX at prices ranging from $299 to $3995. A version of ICSS for Windows should begin beta testing this summer, IBM officials say.

Researchers at Apple Computer are commercializing speaker-independent, continuous-speech technology codenamed "Casper." The first implementation of Apple's speech-recognition technology will likely be released this summer as a Mac OS extension.

But the state of speech recognition on the desktop today is still far from perfect. Some systems, like IBM's ISSS, do an admirable job of accurately taking dictation, but you have to give it several hours to build a model of your voice. Others can accept spoken commands from almost anybody but can recognize only a few hundred words in a given context. To date, the two technologies have not met.

—Dave Andrews

THE BEST OF COMDEX/SPRING 1993

Twice a year, BYTE editors roam the aisles of Comdex in search of the most significant new products and technologies. At May's Spring Comdex in Atlanta, BYTE editors deliberated long and hard before selecting 11 winners from the hundreds of products nominated. Normally, not much good can come from locking 17 BYTE editors in a closed room, but in this case what emerged were a handful of new products and technologies that stood above the hundreds introduced at Comdex.

Best of Show
Microsoft Windows NT
Runner-Up: IBM PowerPC 601 Microprocessor

Most Significant Technology
IBM PowerPC 601 Microprocessor
Runners-Up: IBM Unconstrained Cursive Handwriting; IBM Speech Recognition technologies

Best Applications Software
Lotus 1-2-3 release 4 for Windows
Runners-Up: WordPerfect 6.0 for DOS; Xerox Imaging Systems TextBridge

Best System Software and Tools
Microsoft Windows NT
Runners-Up: IBM OS/2 2.1; Microsoft Visual Basic 3.0

Best System
ALR Evolution V and Evolution V-Q
Runners-Up: NCR 3360; AcerFormula 4000/4400

Best Portable
Hewlett-Packard HP 100LX
Runners-Up: Altima Traveler; Toshiba Satellite T1900C

Best Peripheral
Matrox MGA
Runners-Up: Diamond Computer Systems Viper PCI; Verbex Voice Systems Speech Commander Portable

Best Printer
Star Micronics America SJ144
Runners-Up: Hewlett-Packard DeskJet 1200C; Fargo Electronics Primera Color Printer

Best Connectivity Product
Delrina WinFax Pro for Networks
Runners-Up: Delrina FormFlow; Shany AlertView 2.0

Best Multimedia Product
IBM Multimedia Server/6000
Runners-Up: Gravis UltraSound Max with 3D; IBM Ultimedia Manager/2

Best Rookie
Fargo Electronics for Primera Color Printer

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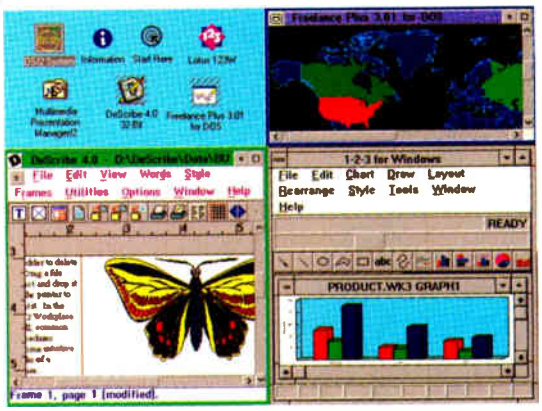

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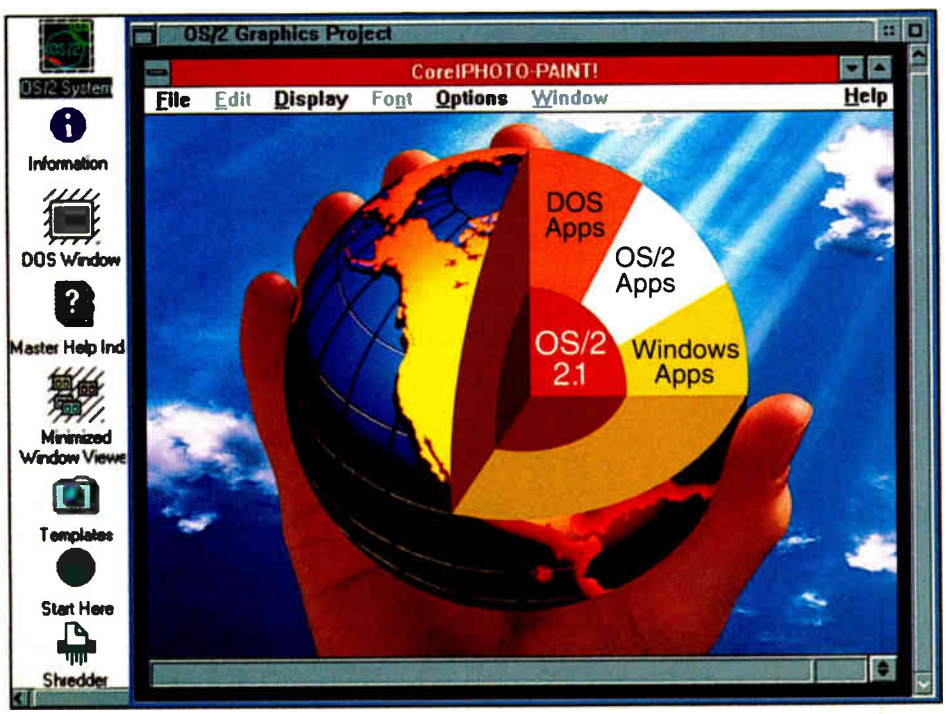

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- Now also available on CD-ROM.
- Object-oriented Workplace Shell interface.

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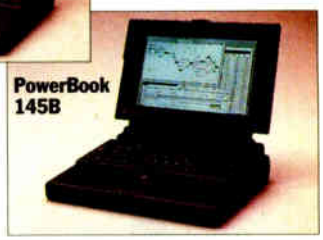
PORTABLES

The PowerBooks of Summer



This summer, Apple introduced two slick new PowerBook models, aimed at the bottom and top of the notebook computer market.

At the high end is a notebook that serves up hot color. The PowerBook 180c is the long-awaited PowerBook with a 256-color active-matrix LCD screen. Under the skin, the 180c has a 33-MHz 68030 processor, a 68882 FPU, RAM expandable to 14 MB, and an external video port that supports an extra monitor—the same as a PowerBook 180. The 180c has an 8.4-inch-diagonal active-matrix LCD with a 640- by 480-pixel screen. While this is physically smaller than the PowerBook 165c's 9-inch-diagonal passive-matrix screen, the 180c's higher 92-dot-per-inch density crams more pixels into the same space. The active-matrix screen makes the 180c a millimeter thicker than the PowerBook 165c, and the new computer's weight is 7.1 pounds. Battery life is estimated at 1 to 2 hours.

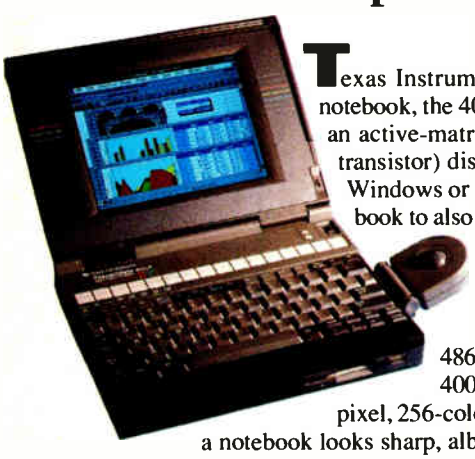
The screen of the 180c I saw had crisp, gorgeous colors, with none of the display artifacts that mar the 165c's screen. The preliminary BYTE low-level benchmarks indicate that the 180c is comparable to the 180. The 180c's display uses the same design as the 165c's—a DRAM-based frame buffer that hampers screen performance. However, a side-by-side comparison of a 165c and a 180c redrawing a complex piece of color artwork in Illustrator 3.2 showed that the latter's active-matrix screen was nearly twice as fast. This observation is confirmed by the BYTE low-level benchmarks. A PowerBook 180c with 4 MB of RAM and an 80-MB hard drive costs $4159, and one with a 160-MB hard drive costs $4519.

At the low end is the PowerBook 145B, a 68030-based Mac notebook priced for the masses: A system with 4 MB of RAM and a 40-MB hard drive costs $1649, and one with 8 MB of RAM and an 80-MB hard drive costs $1899. The 145B is essentially a clone of the PowerBook 145 with a 25-MHz 68030 processor, no FPU, and a black-and-white 640- by 400-pixel passive-matrix LCD screen. The preliminary BYTE low-level benchmarks show that the 145B is indeed as fast as a 145. The 145B's main logic board now has 4 MB soldered on it (the 145 had only 2 MB), allowing an easy upgrade to a maximum of 8 MB of RAM. To cut system costs, the 145B ships without an external microphone and system software floppy disks. System 7.1 comes installed on the hard drive, and a single utility floppy disk lets you back up files and boot the computer in an emergency.

—Tom Thompson

Apple Computer, Inc., Cupertino, CA, (408) 996-1010.

TI Delivers Speed and Color



Texas Instruments' latest TravelMate notebook, the 4000E, is also its first with an active-matrix-color, TFT (thin-film transistor) display. Travelers who use Windows or those looking for a notebook to also serve on the desktop will find the 4000E's graphics speed and quality impressive.

Based on a 50-MHz 486DX2 processor, the $4999 4000E provides 640- by 480-pixel, 256-color VGA resolution that in a notebook looks sharp, albeit cramped (the display measures 8½ inches diagonally). Even more significant than the display quality is the graphics speed of the 4000E, which relies on a TI-designed ASIC (application-specific IC), a high-speed video bus, and 1 MB of video RAM. With a standard Windows VGA driver, the 4000E posted a graphics score that was 3½ times faster than that of our baseline Compaq Deskpro 386/33L.

With the battery installed, the 4000E weighs 6.2 pounds (TI's monochrome 50-MHz 486DX2 TravelMate weighs 5.6 pounds). TI's energy-conserving software compensates for the power appetites of both the 50-MHz processor and the color display. Our battery tests, which simulate real-world use, ran for 3 hours.

Standard is a 200-MB Seagate hard drive, with Windows 3.1 and DOS 6.0 installed. Options include an Ethernet adapter ($469) and a 14.4-Kbps modem with 9600-bps fax ($599). **—Alan Joch**

Texas Instruments, Austin, TX, (214) 995-2011.

SPARCBOOK 2: UNIX ON THE ROAD

Moving a Sun SparcStation around is no fun. Even the small SparcStation IPC has cables, a CPU box, a hefty monitor, and usually a secondary external storage unit. With Tadpole's new SparcBook 2, everything you need is packed into a 7-pound notebook, including an integrated 640- by 480-pixel TFT (thin-film transistor) color LCD flat-panel screen and an internal V.32 9600/V.42bis modem. Thanks to its 40-MHz Cypress CY6111 SPARC MCM (Multichip Module) technology, the performance is roughly twice that of a Sun SparcStation 1.

On the downside, the SparcBook 2's power comes at a significant price: It will run off its internal batteries for less than an hour, and you will end up paying $10,950 for the minimum configuration with 16 MB of DRAM and 250 MB of disk storage. At the high end, with 32 MB of DRAM and 500 MB of disk storage, the price jumps to $14,600.

On the upside, the SparcBook 2 is a high-performance laptop that can run 5000 application programs for SunOS 4.1.2 or, optionally, Solaris 2.1. Nearly 30 MIPS in a laptop is impressive, but it may seem less impressive when we see PowerPC and Mips 4000 laptops in early 1994.

—Ben Smith

Tadpole Technology, Inc., Austin, TX, (800) 232-6656 or (512) 219-220. International: Tadpole Technology PLX, Cambridge, U.K., +44 223 250030; Tadpole Technology SA, Evry, France, +33 1 60 86 27 92.

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PROCESSORS

Intel Overhauls the 486

Intel's recently announced group of 486SL Enhanced microprocessors extend SL-style power management across the entire 486 line and will eventually replace today's 486DX, 486SX, 486DX2, and 486 OverDrive chips. They also make it easier for system designers to follow the U.S. government's Energy Star guidelines. By the end of the year, power management will be a common feature in desktop computers as well as portables.

In all, Intel (Santa Clara, CA) has announced 10 different 486SL Enhanced processors (see chart), not counting packaging variations. They range from 3.3- and 5-V versions of the 25-MHz 486SX to a 5-V, 66-MHz, clock-doubled 486DX2. All but one are direct replacements for existing 486 chips; the exception is a 3.3-V, 40-MHz, clock-doubled 486DX2 for laptops.

Production began in June, except for the 50-MHz 486DX and 66-MHz 486DX2, which are scheduled to ship in the third quarter. Later this year, Intel says it will introduce a 3.3-V version of the 50-MHz 486DX2 and a 100-MHz processor.

The new chips are pin-compatible with existing 486 parts, deliver identical performance, work equally well in systems without power management, and cost exactly the same as existing 486s. Most of the forthcoming "green PCs" will use the new Intel chips, as well as compatible processors from Advanced Micro Devices (Sunnyvale, CA) and Cyrix (Austin, TX). All three companies offer chips with a similar range of power-conservation features: SMM (System Management Mode), which allows the CPU to shut down subsystems during idle periods; suspend modes that put the CPU to sleep by slowing or stopping the clock under hardware or software control; and fully static cores that retain information when the CPU is suspended and reawakened.

Cyrix includes these features in its 486SLC/e, 486S, and 486S2 chips; the 486SLC has a static core and suspend modes, but no SMM. The AMD 486DXLV-33 also has a full complement of power-management features. In July, AMD was expected to announce a new series of 486-compatible processors that will have power management.

Intel's clock-doubled 486SL Enhanced chips introduce a new power-saving mode called Auto Idle that's not found in competing chips. Clock-doubled DX2 processors normally run their internal clock at twice the speed of their I/O bus; for example, a 486DX2-66 runs at 66 MHz internally and 33 MHz externally. The 486SL Enhanced versions of the DX2 can slow the internal clock to match the bus speed during I/O operations, conserving power while the CPU is waiting for data over the bus.

Because all these low-power chips can switch in and out of their suspend modes almost instantly, it's possible for the CPU to sleep between keystrokes as you type and then wake up when the next key is pressed. This "active" power management conserves electricity even during normal use.

The power saved by suspending a CPU chip is small compared to the energy conserved by shutting off such devices as screens. Still, it offers another way for desktop PCs to minimize electric bills.

— Tom R. Halfhill

INTEL'S ENERGY-SAVING PROCESSORS

486SL ENHANCED CPU	VOLTAGE	CPU FREQUENCY (MHZ)
486DX2	5	50, 66
	3.3	40*
486DX	5	33
	5	50
	3.3	33
486SX	5	25, 33
	3.3	25, 33

* The 3.3-V 40-MHz CPU is new to Intel's 486 family.

All Intel 486 CPUs will include SL-enhanced technology. Power management features of the enhanced chips will allow system vendors to go beyond simply powering down the monitor and system during periods of inactivity.

NETWORK PRINTING

VPT Offers Many Printers from One

Dataproducts (Woodland Hills, CA) hopes to make network printing more customizable for users and more manageable for network administrators through its Virtual Printer Technology, which enables a single printer to act as 64 virtual printers for individuals or workgroups. Dataproducts' LZR 1580 and LZR 2080 are the company's first laser printers to use VPT.

According to Dataproducts' director of strategic marketing and product planning Allen Russ, VPT is best suited for enterprise-wide networks running multiple concurrent protocols. VPT supports Novell IPX, Unix TCP/IP, Apple EtherTalk, and DEC LAT (Local Area Transport) through one Ethernet connection. Dataproducts showed BYTE VPT operating over a DEC MicroVAX, a Sun Sparcstation, a Compaq PC running NetWare, and a Mac running over EtherTalk.

The LZR 1580 and 2080 represent only the first of Dataproducts' network laser printers to support VPT. It's also "highly likely that you will see printers from other manufacturers using this technology in this calendar year," according to Russ.

VPT is ideal for companies that have, for example, a graphics department that needs high-resolution PostScript output running Macs over EtherTalk and an accounting department running over Novell IPX that needs access to 11- by 17-inch paper. Stir Unix workstations and VAX terminals into the network mix, and VPT becomes even more appropriate.

—Dan Muse

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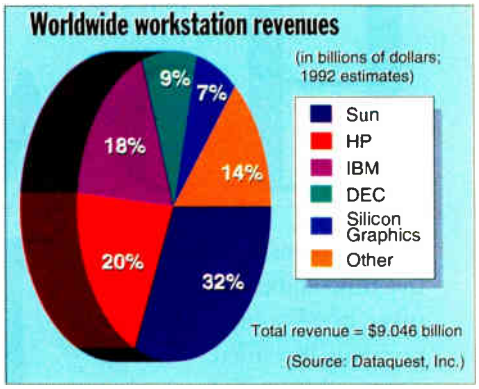
OPERATING SYSTEMS

HP Embraces NextStep for PA-RISC



In what may be viewed as a possible last-gasp effort to stave off extinction, Next Computer (Redwood City, CA) has teamed up with computer giant Hewlett-Packard (Palo Alto, CA) to offer the highly regarded NextStep object-oriented applications development environment on HP's PA-RISC Unix-based workstations and servers.

Next, the struggling eight-year-old workstation venture founded by former Apple wunderkind Steven P. Jobs, wants to convince potential users that its strategy of concentrating on marketing its NextStep software environment will pay off. Earlier this year, Next decided to exit the workstation hardware business, laying off more than half its work force, in hopes of selling its hardware design and manufacturing center to longtime partner Canon.

"We just dropped the risk [of using NextStep] by dropping the $10,000 price, and now it's only $795."

Next Chairman and CEO Steve Jobs

Jobs claimed that Next has an installed base of 50,000 workstations and that the company has 40,000 signed orders in hand for delivery of its software over the next year. However, Jobs pointed out that as a software company Next has no revenues and is not profitable.

HP, which is fighting a hotly contested workstation battle with market leader Sun Microsystems (Mountain View, CA), needs Next to help push into certain applications—particularly the financial segment, where Sun has dominated. Ruann Ernst, HP's director of industry marketing, said that HP's large corporate customers have been clamoring for a solution like NextStep on HP's RISC workstations. "The power of the technology to solve problems for large corporations is here," said Ernst. "The stuff is here today, and people are anxiously looking forward to it," said Ernst.

In Next's partnership with HP, the two companies intend to target mutual corporate customers with a suite of software for workstations and series called Object* Enterprise. This software suite includes Next's NextStep release 3.1 object-oriented software, which is expected to be ported to the HP Apollo 9000 Series 700 workstations in mid-1994. Object*Enterprise also includes Next's PDO (Portable Distributed Objects), a system for deploying object-oriented applications across networks of HP 9000 Series 800 servers running HP-UX, and Next's Netinfo network management servers for the Unix-based Series 800 servers. Both are planned for delivery later this year.

Although the NextStep software environment has always garnered technical accolades, some observers now openly question Jobs's strategy and his company's viability. Aside from the HP alliance, Jobs also gained significant endorsements from large vendors of Intel Pentium– and 486-based systems, which will now either resell or market NextStep 3.1 for Intel processors that began shipping in late May. Among Jobs's backers for Intel platforms are Compaq , DEC, Data General, Dell, NCR, Epson America, HP, NEC Technologies, and Siemens Nixdorf.

—Patrick Waurzyniak

PROCESSORS

CIRRUS LOGIC DEVELOPS 64-BIT GRAPHICS ACCELERATOR CHIP

Keeping pace with today's newest Intel Pentium–based systems, Cirrus Logic (Fremont, CA) has designed a VGA-compatible 64-bit graphics chip that is expected to show up later this year in ISA, VESA (Video Electronics Standards Association) VL-Bus, and PCI-based systems, as well as in add-on graphics cards priced around $300.

Cirrus's new Alpine family of GUI accelerators uses only DRAMs initially, although the company plans to add higher-performance VRAM-based (video RAM) solutions later this year. The first accelerator chip, called the Alpine CL-GD5434 controller, is expected to offer performance that at least doubles that of Cirrus's fastest 32-bit graphics chip.

The Alpine family features a 64-bit GUI accelerator with an integrated DAC (D/A converter) and a programmable dual-clock synthesizer. The chip has a 64-bit bit-block-transfer (BitBlt) engine with 64-bit internal data paths, and it connects directly to local-bus architectures, including the VESA VL-Bus and the Intel PCI bus. The CL-GD5434 is capable of resolutions of up to 1280 by 1024 pixels in 64,000 colors interlaced, and 800 by 600 pixels in 16.8 million colors noninterlaced.

Cirrus's new chip family, which incorporates mixed-signal technology acquired from the Acumos chip-design house that Cirrus bought last year, boasts several advances over older graphics-accelerator designs, according to Jon Peddie, president of graphics consulting firm Jon Peddie Associates (Tiburon, CA). "It has a built-in frequency solver, so literally all you need to have to make a board is four memory chips and a ROM BIOS, and you've got a powerful graphics solution," Peddie said.

This month, Cirrus will begin sampling the CL-GD5434 chip. It's priced at $38 in quantities of 1000 and is targeted for volume shipments to OEM customers by Fall Comdex. Cirrus plans to introduce by December a total of five controllers in the Alpine family; some will use VRAM rather than the less expensive DRAM, said Brent Wientjes, Cirrus's director, desktop graphics. Wientjes said board-level implementations will cost about $300.

Besides alleviating bottlenecks with the fully 64-bit internal architecture, Cirrus also incorporated its own LUT (lookup table) DAC in the chip's design. The DAC is so small that in a motherboard-based design it would use up about the amount of space needed for a business card. "It eats up very little space, and that'll help board makers," noted Peddie.

—P. W.

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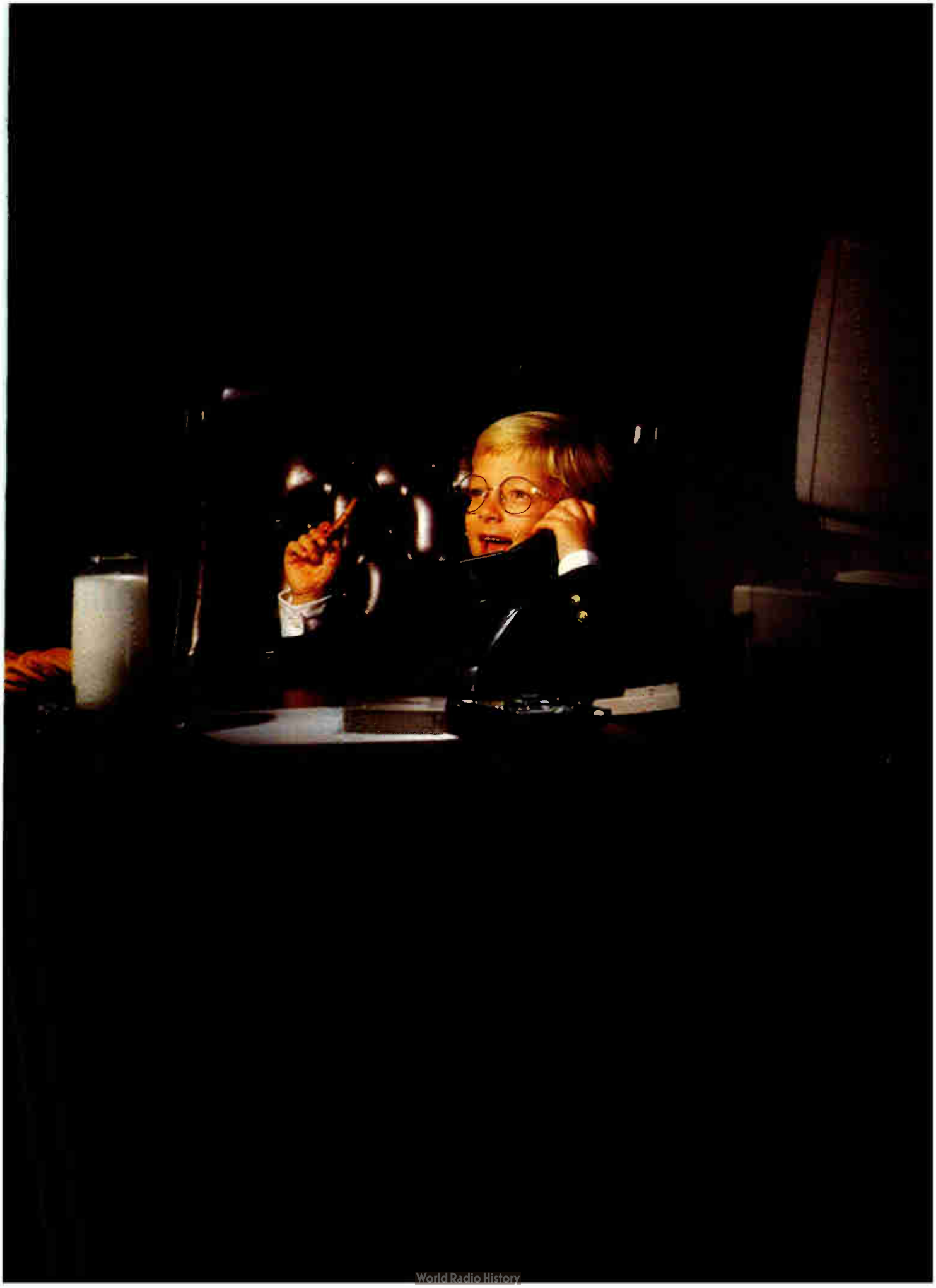
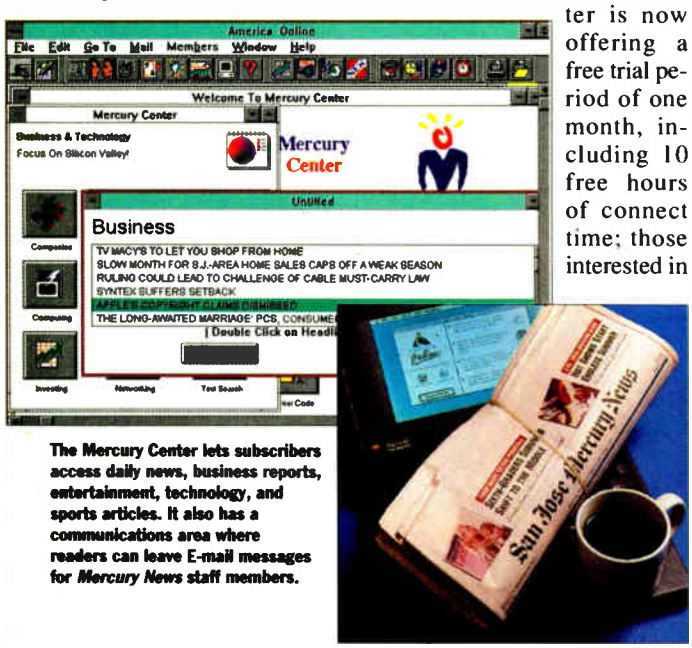


ELECTRONIC PUBLISHING

All the News That Fits On-Line

An on-line version of the *San Jose Mercury News* is now offering information addicts another medium from which to get their fix of the latest news and sports—delivered straight to their computer screens.



The Mercury Center lets subscribers access daily news, business reports, entertainment, technology, and sports articles. It also has a communications area where readers can leave E-mail messages for *Mercury News* staff members.

Part of a service accessed through America Online (Vienna, VA), the Mercury News' Mercury Center project has been deemed an experiment in testing consumer acceptance of on-line newspaper delivery. The Mercury Center, which is similar to the Chicago Online service offered by the Tribune Co. (Chicago, IL) via America Online, tries to take the bulletin-board approach a step further by using the graphical interface of America Online for Macs and Microsoft Windows–based PCs.

Basic charges for Mercury Center are $9.95 per month, which includes 5 hours of connect time. Each additional hour costs $3.50. Users can also research back issues of the *Mercury News*, which are available dating back to 1985, at charges ranging from $48 per hour during prime time (6 a.m. to 6 p.m. weekdays) and $6 an hour at other times. The Mercury Center is now offering a free trial period of one month, including 10 free hours of connect time; those interested in ordering the service can call (408) 297-8495.

With the Mercury Center, users can access the daily's general news articles, business and technology reports, sports, entertainment, and Bay Area Living sections. Another important feature is the capability to search for additional information by a code number that is printed at the end of some stories. For example, you can use Mercury Center to obtain information such as a senate-hearing transcript.

Although many newspapers have struggled with the looming threats of both the electronic media and the even-newer electronic-based information systems, some newspapers have seen on-line delivery of newspapers as the wave of the future. Of the 1570 daily newspapers in the U.S. last year, only 13 dailies have offered some on-line service, most being somewhat primitive text-based, bulletin-board types of systems, according to Randy Bennett, program manager, new technologies, for the Newspaper Association of America (Reston, VA).

Most newspapers' on-line delivery services are positioned as experiments. "[Mercury Center] is a very interesting experiment. It's ambitious, and it's pretty innovative. I don't have a sense that it's going to be a wild success, but then I'm not sure anybody knows how they're going to react to it," said Bennett. Newspapers receive about 80 percent of their revenue from advertising. But now, Bennett says, "this is asking the subscriber to pay for the information."

—Patrick Waurzyniak

SYSTEMS

Apple's Educational Mac

Apple's latest desktop Macintosh, the LC 520, will initially be sold only to schools—but it sports some interesting features that are likely to appear in future Macs. Among other things, the LC 520 is the first Mac to come standard with a CD-ROM drive, internal stereo speakers, modular plug-and-play components, and a built-in 14-inch color monitor. Although Apple won't rule out the possibility of introducing the machine through normal channels, for now it's available only to the educational market.

Schools prefer one-piece computers, says Apple, so the LC 520 puts everything into a single one-plug box. The front panel has push-button brightness and volume controls, a headphone jack, and a microphone. Phase-shifting circuits enhance the stereo effects of the internal speakers. The CD-ROM is a double-speed drive that transfers data at 300 KBps. The 640- by 480-pixel screen is 4 inches larger than a Color Classic's and displays up to 32,768 colors. It qualifies for an Energy Star rating by shutting down after a predetermined period of inactivity, cutting power consumption by 50 percent.

Schools also like computers that are easily repaired, so most of the major components in the LC 520—including the motherboard and disk drives—can be swapped without tools. The slide-out motherboard is the same size as the Color Classic's but is otherwise equivalent to the LC III's. It has a 25-MHz 68030 CPU, 72-pin SIMM slots for up to 36 MB of RAM, and a 114-pin Processor Direct Slot that accepts PDS boards made for other LC-series machines. The BYTE preliminary low-level benchmarks showed the LC 520 to be comparable to a IIci and LC III.

An LC 520 with 5 MB of RAM and an 80-MB hard drive is priced at about $1600. Other configurations have 8 MB of RAM and 160-MB hard drives.

—Tom R. Halfhill

Contact: Apple Computer, Inc., Cupertino, CA, (408) 996-1010.

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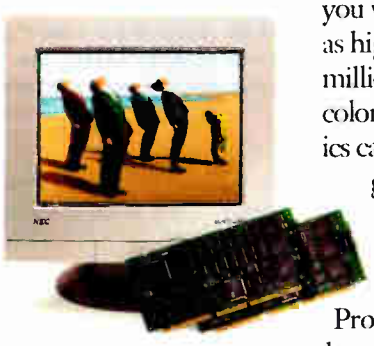

MEDIA VISION

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SYSTEMS

NEC's Pentium-Optimized Image P60

System vendors have a variety of options with which they can introduce Pentium systems to their PC lineup, ranging from Pentium OverDrive designs to systems designed from the ground up to optimize the Pentium. NEC Technologies (Boxborough, MA, (508) 264-8000), like several other PC vendors, is designing systems that use both options. The company's existing Image Series of PCs offers a migration path to the Pentium via a 238-pin ZIF (zero insertion force) socket that will accept a Pentium OverDrive chip, expected to be available from Intel next year. NEC also plans to start shipping its first native Pentium processor–based desktop system, the 60-MHz Image P60, in August. Based on our tests of a preliminary Image P60 system, NEC appears to have a solid contender for the Pentium desktop market.

The Image P60 offers PCI support and a 64-bit data path from the Pentium CPU to memory.

The Image P60's design has a 64-bit path from the Pentium CPU to the secondary cache to memory. With its native 64-bit design, 70-ns-SIMM memory-expansion options of up to 128 MB, 256-KB secondary cache, support for PCI (Peripheral Component Interconnect) local bus and Fast SCSI II, an IDE controller, and an A/D stereo codec for business audio integrated on its motherboard, NEC's Image P60 wields a feature set and performance that you'll see in other vendors' Pentium offerings over the next few months. NEC says prices for the Image P60 will range from under $5000 to about $7500, depending on your configuration.

We tested an early preproduction version of the Image P60 that included two EISA slots, a shared PCI slot that accommodates either a standard EISA, ISA, Micro Channel, or PCI add-in board, and a PCI slot. The Image P60 is the first system that we tested with PCI, which many vendors believe will be the long-term industry local-bus solution. However, we were not able to test it with any PCI add-in boards, due to lack of availability.

We ran a variety of benchmarks on the Image P60. When we tested the Image P60, NEC's engineers were still perfecting and optimizing the system's performance. For example, the system we tested had a write-through secondary cache instead of the write-back cache that NEC will use in the production version. Performance will certainly improve in the commercial unit. Even so, tests that we ran indicate that the 60-MHz Image P60 enjoys about a threefold performance increase in executing integer instructions and a near-fourfold increase in floating-point instructions over a 66-MHz 486DX2-based system. If you are looking for an Intel-based PC to run heavy-duty CAD, spreadsheet, or video applications, the Image P60 will deserve a serious look.

—Dave Andrews

PENTIUM-OPTIMIZED COMPILERS

To test NEC's Image P60, we compiled BYTE's soon-to-be-released platform-portable benchmarks under both Borland's C++ 3.1 and Watcom's new C/C++ 32-bit compiler (version 9.5), which the company sells for $599. In both cases we generated 32-bit code; for the Borland compiler we generated a DOS executable file, while we configured the Watcom compiler to make an extended DOS executable file that could be run with the bundled Rational Systems DOS extender. Furthermore, we had the Watcom compiler generate two program files—one optimized for 386 instruction sequencing, and the other optimized for Pentium instruction sequencing.

The Watcom compiler performs "Pentium optimization" in a three-step process. The compiler decomposes complex instructions into simple instructions and then proceeds to reorder the simple instructions (if possible) for best scheduling through the Pentium's dual-instruction pipelines. Finally, the reordered instructions are recombined into complex instructions (this has the effect of compacting the code).

The results are summarized in the table, where we compare the performances of the Pentium machine and a 66-MHz 486DX2. Notice first that the floating-point improvements are higher, closing in on a fourfold increase in throughput. The Watcom compiler generated the largest boost in integer performance because the code running on the Pentium was also optimized for Pentium instruction timings. It appears that recompiled code can add a boost of somewhere between 30 percent and 40 percent.

PERFORMANCE BOOST: 66-MHZ 486DX2 TO 60-MHZ PENTIUM

	INTEGER	FLOATING-POINT
DOS low-level	2.8	3.9
Portable platform (Borland)	2.7	3.5
Portable platform (Watcom)	3.3	3.8

NEC's 60-MHz Pentium versus a 66-MHz 486DX2. The numbers represent the performance increase in going from the 486 to the Pentium. Integer instructions see a threefold speed increase, while floating-point instructions enjoy a near-fourfold increase.

One caveat: We did not include the string-move tests in our DOS low-level comparisons while testing the Image P60. The system we tested was an early engineering model with the level-two cache configured for write-through operation rather than write-back. The performance hit was severe on our string-move test, which would have skewed the results. You should bear this in mind as you examine the results in the table; it's certain that overall performance will improve when the machine runs with a write-back cache, although it's impossible to gauge precisely how much.

—Rick Grehan

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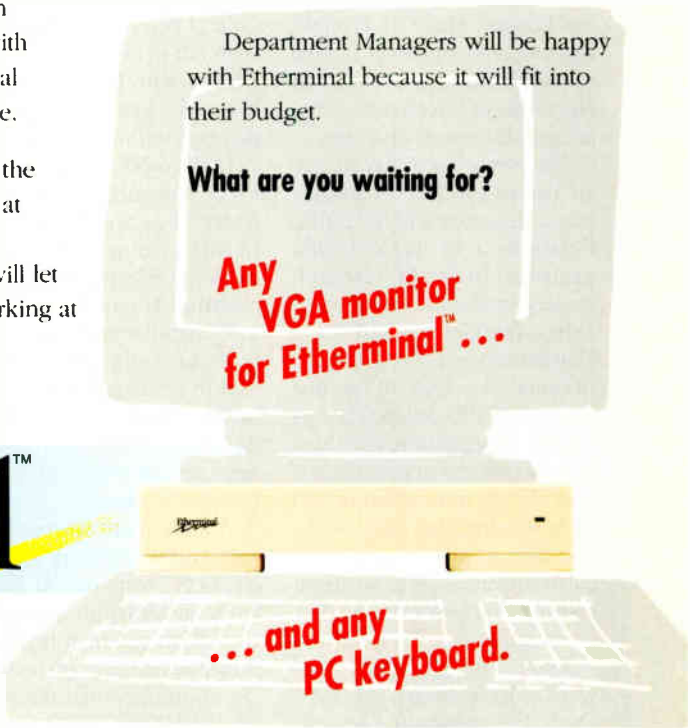

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IGEL

BOB RYAN

Europe's Research Initiative

Like a rite of spring, the world's leading IT (information technology) and communications-technology companies gather every March at CeBIT in Hannover, Germany, to show their wares and provide a glimpse of future technological directions. In many respects, CeBIT is like any other computer trade show, only bigger. In one respect, however, it is unique. It has Halle 22.

Halle 22 is devoted to providing display space to many of the basic research institutions that drive the industry forward. This year, in addition to showcasing IT research from individual institutions throughout Europe, Halle 22 brought together representatives of nine research initiatives—called Networks of Excellence—that are pan-European in scope.

The Networks of Excellence are part of ESPRIT—short for Basic Research and Scientific Relations in IT, the umbrella designation for IT research projects under the direction of Directorate General XIII of the Commission of the European Communities. Each of the nine Networks of Excellence brings together a team of researchers in industry and academia and provides an infrastructure and common direction to its work. The nine networks are devoted to different areas of basic research in IT (see the accompanying list).

Typical of an ESPRIT Network of Excellence is NEOME (New Electroactive Organic Materials for Electronics). Chaired by Professor Giuseppe Zerbi of the Politecnico di Milano, NEOME members investigate the use of organic materials in nanostructures, optical devices, sensors, electro-optical and all-optical switches, and other information-processing and storage devices.

According to NEOME representative Professor Siegmar Roth of the Max Planck Institut für Festkörperforschung (Stuttgart, Germany), much of the research conducted under the NEOME umbrella will not see commercial applications for many years—if ever. Other research, however, does have short- to medium-term applicability in the commercial marketplace. For example, Roth points to the work of Professor G. Leising at the University of Graz. Leising is a leading researcher in the area of organic LEDs, which could lead to low-cost, low-emission color displays within a few years.

Unlike NEOME, the ESPRIT Network of Excellence on the Physics and Technology of Mesoscopic Systems—PHANTOMS for short—is examining the capabilities of more familiar materials, namely semiconductors. PHANTOMS ties together researchers investigating the physical limits of semiconductor devices, semiconductor epitaxy, and nanofabrication.

Another network busily investigating the very small is NEXUS (Network of Excellence in Multifunctional Microsystems), which brings together people who are researching multifunctional microsystems. NEXUS researchers investigate technologies that combine sensors or actuators with the electronics needed to control them on a single microelectronic device.

MANUEL KING © 1993

The Network of Excellence on New Electroactive Organic Materials for Electronics spans the continent and connects researchers at 12 locations in 10 countries. The European Community hopes that this interdisciplinary approach will accelerate the pace of technical innovation and enable European companies to better take advantage of research being done by European laboratories.

Just as the critical mass of computer and semiconductor companies in Silicon Valley helped propel the U.S. into the forefront of the personal computer revolution, the hope is that the Networks of Excellence—by creating "virtual" Silicon Valleys—can achieve a critical mass of expertise that will propel European companies into the forefront of technology innovation. ■

Editor's note: *For more information on the Networks of Excellence, contact the ESPRIT Information Desk, +32 2 235 1603, fax +32 2 235 3221, or through the Internet at Esprit_information_desk@eurokom.ie.*

Bob Ryan is a BYTE technical editor. You can reach him on the Internet at bryan@bix.com..

ESPRIT Networks of Excellence

- **Computational Logic** (COMPULOG)
- **Computing Architectures for Basic European Research** (CABERNET)
- **High-Temperature Electronics** (HITEN)
- **Information and Data on Open Media for Networks of Users** (IDOMENEUS)
- **Machine Learning** (MLnet)
- **Multifunctional Microsystems** (NEXUS)
- **New Electroactive Organic Materials for Electronics** (NEOME)
- **Physics and Technology of Mesoscopic Systems** (PHANTOMS)
- **Speech and Natural Language** (ELSNET)

SEE UPGRADABILITY IN A WHOLE NEW LIGHT.

Intel's OverDrive™ Processor technology represents a new upgrade philosophy. Based on a single chip form factor—not boards, or modules. It lets you add future processor technology to your current PC.

This second Technology Briefing will explain how our OverDrive Processor technology works.

SINGLE CHIP PROCESSOR UPGRADE.

Intel has designed its new microprocessor families to be upgradable with OverDrive Processors. To do this, OverDrive Processors are actually based on and designed in tandem with our latest microprocessors. To make OverDrive Processors compatible with the previous Intel microprocessors, they have been designed with a special external interface. This enables OverDrive Processors to plug directly into existing systems equipped with OverDrive Processor sockets. Once installed, they will increase application performance by 40 to 70%.

THE UPGRADE PATH.

The first OverDrive Processor is based on an Intel486™ DX2 CPU core. It upgrades your Intel486 SX or DX CPU-based system to near Intel486 DX2 performance. Pentium™ OverDrive Processors are under development for Intel486 systems and next-generation OverDrive Processors are already being designed for Pentium processor-based systems.

THE ENABLING TECHNOLOGY.

The core of every OverDrive Processor is a microprocessor, enhanced with new technology such as the DX2's "speed doubling" technology or the Pentium processor's "superscalar" technology.

This enhanced microprocessor core allows faster instruction execution without having to modify the external system clock speed or memory subsystem.

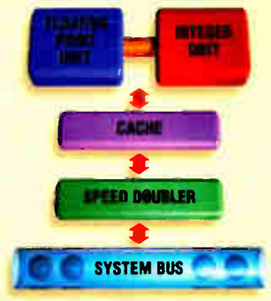
THE CACHE IS KEY.

Simply putting a faster processor core into a PC doesn't help much unless the system can supply enough data to keep it busy. That's why every OverDrive Processor also contains a large on-chip cache. The cache frees the OverDrive Processor to work independently of the memory subsystem. In fact, 90% of the time the cache contains the necessary instructions and data.

BIU CONNECTING THE PIECES.

The final component of an OverDrive Processor is the Bus Interface Unit (BIU). Its job is to transfer data between the OverDrive Processor and the external system in a way that is completely compatible with the original microprocessor. In addition, each BIU is designed to maximize system performance, based on the bus bandwidth of the original system and core microprocessor technology.

OVERDRIVE PROCESSORS



INTEL486 DX2 OVERDRIVE PROCESSOR FOR INTEL486 SX OR DX SYSTEMS.

TODAY'S i486 DX2 OVERDRIVE PROCESSOR COMBINES i486 TECHNOLOGY (AN INTEGER UNIT, A FLOATING-POINT UNIT AND AN 8K CACHE ON ONE CHIP), WITH SPEED DOUBLING TECHNOLOGY. FOR EXAMPLE, THE OVERDRIVE PROCESSOR DOUBLES THE INTERNAL OPERATING SPEED OF A 33-MHz INTEL486 DX CPU-BASED SYSTEM TO 66 MHz. AND WHILE THE CPU IS OPERATING TWICE AS FAST INTERNALLY, IT KEEPS ITS ORIGINAL EXTERNAL SPEED TO MAINTAIN SYSTEM COMPATIBILITY.

PENTIUM OVERDRIVE PROCESSOR ARCHITECTURE FOR INTEL486 SYSTEMS.

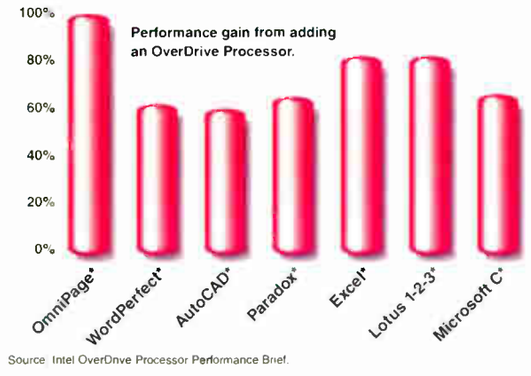
THE NEXT GENERATION PENTIUM OVERDRIVE PROCESSOR WILL USE PENTIUM PROCESSOR SUPERSCALAR TECHNOLOGY THAT EXECUTES TWO INSTRUCTIONS SIMULTANEOUSLY, A 16 KB ON-CHIP CACHE MEMORY, A REDESIGNED FLOATING-POINT UNIT CAPABLE OF ONE INSTRUCTION PER CLOCK CYCLE, WITH A BUS INTERFACE UNIT OPTIMIZED FOR A 32-BIT i486 CPU BUS.

SOFTWARE POWER.

The new "speed doubling" core of the Intel486 DX2 OverDrive Processor roughly doubles your original CPU performance. Overall, this translates into an application performance gain of 40 to 70% (see chart on the back page). Naturally, system bottlenecks such as disk drive accesses, bus bandwidth and graphics speed keep the i486™ DX2 OverDrive Processor from fully doubling system performance.

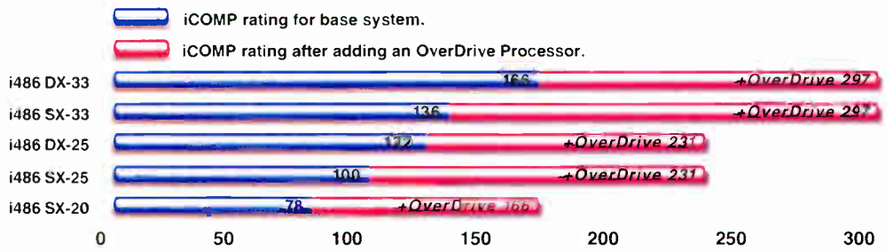
Intel486 DX2 OverDrive processor speeds up applications.

This chart represents the increase in performance with some popular software applications.



Source: Intel OverDrive Processor Performance Brief.

The Intel iCOMP™ Rating Index.*



*The iCOMP index is an Intel microprocessor "horsepower" rating. It is a composite of selected performance measurements from SPEC 92, ZD Bench and Whetstone. Source: iCOMP™: A Simplified Measure of Relative Intel Microprocessor Performance. Intel Corp., 1992

How do I get this technology?

Almost all Intel486 SX systems and most Intel486 DX systems can be upgraded with an Intel486 DX2 OverDrive Processor. For more information on how to upgrade your system, see your authorized Intel dealer. You'll find they have a ready supply of OverDrive Processors, as well as answers. Just look for the box below. And give your PC a mid-life kicker with an Intel OverDrive Processor.

For more information on upgradability, call 1-800-955-5599.

We're ready to supply you with all the additional information you need on OverDrive Processors: a performance brief, a system compatibility guide, a demo disk, and even a specsheet. Ask for literature package #68. Plus, we'll also be happy to send our first Technology Briefing on the Pentium processor. Remember, the information is free. So is the call.

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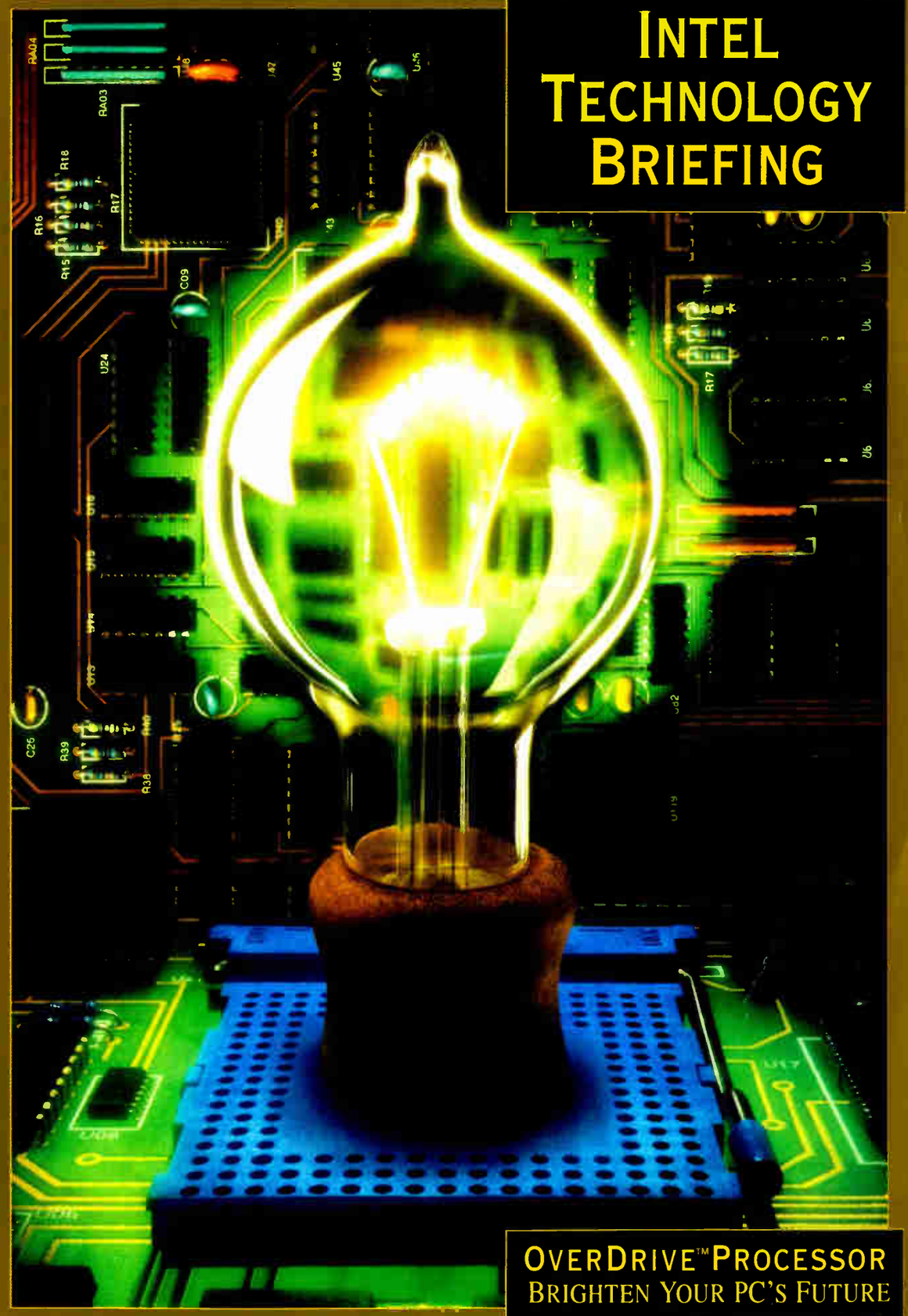
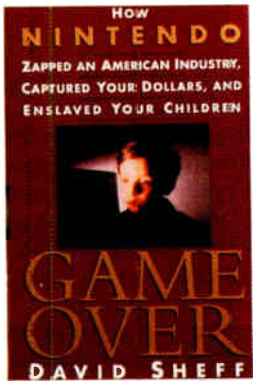


OverDrive™ Processor Brighten Your PC's Future

The Pocket Godzilla



HUGH KENNER

David Sheff's *Game Over* has a helpful subtitle: "How Nintendo Zapped an American Industry, Captured Your Dollars, and Enslaved Your Children." Indeed; and I was just starting to type this when the news broke that both Chelsea C. and her mother Hillary—you know them, their cat's name is Socks—have become "addicted" to Game Boy.

And Game Boy, what is that? A hand-held Nintendo product, powered by two AA batteries: "A tiny computer" meant to "create a viable software market all its own." It sells for $50, and its software capsules, each "the size of a saltine cracker," start at $25. Its launching in 1989 implemented a strategy to broaden the video-game market, at that time mostly boys eight to 13. For, reasoned one executive, "The thirteen year old boy will soon be fourteen years old and pass from our grip." Can't have that.

And Game Boy was just the ticket. "Game Boys were frequently seen in first-class compartments on cross-country flights, in corporate lunchrooms, and in desk drawers and briefcases. President Bush, in the hospital in May 1991, was pictured in newspapers commander-in-chiefing a Game Boy."

Successful hardware, yes indeed. But 100-million-unit sales such as Nintendo hoped for would depend on a killer game, and that proved to be the designed-in-Russia Tetris. One advantage of Tetris was a large monochrome screen; another was its indifference to the gender metaphors that make so many games boy-stuff. A must-have for Nintendo, clearly, except that the rights seemed to be sewn up. But Nintendo's agents and lawyers play such situations the way addicts play their games. The convoluted story makes a 50-page multinational saga.

Founded 104 years ago as a playing-card company in the gentle city of Kyoto, Nintendo (its three-character name means "Work hard, but leave the outcome to heaven") acquired about 1970 an ambitious new chairman resolved to pull it into the electronic century. So high-tech superseded cards. Meanwhile, canny executives hung around arcades, watching what worked. Part of Nintendo's secret lay in devoting much research to the nature of play.

What worked was a quick start: a game that had kids hooked within 30 seconds. Then the end of 2 minutes saw them fumbling for another quarter. When Nintendo moved arcade games into the parlor, the addictiveness came along. The revenues for Super Mario Bros. 3 alone have topped $500 million; among entertainments, only the movie *E.T. The Extra-Terrestrial* has grossed more. By 1991, Nintendo had surpassed Toyota as Japan's most profitable company. More than a third of the households in Japan and the U.S. have Nintendo machines. "When Apple Computer president Michael Spindler was asked in March 1991 which computer company Apple feared most in the 1990s, he answered, 'Nintendo.' "

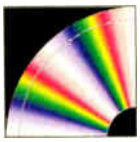
Too Briefly

The Oxford Dictionary of New Words has a page on *hack* you'll want to study. Elsewhere it reminds us that we don't normally speak of the *top* of the *lap*; no, *laptop* was formed by analogy with *desktop*. The book's scope is the last 10 years; its 2000-odd entries are leisurely and anecdotal (try *couch potato*). "Open this at your own risk," was another reviewer's warning. I concur. ■

GAME OVER
David Sheff, Random House, ISBN 0-679-40469-4, $25

THE OXFORD DICTIONARY OF NEW WORDS
Compiled by Sara Tulloch, Oxford University Press, ISBN 019-2830775, $10.95

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. You can contact him on BIX as "hkenner."



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Whether you're trying to find government funding for research or searching for the right federal database, Matthew Lesko's Information USA lets you quickly track down the information without making zillions of phone calls. Lesko is an expert on using the government as a source of information, and this CD puts his massive lists of federal resources in one place.

You can access the data by section. For example, Info-Power breaks down the data into topic areas like science and technology; health and medicine; arts and humanities; and economics, demographics, and statistics. Other sections are more targeted: Government Giveaways for Entrepreneurs, Federal Database Finder, and The Great American Gripe Book, which tells you who to call when you think you've been swindled.

Alternately, you can perform keyword searches. Instead of thumbing pages to find a contact at the Patent Office, what sort of assistance is available for women entrepreneurs, or where to complain about sleazy senatorial behavior, you simply search by keyword.

The navigation tools are adequate; nothing fancy. Likewise, the presentation is plain and simple.

Some information will appeal mostly to data junkies. Stroll through all this information, however, and you'll come across many interesting facts. For example, the agency that regulates emission standards for computing devices is the same one that handles complaints about dial-a-porn services (the FCC).

There are no guarantees that you'll always get satisfaction. To report a senator's impropriety, you call the Senate Ethics Committee. And the phone listed as the place to get the President's schedule rings and rings and rings. But at least you have the number to call.

As Lesko says, your tax dollars paid for all this information. This CD can help you sort through it.

—D. Barker

Books & CD-ROMs

OS/2 APPLICATIONS BY DESIGN

DESIGNING OS/2 APPLICATIONS by David Reich John Wiley & Sons, ISBN 0-471-58889-X, $34.95

A native OS/2 application program has no 64-KB segments, no 640-KB memory limitation, and no near and far pointers. Writing OS/2 software does, however, require a thorough understanding of multithreading, execution priorities, Workplace Shell objects, and the myriads of system calls available to a programmer. A few dozen pounds of IBM technical manuals provide the detail; David Reich's *Designing OS/2 Applications* supplies the concepts and fundamentals that are your road map to OS/2 programming.

Reich explains the features of OS/2 you can take advantage of and patiently describes how you can structure your computer program to behave well under OS/2. He helps you make a program CUA-compliant (Common User Access), so it will look its best. You learn guidelines for when and how to use DLLs, pipes, queues, semaphores, drag-and-drop, and other techniques. The book also provides an overview of the entire development process.

Designing OS/2 Applications encourages good programming habits, teaches you how to fine-tune your software for performance, and even gives you considerations for writing installation programs. It will help you keep your eyes on the forest while you're busy in the trees building logic and function.

—Barry Nance

ATTACK OF THE DOS 6 BOOKS

PETER NORTON'S DOS 6 GUIDE by Peter Norton Brady Books, ISBN 1-56686-045-8, $24.95

DOS 6 by Alfred Glossbrenner Random House Electronic Publishing, ISBN 0-679-74470-3, $24

DOS 6 HANDBOOK by Jack Nimersheim Bantam Computer Books, ISBN 0-553-37229-7, $27.95

RUNNING MS-DOS by Van Wolverton Microsoft Press, ISBN 1-55615-542-5, $24.95

With the advent of MS-DOS 6 comes the usual glut of aftermarket manuals, which generally come in two flavors: those dealing with only DOS 6, and general DOS references that have been updated to include DOS 6. Who needs these books? Can't you find all this information in the manual? Not necessarily, unless you buy a system with DOS 6 bundled. The DOS 6 upgrade package comes with an abridged manual that refers you to your old documentation or the on-line help system for anything beyond the very basics.

If you don't have your old documentation (I'll assume you're not running a pirated version of DOS), you need something like *Peter Norton's DOS 6 Guide*. In 708 pages, Norton does an admirable job of balancing thoroughness with lucidity. The book follows a fairly standard structure: a brief discussion of DOS and its features, sections on using the features, and a command reference section. This last section is more extensive than the usual "copied from the Microsoft manual" approach. It includes notes that you

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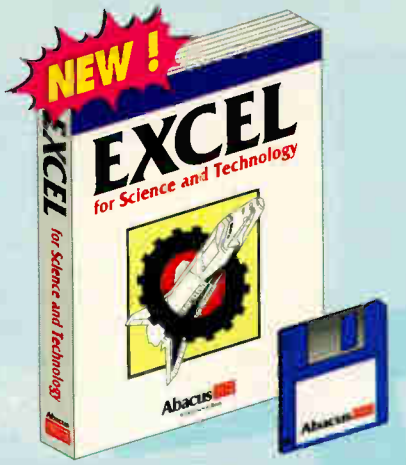

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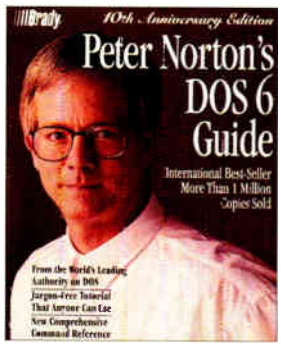


won't get from Microsoft, like a warning not to use the disk-compression utility (DoubleSpace) just to see if you like it, since there's no easy way to remove it once it's activated.

That kind of nonbiased commentary—maybe the main reason to buy a third-party DOS book—runs throughout Alfred Glossbrenner's 633-page *DOS 6*. While Glossbrenner's asides are often interesting, one might wish he'd left out his "12 Pillars of Wisdom" (including, "Don't let computing take over your life") and instead explained clearly that the new MOVE command does not move directories, despite what its name leads you to believe.

Nevertheless, Glossbrenner's discursive style reveals some gems, like the fact that DOS 6's new MSBACKUP doesn't support streaming tape drives. You won't find this troublesome unfeature mentioned in Jack Nimersheim's *DOS 6 Handbook*, an otherwise adequate book that doesn't appear to contain anything special to justify a higher cover price.

If you occasionally deal with older versions of DOS, you might want a general reference book that includes DOS 6. The leader of this pack is the new edition of Van Wolverton's *Running MS-DOS*. Like all such books, it has the problem of keeping the various DOS versions and commands straight, although Wolverton does a better job than the others.

If all you need is a good reference, you can get Microsoft's *MS-DOS Technical Reference* manual. It costs less than any of the aforementioned books ($20) and includes disks of supplemental programs. But don't look there for unbiased opinion or criticism.

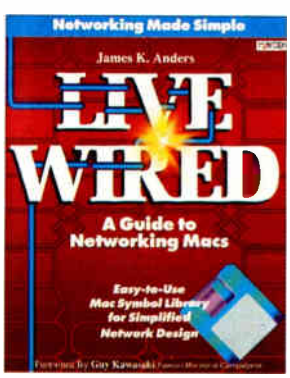
—Kenneth M. Sheldon

THE NETWORKED MAC

LIVE WIRED by James K. Anders **Hayden, ISBN 1-56830-015-8, $29.95**

Not long ago, all you needed to connect a bunch of Macs on a network was wiring and the ability to click on a few menus. If anyone suggested that you should learn about topologies and transport layers, you'd simply give that person a nasty look and suggest he or she go back to PCs.

The world has changed, however, and to help explain it all, there's *Live Wired* by James K. Anders. He starts at the beginning—explaining what a network is and how the different networking layers work together. By the time you get to the last chapter, you've been through Ethernet, talked TCP/IP, acquired backbones, stuck your fingers into sockets, and become a topology star. This book suits network novices and veterans alike.



Live Wired is a rare find—it's entertaining and fast-paced, yet it leaves you feeling totally connected to your Macintosh.

—Howard Eglowstein

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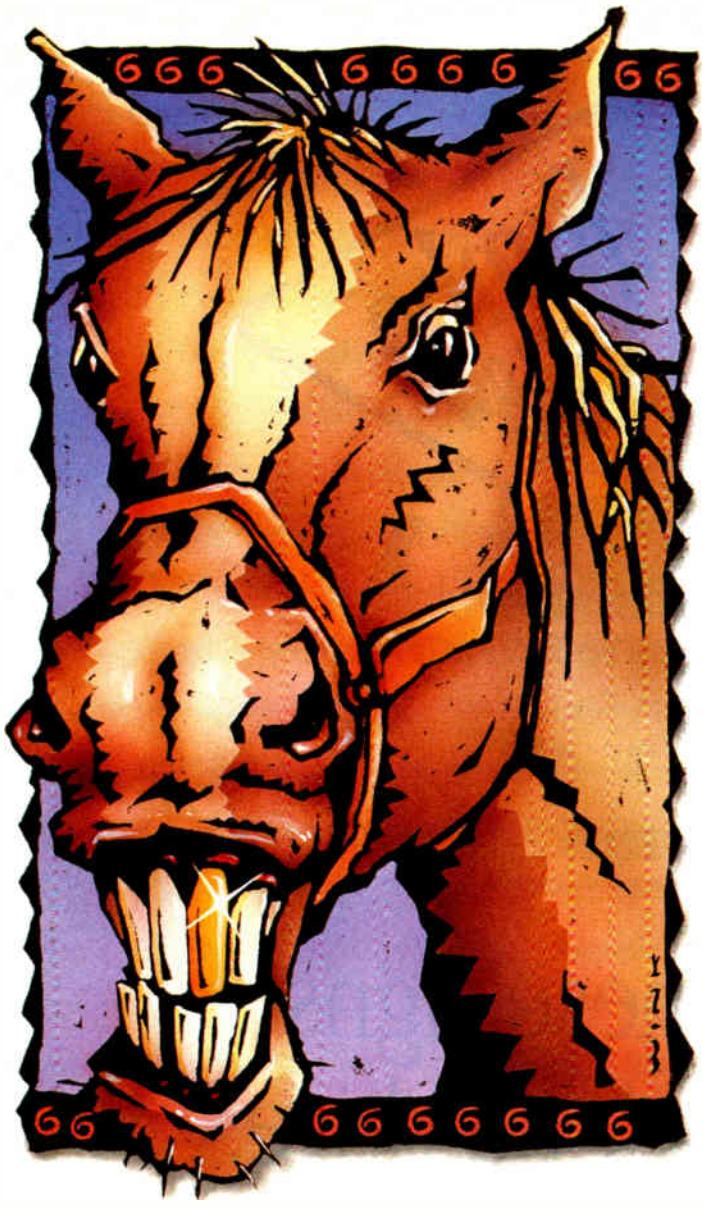


How to Look a Gift Horse in the Mouth

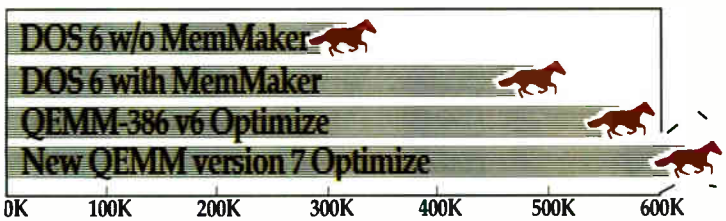
Even a *free* memory manager may not be a bargain—especially if i can't give you all the memory you need.

Introducing QEMM 7 The Memory Manager Worth Paying For

The newest version of the Quarterdeck Expanded Memory Manager (QEMM), version 7, once again is extremely innovative in using the critical area between 640K and 1024K. It finds space for more TSRs and drivers in this area than anyone thought possible. It optimizes this area, taking into account the many drivers that need more memory at start-up than when running; instantly calculating millions of possible memory configurations to find still more memory for your programs tc use. And it treats the rest of memory as a giant pool to instantly fulfill the needs of all of your programs—whether they use extended or expanded memory. Whether your PC has 1 megabyte or 16, you can benefit from new QEMM 7.

Instant Riches

What does more memory mean in a practical sense? It means that your DOS and MS Windows programs run faster, smoother and more reliably. It means you can continue to add valuable utilities, drivers, TSRs and new capabilities to your PC. Whether it's workhorse drivers like LAN utilities and fax drivers; productivity-enhancers like disk caches and disk compressors; or fun and exciting capabilities like sound boards, CD ROM drivers, graphics tablets, etc. The better your memory is managed, the more versatility and flexibility your PC has. QEMM 7 lets you have it all without fear of 'out of memory' messages or crashes.



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

DOS 6 Giveth; DOS 6 Taketh Away

The best feature of new DOS 6 is the stable of utilities it includes. Trouble is, they all eat up memory. DoubleSpace file compression needs 43K, Vsafe anti-virus needs 7-45K, Smartdrv disk cache needs 28K and even Undelete takes 10-14K as a resident program. Using Microsoft's free memory utility, MemMaker, you could easily end up with a net loss of available 'conventional' memory in DOS 6.

New QEMM 7 takes the best of the new DOS 6 features into account, finding ways to give you more free memory for your program while taking full advantage of DOS 6. One new QEMM 7 feature, DOS-Up, moves the DOS 6 kernel, its data and resources to memory above 640K (this feature also works with DOS 3-5), freeing 7-70K. Another new QEMM 7 feature, Stealth DoubleSpace, frees 40K of the memory addresses used by DoubleSpace and makes them available for other drivers and TSRs. Both features ensure that the all-important memory below 640K is free for your programs. And QEMM 7's seemingly small feature of supporting DOS 6's multiple configurations gives you the flexibility and ease of setup that you expect. (MemMaker doesn't work well with this important DOS 6 feature.) That's why it makes more sense than ever to put your money on the best memory manager—QEMM.

Prior versions of QEMM won just about every competition in sight, as well as remaining the #1 best-selling memory manager 5 years straight.

Page Frame: the Key to Your Future

There's been a lot of talk about our patent-pending Stealth technology. Jealous talk, mostly. Because nobody else can touch its performance. Our Stealth ROM feature, pioneered in QEMM 6, frees 48-115K of ROM addresses for use by TSRs and drivers. Our Stealth DoubleSpace feature, described above, frees another 40K. And as you might imagine, there's more to come.

The key to Stealth is its use of a 64K reserved area above 640K called the page frame. Besides being used by Stealth, the page frame is used by Lotus 1-2-3 r2.x for larger spreadsheets and WordPerfect 5.x for larger documents, DESQview for multitasking, Novell Netware, IBM LAN Server and DECnet for reducing the network driver memory footprint, plus games like Wing Commander, Car and Driver, Ultima Underworld II, Wolfenstein and others for fast action. You sacrifice all this when you turn off the page frame (which other memory managers do to maximize available memory above 640K). It's this use of the page frame by Stealth that lets you set up your PC with a mouse, CD ROM, sound board, a network such as Novell NetWare, reserve 8-24K of extra memory for optimal MS Windows performance, use all of DOS 6's memory-hungry utilities and still have more than 630K available for your programs. (Compared to DOS 6's 527K available in the same configuration, after using MemMaker).

There's lots more to QEMM 7:

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Our seventh-generation thoroughbred QEMM has improved ease-of-use, with Express Install and Help features. And for power users, Advanced Install and editable parameters and troubleshooting hints.

And QEMM 7 comes with Manifest, the award-winning memory analyzer—enhanced for more flexibility—from Pentium testing to laptop battery reporting; network analysis to editable configuration files.

The new and ever more exciting capabilities coming to your PC will all compete for memory with your favorite applications, TSRs and drivers. And that makes QEMM 7 the front runner in your efforts to get get the best performance out of your PC today—and tomorrow.

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

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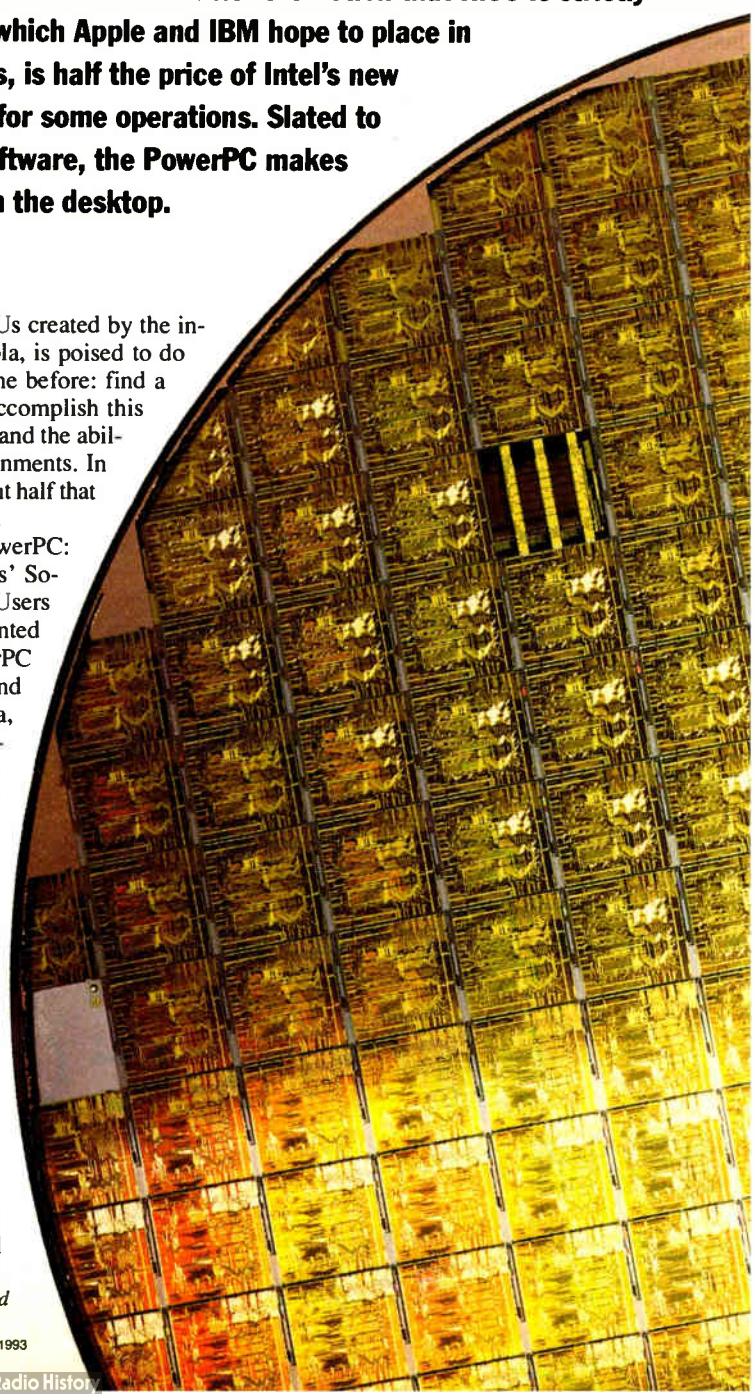
Cover Story

POWER

With the PowerPC, the IBM/Apple/Motorola alliance aims to shatter the notion that RISC is strictly a workstation technology. This new 32-bit CPU, which Apple and IBM hope to place in millions of desktop PCs within the next two years, is half the price of Intel's new Pentium processor and nearly five times as fast for some operations. Slated to eventually run Mac, Windows, OS/2, and Unix software, the PowerPC makes the most compelling case yet for putting RISC on the desktop.

TOM THOMPSON



The PowerPC 601, the first in a series of CPUs created by the industry alliance of IBM, Apple, and Motorola, is poised to do what no other RISC processor has ever done before: find a home in mainstream desktop PCs. It will accomplish this feat with a fantastic price/performance ratio and the ability to run the most popular operating environments. In quantity, the 66-MHz version of the PowerPC 601 is $450, about half that of Intel's 66-MHz Pentium processor, and it is available now.

At least six operating systems are being ported to the PowerPC: Apple's System 7, IBM's OS/2 and AIX, Sun Microsystems' Solaris, the PowerOpen Environment (see "PowerOpen Gives Users Freedom of Choice" on page 58), and Taligent's object-oriented Pink—a joint Apple/IBM project. Windows NT for the PowerPC is rumored to be coming next year, as is Novell NetWare and Unix System V. "All rumors will come true," says Phil Pompa, director of marketing for Motorola's RISC Microprocessor Division (Austin, TX). And, the PowerPC will run both DOS and Windows programs via emulation (see "The PowerPC Does Windows" on page 62).

RISC performance on the desktop could create a fundamental shift in how work is done, enabling new categories of applications such as real-time processing, interactive collaboration, 3-D imagery, and other computationally expensive activities. While this will initially affect scientists, engineers, and power users, these applications are bound to eventually trickle down to the mainstream user. While the Pentium can handle some of these jobs, the reality is that most Pentium-based programs are still using segmented code designed for older processors, which hampers performance.

The PowerPC will have impact beyond the desktop, too, in the traditional RISC world of workstations and even in the mainframe arena. IBM has stated its intent to use the PowerPC in everything from notebook PCs to mainframes. The latter will use multiple PowerPCs in a massively parallel configuration.

continued

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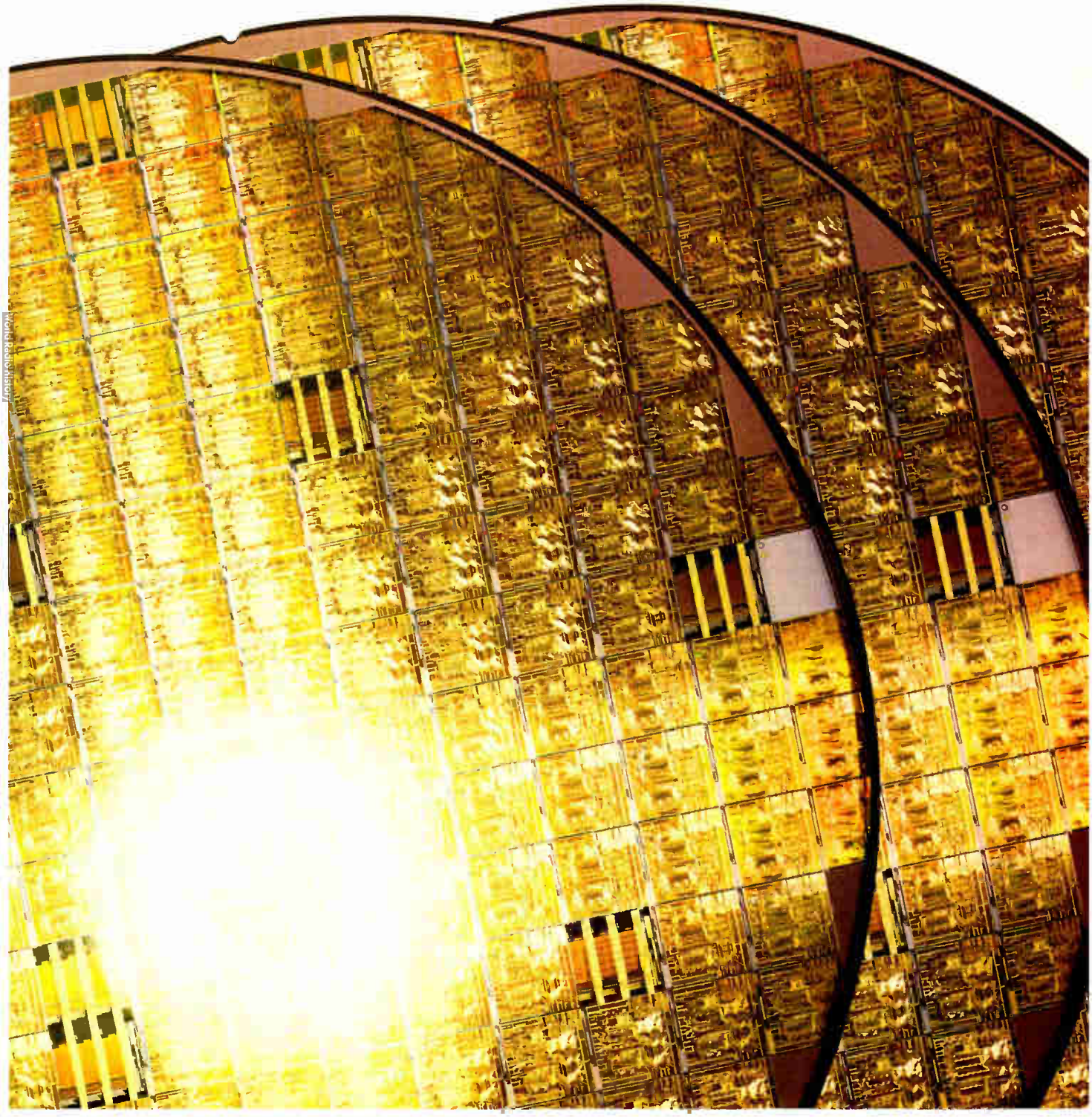


PowerOpen Gives Users Freedom of Choice

TOM R. HALFHILL

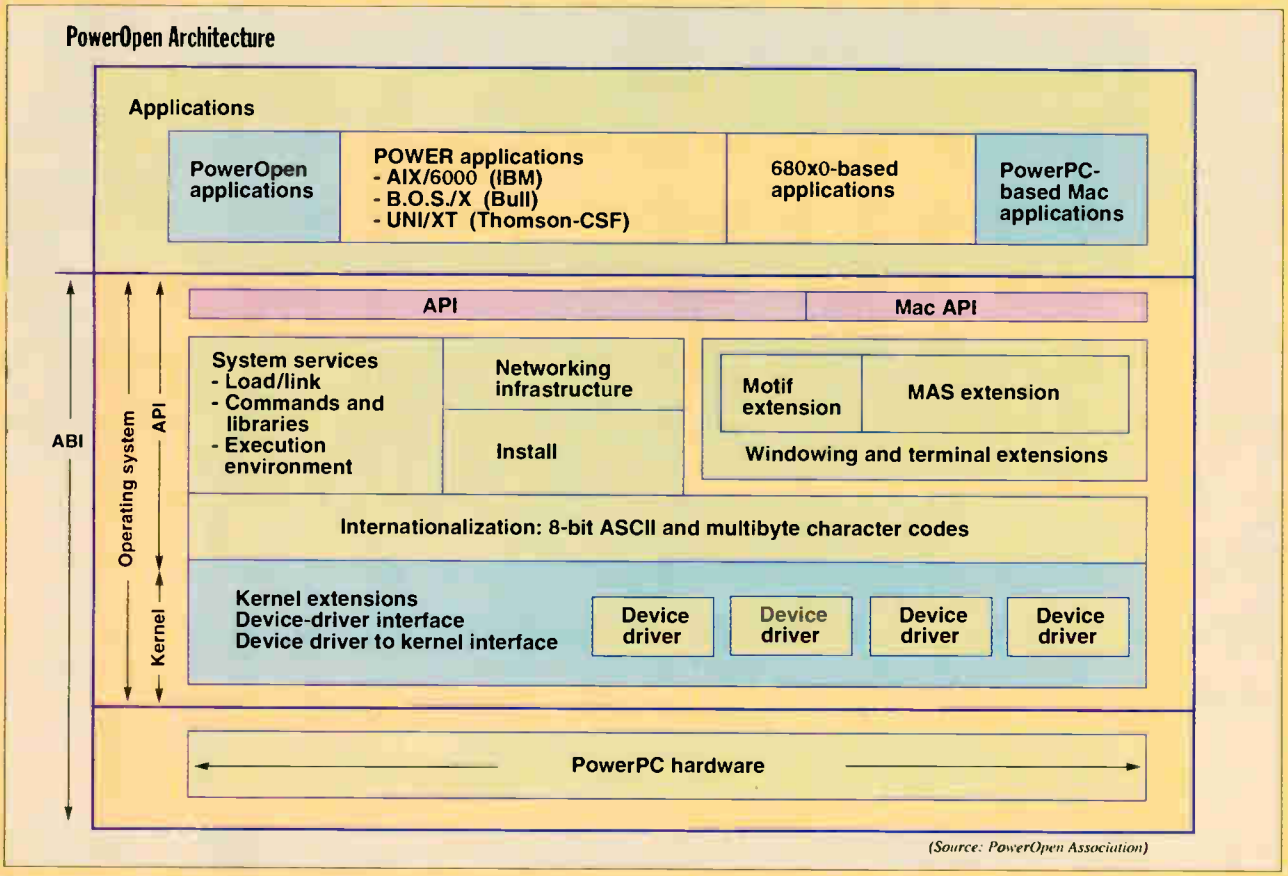
Early next year, you should be able to buy a PowerPC-based computer that will run Mac software about as fast as a Quadra 700, Windows software as fast as a 486, and native Unix software as fast as a Sun SparcStation 10. The high-speed RISC chips, system software, and breakthroughs in emulation technology that make this possible are coalescing under an umbrella known as the PowerOpen Environment. The ambitious goal of PowerOpen is to support a scalable PowerPC-based platform that lets users choose from several different libraries of applications software running atop the most popular user interfaces.

PowerOpen is a fast-track hybrid: It's an ABI (Application Binary Interface) that is derived from IBM's AIX and optionally includes the X Window System and the Open Software Foundation's OSF/Motif. An optional MAS (Macintosh Application Services) environment provides a Motorola 68040 emulator and a PowerPC version of Apple's Mac OS Toolbox to support Mac applications.

PowerOpen promises to run most programs written for IBM RS/6000 workstations and all software written for 680x0-based Macs at near-native speeds. Third-party emulators now under development are expected to run Windows software as fast as a 486. For full-blown performance, PowerOpen will natively host Unix applications from multiple vendors and a new generation of Mac software written especially for PowerPC.

The choice of user interfaces will be equally wide. You'll be able to run character-based Unix programs from a traditional command line or launch graphical applications from an OSF/Motif desktop, including the COSE (Common Open Systems Environment) Dashboard. Some people may prefer the Mac Finder or Windows 3.1. Moreover, PowerOpen is designed to let you juggle all these environments simultaneously, even exchanging data between them.

Announced in 1991 by IBM, Motorola, and Apple, PowerOpen is in the hands of the PowerOpen Association (Billerica, MA), an independent corporation whose founding members also include Groupe Bull, Thomson-CSF, Harris, and Tadpole Technology. The seven



PowerOpen-compliant operating systems *are built on a character-based Unix foundation derived from IBM's AIX. A common ABI ensures that any PowerOpen application will run on any PowerOpen operating system. OSF/Motif and the MAS are optional extensions. The MAS includes a native Toolbox and a 68040 emulator that support existing 680x0-based Mac applications, and a new generation of PowerPC-based Mac applications.*

founders are recruiting additional members, who together will promote PowerOpen and guide its future evolution. You won't be able to buy a product called *PowerOpen*; it's actually a term for compliant operating systems sold by the members of the association.

A major goal of PowerOpen is to avoid the binary incompatibility that currently fractures the Unix world. You'll be able to buy a certified PowerOpen application from any software publisher and be sure it will run on your PowerPC-based computer no matter who made the hardware or who wrote the operating system. Developers won't waste time supporting variations of the same platform, and there will be a larger unified market for compliant software.

The PowerOpen ABI is subdivided into an API and a KPI (kernel programming interface). The API is a library of routines for applications programmers, and the KPI provides the interface to kernel processes and device drivers. PowerOpen is designed to isolate software from the complexities of device I/O—an important consideration for a platform capable of accommodating I/O buses as varied as ISA, NuBus, Micro Channel architecture, PCI, S-Bus, and VME.

At its heart, PowerOpen is a character-based Unix. The OSF/Motif and Mac layers are extensions that vendors can optionally include with their PowerOpen operating system. PowerOpen's window manager, built on X, supports both OSF/Motif for graphical Unix applications and the Mac GUI. Because the COSE Dashboard runs atop OSF/Motif, it offers yet another option. You can use the Mac Finder for systemwide file management, because even non-Mac files will appear as icons on the Mac desktop.

To run a Mac program under PowerOpen, you first launch a System 7 session that executes within an X window. Because the Mac session runs in an independent X window, it can coexist with other X windows running other tasks. The X clipboard lets you cut and paste between different sessions.

As with any X window, you can resize or move the Mac session around the screen. In every respect, it's a fully functional System 7 environment with its own local multitasking, so you can run several Mac programs simultaneously.

Mac programs will multitask cooperatively within their session, because Apple's System 7 doesn't yet support preemptive multitasking. But PowerOpen does support preemptive multitasking, so independent Mac and Unix sessions can preempt each other to win processor cycles.

Even though the PowerPC and the 680x0-series chips' instruction sets are incompatible, existing Mac applications will nevertheless spend most of their time running natively on the PowerPC—thanks to the MAS architecture. The MAS is Apple's key contribution to the PowerOpen alliance.

For the first time, Apple has agreed to license its proprietary Mac OS Toolbox to rival vendors—in this case, for use in their PowerOpen operating systems. In May, PowerOpen was shown running Mac applications and a QuickTime movie on three workstations: an IBM RS/6000, a Sun SparcStation, and a Hewlett-Packard series 720.

The MAS isn't just for backward compatibility, however. It also supports a new generation of Mac software that has been written or ported to run natively on PowerPC. Several major developers—including Microsoft, Quark, Aldus, Adobe Systems, Frame Technology, and WordPerfect—have already announced they will move their applications to the new platform.

If PowerOpen delivers on its promises, it will achieve the Holy Grail of hardware independence—high-performance compatibility with the world's most popular software on a single platform.

Tom R. Halfhill is a BYTE senior news editor. You can reach him on BIX as "thalfhill."

Supported Industry Standards

- **AT&T's Base System V Interface Definition**
- **BSD 4.3**
- **Posix (portable operating system for computer environments)**
- **TCP/IP networking**
- **X/Open Portability Guide, issue 4 (XPG4)**
- **X Window System version 11, release 5**
- **Open Software Foundation's DCE (Distributed Computing Environment) and DME (Distributed Management Environment) may be adopted in the future**

Motorola is trying to make it as easy as possible for system vendors to build PowerPC computers. The company is providing reference designs and memory-interface chips to support popular expansion options such as EISA, ISA, PCI, and VME. It will work with third-party chip-set vendors to mesh the PowerPC 601 with their offerings. IBM alone produces the PowerPC 601—also called the MPC601; Motorola will manufacture subsequent PowerPC chips (see "PowerPC Family" on page 62).

IBM plans to introduce an MPC601-based RS/6000 workstation, a desktop computer, and a laptop by year's end. Apple will produce Macs based on the MPC601, and these systems will be introduced in the first half of 1994.

With all that the MPC601 has going in its favor, however, it still faces an uphill battle for user acceptance. Making a transition from the familiar Intel 80x86 processor means that users will have to forsake their existing software investment to gain the full benefit of the MPC601. Similarly, many peripherals that would survive an upgrade to another Intel architecture might not work with a PowerPC system. This might be a lot to give up in the short term, but over time, users may switch as the demand for more processing power grows.

PowerPC Basics

The PowerPC processors are based on IBM's existing POWER (Performance Optimized With Enhanced RISC) architecture used in IBM RS/6000 workstations (see "The RISC Philosophy" on page 84). This 64-bit architecture was designed to make the best use of superscalar instruction dispatch, which is the ability of the hardware to take a sequential instruction stream and dispatch (or issue) several instructions per clock cycle to other execution units. An execution unit is a subsection of the processor whose logic is dedicated to a specific function (e.g., floating-point math) and operates independently from the rest of the processor. The MPC601 has three execution units, so it can handle three instructions simultaneously.

The POWER architecture uses a fixed-length instruction to simplify decoding and thus speed throughput. It also has a rich set of bit-field manipulation instructions and load/store string instructions that can load or store arbitrarily aligned data. These latter capabilities promote fast emulators. The bit-field operators allow an emulator program to rapidly decode foreign processor instructions, and the unaligned access feature relieves the emulator from managing code alignment.

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Multiple environments are no longer worlds apart. Even if you have Novell Netware on one network, HP-UX on another and EtherTalk on a third, the new HP LaserJet 4Si MX printer easily connects across platforms. Automatically.

The HP LaserJet 4Si MX printer comes out-of-the-box preconfigured for multiple environments. There's nothing more to do than plug-and-play. All interfaces are simultaneously hot, making switching so seamless, end-users won't even notice.

What's more, HP's LaserJet 4Si MX printer is ready to handle whatever needs come down the

that adapts to multiple environments.

pike. More operating systems? No problem. As your network system continues to evolve, the capabilities of this printer are no longer just impressive. They're indispensable.

The HP LaserJet 4Si MX printer is loaded with features that define state-of-the-art. HP's enhanced PCL5 and genuine PostScript™ Level 2 software from Adobe™ come standard. Printer environments are saved while switching. Setup is a cinch with network software utilities and drivers included in the box. And, if you need any reassurance about trouble-free operation, you have it in our Simple Network Management Protocol (SNMP) support.

At 17 ppm, this is the fastest LaserJet ever, with I/Os and RISC-based formatter capabilities matched to support its speed. It delivers impeccable 600 dpi print quality—thanks to HP's microfine toner and Resolution Enhancement technology. Plus, it comes standard with two 500 sheet input trays.

But what if you don't need the full capabilities of the HP LaserJet 4Si MX printer right away? HP offers another printer that's probably a perfect fit. The HP LaserJet 4Si printer delivers the identical 17 ppm performance and superb 600 dpi print quality. It also has room to grow. The two MIO expansion slots let you add HP JetDirect network interface or third party cards. And you can add on Adobe's genuine PostScript Level 2 software and SIMM memory modules, as you need them.

To find out more about the multiple-network HP LaserJet 4Si MX printer and the upgradable HP LaserJet 4Si printer just call 1-800-LASERJET, Ext. 7299.† Capabilities this advanced make a world of difference—in any environment.

HEWLETT PACKARD

Circle 83 on Inquiry Card.

The PowerPC Does Windows

One major developer pledging support for PowerPC is Insignia Solutions (Mountain View, CA), whose emulation technology enables Windows NT to run 80x86 code on non-Intel RISC chips. Insignia is working on a native PowerPC version of SoftPC, an 80x86 emulator that allows current Macintoshes and Unix workstations to run DOS and Windows software.

What makes this significant is that Microsoft recently licensed the Windows API source code to Insignia. That means Insignia can recompile the Windows API to run natively on PowerPC, so Windows applications are expected to run at near-native speeds with a high degree of compatibility. Even undocumented Windows calls would be handled appropriately.

Insignia's implementation may yield a more reliable solution to Windows compatibility than WABI (Windows Application Binary Interface), an emulation technology announced in May by SunSelect (Chelmsford, MA), a subsidiary of Sun Microsystems. WABI essentially reverse-engineers Windows 3.1 by remapping API calls to X Window System routines, providing high performance; thus, WABI can run Windows 3.1 applications while providing complete access to the Unix host's file system, I/O ports, and printers. It will be implemented in PowerPC code and will be available as an option to Sunsoft's Solaris operating system on the PowerPC.

But WABI must overcome the compatibility problems of undocumented calls and an evolving Windows API. It also must face possible copyright challenges from Microsoft.

Finally, IBM has announced that it will deliver an 80x86 emulator for its PowerPC systems. This emulator will run both DOS and Windows application binaries.

POWERPC FAMILY

Following the MPC601 will be several new RISC processors based on the PowerPC architecture. Each processor will use a different feature set to target a specific section of the computer market. The MPC603, 604, and 620 will be introduced in the next 18 months and will be fabricated at Motorola's MOS11 facility.

MPC601
32-bit implementation of the PowerPC architecture
32-bit address bus, 64-bit data bus
Processor bus based on 88110 bus
Target system: low-end desktop
Available: now

MPC603
Same features as MPC601
Low power consumption
Fully static logic with power-saving features
Target system: notebook
Available: mid-1994

MPC604
32-bit address bus, 64-bit data bus
Bigger pipeline, higher parallelism
Advanced branching techniques for higher performance
Target system: next-generation desktop
Available: mid-1994

MPC620
64-bit data and address bus
Multiple levels of parallelism
Will use a different processor bus
Target systems: high-end workstation and server
Available: late 1994

Finally, double-precision floating-point information is a native data type, and the processor directly supports it. This means floating-point computations run in the hardware itself, at hardware speeds.

To meet the constraints of manufacturing a low-cost, high-performance part while providing flexibility for future hardware improvements, engineers at the Somerset PowerPC design facility in Austin, Texas, created a revised design known as the PowerPC architecture. This architecture has the POWER architecture's same 64-bit address space while adding multiprocessor support. It also uses the same POWER instruction op codes so that existing POWER binaries can run on it. Certain complex or rarely used privileged-mode POWER instructions were removed to allow for simpler, low-cost hardware implementations. In some cases, it was easier to leave certain POWER instructions in the design than eliminate them, which aided binary compatibility. Missing POWER instructions can be trapped and emulated in software. In addition, single-precision floating-point (32-bit) instructions were added for those applications that stress speed over accuracy.

The MPC601 can run all POWER binaries. Phil Hester, vice president of systems and technology of IBM's Advanced Workstation Group, says that "the 601 is a migration vehicle from POWER to PowerPC."

The MPC601 packs 2.8 million transistors onto a die only 11 millimeters square. By contrast, the Pentium places 3.1 million transistors on a die that's 16.6 by 17.6 mm in size. The MPC601's smaller die helps reduce the cost of its manufacture. When operating at 3.6 V, the MPC601 consumes 6.5 W at 50 MHz or 9 W at 66 MHz under worst-case conditions. These 3.6-V levels are compatible with 5-V logic. Current Pentium processors operate at 5 V and consume on average 13 W (16 W peak) at 66 MHz. Lower wattage means that the PowerPC dissipates less heat. The extra fans and heat sinks common on Pentium systems might not be necessary on PowerPC systems.

The MPC601 is a 32-bit implementation of the PowerPC architecture. It has a 32-bit external address bus that's capable of accessing 4 GB of physical memory. The external data bus is 64 bits wide. Internal data-bus widths range from 32 to 256 bits. An integral MMU (memory management unit) manages 52-bit virtual addresses (4 terabytes of virtual memory), handles memory protection, and helps implement demand-paged virtual memory. The processor handles both big- and little-endian byte and bit ordering, with big-endian (i.e., the most

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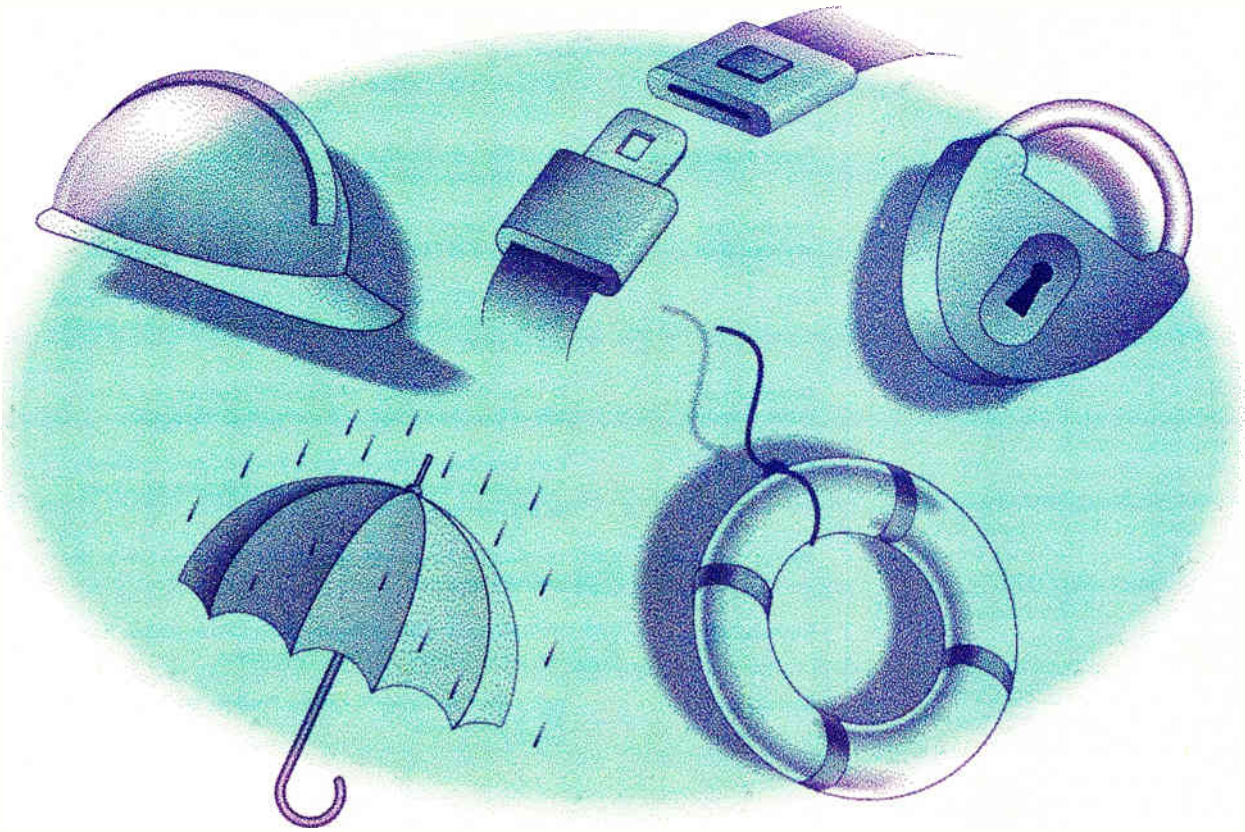

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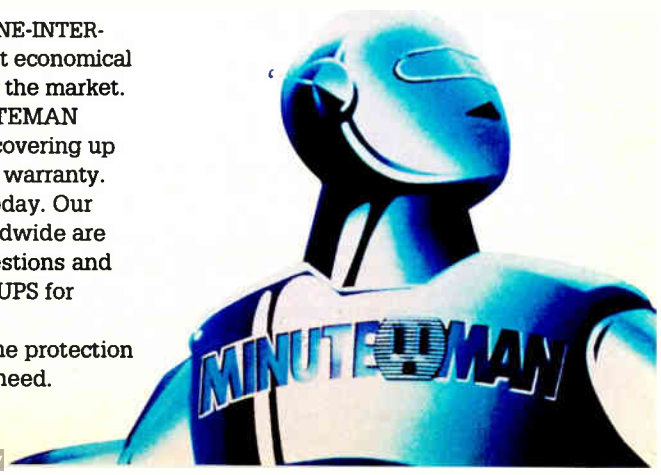


Circle 112 on Inquiry Card.

Pentium Out-Powered

Preliminary MPC601 benchmarks results are clear: It's faster than a Pentium. The MPC601 is 1.44 times faster than the Pentium on numeric sorts, up to 4.7 times faster on bit-field operations. We tested it using the YARC Systems' (Newbury Park, CA) PowerCard, a PowerPC development board for Intel-based PCs.

The MPC601 showed poor results for the transcendental calculations due to the fact that the YARC Systems' software is using unoptimized transcendental libraries. These numbers should improve when the optimized libraries are available.

A better indicator of the MPC601's number crunching power can be seen in the emulated floating-point and simple FPU tests: The ratios varied from 1.53 times faster (FPU operations) to 3.16 times faster (emulated floating-point).

YARC Systems, which makes MPC601 development tools, ran the BYTE DOS low-level CPU and FPU benchmarks on one of its MPC601 development systems. The development system consists of a 60-MHz MPC601 processor on either a NuBus or an ISA expansion board, and GNU C cross-compiler and linker running natively on the MPC601. A 50-MHz version of the board is available. Operating-system hooks allow the processor to write I/O to the host computer's disk or screen. This setup lets you use your host computer to write, compile, and link C programs on the MPC601. The GNU C compiler was used to compile the benchmark code with maximum optimizations in effect.

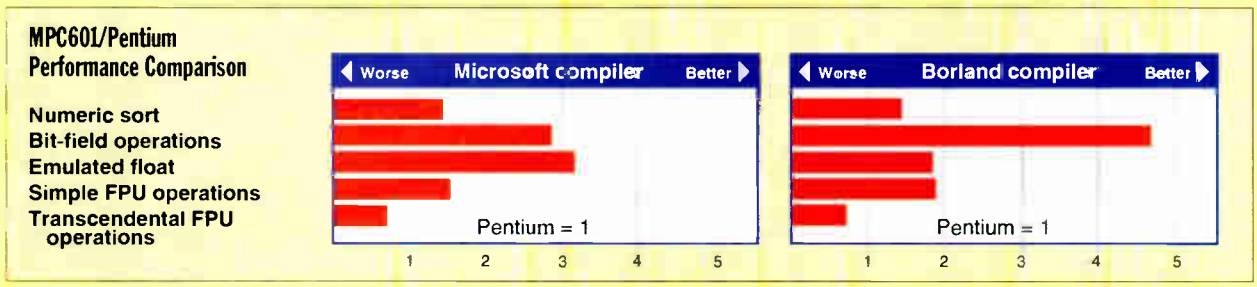
The same benchmark code was run on a Pentium system with 16 MB of RAM, 256 KB of processor cache, and a 510-MB SCSI drive. Two timing runs were made, first with Microsoft's beta March Windows NT compiler and then with the Borland C++ 3.1 compiler, using 32-bit operations.

The results are shown in the graph below. Note that these graphs show the ratio of the GNU C MPC601 results divided by the corresponding Pentium results for each compiler.

Who's Got the Edge?

Multiprocessing	POWERPC PENTIUM	**Both the Pentium and PowerPC were designed for use in symmetric multiprocessing systems.**
Power consumption	POWERPC	**At 66 MHz, the Pentium requires 16 W while the PowerPC needs only 9 W.**
Installed base of native code	PENTIUM	**The Pentium will run 386/486 binaries, while the PowerPC runs only IBM POWER architecture natively at this time.**
Cost	POWERPC	**The PowerPC is expected to cost about $450 each in quantities of 1000; the Pentium costs about $965 each in quantities of 1000.**
Complexity of systems design	POWERPC	**Because it runs cooler, the PowerPC requires less in the way of fans, heat sinks, and enclosed air channels.**
Performance	POWERPC	**Early benchmark tests show the PowerPC running about 1.5 to nearly five times faster than a Pentium, depending on the operation.**
Market acceptance	PENTIUM	**The Pentium has a huge advantage in being the heir to the 386/486 dynasty.**
Expandability	PENTIUM	**Most Pentium systems designs allow CPU upgrades. No mention yet of expandable PowerPC systems.**
Scalability	POWERPC PENTIUM	**Both the PowerPC and the Pentium are fully scalable processors.**

The YARC Systems' PowerCard is a $5000 development platform for the PowerPC. It features an MPC601 and 16 MB of enhanced DRAM. A C compiler and debugging tools for both DOS and Windows are also available. A Mac version is in the works.



The MPC601 easily outguns the Pentium, based on preliminary results of BYTE's low-level benchmarks. The graphs compare the results of a 60-MHz Pentium and a 60-MHz MPC601. The bars show the ratio of the MPC601 results divided by the Pentium results for each compiler, where the Pentium results = 1. In all cases but the transcendental computations, the MPC601 performed 1.44 to 4.7 times faster than a Pentium at the same clock speed. The transcendental numbers are low due to the preliminary form of the YARC Systems' floating-point library. Higher numbers mean better performance.

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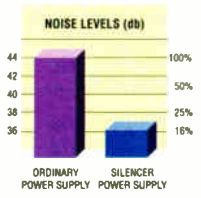

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Lockable Front Door:	Yes	No	Yes
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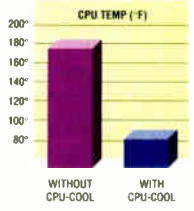

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Circle 114 on Inquiry Card (RESELLERS: 115).

significant bits are assigned to the lowest address) being the default. The MPC601's ability to handle little-endian byte ordering lets it support Intel processor–based operating systems and applications.

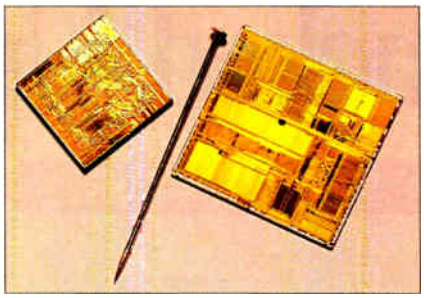
Software Issues

Now more than ever, users buy a computer as a solution to a specific task, choosing the best mix of hardware, operating-system features, and applications. The Pentium has a significant advantage here. It runs three operating systems (DOS/Windows, Unix, and OS/2), and it enjoys a huge applications software base created over the years. If you need software to handle a job, chances are a DOS or Windows application is available for it (see "Pentium Out-Powered" on page 64).

For the MPC601 to succeed, it faces an uphill battle against user inertia. The MPC601-based computers that roll off the assembly line must provide two things. First, they must run a familiar operating system. While users will unhesitatingly spring for faster hardware, they are reluctant to reeducate themselves on a new interface with a new command structure. Second, these computers must have a body of ready-to-go applications software in native PowerPC code, preferably trusted brand-name products.

This application problem goes deeper, however. Apple and IBM have the tools to port their operating systems. But third-party developers need MPC601-specific development tools so that they can create applications software using native MPC601 code. Long before those PowerPC computers ship, developers need to be porting or writing applications software. Besides software publishers, companies that have written their own custom in-house software would consider purchasing MPC601-based computers only if sufficient development tools become available.

As far as operating systems go, the MPC601 promises to be a culturally diverse processor. No less than six operating systems are planned or in the works (see "Operating-System Support"). In terms of applications software, the MPC601 has an installed software base in that it can run existing POWER applications. Also, Motorola offers a suite of development tools, including C and FORTRAN compilers, a source-level debugger, and a PowerPC simulator. These tools run on RS/6000 workstations.



The MPC601 (left) is a much smaller chip than the Pentium due to several factors: It uses a 0.65-micron, four-layer metal CMOS process to pack 2.8 million transistors onto a die only 11 mm square. Intel's 0.8-micron three-layer metal BiCMOS technology limits the Pentium's 3.1 million transistors to a die that's 16.6 by 17.6 mm in size. The MPC601's smaller die helps reduce the cost of its manufacture.

Apple, however, appears to have its job cut out for it, because all Macintosh software—from Apple's own operating system and firmware to all third-party applications—is 680x0 code. Apple's efforts to preserve its existing software base while simultaneously upgrading the Mac operating system to the MPC601 illustrate how complex the migration task to the MPC601 can be.

Apple's first MPC601-based computers will be mid- and high-end Macs. To avoid jeopardizing sales of existing 680x0-based Macs, an upgrade path is in the works. Owners of IIvx, IIvi, Centris 610, Centris 650, and Quadra 800 systems will be able to upgrade them to MPC601 systems. Upgrades for other Macs are being investigated.

The PowerPC boots using a hardware-specific System Enabler and runs System 7.1, just like a 680x0-based Mac. Like its predecessors, the PowerPC operating system still uses cooperative multitasking, because the preemptive, multitasking microkernel is still under development. While the first MPC601 Macs will have NuBus slots, Apple has stated that future PowerPC Macs will incorporate Intel's PCI (Peripheral Component Interconnect) bus, which is becoming an industry-standard bus for high-end PCs.

Compatibility Crucial

Backward compatibility with existing applications binaries based on the 680x0 is possible using a 68LC040 emulator implemented in software. The emulator does not support FPU or MMU instructions. Instead, floating-point calculations should call the SANE (Standard Apple Numeric Environment) traps or use MPC601 floating-point instructions. Only the operating system—not the applications—should program the MMU. Apple hopes to have the emulator execute 680x0-based binaries at comparable Quadra 700 rates (i.e., equivalent to a 68040 processor clocked at 25 MHz). This performance will vary depending on the application. According to Apple, 90 percent of the 600 applications tested on the emulator worked. However, as any OS/2 or NT software engineer will tell you, that last 10 percent might be the most difficult of all to achieve.

This performance level is possible because as much as 60 percent to 90 percent of a Mac application's time is spent in Mac Toolbox code. Toolbox code provides basic services (e.g., file and sound I/O, event processing, menu handling, and window drawing), and it is located in system software. Apple plans to implement some of the most heavily used Toolbox traps in native MPC601 code. This means a 680x0 binary actually spends a major portion of its time in native MPC601 code, yielding reasonable performance. Apple is considering implementing the text-drawing engine, QuickDraw, QuickDraw GX, portions of QuickTime, and SANE as native code.

continued

Operating-System Support

AIX IBM's implementation of Unix is used on IBM workstations, and an MPC601-native version will serve as the foundation for the PowerOpen environment. An emulator will allow AIX to run 80x86-based DOS and Windows applications.

PowerOpen The PowerOpen Association's specification is based on AIX. An optional MAS (Macintosh Applications Services) architecture will let PowerOpen run 680x0- or MPC601-based Mac applications.

OS/2 IBM's multitasking operating system is expected to appear on the MPC601 in 1994.

Pink The 1995 shipping date for Taligent's operating system is so distant that its effect on the outcome of MPC601's acceptance is negligible.

Solaris This flavor of Unix from SunSoft, a subsidiary of Sun Microsystems, has its own GUI and will be ported to the MPC601 with Motorola's assistance. It will be available in 1994. An MPC601-native version of WABI (Windows Application Binary Interface), an emulator that allows Unix systems to run 80x86-based DOS and Windows applications, will be available as an option.

System 7 Apple will port its cooperative multitasking operating system to the MPC601 next year.

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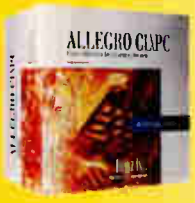

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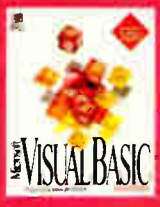

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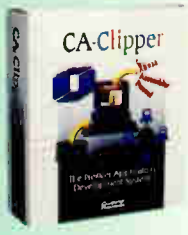

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Translation Tool Ports Programs in a Flash

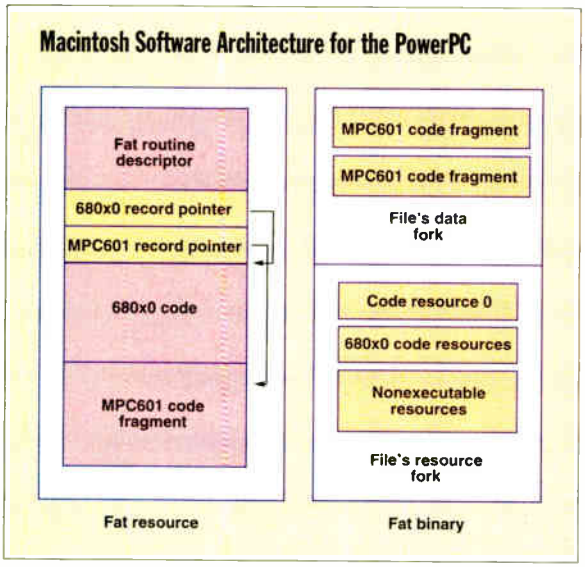
Echo Logic (Holmdel, NJ), which is a spin-off company from Bell Labs, offers a unique translation tool that can help some software publishers who now lack the time or resources to make the move to the PowerPC quickly. The product, called FlashPort, is a binary translator; it reads the original application binary and converts its instructions into equivalent binary instructions for the target processor.

FlashPort's analyzer program first loads the application into memory and performs the necessary setup and address relocations. The analyzer then relies on the reconstructed jump table to trace procedures within the code. The tracing operation performs extensive code analysis to determine the effect of the procedure's code on the program environment. These effects are added to a database that the analyzer uses as it scans and rescans the binary. A "hints" file, along with the database, provides supplemental data to the analyzer to help it when a code ambiguity is detected. A code ambiguity occurs due to insufficient information or unique code structures. For example, the hints file contains templates for all the Mac Toolbox traps.

Next, FlashPort generates a representation of the application in an intermediate object format. This intermediate image is then processed using dead code removal, and a back-end code generator performs hardware-specific optimizations. Code generators for MPC601, Mips, and SPARC processors are available. Finally, this code is linked into a stand-alone application. Echo Logic's goal is to have translated binaries execute three to four times faster than those emulated on the PowerPC.

Currently, FlashPort is only available on IBM RS/6000 workstations. A native MPC601 version is planned. Since it piles everything into memory, FlashPort's resource demands are considerable: The workstation should have 64 MB of RAM. It should also have a 400-MB hard drive and 250 MB of swap space (for virtual memory).

The Echo Logic engineers ported the BYTE low-level Mac benchmarks, which are a mixture of C and assembly language, to the RS/6000 in just under 2 hours. The process isn't automatic: The engineers assisted the analyzer in resolving a number of ambiguities by adding information to the hints file and asked for some source code details surrounding a trap. Nevertheless, the benchmark application started the first time on the RS/6000, which was running the Mac OS using a FlashPort translation of the Mac Toolbox. No timing information was available because floating-point operations were disabled. At the time, Echo Logic was reworking the SANE (Standard Apple Numeric Environment) extended 80-bit data types with POWER's 64-bit data types. (FlashPort can translate applications that use FPU instructions for floating-point math.) However, the disk I/O values were correct, and the video tests worked flawlessly.



The structure of the Mac *software is being designed to support both 680x0 and PowerPC processors. A "fat" resource can encapsulate both 680x0 and MPC601 code. The routine descriptor tells the Mac operating system what instruction set architecture the resource uses (680x0, MPC601, or both). A "fat" binary is a Mac application file that could run on a 680x0-based or MPC601-based Mac. The file's resource fork contains the jump table (code resource 0), any 680x0-code resources, and nonexecutable resources, such as icons, dialog boxes, and window information. The data fork contains MPC601 code fragments.*

Why won't all the Toolbox routines be implemented in native code? Two reasons: The delay to market for a PowerPC Mac would be prohibitive, and it might compromise compatibility with 680x0 applications. Ultimately, the entire Toolbox will be converted to native MPC601 code at an unspecified time in the future.

This solution means that the PowerPC Mac operating system is constantly performing an intricate dance between the 680x0 and the MPC601 environments. A Mixed Mode Manager handles context switches between the two instruction set architectures. In most cases, the Mixed Mode Manager can transparently determine if it must perform a context switch. However, in some situations (e.g., calling an external routine), a developer might need to supply a transition vector that describes to the Mixed Mode Manager what instruction set architecture the routine is written in, so it can handle the switch. It's obvious that applications can run at peak speeds by reducing the overhead of the Mixed Mode Manager.

To this end, Apple is encouraging developers to "go native" by writing their applications in MPC601 code. Apple estimates that native MPC601 applications should run two to four times faster than a 33-MHz Quadra 950. Aldus confirms this, citing a speed increase of twice that of a Quadra 950 with the native-code implementation of FreeHand. Adobe has a measured speed increase of two to four times faster than a Quadra 700 for integer operations, and up to 10 times faster for floating-point operations.

While considerable effort is being spent on compatibility, Apple is also carefully revamping the system software to eliminate design compromises introduced by the 680x0-based architecture. MPC601 code fragments—that can be of any size—replace the 32-KB code segments. A code fragment might be an application, a shared library, or an extension (i.e., the equivalent

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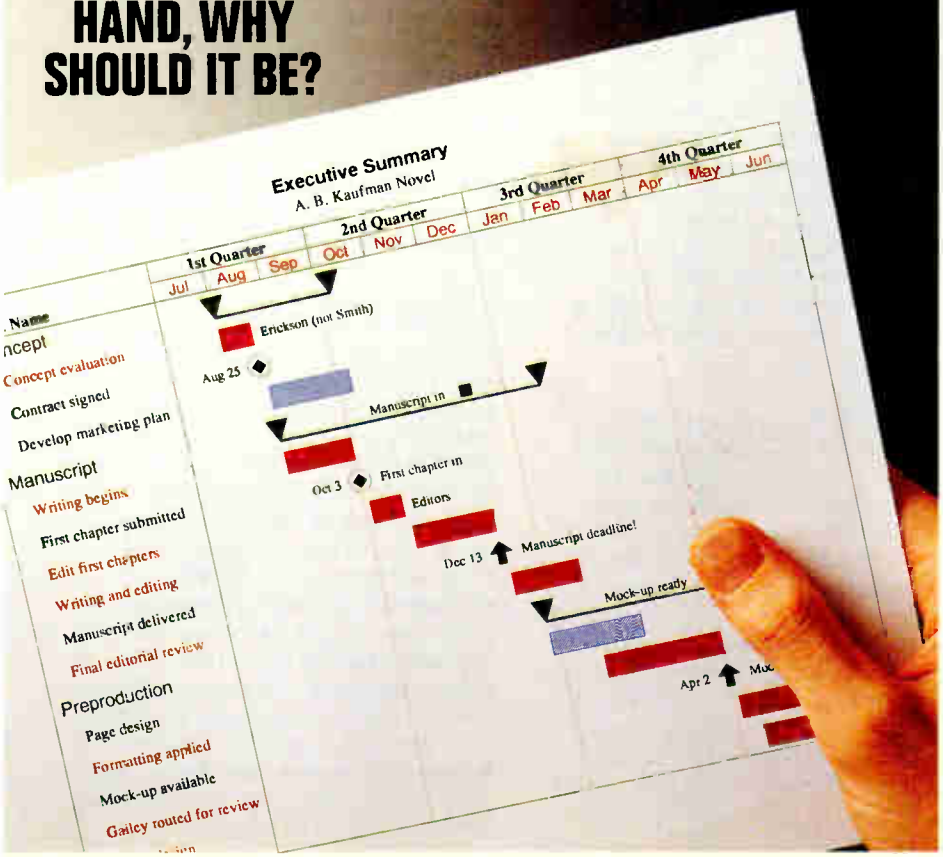

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IBM/Apple/Motorola: An Industry Alliance Bears Fruit

In October 1991, Apple, IBM, and Motorola formed an alliance whose goal was simple: seize the lead in the desktop computer industry. The trio had tremendous resources that could be brought to bear on the problem. IBM's research teams and chip design expertise are second to none. Motorola has its own crack chip designers as well, not to mention its recently completed half-billion-dollar MOS11 submicron fabrication plant in Austin, Texas, which is capable of mass-producing high-density chips. Apple has Taligent's Pink, an advanced object-oriented operating system, to offer. With resources like these, expectations run high for the success of the PowerPC.

But the IBM/Apple/Motorola alliance goes beyond just the PowerPC processor. The short- and long-term goals of the group are as follows:

Consolidate R&D on future software technologies. Owned jointly by Apple and IBM, Taligent will craft Pink into a platform-independent operating system. Another Apple/IBM company, Kaleida, will handle multimedia development and data standards. Taligent's product is not expected until 1995, while Kaleida's ScriptX, a cross-platform multimedia authoring language, goes into beta testing soon.

Promote open systems. PowerOpen will let users work on a Unix system while simultaneously using character-based Unix applications, OSF/Motif-based Unix applications, and Mac applications. In May, PowerOpen was demonstrated operating on four different workstations. PowerOpen is planned to ship by the end of the year.

Construct new processors. The alliance would design and manufacture a new set of RISC processors, termed the PowerPC. The PowerPC chip would serve as the hardware foundation for PowerOpen systems, and the next generation of desktop and workstation computers from IBM and Apple. In the next 18 months, several other PowerPC processors are to be introduced. The first of these chips, the MPC601, was announced in November 1991. Design and implementation of the chip was to take only one year. The MPC601 saw first silicon in September 1992—on schedule. Since the MPC601 comprises the hardware linchpin of the alliance's future plans, the timely delivery of these samples was crucial.

Cut development costs. Although RISC processors are traditionally high priced, the Apple/IBM/Motorola alliance is able to sell the MPC601 at a price lower than some Intel 486DX chips. It achieved this by sharing costs and using existing alliance members' technology. Most of the MPC601 processor design was based on IBM's RSC (RISC Single Chip) processor, found in Model 220 workstations. This decision also provided a ready-made instruction set for the chip.

The MPC601's processor bus was derived from one used on Motorola's 88110 RISC processor. This bus was chosen because of its high throughput and multiprocessor support. It would also allow most bus-interface parts based on an 88110 design to work with the MPC601 with minor modifications. This spares hardware designers some headaches and reduces system design costs.

to a plug-in module).

Within the code fragment, portions of its code and data can be imported (i.e., if the required information is missing from this fragment) or exported (i.e., the fragment contains the information and can share it with other fragments). You can reference this information by name, allowing run-time binding of code and data, which promotes both an OOP (object-oriented programming) design and a DLL mechanism. The convoluted program trajectory taken by the trap dispatcher in the 680x0-based Mac goes away. Instead, the MPC601 Mac's ROM code consists of exportable DLLs, and their services are bound to an application when it needs it. These DLLs allow native-code applications to access Mac Toolbox services faster, and they also lay the groundwork for the microkernel when it arrives.

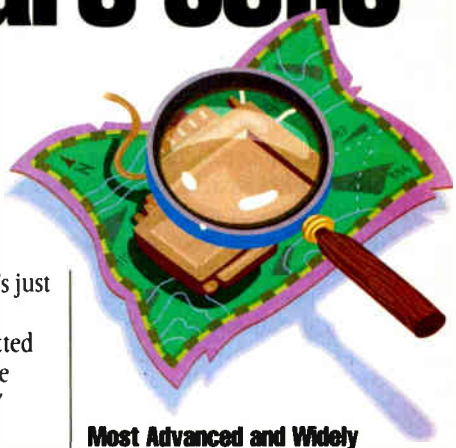
To support both 680x0-based and MPC601-based platforms, it is possible to create "fat resources" and "fat binaries" that contain both PowerPC and 680x0 code. A fat resource contains pointers to 680x0 code segments and PowerPC code fragments. A fat binary is an application file that contains nonexecutable resources such as icons, windows, and menus in the resource fork. Also in the resource fork are the application's jump table and 680x0 code segments. The data fork contains MPC601 code fragments. This allows the same application to run on both computers.

Going Native

When migrating to the PowerPC, Mac developers face several choices. They can do nothing, port the application, or do a binary translation. In the first case, you simply stick with the 680x0 development tools and let the emulator deal with the application as best it can. In the second case, some MPC601 development tools are available for you to port the application. Apple promises a developer's kit this fall that will contain MPW with A/UX (Apple's implementation of Unix), a C and C++ cross-compiler, and a linker. A/UX is required because the C compiler is currently Unix-based. Again, Apple wants the tools in the hands of developers as soon as possible, rather than wait several months for the MPW version of the compiler. Symantec (Cupertino, CA) plans to assist Apple in creating MPC601 native development tools. Third-party developer Metrowerks (St. Laurent, Quebec, Canada) plans to have ready this fall C, C++, and Pascal compilers that sport a Symantec Think-style integrated environment and that can generate 680x0 code, MPC601 code, or fat binaries.

continued

Why some software sells more than others.



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Finally, Don leaned back and asked the assumptive question, "What about protection – are you using Sentinel?"

Nervously, Simon sipped his coffee. His hands shaking as his eyes darted the room. "No. I didn't think I needed to."

Don's chair slid out from under him and he crashed to the floor. Amazed in disbelief, Don cried, "You What?!" Grabbing his tattered scrapbook, Don pulled out photos of his travels. "Ever been to Seoul? Prague? Anywhere? Ten bucks will buy you anything, even bootlegged copies of software."

Don's Road to Success

Thumbing through the scrapbook, Don shared his experiences. "Back in the '80s, I was in your shoes – beaten, battered and bruised." Simon listened. "Then, after a heart breaking trip around the world, I called the Software Publishers Association (SPA)."

"I could hardly believe it. They told me developers lose billions of dollars each year. Why? Illegally copied software. In some countries there are nine pirated copies for each legal copy sold."

Simon was disgusted, "It's just not fair."

"That's why I committed myself to solving the piracy problem," explained Don.

Simon's eyes lit up. "The dongle!" he shouted. Don corrected him, "Not just any dongle — the dongle that paved the road to success for over 10,000 developers worldwide — Sentinel."

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Don pulled a stack of letters out of his gunny sack. "All of these people tell the same story." Don read about a successful developer from California who swears she wouldn't be in business without Sentinel. Another company says protection costs less than litigation, plus they don't have to spend time and money supporting illegal users.

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The porting process involves some tweaks to the source code. You must first ensure that the application uses only Toolbox calls to access system resources. Next, the source code must be ANSI C compliant. You must then eliminate any 68881/68882 FPU instructions. You can use SANE traps or native MPC601 instructions for floating-point math instead. Also, you'll have to change the floating-point data types from `extended`, which is 80 bits in size, to `double double`, which is 128 bits. Finally, references to external code will require the addition of transition vector information. The MPW developer's kit will supply header files that provide transition vectors for all Toolbox calls; developers need only add the transition vector information to code that they write. This setup should let you maintain one set of source code while compiling code for both the 680x0 and MPC601 processors.

From preliminary reports, porting to a PowerPC Mac won't be a painful process. A single engineer at Aldus took only two weeks to port 500,000 lines of FreeHand code to the MPC601. One reason that the job was accomplished so quickly was that FreeHand's C code had few idiosyncrasies, having previously been ported to different platforms. Likewise, Adobe is doing a port of an application written in C++ and C. The application uses assembly language in some places for speed, but the Adobe engineers had prepared for this by writing C-language analogs of the assembly language code. Says Doug Olsen, an Adobe software engineer, porting to the MPC601 on the Mac is "no harder than porting to Windows NT."

Finally, what if you have a Mac application that relies on scary assembly language code for speed, or you don't have tidy C source code? Echo Logic has Flashport, a software tool that reads 680x0 Mac binary code and converts it to the equivalent MPC601 machine code (see "Translation Tool Ports Programs in a Flash" on page 70).

Branch Prediction

Moving the Mac operating system and applications to the PowerPC is an enormous undertaking. Apple's plan is ambitious. It's attempting to both protect the user's investment in 680x0-based software while streamlining the Mac operating system to wring the last iota of speed out of the PowerPC.

Apple is coordinating this operation with companies that make the developer tools and applications software. Still, small developers with limited resources have some concerns. Eric Shapiro, president of Rock Ridge Enterprises, a Macintosh consulting firm, says, "This makes software development and testing more complicated and costly for me. Up to now, if I wrote a program and it worked on several Macs, I was certain that it usually worked on all of them. Because the PowerPC Mac is quite a different machine beneath the surface, now I need both a 680x0 Mac and a PowerPC Mac. I hope Apple lets developers have reasonable access to PowerPC hardware and development tools."

VENDORS SUPPORTING POWERPC

- **Chorus Systems will implement with Motorola its embedded operating systems on the PowerPC.**
- **MacroTek makes interface/controller chip sets that connect the PowerPC to system buses, memory, and peripherals.**
- **Tandberg Data plans to use the PowerPC architecture in its next-generation desktop products.**
- **Tadpole Technology is expected to design a PowerPC notebook.**

Will it be worth the trouble to move to RISC or will users stick with the existing Intel-oriented software base? The mainstream PC is already in a state of change. First, hardware vendors are facing some tough decisions. Designing for 60-MHz or faster processors is so difficult, even existing personal computer designs are undergoing drastic revisions. Designing a new system around a RISC processor with the same clock speed might not be much more of a stretch. Second, new technologies using live video, telephony, and real-time processing will tax the power of today's processors. As processing demands escalate, it appears that only RISC processor technology can muster the horsepower to cope.

CISC processors might be able to hold the line for a while longer. For the short term, Intel can pump up the Pentium's clock speed, but the system's complicated instruction decoder, which must fetch and process variable-length instructions, eventually becomes a bottleneck. Also, vendors considering recompiling their application code for the Pentium might just do it for another processor instead.

So the question really becomes, When will you move to RISC? The Apple/IBM/Motorola alliance says the time is now. And the alliance is providing ample design and development tools to bolster its position. This should result in low-priced, high-powered systems that could change the shape of the market dramatically. Apple has gone on record as planning to ship a million computers next year.

"If the PowerPC Mac prices are aimed at growing market share rather than improving margins, if they're fast, and if the software compatibility is excellent," says Shapiro, "then it's possible that Apple could sell that many systems." What this also means is that existing 680x0-based Mac prices will undoubtedly drop further and put the squeeze on PC-clone systems.

The combination of RISC performance, reasonable prices, and familiar software might tempt users to switch to RISC. Even the most eclectic of users will find their operating system of choice on a PowerPC system. IBM POWER applications will already run on the MPC601. Emulators will run Windows or—via PowerOpen—Mac applications, and several native-code applications should be available. For IBM and Mac users, the initial software investment might be small.

Interestingly, with readily available RISC systems, you will be able to pick and choose your applications software, no matter what operating system you use. If the emulators can accomplish this with reasonable performance, then the real issue might boil down to the performance of the applications you prefer. The choice of platform might become less important.

Then again, if you worry less about the applications, you can focus on other issues. Does the computer set up easily? Can you plug it into a network without having a degree in rocket science? Does it support multiple-network protocols? Will it let you collaborate with others? In this case, computer vendors will still differentiate products to cinch a sale. For example, PowerPC Macs will enjoy the same built-in network file-sharing, collaboration facilities and color matching features as their 680x0-based counterparts—while doing it all faster. Expect IBM to have some enhancements for its PowerPC systems, too. It will be interesting to see in a year if what's more important to you is the applications you use or the computer that the applications run on. ■

ACKNOWLEDGMENTS

Also contributing to this story were BYTE senior news editor Tom R. Halfhill, news editor Ed Perratore, and technical editor Bob Ryan. Special thanks to Jim Gable at Apple for his technical assistance.

Tom Thompson is a senior technical editor at large for BYTE and a certified Apple developer. You can reach him on BIX as "tom_thompson" or the Internet at tomt@bytepb.byte.com.

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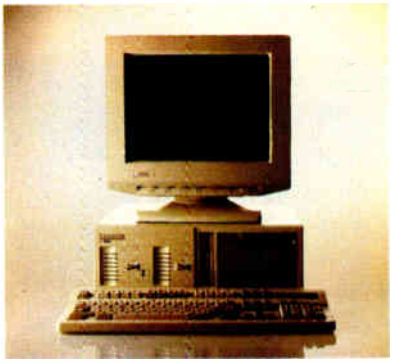

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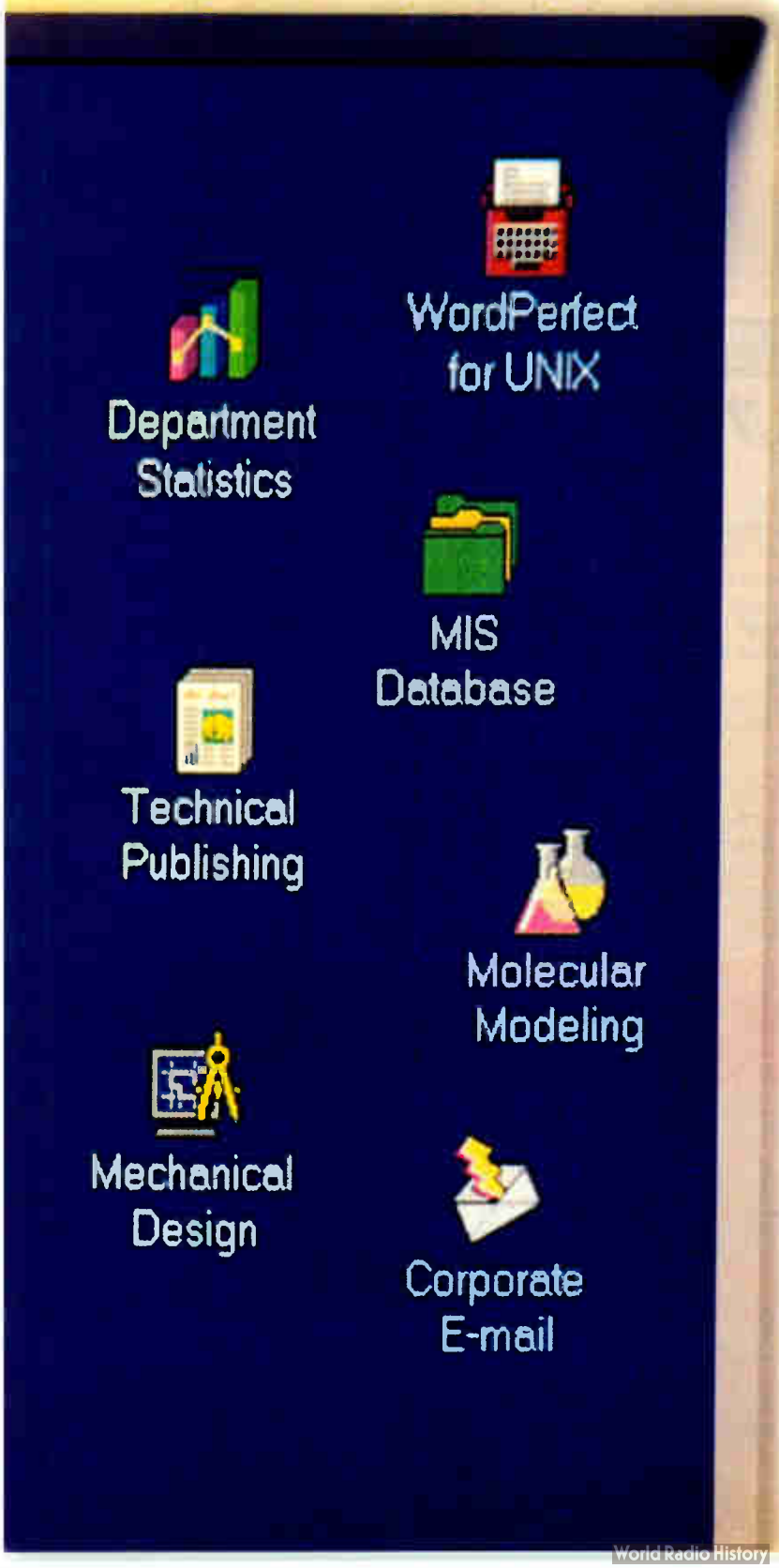

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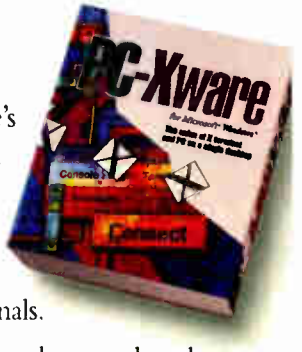

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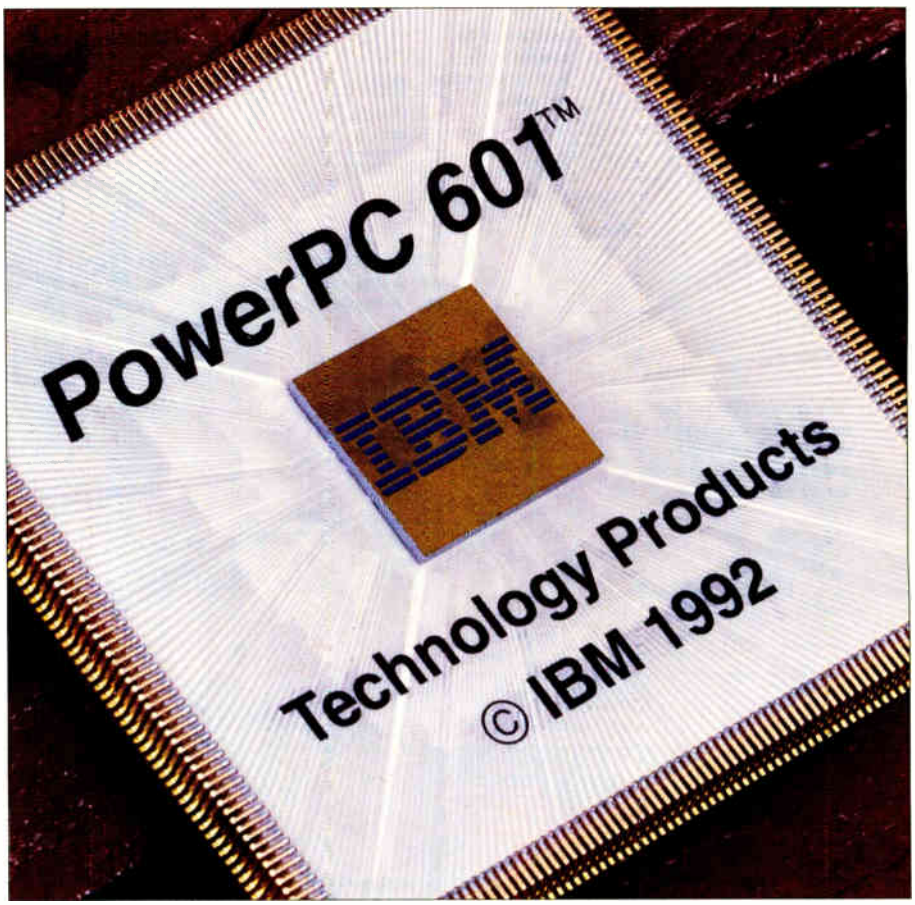


THOMAS A. WAY / IBM TP / BTV © 1993

Despite the fact that RISC has demonstrated superior performance, at least 95 percent of the desktop computers purchased on any given day use a CISC processor. The reason, of course, is that CISC—primarily in the form of Intel 80x86 processors—is far cheaper than RISC and runs most of the software the world wants to use.

The PowerPC 601 (also known as the MPC601) knocks away one CISC advantage—price. It does this using a mixture of advanced and not so advanced design features that provides lots of performance while making the chip relatively inexpensive to manufacture.

The elements that make up the PowerPC 601 have a single-minded purpose—to keep the execution pipelines busy

A Question of Balance

The MPC601 is first and foremost a RISC processor. Using the pipeline concept, it breaks instruction execution into small stages, thus permitting it to work on more than one instruction at a time. To this "vertical" parallelism, the MPC601 adds "horizontal" parallelism, in the form of multiple pipelines. The MPC601 has three independent execution pipelines, which together can have up to eight instructions in various stages of execution at any one time.

To support this degree of processing parallelism, the MPC601 has to be able to quickly move both instructions and data between external memory and the execution pipelines. For the data side, it provides a generous supply of registers and access to the large on-chip cache, as well as numerous temporary queues and buffers that keep the data moving when conflicts arise. Instructions also use the cache and an instruction queue to keep the pipelines filled. Balancing the movement of instructions and data to and from the processing units is the most important aspect of the MPC601 design (see "Inside the PowerPC, Piece by Piece").

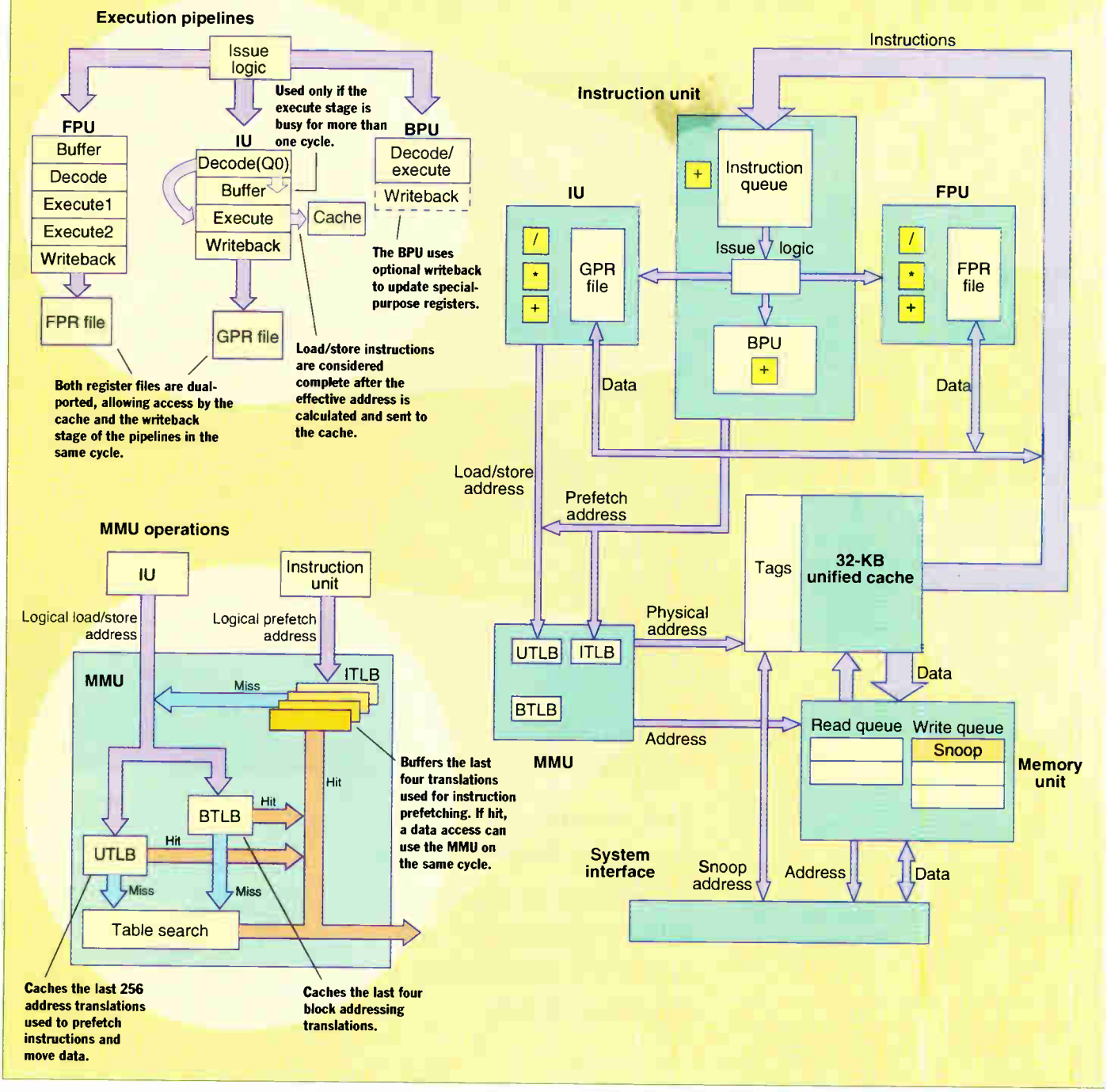
Typical of RISC, the MPC601 has a lot of registers—32 32-bit GPRs (general-purpose registers) and 32 64-bit FPRs (floating-point registers)—where it stores important data that the execution pipelines can immediately access. For the temporary storage of instructions and data before they are needed by the execution pipelines, the MPC601 also has a large, 32-KB unified data and instruction cache.

The core of the MPC601 consists of three independent pipelined execution units—integer, floating-point, and branch processing—that can execute three different instructions at one time. The IU (integer unit) handles fixed-point operations, as well as load/stores between the register files and the cache. The FPU fully supports IEEE-754 floating-point operations on single- and double-precision data. The BPU (branch-processing unit) tries to anticipate when program logic dictates a change in the normal sequential flow of instructions to the processor.

continued

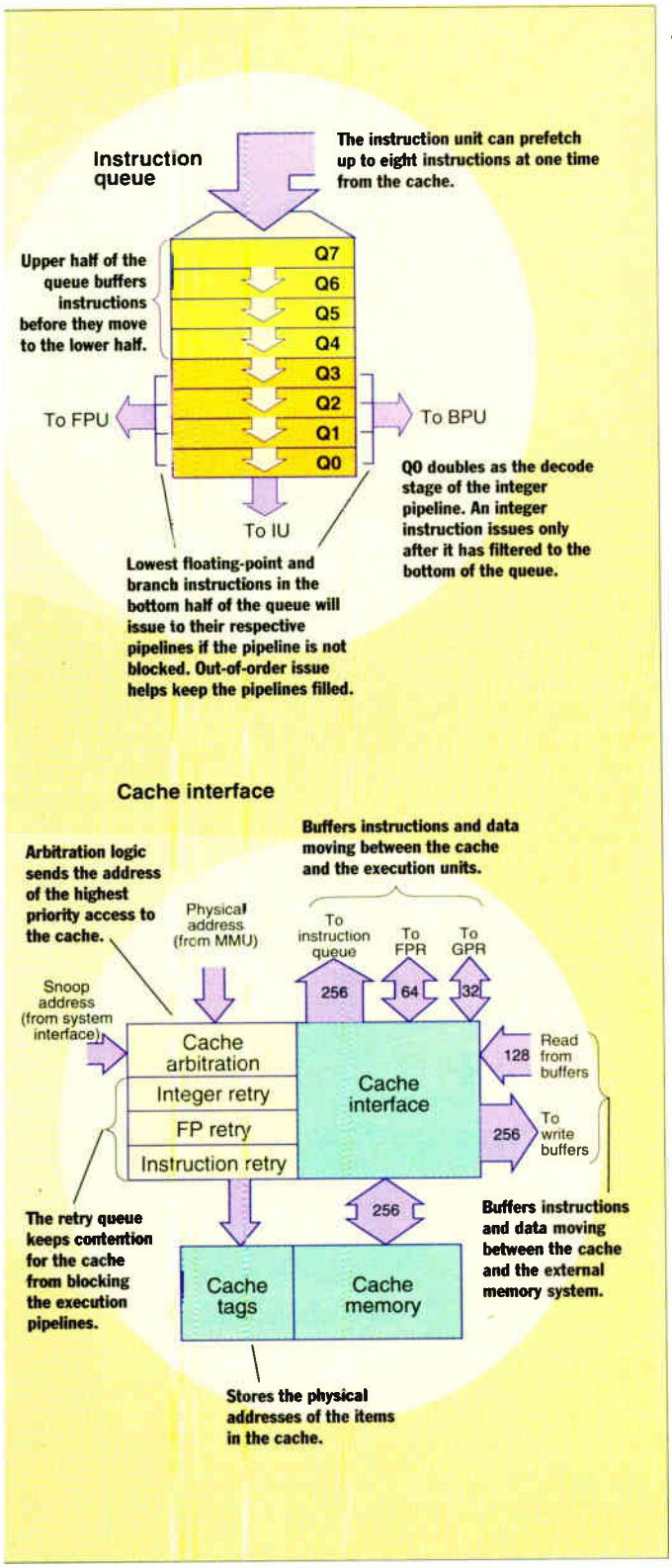
Inside the PowerPC, Piece by Piece

The major elements of the PowerPC 601 work in synchrony to move instructions and data as expeditiously as possible from memory, through the cache, and into the execution pipelines. They must also move results quickly in the opposite direction. Numerous buffers and queues ensure that the execution units will rarely have to wait while an external access brings needed instructions and data from off-chip.



To achieve optimal performance, the MPC601 must keep its three execution units busy. This task falls primarily to the instruction unit, which fetches instructions from the internal cache and issues them to the individual execution pipelines.

The instruction unit contains the instruction queue, which holds up to eight instructions. Once in the queue, instructions move from the top of the queue toward the bottom as instructions are issued to the execution units. The instruction unit tries to keep the queue filled at all times. If, in one cycle, it issues three instructions from the queue, it will try to fetch three more from the cache. If the follow-on instructions aren't in the cache, however, the instruction unit will wait until the queue is at least half empty before issuing the memory accesses necessary to bring the instructions into the cache. The instruction



unit can fetch up to eight instructions from the cache during any one tick of the 601's master clock, meaning that the queue can go from empty to full in one clock cycle, assuming a cache hit.

The upper half of the queue is a buffer—instructions wait there until they can move to the lower half. The instruction unit issues instructions in the lower half of the queue to any available (and appropriate) execution pipeline.

If the floating-point pipeline is available, the instruction unit will issue the floating-point instruction lowest in the queue to the pipeline. It will do the same with the branching instruction lowest in the queue if the BPU is free; thus, the instruction unit can issue floating-point and branching instructions to their respective pipelines, even when such instructions are not the next to be issued according to the order of instructions in the program. This out-of-order instruction issue helps keep the pipelines filled by loosening the strict determinist order of the instructions that the compiler sets.

The IU, however, can only take instructions from the lowest element in the queue. When it contains an integer instruction, the lowest element of the queue acts as the decode stage of the integer pipeline.

The instruction unit also contains a dedicated adder that lets it calculate the prefetch address. It continues fetching instructions sequentially until a branching instruction moves into the lower half of the queue.

Fork in the Road

Although it is an execution unit, the BPU is logically a part of the instruction unit. Its job is to prevent delays caused by branching instructions. It tries to keep instructions flowing into the queue even when program logic dictates a change in the base address used for prefetching instructions from the cache.

In the case of unconditional branches—or of conditional branches where the condition required to resolve the branch has previously been calculated—the BPU removes the instruction from the queue, calculates the target address (the BPU contains a dedicated adder), and sends the new target address to the cache for prefetching. The instruction unit then resumes sequential fetching using the new base address. Removing branches from the instruction stream in this manner is called *branch folding*.

The BPU also attempts to predict conditional branches that are unresolved (i.e., before the condition on which the branch will be taken or not taken is calculated). For example, say the instruction queue contains three integer instructions and a conditional branch, and the condition used to determine whether or not the branch is taken depends on the result of the third integer instruction. On the next clock, the first integer instruction is issued to the IU, and the branch instruction goes to the BPU. Rather than wait for the third integer instruction to filter to the bottom of the queue and then enter the pipeline and complete execution, the BPU immediately decides whether the branch will be taken or not and starts to prefetch instructions based on this decision. By starting the prefetching early, the BPU ensures that the correct follow-on instructions will be in the queue after the branch is taken, thus eliminating a stall as the pipelines wait for the new instructions.

Unlike the Pentium and some other processors, which dynamically predict branches based on the history of branches taken or not, the MPC601 uses static branch prediction, which is simpler to implement. By default, backward branches (e.g., those used in looping control structures) are predicted to be taken, while forward branches are not. A compiler can use a single bit in the instruction coding to override this default behavior.

Whether or not the BPU predicts a conditional branch to be taken, it enforces two rules until the conditional branch instruction is resolved: No instruction that follows the branch instruction in the program stream can actually write its results to a register, and no other branch instruction can be issued to the BPU.

If the BPU does not predict the branch to be taken, fetching and execution proceed normally. When the branch condition is resolved and it turns out the branch should be taken, the pipelines and queue are flushed, and prefetching begins using the new target address.

If the BPU predicts the branch, it initiates a prefetch based on the new target address and freezes the execution of all

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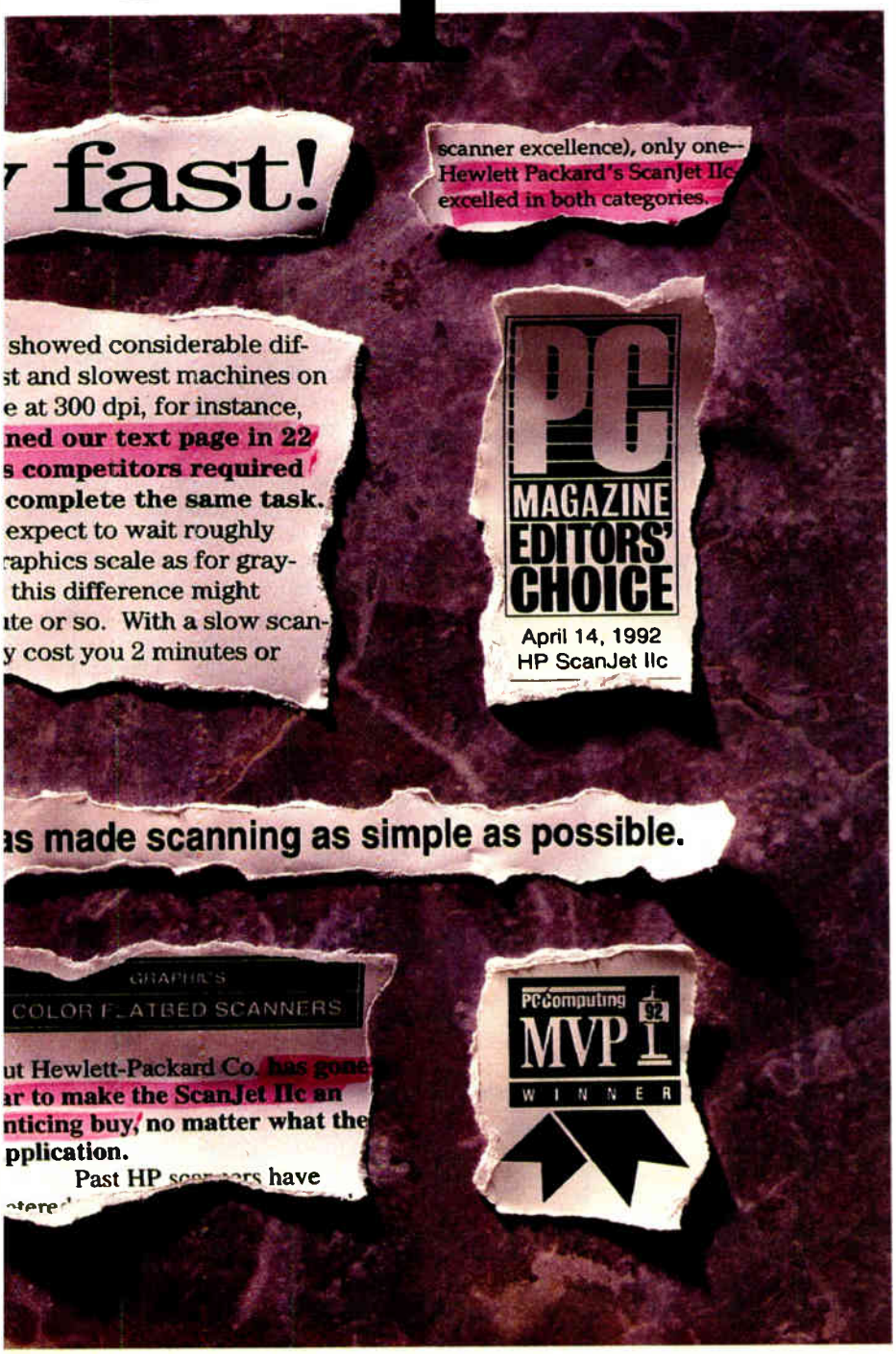
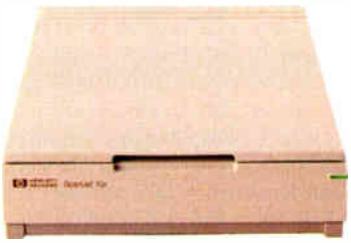


HP ScanJet IIc



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HEWLETT PACKARD

The RISC Philosophy

RISC adheres to that age-old principle, KISS (keep it simple, stupid). RISC instructions are simple and usually the same length. They don't support as many addressing modes as CISC instructions, and they only access memory using dedicated instructions that load a value into a register or store a value from a register to memory (thus the term load/store architecture, which is often used synonymously with RISC). However, this simplicity allows the instruction decoder to be implemented in fast hardware, rather than relying on more complex, slower decoder logic controlled by microcode.

RISC processors are based on pipelines, where instruction execution is divided into distinct stages. At any given moment, each stage of a pipeline can be working on a different instruction. The result is not faster execution of a single instruction, but faster throughput. If a pipeline takes four cycles to process one instruction, it will take five cycles to complete two instructions and six cycles to finish three. A nonpipelined processor may take the same four cycles to complete one instruction, but it will take eight cycles to finish two instructions and 12 cycles to finish three.

RISC instructions are crafted to work in pipelines. Because the instructions are all the same length, most take just one cycle to complete each pipeline stage. So while most RISC instructions don't do as much as the average CISC instruction, they outperform CISC instructions by a wide margin because they fit better and move faster in pipelines.

instructions subsequent to the branching one. When the newly prefetched instructions arrive from the cache, it then discards the frozen instructions. If the BPU discovers that its prediction is proven wrong before the new instructions arrive in the queue, the frozen instructions are "thawed" and processing proceeds normally; otherwise, the new instructions will have to be discarded and the original ones prefetched.

Although the penalties for mispredicting a branch are great, the rewards of correct branch prediction are greater. If the BPU predicts a branch correctly and the follow-on instructions are in the cache, it will usually achieve its goal of no-delay branching. This in turn keeps the execution pipelines churning.

Power Pipelines

The three execution units of the MPC601 consist of pipelines of differing lengths. The simplest is the BPU, which decodes and executes branching instructions in one cycle. Sometimes, the BPU has to write back to special-purpose registers, but, for the most part, the BPU is a one-stage pipeline.

The IU handles all integer, bit-field, and load/store instructions, including floating-point load/stores. It consists of a three-stage pipeline, which may sometimes expand to four stages. Integer decode, where the pipeline determines what the instruction is and what operands it needs, takes place in the bottom element of the instruction queue. After decode, the instruction will issue to the execute stage if that stage is empty. If not, the instruction will issue to the integer buffer, where it will wait until the execute stage becomes available. The buffer helps keep the queue from stalling when a multicycle integer instruction—such as an integer multiply—is executing. After execution, integer instructions (except for load/stores) move to the writeback stage, where their results are written to the register file.

Load/store instructions are special cases. They are considered complete once the effective address is calculated and translated by the MMU (memory management unit), allowing the following integer instruction to begin execution without delay. With load instructions, the effective address that is calculated and translated during the execute stage is first sent to the cache. On a cache hit, the data is returned to the register file following a one-cycle delay for the cache access.

If the data isn't in the cache, the address moves to the two-element read buffer of the memory unit, where it is used to retrieve the data from off-chip to the cache. The data is then written back to the register file. Follow-on load instructions that hit the cache can proceed, as long as no data dependencies exist between the first load and subsequent ones. A second load that misses the cache may stall the integer pipeline.

Store operations move data from the register file to the cache in the execute stage once the effective address is generated. On a cache miss, the data waits in one of the three elements of the write buffer of the memory unit. Follow-on store operations that hit the cache can proceed; as can stores that miss the cache, as long as the write buffer isn't full.

The IU contains the ALU, a multiplier, a divider, an exception register, and the 32 general-purpose registers. The register file has two writeback buses; therefore, two operations can access the register file—say, one from the execute unit and another from the cache—in one clock cycle. The register file also features a mechanism called feed forwarding that helps prevent pipeline stalls.

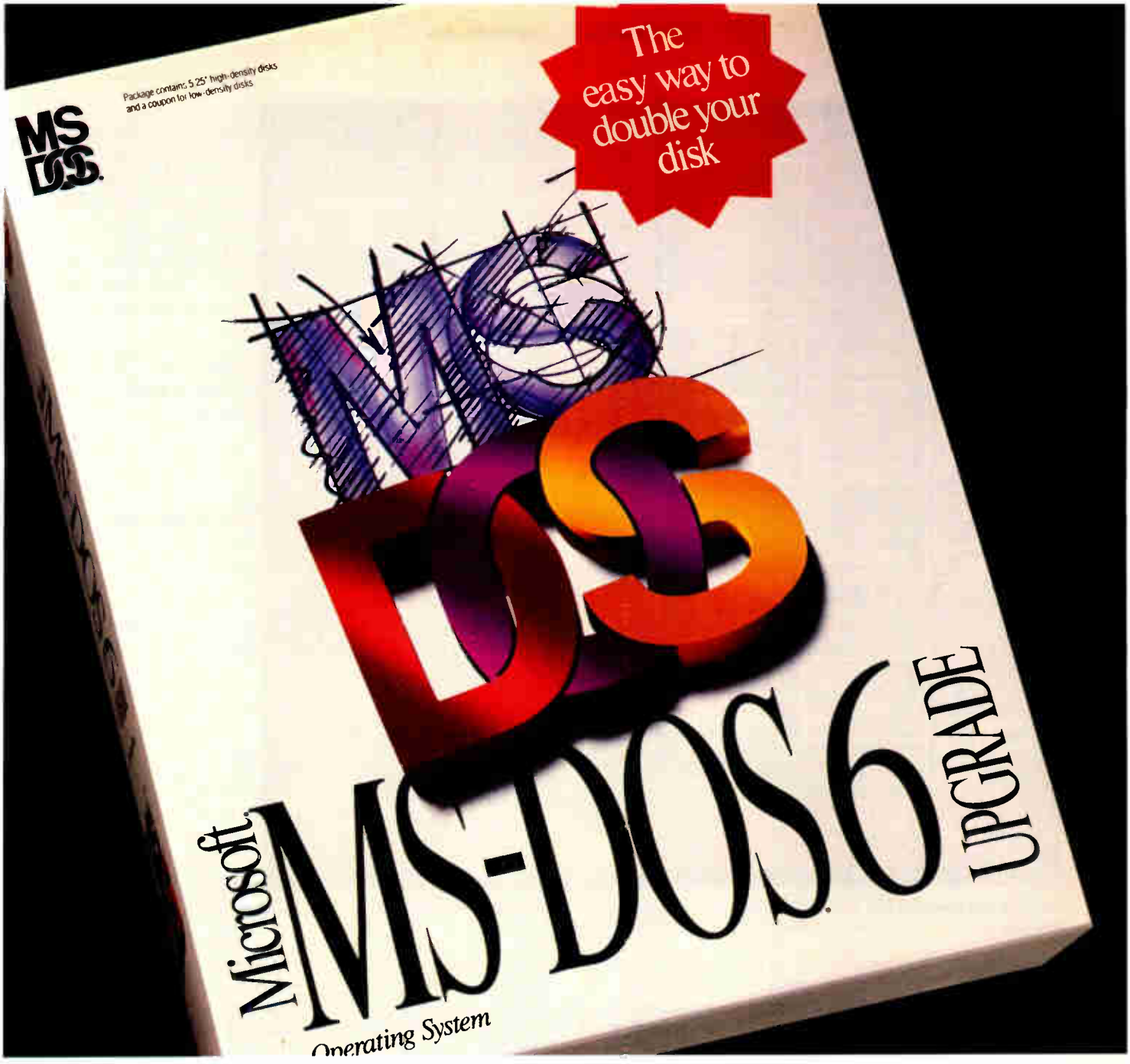
For example, consider two integer instructions in the pipeline, where the second instruction uses the results that the first one generates. The instructions are back to back in the pipeline so that when the first instruction moves to writeback, the second moves into execution. Without feed forwarding, the second instruction would have to spend one cycle idling in the execute stage while the first instruction writes to a register. With feed forwarding, the results of the first instruction are immediately available to the second one, eliminating the one-cycle stall.

The fully pipelined FPU contains a single-precision multiply array, a double-precision add array, a divider, and the floating-point register file. Like the GPRs, the FPR file is dual ported to allow two accesses in one cycle. The FPU consists of five pipeline stages: buffer, decode, execute1, execute2, and writeback to the floating-point registers. When issued from the queue, floating-point instructions must spend one cycle in the buffer. Unlike the integer buffer, they don't fall through if the next stage is open.

All floating-point instructions spend at least a cycle in decode and one each in the two execute stages. Unlike the IU, the FPU

POWERPC AND PENTIUM COMPARED

	POWERPC	PENTIUM
Instruction architecture:	RISC	CISC/RISC
Maximum instructions per cycle:	3	2
Cache:	32-KB unified	8-KB instruction, 8-KB data
External data bus:	64 bits	64 bits
External address bus:	32 bits	32 bits
Word size:	32 bits	32 bits
User registers:	32 GPR, 32 FPR	8 GPR, FP stack



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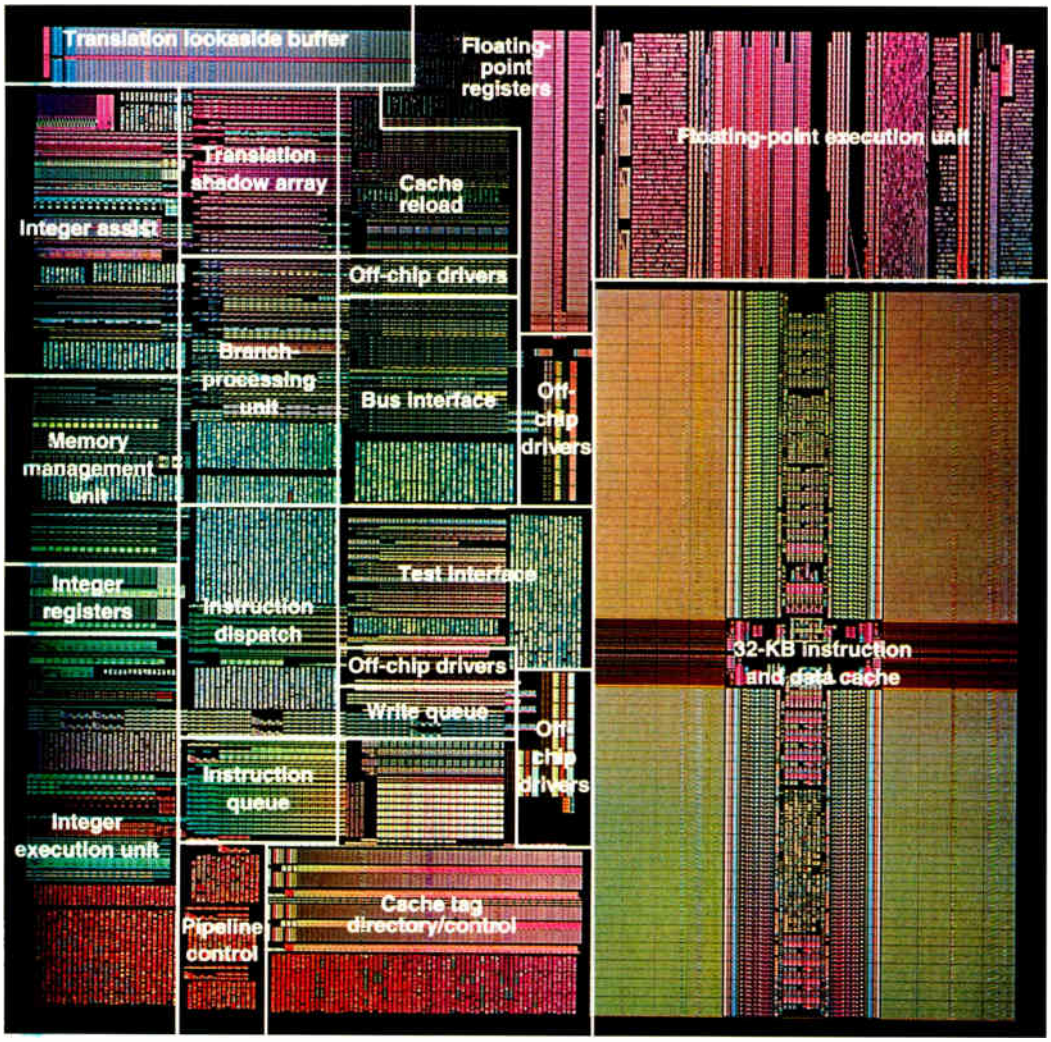

One way the PowerPC 601 *conserves die area is to cluster its off-chip connection points in the interior of the die. This eliminates lines needed to move the connections to the periphery of the chip.*

doesn't support feed forwarding: An instruction that is dependent on a previous one must wait until that instruction finishes writeback.

While the instruction set doesn't support transcendental functions directly, the architecture of the FPU contains implicit support that speeds up the Taylor-series expansions that underlie the calculation of transcendentals. The branch-on-count instruction enables faster loops for the expansion, and the multiply-add instruction provides a greater precision than is normal for IEEE-754 floating-point operations by performing its rounding only after both operations are complete.

Disorderly Conduct

With three execution units and an instruction queue that can issue up to three instructions at a time, it is not uncommon for the MPC601 to issue and execute instructions out of order (i.e., not in the order that they appear in the program). For example, if the bottom half of the instruction queue contains three integer instructions and one floating-point instruction, the floating-point instruction will be issued before two of the integer instruction, even though they come before it in the program stream. There will even be instances where the floating-point instruction will execute before the integer instructions. Without the proper controls, out-of-order issue and out-of-order execution could make a mess of your program's logic.

Of course, the MPC601 has those controls. It can issue floating-point and branching instructions out of order and can execute any instruction out of order, except where specific dependencies exist between instructions. When a data dependency exists (i.e., when an instruction attempts to use an operand that is still being computed by a previous instruction), the pipeline stalls. The stage where it stalls depends on the instruction type; floating-point instructions with data dependencies stall in the decode stage, integer instructions stall in the execute stage. Load instructions stall in either execute or the write buffer, depending on whether address calculation is complete. The IU uses a special register interlock mechanism to ensure that one instruction doesn't overwrite the operand of another before the second instruction can read the operand.

Given that it can issue and execute instructions out of order, the MPC601 must handle exceptions such as external interrupts with great care. The MPC601 divides exceptions into two categories: those caused by the execution of an instruction and those caused by an external event. With the exception of catastrophic events like a system reset, all exceptions on the MPC601 are said to be precise (i.e., all instructions that come before the excepting event in the program stream are handled before the exception mechanism kicks in). This handling includes letting execution proceed to a point where these instructions would generate their own exceptions. The exception mechanism saves the current state of the processor, handles the specific exception, and then restores the state of the currently executing program.

As previously mentioned, the integer and floating-point instructions that have been prefetched speculatively while a conditional branch is unresolved can't write to a register until the conditional branch is resolved. This makes restoring the machine state after an exception relatively easy. To enable the speculative prefetching, however, the branch instruction writes to special LINK and COUNT registers (i.e., the branch instruction executes speculatively). The MPC601 provides a special hardware mechanism to back out and renew these registers if an exception occurs while a conditional branch is pending.

The Memory Side

While the instruction unit and the three execution pipelines are handling program

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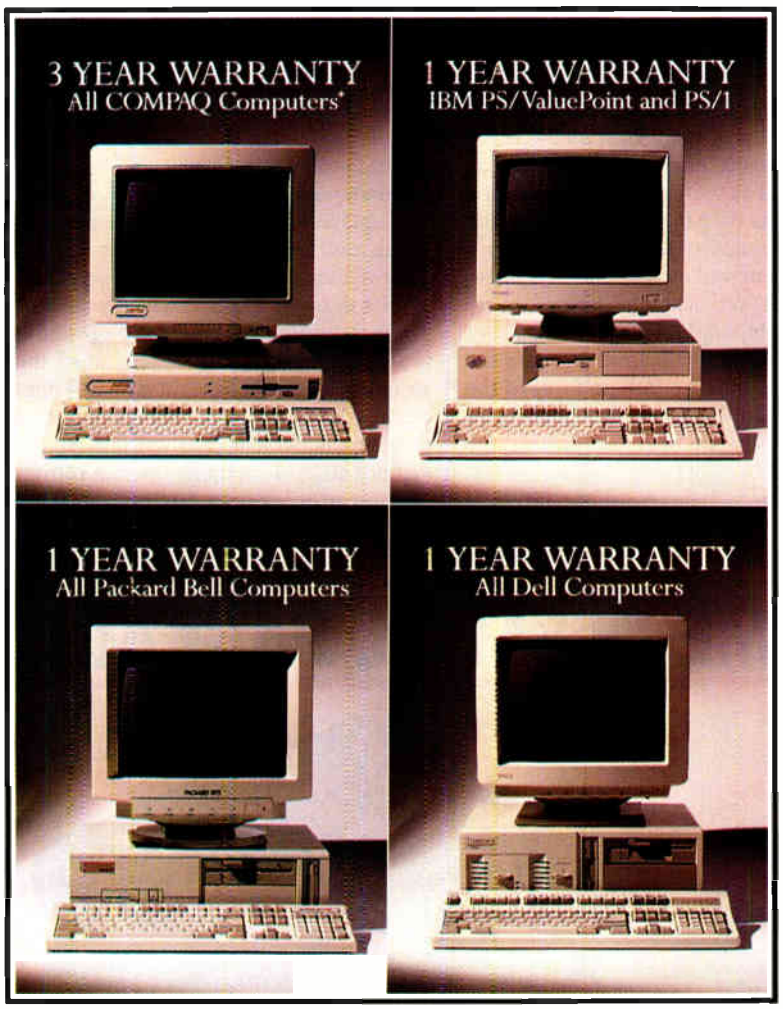

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execution, the rest of the PowerPC is busy shuffling data and instructions between the processing core and external memory. The place where instruction processing and data access come together is the cache.

The cache on the MPC601 is out of the ordinary in two ways. First, it is large—32 KB of storage space, as opposed to 8 or 16 KB in most processors—which is a big plus in keeping the execution pipelines busy. However, the cache is also unified—it stores instructions and data together. Most processors these days split the cache so that data accesses and instruction fetches can occur on the same cycle. With a unified cache, the MPC601 can't service an instruction fetch and a data access on the same cycle.

The MPC601 compensates for this by buffering and queuing many cache accesses. The cache provides a retry queue that can buffer one floating-point access, one integer access, and one instruction fetch, and it uses the read and write buffers in the memory unit to keep off-chip accesses from blocking cache operation. The eight-element instruction queue also acts in effect as a write buffer for the cache into the instruction pipelines. When accesses to the cache do conflict, it arbitrates between them and services the access with the highest priority. Cache reloads have the highest priority, followed in order by snoop operations, floating-point stores, integer accesses, and instruction fetches.

In terms of design complexity and chip real estate, the unified cache is easier to implement than a split one. The unified cache also has the benefit of being able to adopt a dynamic balance between instructions and data.

The MPC601 cache is eight-way set associative with a 64-byte line, divided into two eight-word (32-bit) sectors (a word in the MPC601 is 32 bits). The cache is write-back by default, but individual lines can be specified as write-through. It supports snooping and the MESI protocol to ensure cache coherency in multiprocessing implementations and uses an LRU (least recently used) replacement policy. It presents an eight-word interface to the rest of the processor, which helps move data and instructions quickly into and out of the cache. In addition, it can perform a read/modify/write operation in just one cycle.

The cache is indexed on the physical address of each line; when checking an access for a cache hit, the MMU-generated physical address is checked against the tags. This differs from many processors that index the cache using the virtual address. Using the physical address avoids update and coherency problems where multiple virtual pages map to the same physical page, but it means that cache lookup can't occur until after the MMU performs address translation. This isn't a bottleneck with the MPC601, however, because address translation takes place during the execute stage of the IU: No additional clock cycles are used for translation.

The cache works closely with the memory unit, which contains the two-element read queue and the three-element write queue used to buffer external memory accesses when data accesses or instruction fetches miss in the cache, when cache sectors need updating, and for page-table search operations. Each element of the write queue can hold eight words—one cache sector—of data. One of the write elements is dedicated to writing sectors that are hit by a snooping operation from another processor or bus master. This

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snoop element has the highest priority of the three elements in the queue.

The memory unit connects the MPC601 with the rest of the system via a bus interface based on Motorola's 88110 RISC processor. Unlike some RISC chips, the MPC601 supports misaligned memory accesses, which is plus when it is used in 680x0 processor (or 68K) emulations.

Memory Master

Both the cache and the memory unit depend on the operation of the MMU, which translates the logical addresses generated by the execution side of the processor into the physical addresses used by the external memory system. The MMU supports a 4-GB logical address space divided into 256-MB segments (the segmentation is invisible to programmers). The MMU supports demand-memory paging using 4-KB pages and also supports block addressing—with block sizes ranging from 128 KB to 8 MB—for situations where you want to keep logical addresses contiguous in the physical-address space—the frame buffer of a display card, for instance.

Like other demand-paged memory systems, the MPC601's MMU stores the information it uses to translate between logical and physical addresses in page tables. Page tables are kept in memory, under the control of the operating system. The MMU caches as many page table entries as possible in its three TLBs (translation lookaside buffers), using an LRU algorithm. A 256-entry, two-way set associative UTLB (unified TLB) stores translations for paged data and instruction access, while the BTLB (block TLB) stores four block-address translations.

The four-entry fully associative ITLB (instruction TLB) contains the four most recently used instruction address translations, providing a shortcut for translating prefetch addresses by capitalizing on the highly local nature of sequential instruction accesses. Because it is checked first on instruction accesses, the ITLB also helps reduce contention for the MMU between instruction and data accesses. When an instruction fetch hits in the ITLB, a data access can move through the MMU in the same cycle. The contents of the ITLB is usually a subset of the contents of the UTLB and the BTLB, or both.

In addition to address translation, the MMU also provides memory protection for supervisor and user programs and data. It can offer protection at the page, block, or segment level.

How the MPC601 Stacks Up

The MPC601 is advanced in some respects, such as its ability to issue three instructions per clock, and it is fairly ordinary in others, such as its use of a unified cache (although the use of read and write queues, cache retry queues, the ITLB, and the instruction queue eliminate much of the contention you'd expect with such a cache). The result is a processor that is both powerful and inexpensive to produce—a nice combination.

Another artifact of this mixture is that it creates some obvious targets (e.g., split caches) for the design team to go after in the higher-performance members of the PowerPC family, the 604 and the 620. In both price/performance and the future directions it maps out, the MPC601 is a strong foundation for the PowerPC family. ■

ACKNOWLEDGMENT

Also contributing to this story was BYTE senior technical editor Tom Thompson.

Bob Ryan is a BYTE technical editor. You can reach him on BIX as "b.ryan" or on the Internet at bryan@bix.com.

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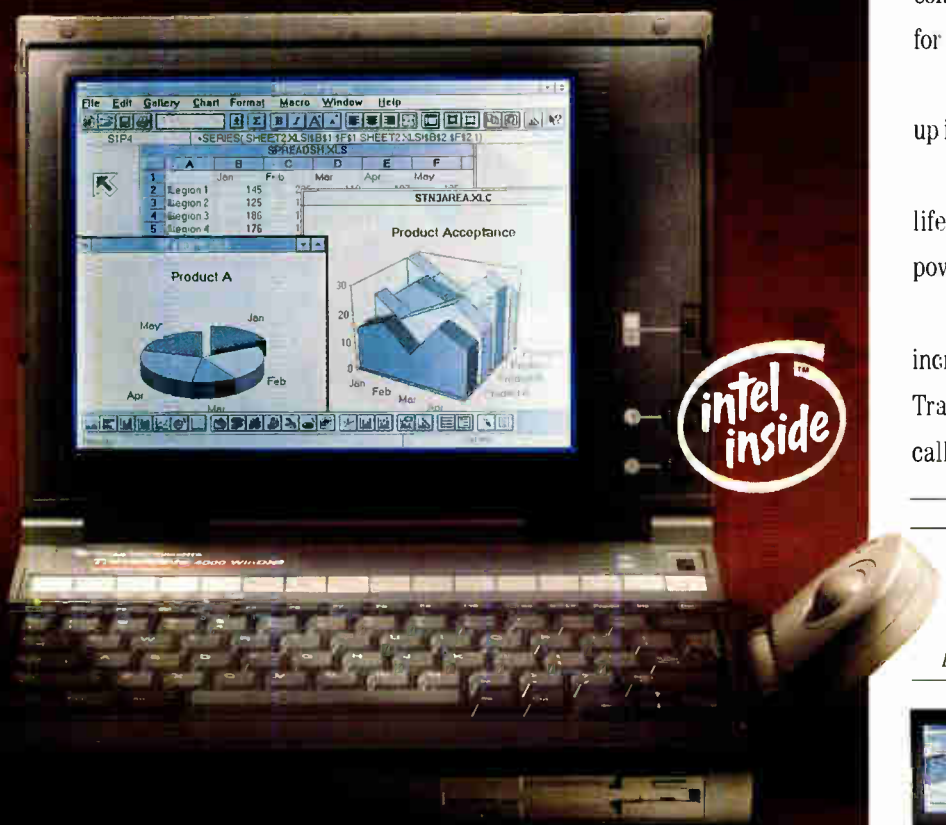

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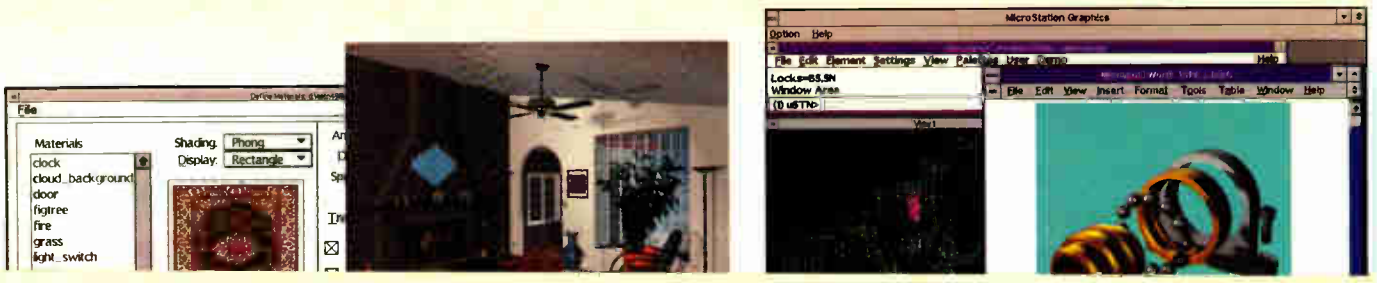
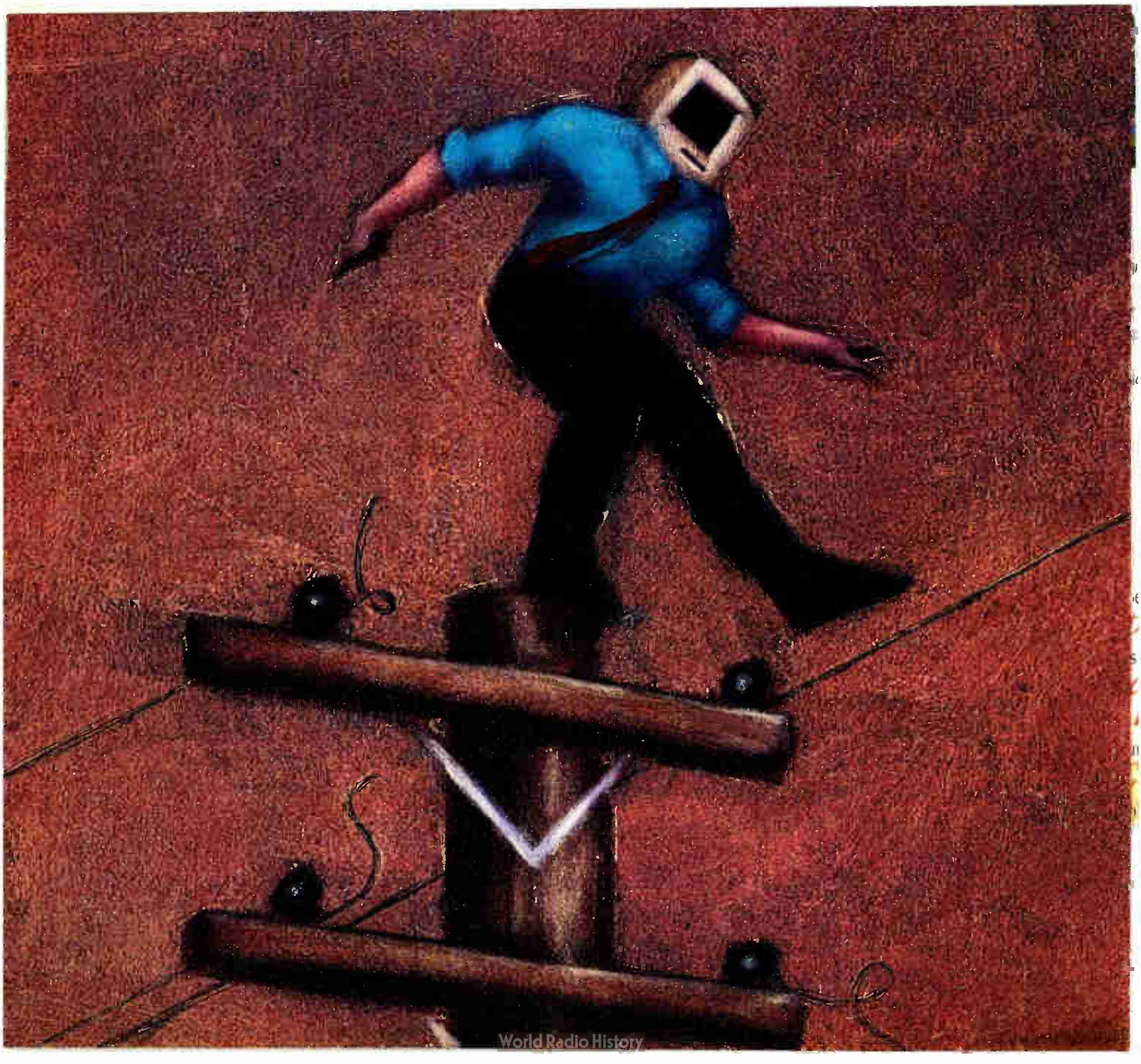


State of the Art

FUTURE COMMUNICATIONS

Today, two parallel technologies—the public telephone network and public and private data networks—handle most of your communications needs. In the near future, the melding of voice and data communications will bring unparalleled richness to your personal and business communications.

JOHN P. MELLO JR.



Connecting computers means connecting people, and today a number of technologies are making this point more explicitly than ever before. The drive to create a connected society is creating a demand for applications that let a richer mix of information travel over a network—a mix that includes voice, graphics, and full-motion video—and a high level of interactivity.

Before the dreams of network grand designers can be realized, however, connectedness must become a more popular notion than it is now. That will be accomplished by building on our most popular instrument of communication: the telephone.

The telecommunications sector is where the computer industry was before the personal computer came along, contends John Landau, vice president for marketing at Dialogic (Parsippany, NJ). In the mainframe era, you leased a system from a company like IBM or Burroughs, which owned the hardware platform, operating system, applications, and networking elements. Personal computers broke apart the hardware platform; open operating systems broke apart the software environment; and the computing world went from a vertical model to a horizontal one. "In telecommunications," says Landau, "the PBX is still in a vertical model."

This year, however, Dialogic introduced SCSA (Signal Computing Systems Architecture) for building open distributed communications systems using multiple technologies. Dialogic hopes an open architecture for telecommunications will break up the top-down hierarchy that exists in the industry. With an open telecommunications architecture, more applications developers can be drawn into the market.

Landau sees a world where faxes can be sent to your home office, translated into text automatically by character-recognition software, and forwarded to the desired party via E-mail. And if you're in the field, you will be able to call your home office on a telephone, and the system will convert your E-mail into speech and read it back to you. "Nobody is shipping products like that today, but by the end of 1993, such products will be demonstrated in trade shows and used in the field."

A Computer in a Telephone

Within a year, you will be able to buy a *smartphone*, a telephone that comes with an LCD and maybe even a pull-out keyboard. The companies that are manufacturing smartphones will package services with them that will let you order airline and concert tickets, pay bills, close brokerage deals, bank electronically, and send E-mail and faxes.

Smartphones are expected to cost between $200 and $650. Philips Home Services International is teaming up with Nynex to market the phones in the U.S. And AT&T, Northern Telecom, Matsushita Electric Industrial, and Online Resources & Communications are also expected to enter the market.

Philips considers the smartphone to be a way of delivering more services to consumers and businesses via telephone networks. The company believes that the proliferation of services is far outstripping the capabilities of the Touch-Tone phone. "There are 25 custom services offered by the telephone companies," says Larry Moore, CEO of Philips (Burlington, MA). "At some point," he says, "the consumer needs a visual user interface to make it easier to figure these things out. A screen-enhanced telephone is a first step."

Smartphones are an attempt to bring to the telephone system the client-server paradigm that's the backbone of computer networks, but without the pain and learning curve connected with personal computer telecommunications. "Telecommunications seems to be the ugly little secret of the computer world," says Moore. "Easy telecommunications is difficult on a personal computer. Contrast that with how easy it is to buy a telephone, take it out of the box, and plug it in. We've got to make the technology that easy. It's got to come out of the box and plug into the wall, and that's it."

"By computer standards, the services offered with smartphones appear crude. However, they deliver many features with zero investment in learning," says Moore.

Smartphones can make consumers network clients without them being aware that they are on a network, Moore contends. "The consumer or small businessperson doesn't have to make an event out of accessing a service, they just get it. It feels like it's in the phone, not on a network."

COMMUNICATIONS OUTLOOK

Computers and computer networks are becoming the primary medium of business communications.

- **Computers and telephones are merging.**
- **Computers and networks can handle real-world data types.**
- **Increasing network bandwidth makes possible real-time multimedia applications, such as videoconferencing.**

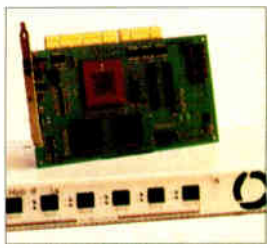
A Telephone in a Computer

The melding of telecommunications and data communications is also advancing in the computer arena, where the drive is to create seamless integration of telephones and computers. Building information autobahns is fine, but if a driver needs an engineering degree to use them, their usage

Future Communications
Will your LAN become your preferred communications device? 94

All-Terrain Networking
ATM provides the backbone needed by the applications of tomorrow 111

Pumping Up Ethernet
Bringing 100 Mbps to Ethernet 121



belies their purpose.

Network vendors, telephone companies, and software makers are bringing to market products to fill in the potholes in tomorrow's information highways. Novell and AT&T released a product to link one model of PBX, AT&T's Definity Communications System, with Novell's NetWare. The product, called Telephony Server NetWare Loadable Module, enables customers to use telephone features—such as automatic dialing, conference calls, and message management—with information that is stored on their networks.

Jerry Michalski, contributing editor to the computer-industry newsletter *Release 1.0*, sees the engagement between AT&T and Novell as an important development in the marriage of telephones and computers. For the first time, a popular network operating system will be able to issue commands to a PBX and allow applications to act on information received from a PBX, says Michalski.

Michalski predicts that the Telephony Server NetWare Loadable Module will make telephone-computer applications practical. "People will write applications that will call the module and, for instance, get an inbound number or set up automatic dialing sequences," he says. "You might even be able to emulate a voice-response system with that kind of technology."

The Philips Smartphone *(below) and the Rolm NotePhone (left) are tangible evidence of the convergence of telephony and computers. They supply a computer interface that lets you access the complex services available by telephone and take advantage of applications that integrate voice and data.*

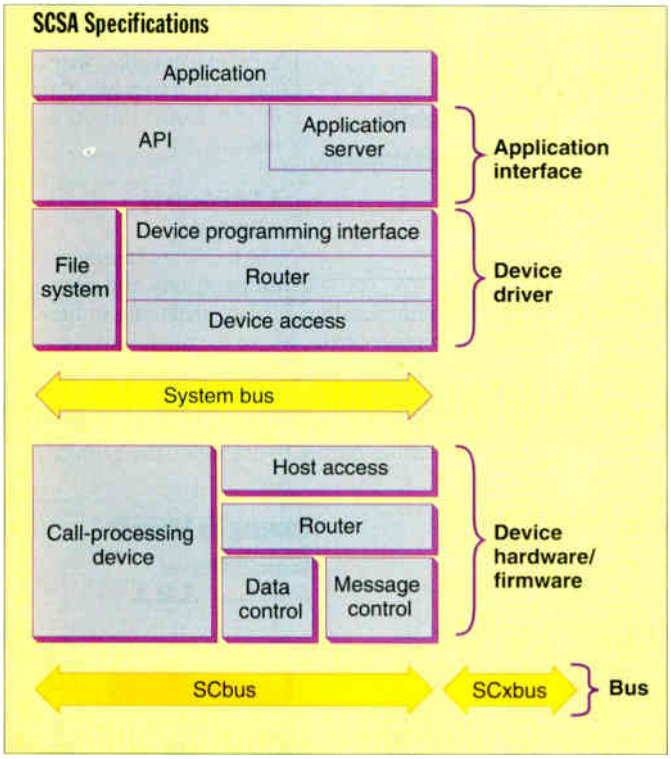
In addition to the AT&T-Novell alliance, Rolm (Santa Clara, CA), a Siemens company, and Apple (Cupertino, CA) have teamed up to create the NotePhone, which will couple technology from Apple's Newton PDA (Personal Digital Assistant) with the ability to access Rolm PBXes. The NotePhone is part of a strategy adopted by Siemens to tie together networks of telephones and computers.

The first phase of this strategy is to create network applications that can use telephony and data. The next stage is to bring to the desktop applications that are anchored to high-volume, call-center environments. With the Newton technology, Rolm hopes to enable users to take these features on the road and to enjoy a friendlier interface. "What we're doing with Apple is expanding the range of applications that take advantage of voice and data and the synergy between the two technologies," says Johanna Cummings, director of alliances at Siemens Private Communication Systems Group (Santa Clara, CA).

According to Michalski, the Rolm-Apple alliance cuts across the grain of how computer companies look at these converging technologies. "One of the problems with the personal computer companies addressing this issue is they want to bring multimedia to the desktop machine and give it all these great features," says Michalski. "What they're missing are the major trends in the market: Computers and telephones are becoming portable. Cellular phones are selling well. Cordless phones are owned by 30 percent of U.S. households. And 30 percent of all personal computer sales are laptops."

Michalski contends that the computer industry lacks foresight in the way multimedia should be integrated into future network applications. "They are trying to convince us that we want multimedia, and they have yet to prove there is any real value behind it," he says.

The real value of multimedia, asserts Michalski, becomes apparent only if you throw out its traditional definition as a combination of text, video, sound, and animation. Michalski sees multimedia as the ability to switch modes of communication easily. For example, if you're having a telephone conversation and you want to show the other person a graph, a good multimedia platform will make that task transparent. If you want to add people to the conversation, you should be able to find the people on your directory, drag their icons into your conversation, and let the telephone system do the rest of the work. "That is good multimedia," says Michalski, "and I find that almost no computer



Dialogic's SCSA takes a layered approach *to integrating telephony with computer applications. At the top of the stack are applications that access a standard API set. Applications—and applications developers—are freed from dealing with the complexities of device drivers, call-processing hardware, or interfaces to telephone lines.*

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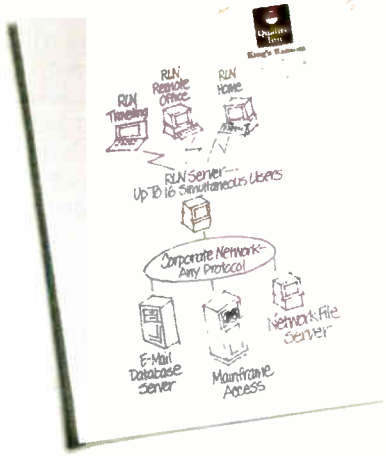

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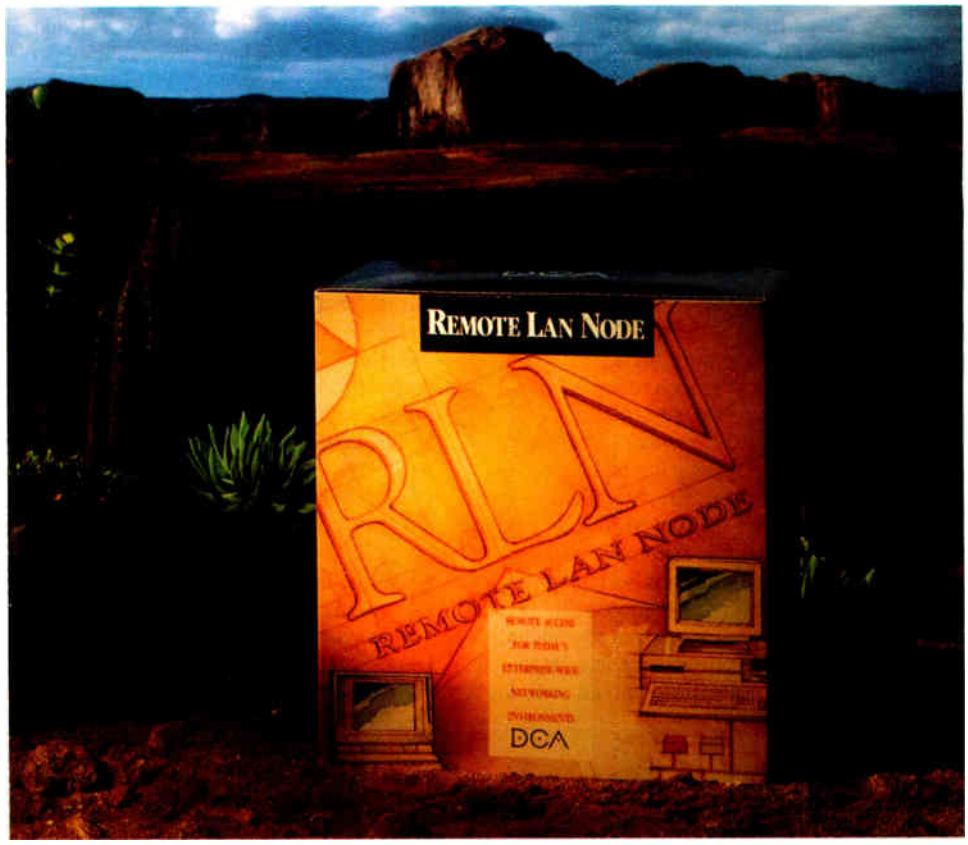
The magazine went on to say, "Our winner, DCA's RLN, stood out for its capability to handle multiple communications protocols," commenting that "it won hands-down on flexibility, allowing our remote users to connect to both IPX and IP servers in the same call."

All in all, the article concluded, if you're looking for versatility, "None of the other units we tested came close."



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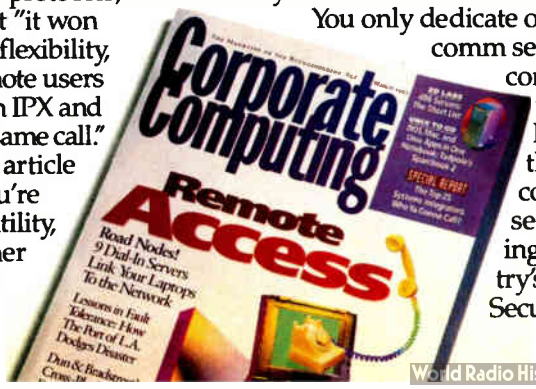

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companies are looking at doing that."

More companies may be willing to take up Michalski's challenge as standard ways of connecting telephones and computers evolve. Recently, Microsoft (Redmond, WA) and Intel (Santa Clara, CA) announced the Windows TAPI (Telephony API), which provides hooks that enable Windows applications to integrate with telephone-based and wireless communications devices. Due on the market in 1994, TAPI will ensure that Windows applications have standard interfaces to telephony-based products.

Understanding Networks

More evidence of the convergence of computer and telephone technology comes from the area of speech recognition. Many speech-recognition systems under development let you access data stored on computer networks using a telephone.

You can see the direction that this technology is heading in at MIT (Cambridge, MA), where a research system called the Air Travel Information System helps people make airline reservations. The system understands continuous speech—including speakers with foreign accents—as long as the person is just talking about ordering a ticket. Although people ask questions in many different ways, the universe the computer navigates is so narrow (i.e., only arranging ticket orders) that it can make sense of any speaker's questions.

"Speaker independence is now adequate to accommodate a large population of people," says Dialogics's Landau. "Voice-recognition systems can accommodate a wide range of dialects, voice pitches, sore throats, and everything else that used to keep the error rates in these things at 10 percent. Now the error rate is in the 2 percent to 3 percent range."

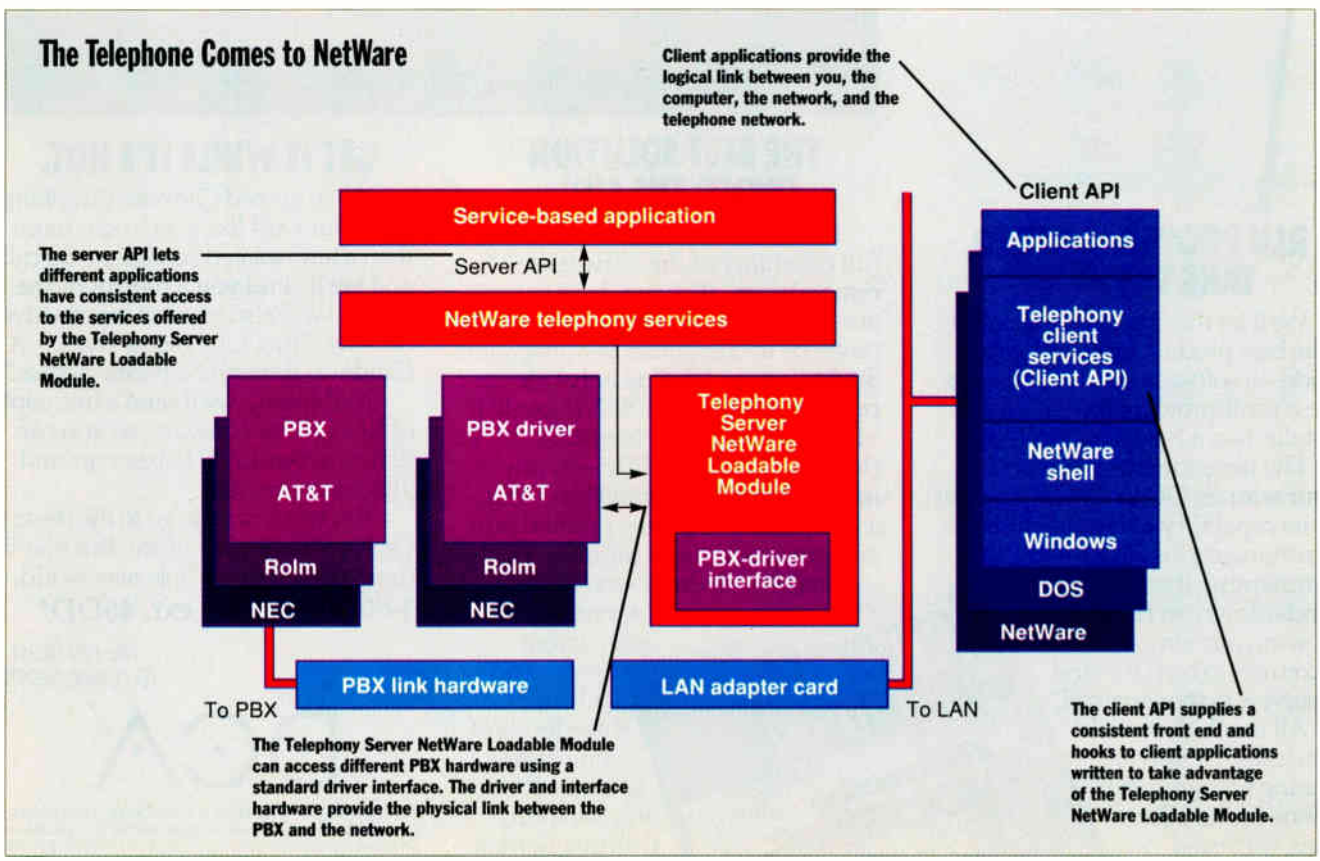
Virtual Meetings

Creating a computer-telephone hybrid, though, is only one instance of how future computer networks will incorporate additional communications functions. Network applications with greater interactivity than has previously been seen will make workgroups more powerful. Some of these applications are already in the pipeline.

For instance, groupware that arranges meetings has been available for several years. But now the network can be the medium for the meeting. Once a meeting is set up, software designed along the lines of the Kiva NetConferencing system from Artisoft (Tucson, AZ) can administer the process. "In a traditional conference, you get a bunch of people on a network, and they type simultaneously into one big bucket," says Jack Schoof, former Artisoft chairman and CEO. "What Kiva does is let people speak. I believe you can convey so much more information by speaking than by typing."

The Kiva NetConferencing system, still in the developmental stage, allows a meeting moderator to define an order, format, and time frame for participation in the meeting. As the proceedings take place, they are archived and compressed in a voice-and-text file. Participants can monitor their place in the queue, access the conference archive to catch up on the meeting in progress, and distribute text and graphics handouts to conference members.

Artisoft's system also offers its own brand of electronic democracy by providing for anonymous, on-line votes. "A moderator can ask for a vote, and Kiva will take the tally," Schoof says. An approval meter allows groups to rate presentations: While someone is making a presentation, the other people in the conference can register their reaction to it by pushing a button; a meter on the presenter's screen can



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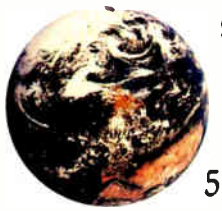

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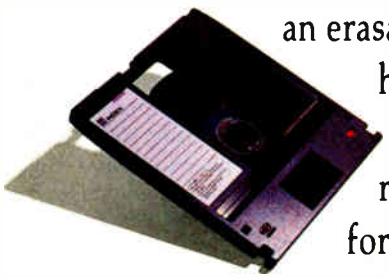

an erasable, rewritable work-horse drive. And as a WORM (write once read many) archiver for mass storage.

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The Cable Connection

Interest in a connected society isn't limited to computer visionaries and network engineers. A group of companies representing the consumer electronics, computer, and cable and satellite TV industries is backing the First Cities Consortium, a comprehensive attempt to create interactive multimedia network services. The consortium expects to be experimenting with test sites through December 1994 and is developing the software to connect homes to application servers. It wants subscribers to be able to get the product no matter what the platform or transmission medium, be it satellite, cable, glass fiber, or microcellular broadcast. Three of the U.S.'s major cable TV companies are investing millions to create information superhighways.

Time-Warner (New York, NY) was the first cable TV company to announce that it was building an electronic superhighway into the home. The company's network will serve 4000 subscribers in the Orlando, Florida, area by the beginning of 1994.

Time-Warner intends to run a number of services on the network, such as interactive, full-motion video educational services produced in conjunction with local schools and universities; full video on demand, including movies, sporting and cultural events, and documentaries; interactive video games, which customers can play with other subscribers on the network; full-motion video interactive home shopping; and long-distance telephone access and picture-phone services.

Next to announce this new type of service was Cablevision (Woodbury, NY), the nation's fourth-largest cable TV company. Cablevision is investing $300 million to create a network that will service 1.1 million customers in the New York metropolitan area. The company has already built a 1400-mile fiber-optic backbone for the network. Cablevision will offer movies on demand, telephone services, and videoconferencing, and the network will link the State University of New York at Stony Brook, Cold Spring Harbor Laboratory, and Brookhaven National Laboratory with high-speed, fiber-optic cable.

The U.S.'s largest cable TV operator, Tele-Communications, Inc. (Denver, CO), says it plans to invest $2 billion over the next four years to build an information highway. The company says that its upgraded cable network, which will use fiber-optic technology, will service hundreds of U.S. cities and bring voice, data, video, and computer services into the home.

Tele-Communications, Inc. says it will spend $750 million this year alone to upgrade its existing coaxial-cable network by installing 7000 miles of fiber-optic cable to 100 U.S. cities and towns. By 1996, the company says it expects that the network will provide the new services to 90 percent of its 10 million customers.

Although the amounts of money that the cable TV companies are spending to create their information highways aren't meager by most standards, Jerry Michalski of *Release 1.0* says the investments must be put into perspective. For example, he notes that the Bell operating companies invest $10 billion a year to upgrade and maintain their infrastructure. And Japan's Nippon Telegraph & Telephone has announced that it is going to spend $300 billion over the next 20 years to bring fiber-optic service to every doorstep in the country.

"Two billion dollars is nothing to sneeze at," he added, "but it isn't as big as some other investments that are being made."

First Cities Consortium

- Apple Computer
- Bell Communications Research
- BieberTaki Associates
- COMSAT Video Enterprises
- Corning
- Eastman Kodak
- Kaleida Labs
- MCC
- North American Philips
- Southwestern Bell Technology Resources
- Sutter Bay Associates
- Tandem Computers
- US West Communications

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indicate a range from a smiling face to a frowning one.

Moving Beyond Voice

By far the richest form of information traveling over the networks of the future will be multimedia data types (e.g., audio and full-motion video) and voice. Multimedia is to computing what sound was to motion pictures: a development that is essential to the full exploitation of the medium.

When computer networks were first introduced, the demands on them were relatively simple. "Lots of the services back then, in the mainframe environment, were transaction processing and textual-based objects," explains Nick Lippis, president of Strategic Networks Consulting (Rockland, MA) and the writer of the *Internetwork Adviser*, a monthly analysis of internetworking implementation issues. "Today, we're including other data types, such as audio. We're entering a phase where we will see video as just another data type. In the 1995 time frame, we will have objects on the desktop that have pieces of audio, video, and data, and that's what's going to be transported across the network."

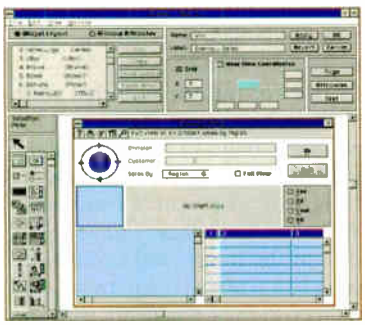
Lippis thinks that the confusion over the meaning of *multimedia* stems from the fact that different people use the term to refer to different things. He sees the use of the word in the broad sense—the convergence of computers, home electronics, and TV—as being confusing to computer users and network planners alike. "If network managers think of multimedia as convergence, they can ignore it, because it doesn't really affect them. But if they ignore multimedia on the desktop, they're courting disaster," says Lippis.

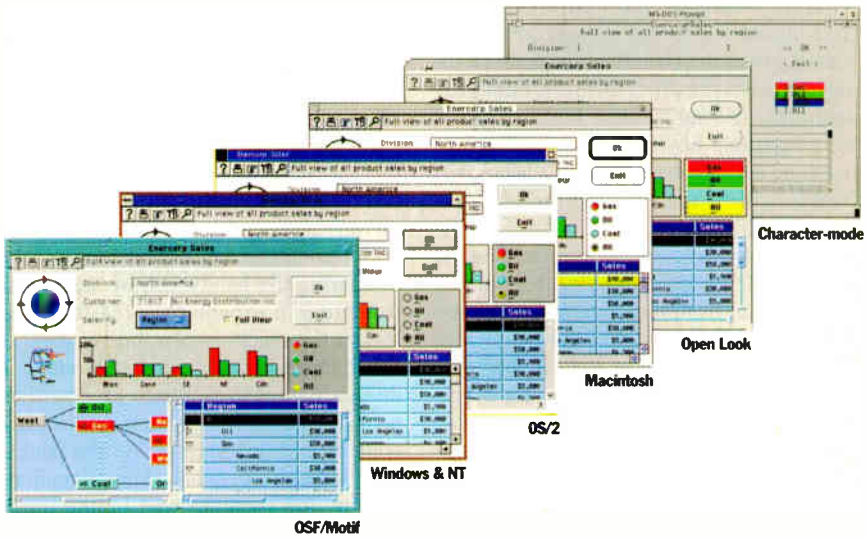
Lippis believes that concurrent engineering and electronic co-location are fertile areas for multimedia applications on networks. "If you look at the aerospace industry, you will see very vertical companies," says Lippis. "But with defense contracts drying up, companies are finding that they need tighter horizontal linkages between groups. Talking together and sending E-mail isn't good enough. Companies need video to make concurrent engineering happen." Concurrent engineering has become important to defense industries, observes Lippis, as they move to commercial markets and product development cycles drop from two to three years to six to nine months.

Technical Challenges

To handle such multimedia data types as full-motion video, future networks will

Extraordinary Claims





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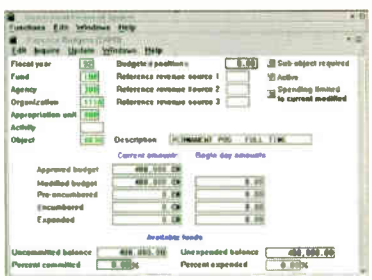

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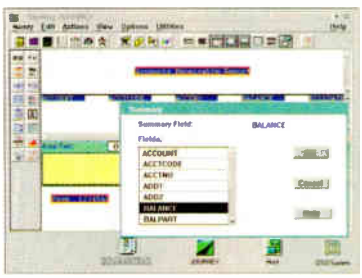

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need tremendous muscle. One industry executive estimates that multimedia with full-motion video and audio requires processing rates, bus bandwidths, main memory and video/graphics memory, mass storage, and I/O bandwidths at least two orders of magnitude beyond those required for text and data. In the future, 100-Mbps networks will be the baseline for network-based multimedia.

Network designers are approaching the grueling demands that multimedia places on a system from two directions. On one hand, they are increasing the bandwidth of the buses and network links in their systems. On the other hand, they are developing compression strategies that reduce the bandwidth requirements of multimedia information.

One technology that lies down the road may be just what the doctor ordered. It's called ATM (Asynchronous Transfer Mode), an evolving switched, cell-based transmission technique that simultaneously supports voice, traditional data, image, and video signals by rapidly switching micro packets of information (see "All-Terrain Networking" on page 111).

Multimedia poses another problem for computer networks, however. When computers began talking to one another in the 1970s, network designers looked at the existing telephone system with dismay. Although it was well suited for voice calls, the system's fixed 64-Kbps bandwidth couldn't handle the traffic for those intent on moving megabits of data per second.

So, computer engineers devised ways of sharing the bandwidth by sending information in irregularly sized bursts and letting the machines on the network use the channels by interleaving the bursts. To do this, data is broken into packets. Each packet contains information describing its content and destination. As the packets whiz through a network, the information is read by the switches routing the traffic, and the entire block of data is reassembled at the destination.

Data-oriented LANs weren't designed to support multimedia services. Such services require guaranteed bandwidth for applications and synchronization of information. The pioneers of first-generation LANs—such as FDDI (Fiber Distributed Data Interface), Ethernet, and Token Ring—never envisioned multimedia requirements. They simply sought to devise a standard way of handling the bursty traffic associated with simple file transfers and other applications in multivendor computing environments. And because these applications don't have strict timing requirements, developers focused solely on providing asynchronous services for networks.

That's fine for information that isn't time-sensitive, but video, audio, and interleaved video/audio in multimedia applications require simultaneous, nonstop data transfers. If a network's bandwidth is too narrow, video frames have to be dropped until the image and audio files are reduced to a size that the network can handle. Forced to share a network with applications that do not require time- or bandwidth-sensitive services, voice and video can be preempted and degraded to garbled sounds and scrambled images. For the end user, that means Max Headroom instead of Dan Rather.

You can overcome some limitations that

are encountered when you run multimedia applications on asynchronous LANs by using buffers, improved software, or switching technology that increases bandwidth and access on a per-station basis. However, the costs of add-on solutions are expensive, and the number of stations is limited. For example, EtherSwitch EPS-1500, a product from Kalpana (Santa Clara, CA), can provide multimedia users with a dedicated 10-Mbps pipe for transmitting multimedia data, but at $900 a port, it's much more expensive than a standard Ethernet hub, which can cost under $100 per port.

Future Visions

Because the promise of ATM and other switching technologies won't be fully realized for some time, network engineers are looking to applications for interim solutions to their multimedia problems. One approach being used is the *videoserver*. This is a specialized type of server that integrates video traffic into LANs. To meet the demands of desktop video, a videoserver can be more than one computer (e.g., two or three 386s or 486s). The big players in the nascent videoserver market are Fluent (Natick, MA), ProtoComm (Trevose, PA), and Starlight Networks (Mountain View, CA).

A videoserver compresses the frames of video signals so they can be sent across a network. The videoserver uses a mix of off-the-shelf and proprietary video-compression chips to deliver variable bandwidth sessions. It links telephone calls and videoconferencing services and converts analog TV signals to compressed digital video.

Among its many functions, the videoserver can set up and oversee desktop videoconferences among several participants, each of whom is displayed in a window on-screen. Because a videoserver can create a composite display from signals fed to it from different desktops and videoconferencing units, it can dedicate a single session to each participant, conserving bandwidth.

A videoserver also stores the digital video clips that are used in videomail, training presentations, and similar multimedia applications. Because it must handle video compression and A/D conversion, a videoserver needs a lot of specialized hardware. And the demands of store-and-forward services require tremendous amounts of disk storage, such as that offered by RAID (redundant arrays of inexpensive disks) or optical media (see "Storage Without Limits" on page 104).

Distributed Multimedia

Hewlett-Packard (Palo Alto, CA) also has an eye on the information-rich demands of future networks, and Fibronics International (Pembroke, MA) is seeking to improve the performance of existing networks.

Late last year, Fibronics International announced a multimedia system for networks that supports surveillance and videoconferencing. Called MAVIX (multimedia audiovisual information exchange), the system gives network managers an array of powerful tools to monitor and control multimedia applications that are running across 100-Mbps FDDI and 10-Mbps Ethernet networks.

MAVIX is based on Microsoft Windows

Storage Without Limits

BOB RYAN

Bandwidth isn't the only limiting factor in providing multimedia services over a LAN. Compared to conventional ASCII text, multimedia data types have huge storage requirements. Even using current compression technologies, multimedia applications can easily overwhelm network storage devices.

Companies are addressing these concerns on many different levels. IBM, for example, is a leader in squeezing more bits onto a track and more tracks onto the surface of a hard disk. Using advanced thin films and new recording techniques, manufacturers are constantly pushing the envelope in magnetic disk performance and capacity.

Capacity isn't as much a concern to optical disk manufacturers as performance is. Because of their relatively large size and mass, optical read/write heads are slower to position over a track than magnetic read/write heads. For the foreseeable future, high-capacity optical storage will take a backseat to magnetic storage in handling performance-sensitive applications.

In addition to improvements in basic technology, advances in network storage are also coming at the subsystem level. RAID (redundant arrays of inexpensive disks) technology has been embraced by both storage manufacturers and end users as an efficient and effective way of providing fault-tolerant storage for critical LAN-based applications. For example, using 2.1-GB 3 ½-inch drives, the LANStor Continua from Storage Dimensions (Milpitas, CA) offers up to 8.4 GB of RAID level 5 storage in a single enclosure. The LANStor Reflex offers even more capacity for applications that require only RAID level 1 storage. Both systems let you integrate 48 GB of tape backup in the disk drive. Such capacities will become commonplace as multimedia migrates to the LAN.

The Storage Network

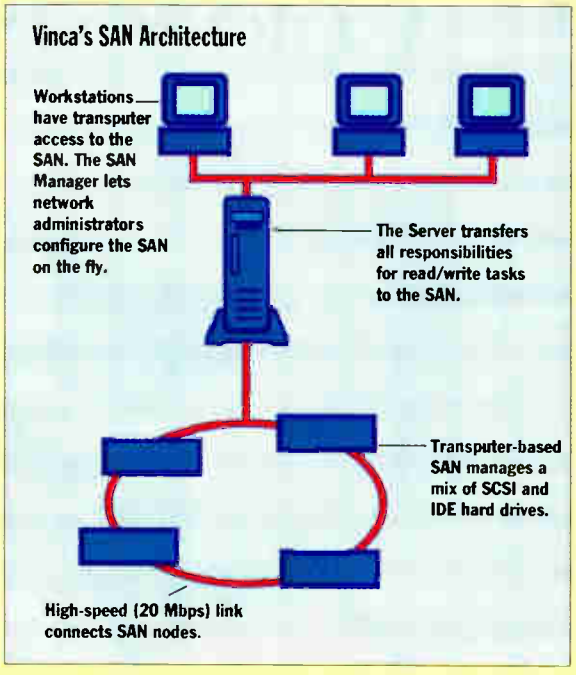
Moving beyond single storage devices, Vinca (Orem, UT) has developed SAN (Storage Access Network) to complement the LAN. SAN takes on read/write tasks from a network server and handles them with a network of intelligent storage devices interconnected by a 20-Mbps data link. The storage devices are controlled by derivatives of the Inmos T400 transputer. Thus, the devices on SAN can work in parallel to handle read/write requests and provide unprecedented fault tolerance.

The main attraction of SAN architecture is its flexibility. SAN storage devices make no distinction between SCSI and IDE drives; both can coexist in the same box. SAN also lets you mix and match drives of different capacities and characteristics. Using Vinca's SAN Manager software, which runs on Windows workstations, you can configure your physical storage in practically any number of ways. You can configure a SAN to provide mirroring, data striping, or striping with parity. In fact, you can create any RAID level with SAN software.

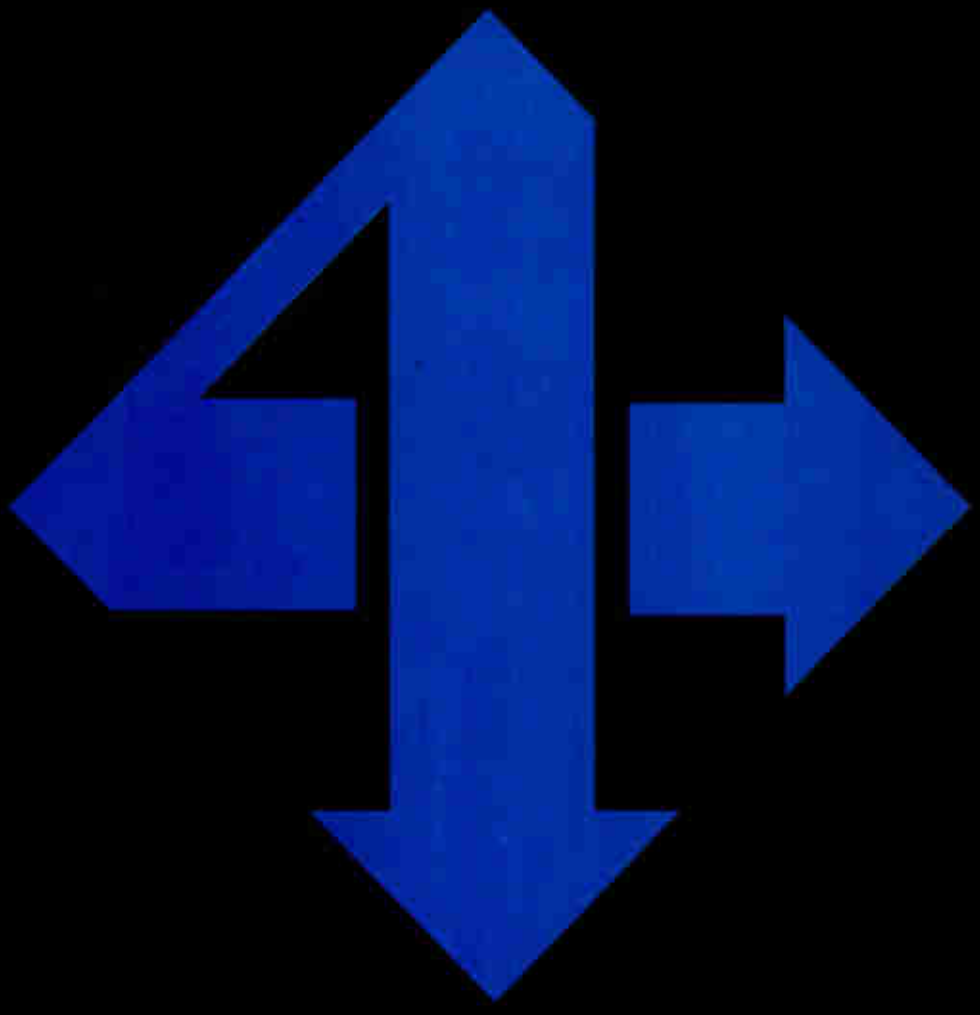
SAN can even heal itself if a drive fails by rebuilding the data from the remaining devices and returning to a fault-tolerant configuration without operator intervention. By taking advantage of the parallel nature of the T400 processors, SAN can also increase performance as you add drives. With a SAN, you can add or change drives and cables while the system is in operation. When it ships, SAN will work with Novell NetWare 3.11 and 4.0. Future versions will support Windows NT and Unix.

Vinca expects to roll out SAN in the fourth quarter of this year and hopes to establish it as a de facto standard for network storage. In the meantime, Vinca will ship MDL (Mirrored Data Links), a SAN-derived product that adds another level of fault tolerance to Novell's SFT III. Presently, SFT III links two file servers. With MDL, the data-storage devices of each server are also linked, and it's possible to retain the data redundancy provided by SFT III in the event that a server goes down. MDL is designed for use in applications that can't afford to lose data redundancy, even when a server is brought down for routine maintenance.

In the future, Vinca also plans to offer storage migration for SAN and to provide hooks for third-party development of such storage services as compression/decompression, disk defragmentation, and encryption.



Bob Ryan is a technical editor for BYTE. You can reach him on BIX as "b.ryan."



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and features software and hardware that provide interfaces to video equipment and networks. By extending multimedia capabilities to the desktop by using the existing network infrastructure, the system allows network managers to leverage existing computer investments and eliminate the need for new or additional video cabling and equipment.

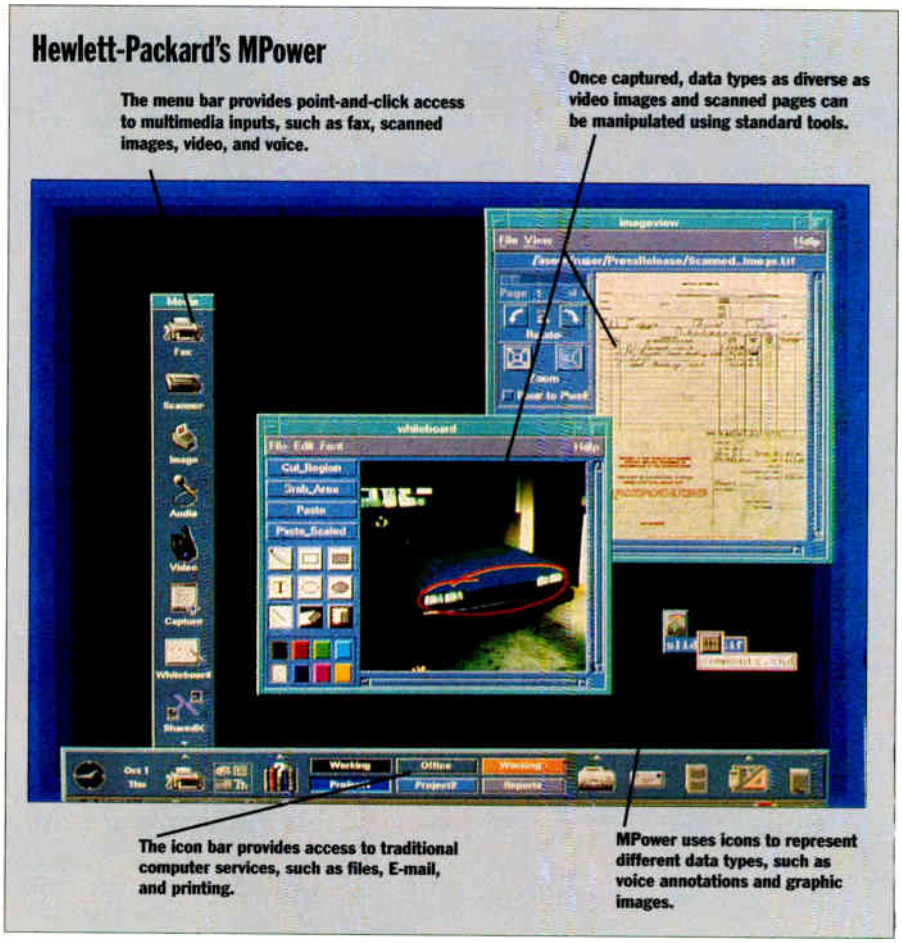
Bandwidth and traffic problems associated with multimedia on a network are addressed by Fibronics International by using real-time, two-way video compression and a switching strategy. MAVIX digitizes and compresses analog video signals through Ethernet/802.3 ports. It also uses a matrix-switching architecture to increase network efficiency and maximize bandwidth.

Switching resembles an old network strategy called *bridging*, which calls for bridges at strategic locations throughout a network to diffuse traffic congestion. Switching adds the ability to handle multiple transactions simultaneously. Given the disdain with which network engineers have viewed the designs of their telephonic counterparts, it's ironic that telephone companies have used switching to manage their high-capacity network circuits for decades.

However, unlike bridges and routers, which wait for an entire data packet to come through before looking for a destination, a switch reads packet header information on the fly, establishes a direct connection with the receiving port, and immediately starts transferring data. When the bus or processor in a bridge or router becomes busy handling data, incoming packets are parked in a buffer. Switches, however, use multiple ports to let several network conversations take place at one time. Usually, switches have faster processors than routers or bridges.

Fibronics International sees MAVIX as an appropriate product for large enterprise systems and organizations that are moving toward comprehensive surveillance and videoconferencing (e.g., schools and hospitals). "Hospitals rely on slow-speed LAN cabling to support transmission of patient records, administrative documents, digital x-rays, CT [computerized tomography] scans, and MRI [magnetic resonance imaging] data. MAVIX can provide hospitals with video surveillance of critical-care patients on the same LANs," says Moshe Levin, president of Fibronics America.

For example, local video sessions can be implemented on each floor by clusters of cameras monitored at a nurses' station. The MAVIX system enables selected multiple video sessions to be switched between floors over FDDI for global monitoring. This application allows hospitals to enhance information systems to keep up with advances in medical requirements while maintaining cost-efficiency. Doctors and nurses can also use MAVIX to simultaneously monitor emergency rooms, entrances, and exits.



Early this year, HP rolled out MPower, a product that integrates multimedia capabilities into distributed-computing environments. It gives users point-and-click access to multimedia data types and the ability to share and edit applications and images across a network. Other features in MPower read like a checklist of what a basic network multimedia applications package should contain.

MPower enhances standard Unix mail so that you can include audio, graphics, and video frames in a logical sequence throughout an E-mail message. It enables you, working from a desktop system, to send faxes to or receive them from any workstation, PC, or X Window System station on the network equipped with a fax. With MPower, you can scan and view; manipulate scale, contrast, and brightness; and store and print high-resolution color and monochrome images. You can view PostScript-based objects on a display. And MPower supports the VideoLive card to enable real-time video playback in a window on a workstation and capture of video frames for use in documentation or E-mail messages.

These applications are just the beginning of what will become the network of the future. "What we're looking at here are crossover technologies," says Moore of Philips. "We're looking at the crossover of telecommunications, computing, consumer electronics, and entertainment. And the cross-fertilization is happening at an accelerating rate. So, watch out!" ■

John P. Mello Jr. is a freelance writer based in Woonsocket, Rhode Island. You can contact him on BIX c/o "editors" or on the Internet at jmell @igc.apc.org.

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MARK CLARKSON

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Even in an industry renowned for hype and hoopla, it's difficult to comprehend the storm of hyperbole surrounding ATM (Asynchronous Transfer Mode). Conceived in the early 1980s as a technology for switched public telephone networks, ATM is now being hailed as the key to interconnecting the world.

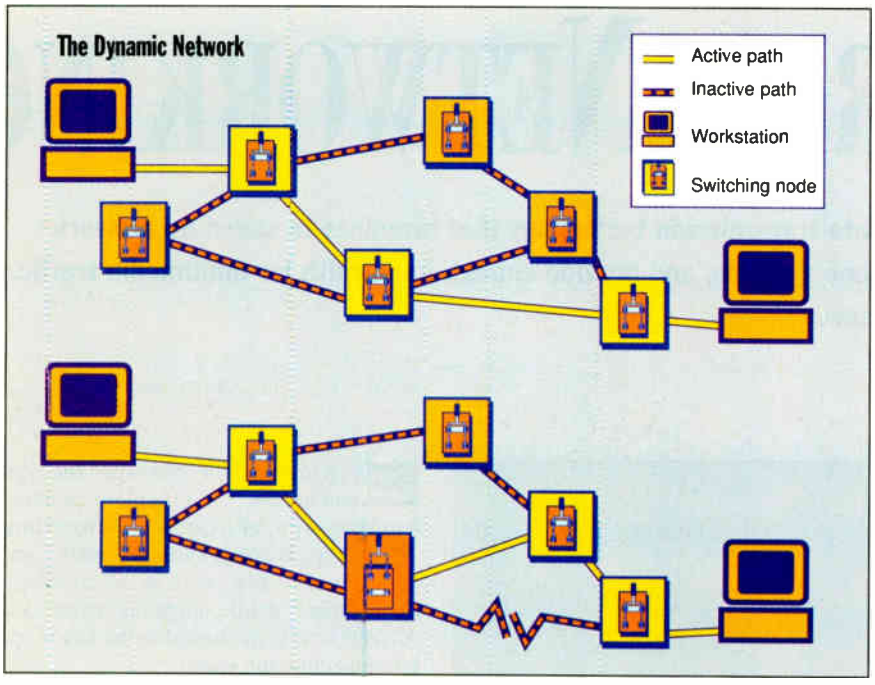
This technology, the zealots say, will offer easy, seamless connections between your LAN and the public telephone network. ATM will provide your desktop system with almost unlimited bandwidth on demand and will enable multimedia applications with real-time, high-fidelity audio and video. ATM supporters are even predicting that the technology will improve the performance of your Ethernet. The truth is that the technology will do all these things, but not until all the pieces are in place.

ATM Explained

ATM is a method of breaking up data into 53-byte cells, or packets, and transmitting them from place to place on a network over a series of switches. In operation, it resembles the transporter on the starship *Enterprise*: Your data is disassembled at one point, transmitted to the destination, and reassembled in the proper order.

ATM is a universal system: Anything can go in one side and come out the other. You're not limited to one kind of data. The system neither knows nor cares what's inside the cells. It can be voice, audio, ASCII text, a series of Ethernet or FDDI (Fiber Distributed Data Interface) frames, or a combination of the above. Each data type has different characteristics (e.g., computer data is bursty, but video is continuous), and ATM technology is designed to accommodate those differences.

ATM supplies bandwidth on demand. You can grab as big or as small a chunk of



Like other switching technologies, *such as X.25 and voice telephony, ATM networks consist of switches located at communications nodes. If a communications link fails, the network can dynamically reroute traffic to bypass the fault and maintain communications.*

network bandwidth as you need, and pay for only as much as you use.

Switched Data

Like drivers in a transcontinental road rally, ATM cells start out knowing where and when they must arrive at the end of the journey but free to choose from various routes to get there. In fact, different cells from the same chunk of data can take different routes across the network.

Packet-switching technologies, such as X.25 and frame relay, also work this way. This contrasts with circuit-switched systems like the telephone network, in which a circuit is established between two people for the duration of the conversation. With ATM, a cell's route may not be determined when the cell leaves its source, but rather invented dynamically as it makes its way through the fabric of switches that make up a network. This allows data to be dynamically rerouted if there's a network failure.

The Hardware Edge

Traditional network routers must be smart, because they deal with cells of information

of varying lengths. ATM switches, on the other hand, deal with cells that are always the same size. This allows ATM technology to perform switching in hardware. Because hardware switching is faster than software routing, ATM switches are universal *and* blindingly fast. While Ethernet and token-ring LANs run at 10 and 16 Mbps, respectively, ATM speeds begin at 155 Mbps and increase rapidly from there. First-generation ATM switches run at 2.4 Gbps.

ATM's promise of almost unlimited speed is a strong motivator for network developers. "What drove our company to look at ATM," says Ron Schmidt, senior vice president for Synoptics Communications, "was the increasing demand for bandwidth to the desktop. Over the last three decades, the bandwidth available to the desktop has increased by an order of magnitude every seven years. Given that, what do we need to do to deliver adequate bandwidth in the mid-1990s? We can't use a shared medium."

A typical LAN is just such a shared medium. Instead of relying on a dedicated line between workstations for communications, it uses a single party line to carry each conversation intermixed with dozens of others. Every node in a LAN uses the same line to communicate on the network.

Adding nodes to the typical network increases the load, but not the capacity. Because the entire network is a single line, the aggregate bandwidth (i.e., the total bandwidth of the network) and the peak bandwidth (i.e., the bandwidth of an individual line) are the same.

Even with a fast, fiber-based network like FDDI running at 100 Mbps, you're sharing that throughput with every node in the network. A shared-medium LAN is only as fast as its slowest node.

In contrast, ATM is a switched medium. To understand switching, think about making a telephone call. You dial my number, I answer, we talk. In effect, we have a private dedicated line connecting our two telephones. In fact, our telephones are connected through several switches, which are universal connections. We can be connected to any one of millions of other telephones throughout the world. Even though telephone lines have low bandwidth, the capacity of the huge switched network is astronomical.

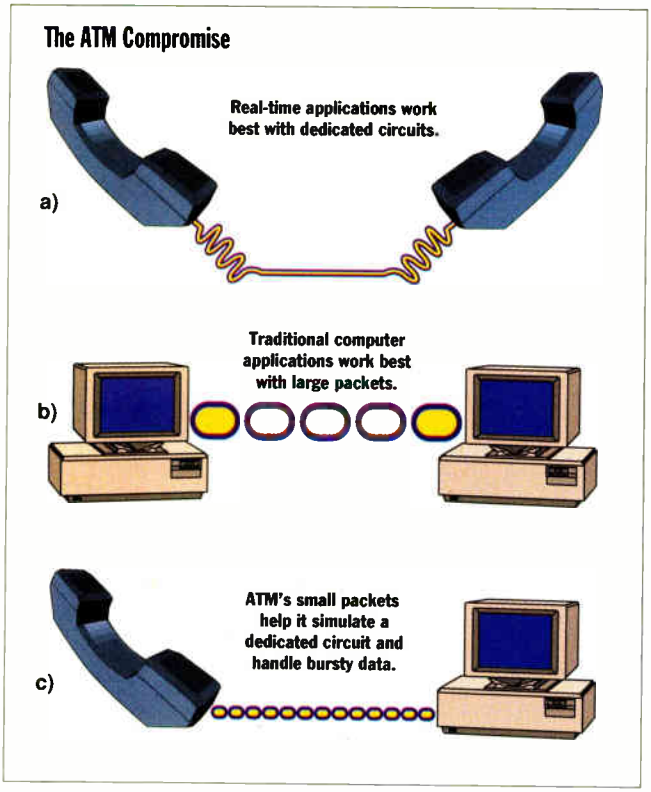
Like the telephone network, ATM also uses switches. The theoretical aggregate bandwidth of an ATM switch is equal to the peak bandwidth of each line *multiplied by* the number of lines going into the switch (e.g., 10 155-Mbps lines = 10 × 155 Mbps, or 1.55 Gbps). A modest-size switch can have a startlingly high aggregate bandwidth.

But individual nodes don't have to run at the high aggregate speeds of the network. Network adapter cards, with their expensive analog drivers, need only run fast enough to accommodate the needs of their own workstation. The aggregate bandwidth of a network can be much higher than the peak speeds of individual nodes. Ironically, no part of a network has to run at the aggregate-bandwidth speed.

ATM switches themselves, embedded in silicon chips, are inexpensive. And compared to the high aggregate bandwidth of the switching fabric, individual switches run at a low speed.

continued

All-Terrain Networking



ATM is not an ideal choice *for real-time applications like voice and video* (a), *or for data communications applications like file transfers* (b). *It is, however, the best technology on the horizon for combining both functions. Because of its fast, hardware-based switching, it can emulate the dedicated circuits usually required for real-time applications. And because it is packet-based, it can handle the bursty traffic characteristic of traditional data communications applications* (c).

Switching Your Hubs

Although ATM was conceived as a public telephone technology, LAN vendors and users are embracing it to such an extent that the majority of ATM products are expected to initially be used in private networks. Eventually, ATM will interconnect workstations and carry sophisticated multimedia applications, such as desktop videoconferencing.

But for the near term, ATM will see duty in the workplace primarily as a way of adding switching capabilities to networks. LANs are usually wired as a star, with each node connected to a hub. By adding ATM switching hubs to LANs, you can dramatically increase the performance of your installed base of workstation adapter cards.

Say you have 50 people on your office Ethernet. By taking the old hub out of the wiring closet and putting in a switched hub, you can turn the one Ethernet into 10, or 50—one for each user. You haven't moved any wires, and you're using the same adapter cards and software as before. It's still Ethernet, but now each user has a dedicated Ethernet of his or her own.

The ATM switching hub is more expensive than a 10Base-T hub, but with an ATM hub, you preserve a significant part of your network investment. "Not everyone needs ATM to the desktop," says Schmidt. "If you deliver 10 Mbps to everyone's desk, you turn Ethernet from a bottleneck into a highway." Schmidt sees the networking market as in transition, with switching technologies playing a big role. "It'll be a big change—as big as the change from terminal-server networks to [client-server] shared media access LANs."

However, a transition that shuts out the huge installed base of Ethernet and token-ring installations is a transition to nowhere. ATM provides the capability of carrying these legacy systems—and the software that works with them—into a switching environment. For example, Schmidt considers the ATM hub an enabler for new applications requiring high bandwidth. The good news for network managers is that they need not change the adapters in workstations to get the benefits of high bandwidth.

> **ATM is here. It's starting on the customer premises and in the [public] infrastructure. Where we are at now is putting together the switches. Where we have to get to is putting the applications on those switches. The technology has a lot of advantages for multimedia traffic, and applications are going to be generated on it.**
>
> —Harry Bosco
> Vice president for AT&T Network Systems' ATM platform

According to John Carosella, director of business development for Newbridge Networks' ATM initiative, ATM technology is going to be pushed by the hub vendors, who have an incentive to increase their role and importance in the networking world. LAN hubs currently support multiple LAN segments (e.g., a couple of Ethernets and a couple of token rings). What they lack, says Carosella, is a good method of interconnecting the segments. ATM provides that method. The technology offers a standard approach that will allow you to seamlessly plug the hub into other LANs and WANs (wide-area networks) in the coming years.

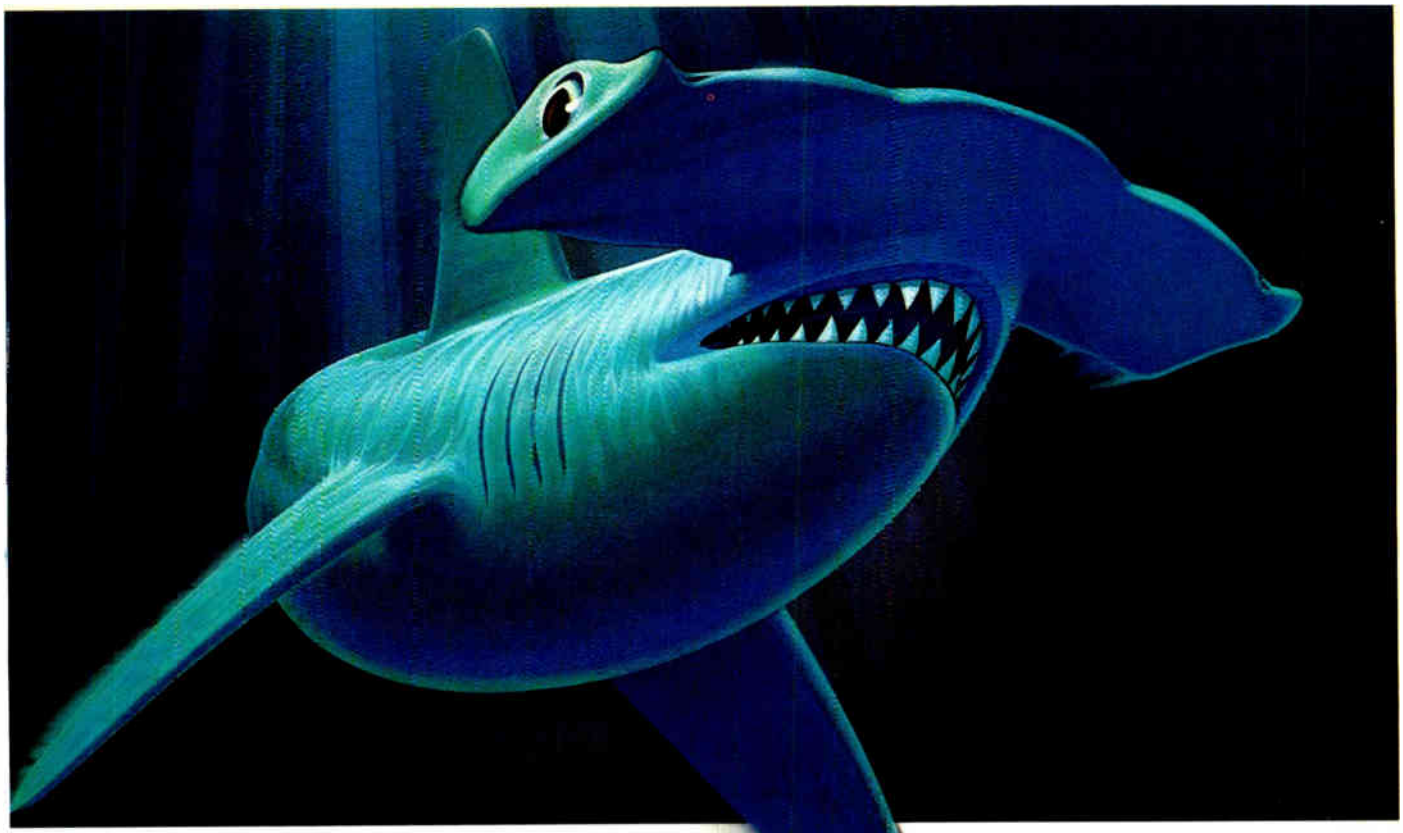
ATM will get a lot of initial play in high-speed campus backbones—which tie together LANS—and other high-bandwidth data highways. ATM is especially applicable because of its ability to carry all kinds of data intermingled.

Flattening the Hierarchy

The amazing thing about ATM is that for the first time telephone-equipment vendors and LAN-equipment vendors are working with the same standards, developing the same technologies, and deploying those technologies in the same time scale. Even cable TV companies are testing the waters with ATM. Time-Warner has announced its intention to use AT&T ATM switches in its interactive cable TV pilot project in Orlando, Florida.

"As the public-carrier infrastructure appears ready to make a transition [to support high-bandwidth applications]," says Carosella, "the local networks are hitting the same issues. The applicability of ATM technology for both is exciting. With ATM, you are flattening the data communications hierarchy and creating fewer transitions from technology to technology. That fundamentally simplifies things."

ATM is also scalable. You can increase or decrease such things as bandwidth and data rates and still maintain the architecture of the signaling process. Data can move from your desktop to a campus backbone, onto a private WAN and then to the public network, and back to a colleague's desktop. The same switching



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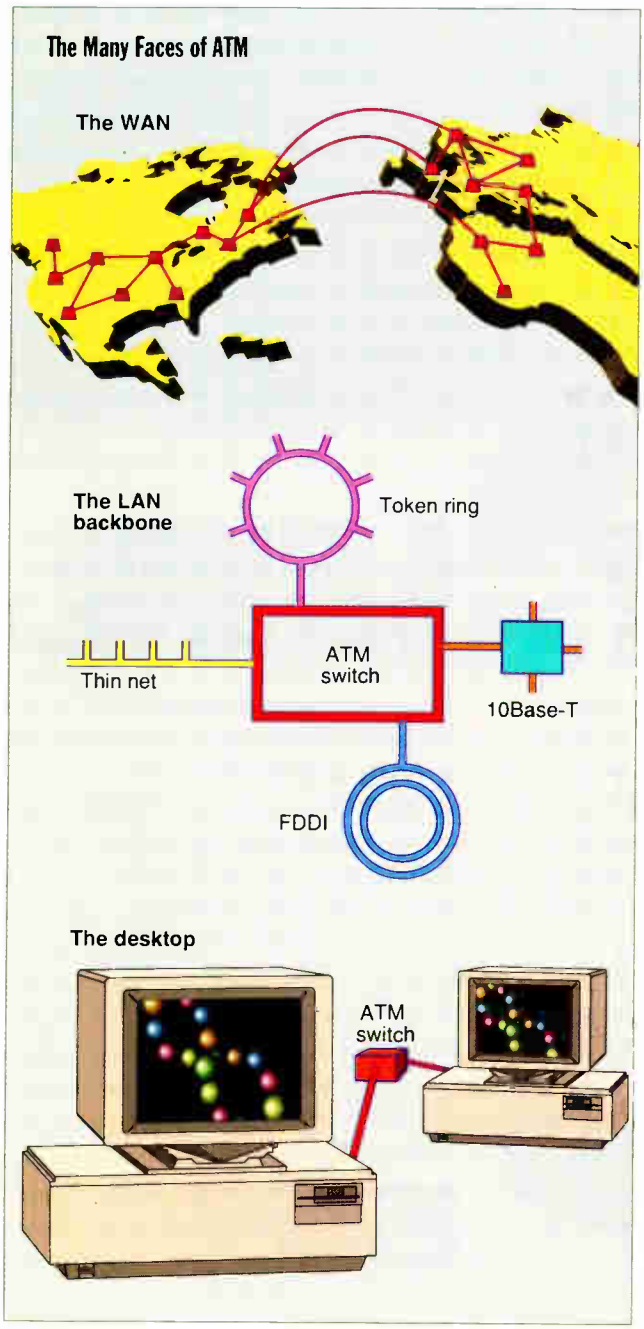
technology is used throughout the process.

Many of the same arguments and promises have been made regarding ISDN, which is increasingly viewed as a technology whose time will never come. Do fate and the market hold the same outcome for ATM?

"With ISDN," says Carosella, "the telephone companies waited until they had enough confidence and experience with updating massive central-office switches with ISDN technology. But by then the technology had passed everybody by. Nobody wanted it." With ATM, companies can start with easily tested and deployed small machines and then scale up to bigger systems.



What separates ATM *from other networking technologies is its ability to scale from the desktop to the WAN to cable TV to voice networks. Its enormous throughput makes it a strong technology for implementing WANs, and its fast switching makes it ideal as a backbone for interconnecting LANs. It will even show up on some desktops, but only supporting the most data-intensive—and price-insensitive—applications.*

New Kinds of Networks

"In today's world," says Harry Bosco, ATM platform vice president for AT&T Network Systems (Red Bank, NJ), "you may have three separate networks that you, as a company, are administering: a data network, a voice telephone network, and a videoconferencing network. With ATM, it collapses into a single interface."

Bosco sees a future in which service providers use ATM technology in *overlay networks*—networks that consolidate and carry different types of data traffic (e.g., frame relay or SMDS [switched multimegabit data services]) on ATM. "Once you can carry different kinds of data on a common infrastructure, from LAN to WAN and back again," says Bosco, "then the games begin. I, as a service provider, can store the maps of who you want to talk to in the core ATM network." In such a scenario, public telephone service providers could take over much of your network administration.

ATM also promises to simplify network management. Once the ATM infrastructure is in place, setting up a LAN should be almost as easy as setting up a conference call. Setting up virtual LANs within a LAN will also become possible, so you can, say, move one group of people off the main network onto their own private network without moving any cables.

> **There's a couple-year period of validating a product before there is large market adoption of it. Applications must be written to take advantage of the new technologies. We'll have a lot of chaos in the next couple of years as this stuff unravels.**
>
> **—John Carosella**
> **Director of business development for Newbridge Networks' ATM initiative**

A Standard with a Future

ATM may be here, but as a standard it's still incomplete. Some parts of the standard (e.g., congestion control and support for switched virtual circuits) have yet to be finalized. "It's not a matter of ATM not being a usable technology without *x*, *y*, or *z*. Some standards have yet to be solidified, but you don't need those capabilities right out of the gate," says Carosella.

Carosella points to congestion control as an example of a feature that isn't needed right away. "ATM fabrics are massive compared to traditional fabrics. You've got 2.4 Gbps in first-generation ATM switches, and it's only going up from there. Not many LANs would burden one switching element with that kind of bandwidth."

The consensus in the data communications industry is that ATM is at least 18 months away from widespread implementation. You don't have to wait that long to take advantage of the technology, however. Synoptics Communications, for one, has already announced an ATM router that can greatly enhance the performance of a campus backbone. Such developments point out one of the greatest attractions of ATM: It is usable now at many different levels and will be more useful still when you can integrate the levels. That integration is a few years away, but it's never too early to start planning for it. ■

Mark Clarkson is a BYTE consulting editor based in Wichita, Kansas. You can reach him on BIX c/o "editors."

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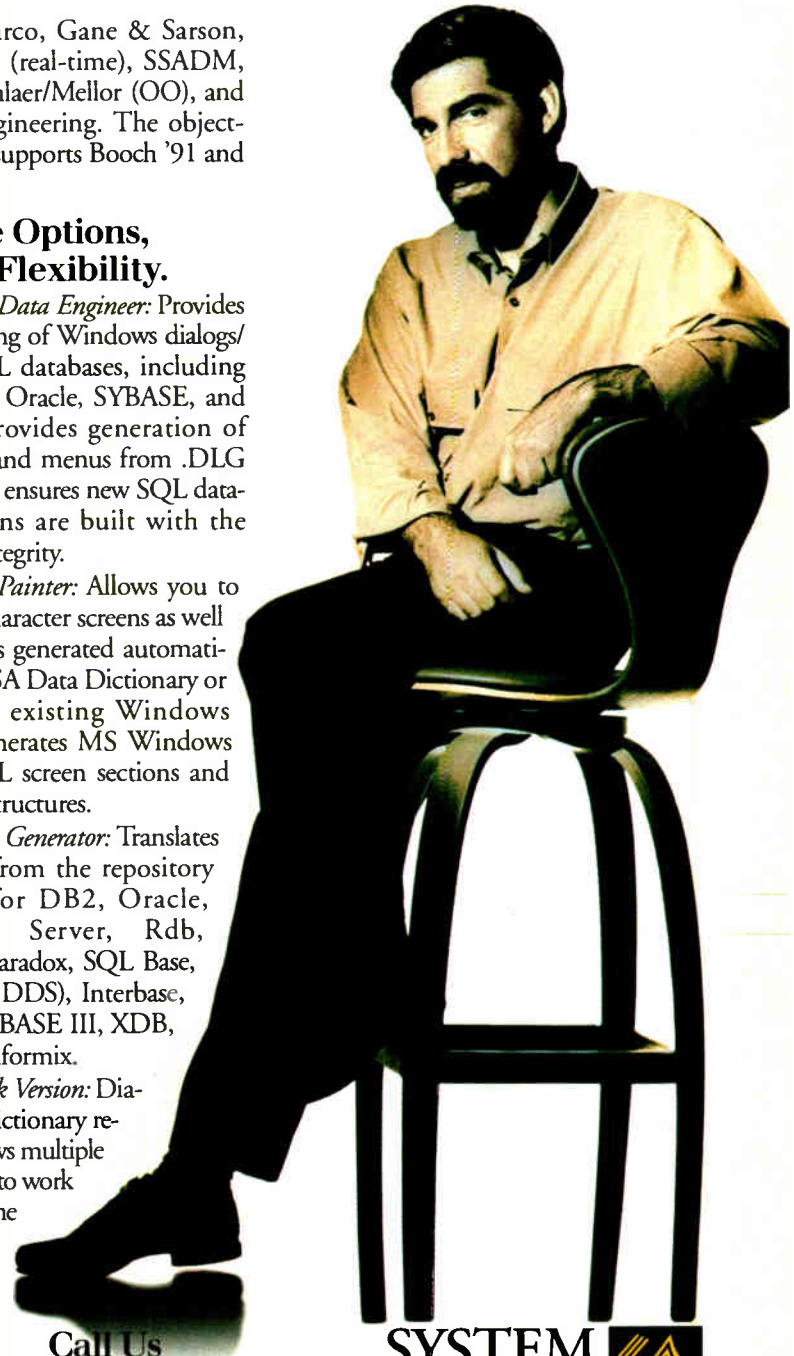

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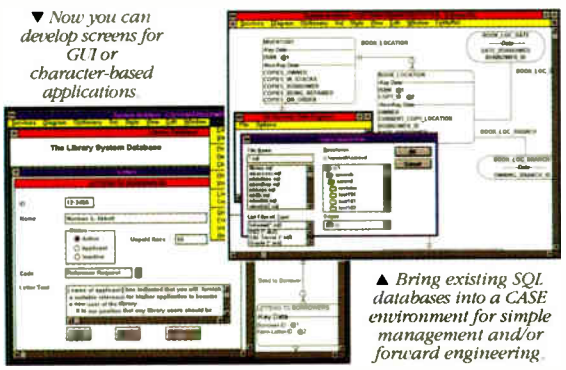

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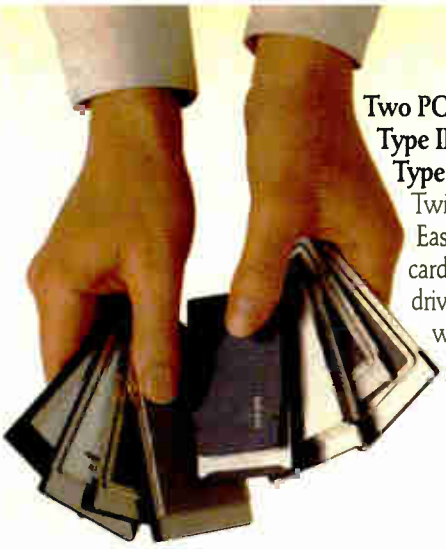

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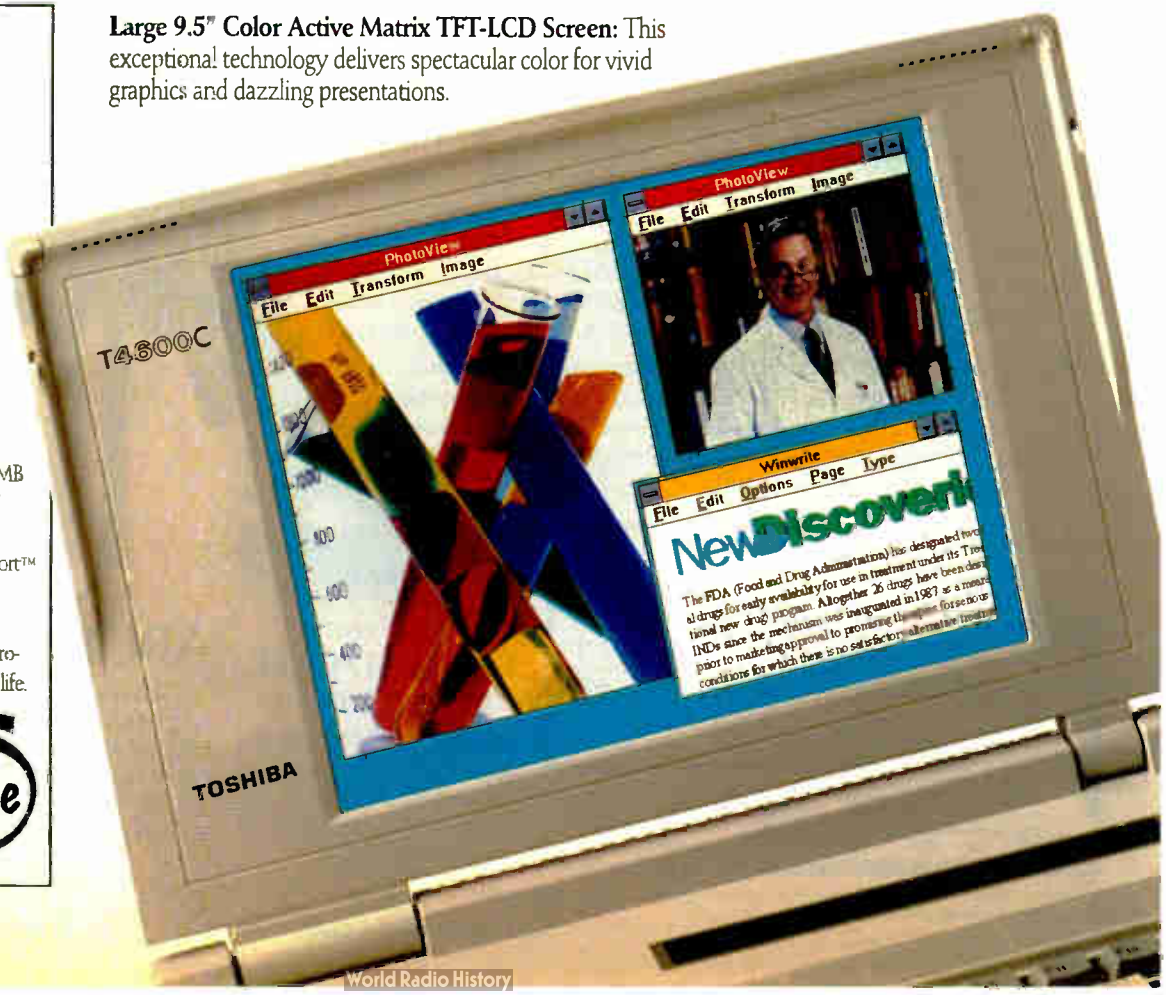

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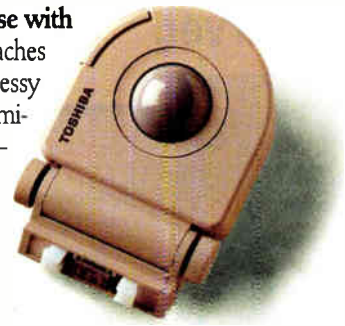

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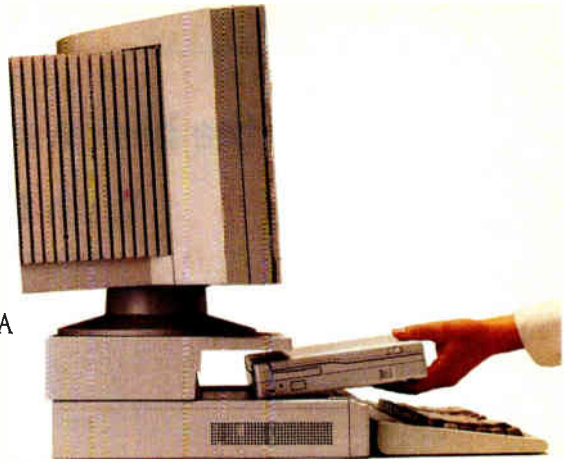

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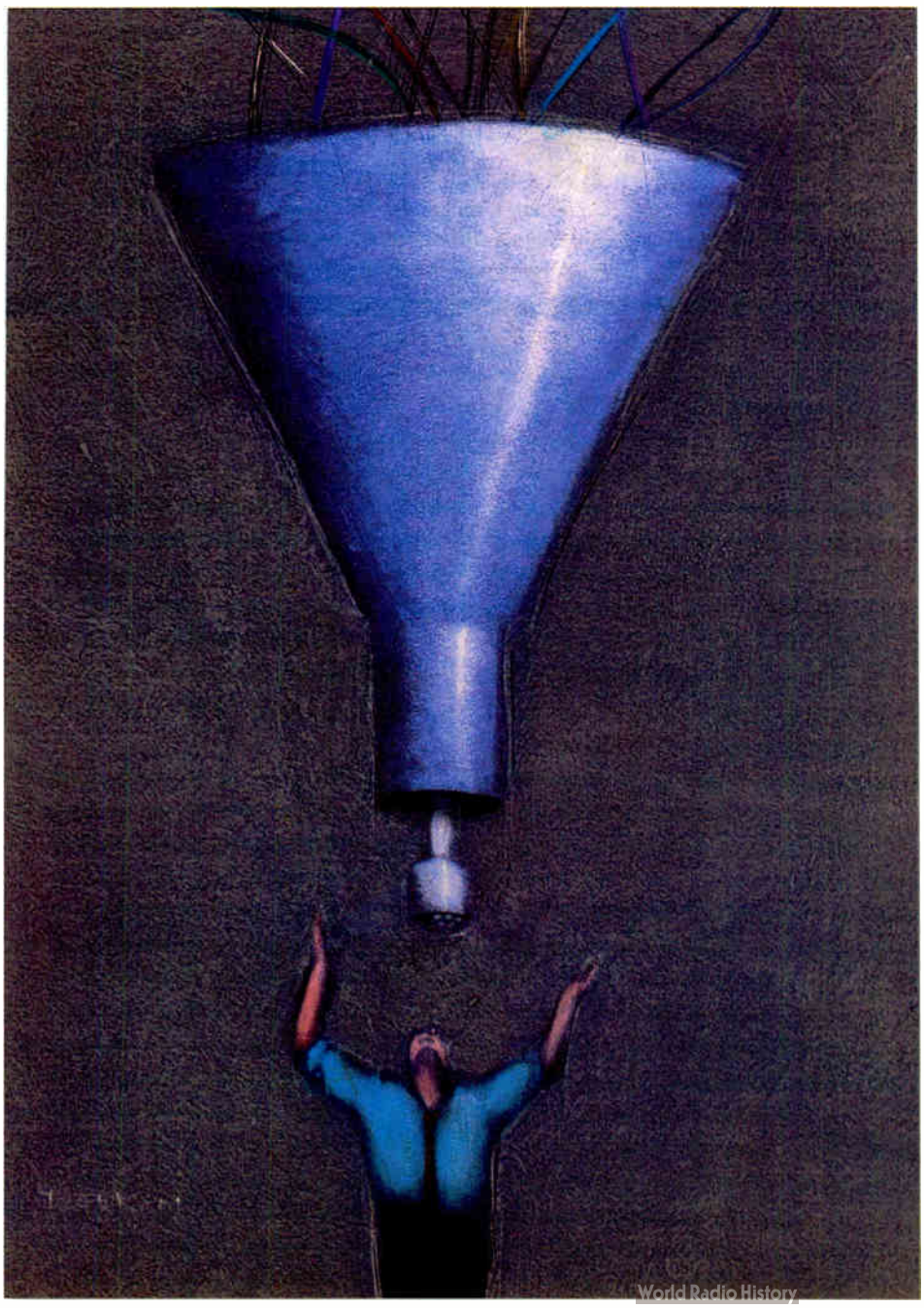

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With more than 20 million installed nodes, Ethernet is the world's most popular method of linking computers on a network. As companies connect more users to networks and deploy more data-intensive applications, however, Ethernet's 10-Mbps speed can seem positively slow. The need for a higher bandwidth on Ethernet has spawned intense competition to define the next generation of technology: 100-Mbps Ethernet.

The focus of this competition is the IEEE 802.3 committee, the official arbiter of the Ethernet standard. The committee is now reviewing several proposals for fast Ethernet. The winning proposal will have a huge advantage in bringing 100-Mbps throughput to the desktop.

Going Faster

There are several ways to increase data throughput on your network. The most straightforward of these is to simply increase the frequency of the data signal. Standard Ethernet runs at 10 MHz, and pumping it up to 100 MHz produces a tenfold increase in throughput. Unfortunately, it also generates enough electrical noise to require you to apply for an FCC broadcast license or to install network wiring similar to the transatlantic cable.

Another solution is to string a lot of parallel wires between network nodes, in effect creating an external bus. But buses are *inside* computers for a reason: They're extremely expensive to implement over any distance greater than a few feet. However, a few parallel wires can greatly enhance your data-passing ability. A four-wire solution, called 10Base-T, gained popularity because it runs on standard UTP (unshielded twisted-pair) cable, which is installed in most business environments.

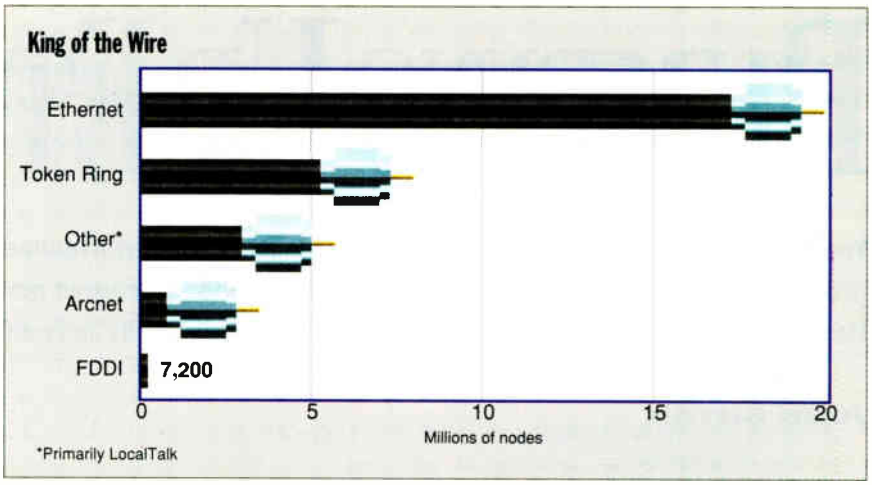
continued

Pumping Up Ethernet

The problem with using more wires is that installing them becomes a major expense in configuring a network.

Yet another method of increasing network throughput is to compress the data, a technique widely used in storage devices and data communications. In fact, Ethernet already uses an encoding method, and most of the fast Ethernet proposals use some type of optimization scheme to increase the amount of data in a packet.

The fast Ethernet proposals and technologies currently on the table generally use a combination of these methods to achieve the required throughput. Each method has its own advantages and disadvantages, which is why choosing a fast Ethernet standard is not a cut-and-dried proposition.



The installed base of LAN nodes in 1992 *using the more popular physical connection schemes. (Source: IDC)*

Going Parallel

Of the companies with proposals before the IEEE 802.3 committee, only one—MicroAccess (Fremont, CA)—is shipping a 100-Mbps Ethernet solution. MicroAccess has developed fastEthernet, a combination of techniques that transmits data over six pairs of parallel wires at 11 MHz, a slightly higher clock rate than standard Ethernet.

One of the key advantages to MicroAccess's approach is economy. Because its baseband speed is not much higher than that of standard Ethernet, you don't encounter any problems using voice-grade wiring (i.e., Category 3 UTP cable). If you are moving from 10Base-T to the MicroAccess solution, you'll need four more pairs of wires, which you will have to install if they aren't already available. The difficulty and expense of doing that can be an issue, depending on the installation

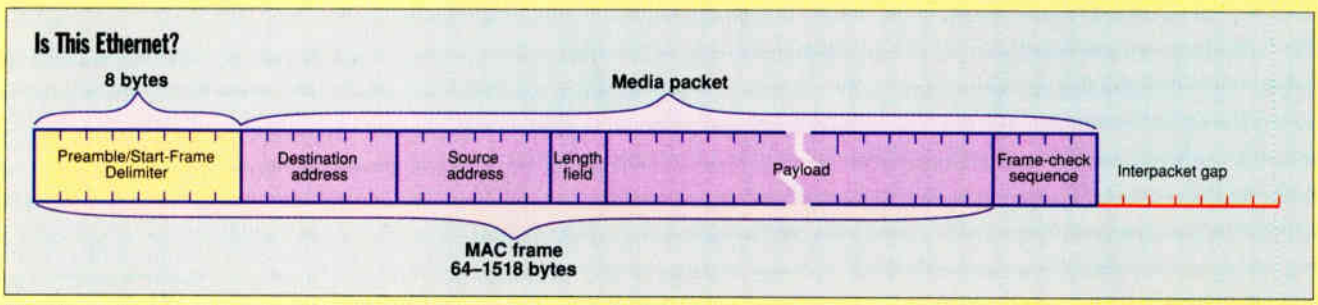
KEEPERS OF THE FLAME

Much of the controversy surrounding fast Ethernet revolves around just what constitutes Ethernet. Robert M. Metcalfe, publisher of *InfoWorld* magazine (Menlo Park, CA), was the architect of the original Ethernet specification. Although there are several parts to the specification, Metcalfe contends that it is CSMA/CD that has made Ethernet the robust and popular product that it is.

CSMA/CD is the method that ensures the integrity of the packets that cross the network. It's the core of the Ethernet MAC (media access control) layer, which defines how a transceiver places data onto and gets data off the wire. CSMA/CD informs a sender when its packet collides with a packet sent by another node on the network and lets each sender retransmit after a random amount of time.

Metcalfe contends that any proposal that doesn't have CSMA/CD at its core doesn't belong before the IEEE 802.3 committee. "Hewlett-Packard's calling their proposal 100Base-VG is an abomination, and all they're doing is screwing up the standardization process with a move motivated entirely by the marketing value of the Ethernet name," he says.

Obviously, HP and AT&T see things differently: "The 100Base-VG proposal was presented to the IEEE 802.3 committee after consulting with and gaining approval from the IEEE 802 Executive



The Ethernet frame *defines how Ethernet organizes the data in a packet. Hewlett-Packard and AT&T say that the frame defines Ethernet; Grand Junction Networks and its supporters say that the frame is necessary but not sufficient by itself.*

and configuration of your network wiring. MicroAccess's adapters don't require a hub, but they can be installed in a star topology with a hub.

The key to MicroAccess's process is an encoding method called DCM (differential code modulation), which enables the interface cards to send 9 bits of data during each clock cycle, unlike the 1 bit sent in other implementations. MicroAccess uses an FDDI (Fiber Distributed Data Interface) frame (see "The Great Light Hope" on page 124) that has a 4500-bit packet, giving the system the benefit of at least one nominal standard and the bonus of a larger packet.

In contrast, the 10-Mbps Ethernet MAC (media access control) used in thick, thin, and twisted-pair Ethernet outputs NRZ (nonreturn to zero) data. The data is converted into a Manchester encoding stream to the transceiver, which creates the signal. In the MicroAccess scheme, output from the MAC passes through an encoder that turns 4 data bits into 5 transmit bits. Thus, to transmit at 100 Mbps, the card has to process 125 Mbps. The data stream is passed through the DCM portion of the network interface card and sent to the transceiver.

MicroAccess calls its family of products Optilan, and it includes interface cards for the 16-bit ISA and 32-bit EISA buses. MicroAccess claims the products have been optimized for the Novell network operating system, and Novell's Perform test bears this out. Perform rated these cards at 150 Mbps, faster throughput than that claimed for any of the competing fast Ethernet products that are supposed to become available in the future.

The MicroAccess Optilan family.

MicroAccess also has hubs and repeaters for the product line. The hub, or concentrator, is an eight-channel device that supports 20 or more nodes off each channel. The repeater extends the effective cable length. Both the hubs and the repeaters support either UTP or STP (shielded twisted-pair) cable.

Perhaps the best feature of the Optilan system is the cost. A 16-bit ISA card costs $399, and an EISA card goes for $599. A hub costs $1595, and a stackable repeater is priced at $995. This is at most a threefold cost premium over 10-Mbps Ethernet, and it offers 10 times the performance.

MicroAccess claims that it will have a four-pair solution on the market by the time you read this article. Whether the release conforms to one of the other standards being proposed to the IEEE 802.3 committee is not clear, but whatever standard is used, it will certainly be just as compatible as the others are to each other and to 10-Mbps Ethernet.

100Base-X

Another fast Ethernet scheme comes from Grand Junction Networks (Union City, CA) in the form of a proposal to consolidate two standards: the Ethernet MAC and the FDDI PMD (Physical Media Dependent) layer (ANSI standard X3T9.5). Like MicroAccess's approach, Grand Junction Networks' scheme doesn't compress the data that flows over the cable but uses a three-level code that doubles the significance of a voltage change, enabling 100-Mbps throughput (i.e., a 125-Mbps data stream) with a worst-case baseband signal of 31.25 MHz. In this mechanism, the MAC output—the NRZ code—passes to a 4B/5B encoder. The code then goes to a scrambler, which ensures that there are no invalid data groups in its NRZI (nonretum- to-zero inverted) output. The NRZI-converted data is passed to the three-level code block, and the output is sent to a transceiver.

MLT-3 is the three-level code. Instead of changing the voltage from +1 to –1 to signify a bit, MLT-3 changes it from +1 to 0 (Grand Junction Networks' product runs between 2 and 0 V). The result is a lower-frequency signal and less noise on the cable, a significant factor when using UTP wiring. Grand Junction Networks' solution is slated to work only on Category 5 (i.e., data grade) wire, but the company doesn't think this will be a limiting factor.

According to Jack Moses, Grand Junction Networks' vice president of marketing, "Our research shows that a significant number of the large installations in the U.S. [Fortune 1000 companies] already have Category 5 wire installed. In addition, the growth rate of shipments of Category 5 or better wire is accelerating and may already match or exceed shipments of voice grade." According to Forrester Research, 23 percent of Fortune 1000 companies have installed data-grade UTP cable.

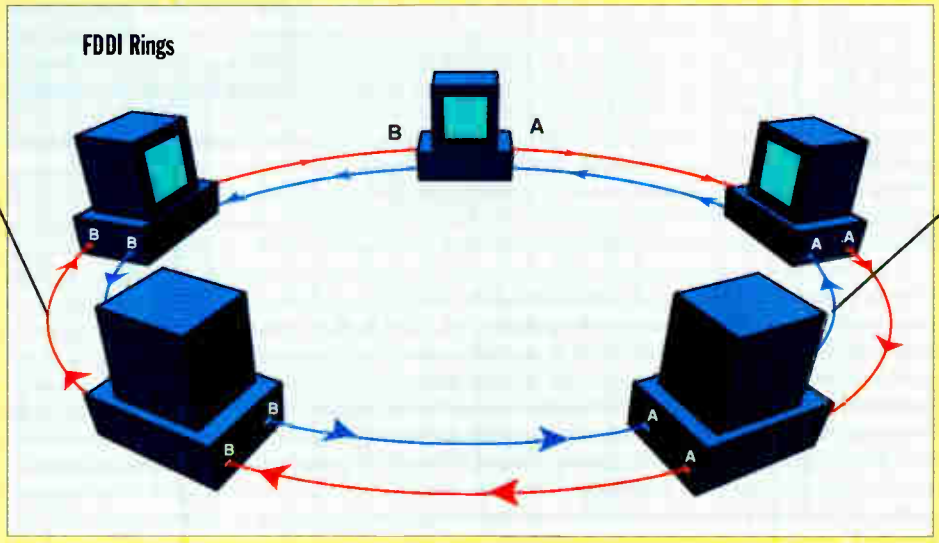
In other respects, the physical requirements of 100Base-X are similar to those of 10Base-T: It uses two-pair wiring and RJ-45 connectors. In addition, 100Base-X will work over fiber-optic or STP cable. And 100Base-X requires a hub. The maximum distance that cable can run from one concentrator to another is 100 meters, with a maximum network diameter of 250 meters.

By mating existing standards, Grand Junction Networks believes that its proposal will be an easy-to-implement standard, resulting in low-cost products (i.e., two to three times the cost of 10-Mbps cards) that network managers and applications developers are familiar with. Many vendors (e.g., Cabletron, Chipcom, David Systems, Intel, National Semiconductor, and 3Com) support Grand Junction Networks' proposal. The system manufacturer Sun Microsystems also supports it, and, interestingly, so do NCR Microelectronics and Networth. NCR Microelectronics is a

Committee," says Tim McShane, program manager for HP's networks division (Roseville, CA). "This allows the IEEE to evaluate all proposals for using the Ethernet frame at 100 Mbps over voice-grade UTP in the same forum."

The question of what constitutes Ethernet—CSMA/CD, the Ethernet frame, voice-grade wiring, or some or all of these in combination—will underpin any decision made by the IEEE 802.3 committee's high-speed study group, chaired by Peter Tarrant of Synoptics Communications (Santa Clara, CA). Tarrant thinks that it is appropriate to study all the high-speed proposals in one forum, but he won't be surprised if some proposals—perhaps the non-CSMA/CD schemes—wind up before another committee. This is the position of the IEEE, which states in a release that "should adequate justification, need, and feasibility be established...for two major projects, then an additional working group within project 802 would likely be established."

The Great Light Hope



Each station on an FDDI network *requires connections to both fiber-optic rings, with the primary ring handling data transmission and the secondary one providing fault tolerance and system management.*

FDDI (Fiber Distributed Data Interface) is the best-known option for 100-Mbps LANs. Although fast Ethernet and other technologies promise a solution in the near future, FDDI and its copper implementation, CDDI, are the only standards-based technologies that deliver 100 Mbps (the CDDI standard is still under development). But FDDI has been slow to gain a foothold in the market, even in areas where it would be of significant benefit.

The reasons for the slow acceptance are varied. Original work on the the FDDI specification started in 1984, but it was not finished until eight years later. That's a long time to wait for high technology. However, the result of all the effort is worth the wait, if not the costs.

The FDDI specification has benefitted from all its predecessors. For one thing, it isn't susceptible to any of the problems that copper wire is frequently subject to (e.g., breakage or interference), because it uses fiber-optic cable. In addition, because FDDI is designed from the ground up to deliver high performance in a backbone role, and because automatic collision detection like Ethernet's CSMA/CD causes severe performance degradation in high-traffic implementations, FDDI uses a token-passing scheme. FDDI also has built-in network management features that allow you to isolate faults.

The standard FDDI installation consists of two counter-rotating fiber-optic rings, with nodes attached to both (the rings themselves don't rotate; the data does). One ring is designated as primary; the other is secondary. The primary ring is generally used for network data traffic, and the secondary ring functions as a fault-tolerant backup.

Each device on the network has at least two ports, an A and a B port, which are connected to both the primary and secondary rings. The A port provides a connection to the incoming primary ring and the outgoing secondary ring; the B port connects to the outgoing primary ring and the incoming secondary ring.

There are also M and S ports on certain devices. An M port is for concentrators only and is used for single or double connections to workstations or other concentrators. The S port is for workstations only and is used to connect them to the M port on a concentrator. The object of all these ports is to provide fault tolerance and fault detection.

The building blocks of an FDDI network consist of concentrators, or *stations*. Stations are not necessarily workstations. A bridge or a router is also called a station. And you can have either an SAS (single-attached station) or a DAS (double-attached station). It isn't necessary or even desirable to attach a workstation in a double fashion for two reasons: First, any DAS is an integral part of the fault-tolerance scheme of a network, and second, the connection is complicated and expensive.

Because of the bandwidth of fiber-optic cable, FDDI doesn't have to resort to the multilevel codes found in some of the new fast Ethernet proposals. It uses NRZI (nonreturn-to-zero inverted) output after a 4B/5B translation (in which 4 data bits produce 5 transmit bits) has occurred. FDDI also provides station synchronization, which is important at 100-Mbps speeds.

The FDDI standard has four layers. The code-translation section described above is in the PHY (Physical Layer Protocol). This layer sits on top of the PMD (physical media department) layer, which defines the frequency and signal levels of

the optical pulses in the cable and the types of connectors and cabling that can be used. The PMD and PHY layers define the physical portion of the FDDI specification, and they make up most of what is unique to FDDI.

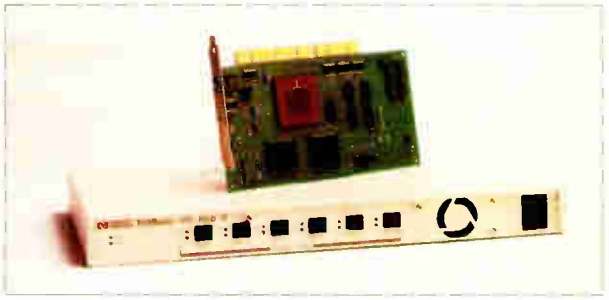
On top of these is the MAC (media access control) layer, which handles the construction of packets (or frames), addressing, and token handling. The FDDI token is held and passed according to limits that you can specify. The TTRT (target token rotation time) is set, in part, according to the parameters of the data types on your network. By using a calculation that involves the number of stations on the network and the TTRT, the THT (token holding time) is determined. High THT values are better when the data blocks are large and not time critical. Low values result in more even station access to the FDDI backbone ring.

While the MAC, PHY, and PMD segments are layered, SMT (station management component) logically spans all three. SMT can be broken down into three parts: SMT Frame Services, which generate diagnostic frames; CMT (connection management), which controls access to the network; and Ring Management, which performs the troubleshooting for the physical network. SMT monitors and manages the network, providing a comprehensive suite of functions found in no other protocol. Thus, FDDI is probably the most robust network implementation available.

So, if throughput performance is good and the fault tolerance is unmatched, why hasn't FDDI spread like wildfire? The answer is cost, but it's more than the initial price of the hardware installation, although that is significant (the cost per node of an FDDI network can run as high as $10,000). The other cost is more subtle: FDDI is a complex protocol, and training and support can double the price of the network.

FDDI should go a long way toward reducing the price gap between this set of protocols and others that are just around the corner. But with fast Ethernet almost a reality, FDDI may be too little, too late.

division of AT&T, and Networth is a subsidiary of Ungermann-Bass. Both parent companies support the 100Base-VG proposal. One important note is that while the vendors mentioned above support Grand Junction Networks' MAC, they don't necessarily support the physical-interface portion of the proposal.



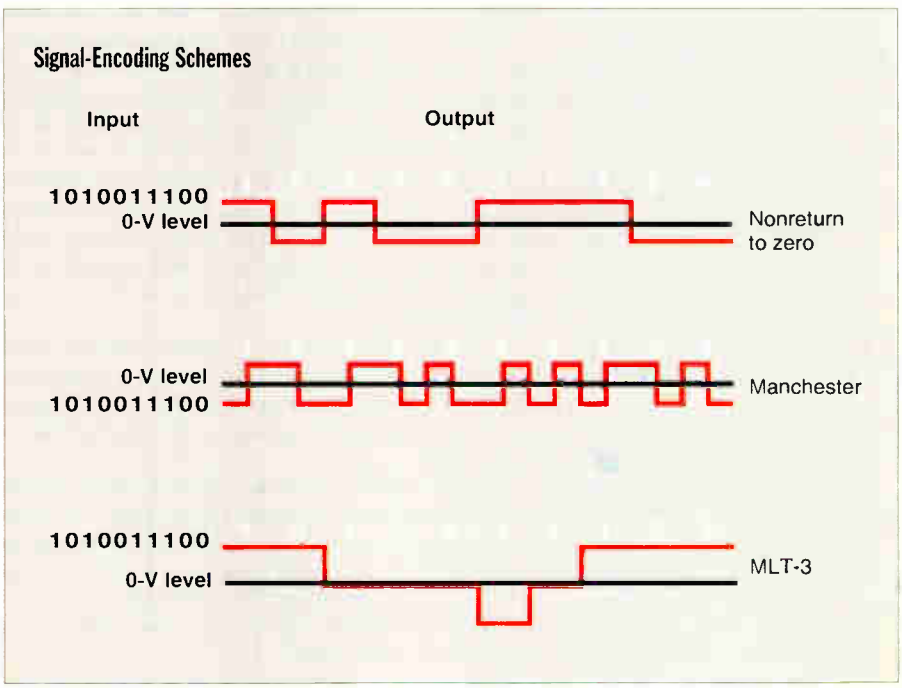
A prototype *of the HP 100Base-VG EISA card.*

100Base-VG

In its approach to achieve accelerated Ethernet performance, Hewlett-Packard allows users and applications developers to assign a priority (either normal or high) to packets. HP argues that this method will better serve time-sensitive applications, such as full-motion video. This focus is also the basis of the proposal's name: 100Base-VG (Voice Grade).

In this proposal, a node sends a packet to a hub using all four pairs of wire required to support the network, and the hub sends the packet to the addressed node. If more than one packet arrives at the hub at the same time, the hub first services the packet with the highest priority. If all have the same priority, the hub services the requests in round-robin fashion.

The design of 100Base-VG also includes a code implementation that is different than that of either MicroAccess or Grand Junction Networks. Where Grand Junction Networks uses a three-level code to decrease frequency modulation and reduce noise emissions, HP sticks with a two-level NRZ output, produced with a scheme in which 5 data bits are converted to 6 transmit bits. The resulting baseband would be fairly high, but 100Base-VG uses four pairs of UTP cable in half-duplex mode (the other schemes are in full-duplex mode), using all the wires to either transmit or receive exclusively. Because the hub monitors and switches traffic, this works just fine, and because the baseband signal on each wire is low frequency, the



The way a signaling scheme *represents strings of bits determines the electrical characteristics of a network. Although complex signaling schemes (e.g., MLT-3) have greater processing overhead, they can reduce electrical noise by decreasing the voltage changes necessary to transmit a signal.*

Pumping Up Ethernet

Fast Ethernet Contenders

Feature \ Proposal	Optilan	100Base-X	100Base-VG
Ethernet frame	✓ *	✓	✓
CSMA/CD	✓	✓	
Voice-grade UTP	✓ **		✓

* FDDI data field in Ethernet Frame.
** Requires six pairs.

The contenders *vying to become the annointed 100-Mbps Ethernet solution. All carry forward some part of the current Ethernet standard.*

system works on Category 3 wire.

This is the main attraction of 100Base-VG. The designers at HP and AT&T are convinced that customers do not care about CSMA/CD but want an easy-to-implement, high-speed network solution that they can use with existing wiring.

Decisions, Decisions

Although the market will undoubtedly make the final decision regarding the merits of the various high-speed networking solutions now on the table, getting the nod from the IEEE 802.3 committee as the standard 100-Mbps Ethernet scheme will certainly give the annointed technology a tremendous boost. Most observers think the choice will be between HP-AT&T and Grand Junction Networks, with the deciding factor being the importance the committee places on carrying over different parts of 10-Mbps Ethernet technology.

Supporters of 100Base-VG are of the opinion that it is the frame that defines the Ethernet. "CSMA/CD has, by definition, a number of well-known limitations when operating over a 'large' topology or with heavy loads," states Brice Clark, a strategic planning manager for HP. He sees the frame—the basis of most network traffic analysis and of the structure of bridges, routers, and network software in general—as the necessary element of Ethernet.

Yoseph Linde, the president and CEO of LANart (Needham, MA) and founder of Chipcom, thinks that 100-Mbps Ethernet requires CSMA/CD as well as the Ethernet frame. "It is totally irrational to invent a new MAC," says Linde, who believes that because every MAC has problems, the IEEE 802.3 committee should stick with one that is well known. This is the general position of supporters of Grand Junction Networks' proposal, although many are less than enthusiastic about the 100Base-X signaling layer.

Whatever the committee decides, you'll have a greater number and variety of high-speed LAN options available to you. High-speed network solutions are no longer just for backbones or engineering networks; competition will make 100-Mbps LANs relatively common in the next few years. In any case, there will surely be further developments, because, as each of us knows, speed is contagious. ■

John Bryan is a freelance technology writer and consultant based in San Jose, California. You can reach him on BIX c/o "editors."

ARCnet Keeps Pace

With an installed base nearly as large as that of token-ring networks, ARCnet is a major networking technology. It shares many of the characteristics of its more popular rivals but isn't an independently sanctioned standard.

TCNS is Thomas-Conrad's 100-Mbps implementation of the ARCnet protocol, and the company has been shipping its product for three years. In fact, TCNS has outsold FDDI (Fiber Distributed Data Interface) technology by a significant margin over the last couple of years. TCNS uses existing ARCnet drivers, which give it support on several popular network operating systems, including Novell NetWare, Banyan Vines, Unix systems, Microsoft's LAN Manager, and LANtastic. It also uses standard ARCnet cabling, so setting up 100-Mbps installations is relatively painless for those who are already using ARCnet systems.

ARCnet is a distributed-star technology, based on hubs and nodes. TCNS supports only 255 stations in a network. But the TCNS hub is active: It's a powered repeater that enhances the signal and filters noise simultaneously. The hubs have the same type of logic as nodes, which take the signal off the cable and convert it to a digital form. The hub processes the digital signal and then reconverts it for transmission to the next stop in the network.

TCNS does not use UTP (unshielded twisted-pair) cable. Instead, nodes can be connected with fiber-optic, coaxial, or STP (shielded twisted-pair) cable. Because of this feature, baseband rates can be much higher than those of solutions that strive to use UTP cable for cost and convenience considerations. Just as with FDDI technology, data is initially passed through an encoder that converts 4 data bits into 5 transmit bits before the adapter generates an NRZI (nonreturn-to-zero inverted) signal.

TCNS and ARCnet are token-passing schemes, so collision detection is not required. Thus, overall network throughput can be determined by a calculation involving the number of nodes in the network; the delay, or token-passing time; and the signal-transition time through hubs. Using these figures, you can calculate whether TCNS is appropriate for the high-speed network application you have in mind.

Because TCNS is a relatively straightforward evolution of the ARCnet protocols, much of the error detection and network analysis is carried out in the same fashion as it is in ARCnet. Nodes can be added to or deleted from a network without bringing down the system, and the network will reconfigure itself if 840 milliseconds pass without a node receiving a token. Like FDDI, TCNS uses the token-after-send method of passing the token from node to node. Unlike FDDI, the size of data packets is limited to 512 bytes, so networks consistently generating large files are not a good match for this technology.

TCNS is relatively inexpensive, especially when compared to a solution like FDDI. Another bonus is that you need only a network adapter and hub to integrate TCNS with your existing ARCnet installation, which is simplicity that none of the other solutions offers.

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STAN WSZOLA

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The marriage of OCR with desktop faxing is a natural one. The new generation of Windows and Mac fax programs includes OCR algorithms to convert a received fax into ASCII text. The resulting file takes up much less hard disk space than a graphics file and is of course more useful for most applications.

An Eye on Features

All the fax/OCR software packages that I looked at run either under Microsoft Windows or on the Mac. The fax programs install as a printer driver in your applications, and you simply select the fax option instead of a physical printer. You can then transmit a fax in the same way that you would print a document. In most cases, a dialog box pops up and asks you to enter the name and phone number of the recipient of the fax or to pick a name from a phone book.

Fax software offers tremendous advantages over stand-alone fax machines and provides many additional features. Take a look at the feature table on page 132, and you'll see entries for scheduling fax transmissions, sending faxes to a group of recipients, and attaching binary files to faxes. The call-grouping feature lets you send different faxes to different people at the same phone number during a single call. Annotation features let you mark up a fax image and resend it.

A fax/OCR package should have an easy-to-use phone book and customizable cover sheets. You might also look for a library of sample cover sheets bundled with the software. You should be able to include a note on each cover sheet and embed graphics such as your company logo. Also consider how well a package stores, groups, and locates faxes. A couple of the reviewed packages include antialiasing algorithms to improve the display of a fax image. All the packages include send and receive logs, multiple zoom levels, and automatic retry.

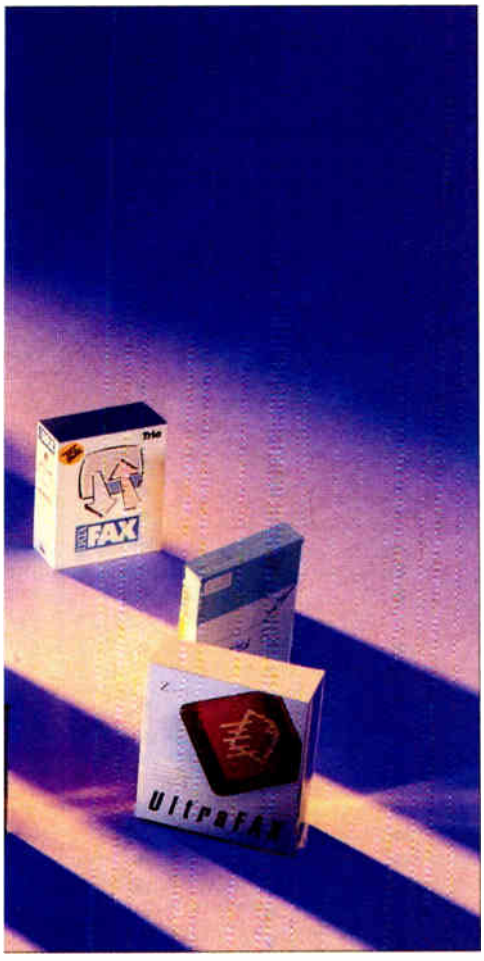
Fax Standards

Three standards that have been authorized by the CCITT, the international governing body on communications standards, cover the transmission of faxes. Group 3, the current standard, designates transmission speeds of 9600 to 14,400 bps and incorporates a compression scheme; a typical page can be transmitted in 30 to 60 seconds. A faster Group 4 standard with additional compression has not yet been adopted.

The Group 3 standard is the most widely used. All the software and modems I tested are compatible with Group 3 and usable with older Group 1 and Group 2 fax machines.

The TIA (Telecommunications Industry Association), which sets standards for the communications protocol between computers and fax modems, defines two levels of fax modems: Class 1 (which is the most

widely used) and Class 2 (currently only a recommendation). The de facto PC fax standard is CAS (Communications Applications Specification), a standard for internal PC modems developed by Intel. All the PC packages can handle Class 1, Class 2, and CAS modems. As you would expect, the Mac package, FaxSTF, does not handle CAS.



MEL LINDSTROM © 1993

I tested these packages with a variety of fax modems. Unfortunately, not every package was compatible with every modem. Despite all these standards, computer-based faxing is still not completely reliable. Manufacturers are constantly updating fax modems, adding new features, and requiring new modem initialization strings. Don't assume that your fax modem will work with your favorite software. Call the makers of both the hardware and the software to confirm that the products work together.

OCR Tests

Except for Caere's FaxMaster, each of these packages uses an OCR engine licensed from a third party. The three main OCR players are Calera, Caere, and Ocron. Each of these companies has significant experience with text conversion. Calera's FaxGrabber was the first add-on fax/OCR package. Calera also makes Wordscan, which is one of the best-known text-recognition packages. Caere manufactures Omnipage Professional, another popular OCR program.

I tested the PC fax/OCR software on a 25-MHz 386 PC running DOS 5.0 and Windows 3.1. The 386 machine used an Intel Model 200 fax-modem board. The Mac software was tested on a Mac II with a Radius Rocket accelerator running a 68040 processor at 40 MHz; connected to the Mac was a Supra V.32bis fax modem. To test OCR conversion speeds, I used a Dell 486DX/2 50 running DOS 6 and Windows 3.1 to send and receive faxes to and from the 386 machine and the Mac II. The Dell was equipped with an older Frecom Class 1 fax-modem board driven by WinFax Lite.

The two-page OCR test document included four fonts—Times New Roman, Courier, MS Sans Serif, and Lucida Fax—at 10- and 12-point sizes. The table on page 134 shows how well each of the packages converted the fax image into editable text. I also timed each package on how long it took to do a manual conversion of the test fax.

No package had a perfect score. The packages varied considerably in their ability to discern the letters in the test fax. The overall winner for accuracy was Eclipse Fax running the Ocron OCR engine, but it was slow. The next-best packages were UltraFax, also running the Ocron engine with a slow time, and Faxability Plus/OCR, with the Calera engine and a much faster time.

BitFax/OCR for Windows 2.09

Bit Software's BitFax did well in the character-recognition tests, but its conversion time was poor. The software does a good job on the basics, such as fax send and receive and OCR conversion, but it doesn't have many convenience features (e.g., integrated editing functions) found in other packages, and the user interface often leaves you wondering what to do next.

BitFax can automatically detect column layouts, or you can specify the number of columns for greater accuracy. It is the only reviewed program with support for a variety of languages. It recognizes non-English characters, like circumflexes and umlauts.

Only one phone book is supported, but there's no limit on number of entries. You can assign phone book entries to 20 call groups. Unfortunately, you can't label groups with names; they're assigned a number from 1 to 20. A quick-dial directory can hold up to eight phone numbers.

Faxes are sent and received in the background. This background processing can slow down foreground operations; you may notice pauses in screen updates. To view received faxes, you select an entry in the receive log. The viewer offers five levels of zoom, and you can rotate and invert pages. You can also print from the viewer and add attachments to the fax and resend it. There is no editing function.

By the time you read this, BitFax/OCR will have been replaced by BitFax Easy, and an enhanced version, BitFax Professional, will be available.

DataFax 4.01

Trio Information Systems' DataFax is composed of five modules. Winserve, the main module, controls the modem and manages the fax traffic. Faxes are either sent in the background or, if Winserve is not running, stored in an outbound queue.

The FaxLogs module lets you display the four fax logs (outbound, inbound, transmitted, and erroneous) and view any fax. The Infax module is an icon that alerts you to an incoming fax, and the Faxoffice module is the management center for DataFax. Each inbound and outbound fax can be indexed according to any text in the fax.

continued

Fax Plus OCR: More Than Meets the Eye

FAX/OCR SOFTWARE FEATURES

Powerful features make computer-based faxing more efficient than faxing with most stand-alone machines. (●=yes, ○=no; N/A=not applicable.)

	BITFAX/OCR 2.09	DATAFAX 4.01	ECLIPSE FAX 1.21	FAXABILITY PLUS/OCR	FAXMASTER 1.01	ULTRAFAX 1.1	WINFAX PRO 3.0	FAXSTF
Company	Bit Software	Trio Information Systems	Phoenix Technologies	Intel	Caere	WordStar International	Delrina	STF Technologies
Price	$199	$129	$149	$249	$149	$119	$129	$89
Platform	Windows	Windows	Windows	Windows	Windows	Windows	Windows	Mac
Hard disk space required (MB)	4	8.5	3.5	6	8	4.5	7	2.4
Modems supported								
Class 1	●	●	●	●	●	●	●	●
Class 2	●	●	●	●	●	●	●	●
CAS	●	●	●	●	●	●	●	○
Sierra Send Fax (send-only fax modem)	○	●	○	●	●	○	●	●
Send fax at 14.4 Kbps (with appropriate modem)	●	●	●	○	●	●	●	○
Multiple phone books	○	●	●	●	○	●	●	●
Import phone book	dBase	File-import utility	ASCII, CAS, WinFax	○	dBase	ASCII, CAS	dBase, ASCII, CAS	○
Export phone book	dBase	ASCII	ASCII	○	dBase	ASCII, CAS	dBase, ASCII, CAS	○
Phone book search	●	●	●	○	●	○	●	○
Send fax from within other applications	●	●	Macro	●	Macro	●	●	●
Send group fax	●	●	●	●	●	●	●	●
Call grouping	○	●	○	○	●	○	●	●
Schedule fax transmission	●	●	●	●	●	●	●	●
Automatic retry for fax send	●	●	●	●	●	●	●	●
Resend partial fax	○	●	○	○	●	○	●	●
Fax indexing	●	●	●	●	○	●	●	○
Send fax auto-delete	○	●	○	○	○	●	●	●
Timed auto-delete	○	○	○	○	○	○	●	○
Auto-answer phone for receive	●	●	●	●	●	●	●	●
Auto-print incoming fax	○	●	●	○	●	●	●	○
Time-and-date stamp	○	●	●	●	●	●	●	●
Export graphics file formats	4	5	4	4	2	5	5	3
Import graphics file formats	1	5	4	3	Proprietary	5	4	Via Mac app
Compress fax file	○	●	●	○	●	●	●	○
Automatic cover sheet	●	●	●	●	●	●	●	●
Cover-page library	○	●	●	○	○	●	●	○
Edit cover sheet	●	●	●	○	●	●	●	●
Edit text	○	●	●	○	●	●	●	●
Edit graphics	Select logo	●	●	Select logo	Select logo	●	●	●
Preview fax	○	●	●	○	○	●	●	●
Thumbnail view	●	●	●	○	●	●	●	○
Antialiasing (improve text display)	○	○	●	○	○	●	●	○
Flip/rotate fax	●	●	●	○	●	●	●	○
Invert fax (black and white reversal)	●	○	●	○	○	●	●	○
Annotate and resend fax	●	●	●	●	○	●	●	○
Attach binary file	○	○	○	○	○	●	○	○
OCR translation								
Work with high- or low-resolution fax	High	●	High	High	●	High	●	High
Background operation	●	●	●	●	●	○	●	○
Automatic translation	●	●	●	○	●	○	●	○
OCR to text file formats	62	8	33	56	4	ASCII	4	11
Spelling checker	○	●	●	○	●	○	●	○
Engine	Caere	Expervision	Ocron	Calera	Caere	Ocron	Caere	Calera
Scanner support								
TWAIN interface	○	●	○	●	●	○	●	○
Communications program	●	○	○	○	○	○	○	○

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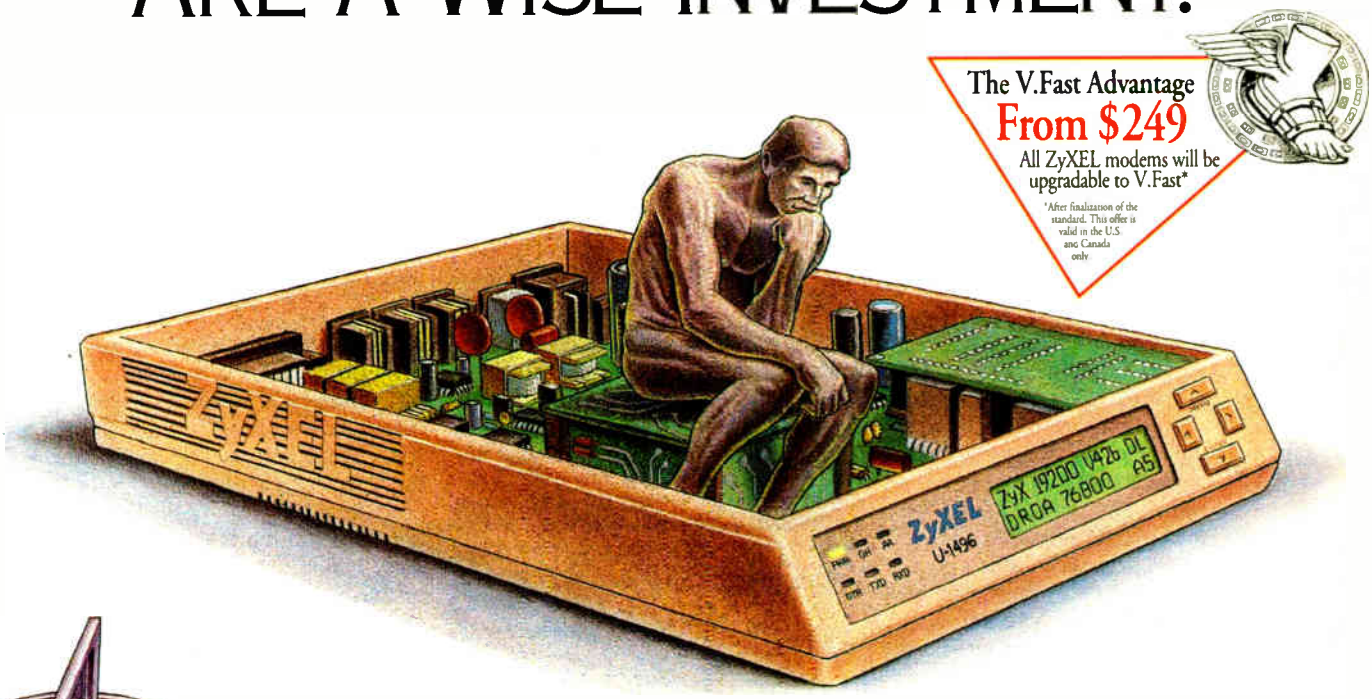

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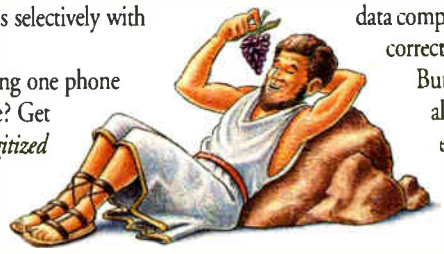

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Winter 1992 — ZyXEL U-1496 — Awarded 5 NeXTWORLD Cubes

200 — June 1993 — ZyXEL U-1496E

PC MAGAZINE EDITORS' CHOICE — June 29 1993 — ZyXEL U-1496 Plus

PC PROFESSIONAL — February 1993 — ZyXEL U-1496E Plus

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Circle 152 on Inquiry Card (RESELLERS: 153).

Fax Plus OCR: More Than Meets the Eye

QUALITY OF CONVERSION

The accuracy of OCR conversion ranged from outstanding (1) to unusable (4). The test document included four fonts at two point sizes.

	BITFAX/OCR	DATAFAX	ECLIPSE FAX	FAXABILITY PLUS/OCR	FAXMASTER	ULTRAFAX	WINFAX PRO	FAXSTF
Times New Roman 10 pt	3	1	1	2	3	3	3	4
Times New Roman 12 pt	2	4	1	3	1	2	1	3
Courier 10 pt	2	1	3	1	2	1	3	1
Courier 12 pt	2	3	1	4	2	2	3	2
Lucida Fax 10 pt	2	3	2	1	1	2	1	1
Lucida Fax 12 pt	2	1	1	1	1	1	1	1
MS Sans Serif 10 pt	4	4	4	3	4	4	4	3
MS Sans Serif 12 pt	2	2	1	1	1	1	1	1

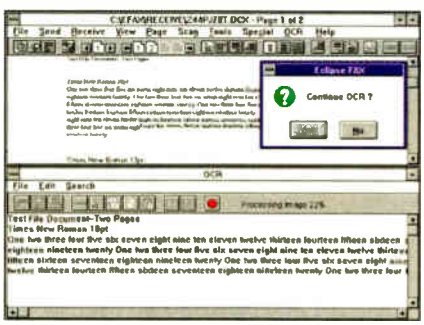
The Captive module always displays an icon on the screen. Clicking on Captive displays a set of tools that lets you clip material from the screen and send it as a fax. You can send a cover-sheet-only note by clicking on the Captive icon. From the File Manager, you can simply drag and drop file icons onto the Captive icon to send a fax.

An import dialog box in DataFax's phone book lets you convert data from most other database formats. For each separate phone book entry, you can specify a national character set for international communications.

DataFax uses the Expervision OCR engine. The conversion was slightly worse than average, and DataFax had the longest time: 8 minutes, 11 seconds.

DataFax offers several convenient features, but it suffers from the OCR engine's slow performance. I had considerable difficulty getting it to work with the Intel Model 200 modem, and I had to switch to the Trio-supplied Zyxel U-1496E V.32bis modem before the package worked correctly.

Eclipse Fax 1.21



Eclipse Fax from Phoenix Technologies includes an indexing feature that's handy for locating fax files. When you receive a fax, you can enter an index name (up to 50 characters) in the index box. You can also add a six-line note that is stored with the fax file. To save space on your hard drive, you can save the indexed fax file as a compressed Group 4 TIFF file.

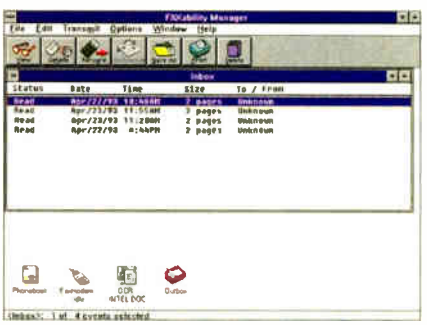
The Edit toolbar provides a rich set of tools for marking and annotating received faxes. You can add lines, ellipses, and rectangles or use a freehand drawing tool. The editor is powerful enough to use for creating or modifying cover sheets. You can insert text onto the fax in a variety of fonts and at any angle, so it is also ideal for adding vertical or horizontal notes in margins.

A unique antialiasing option creates a sharper image of a fax, although it slows down the redisplay of the screen. This can save you from having to print out a blurry fax just to read it.

Eclipse Fax's biggest failing is its sluggish performance. It was one of the slowest packages in the OCR conversion test, taking over 5 minutes to convert the test file. The quality of the conversion was good, but still not the best.

Eclipse Fax is well thought out. The indexing feature makes storing, grouping, and finding faxes simple. The fax editor makes it easy to create, modify, or annotate faxes and cover sheets. And the option to store received faxes in Group 4 compressed format adds to the package's attractiveness.

Faxability Plus/OCR

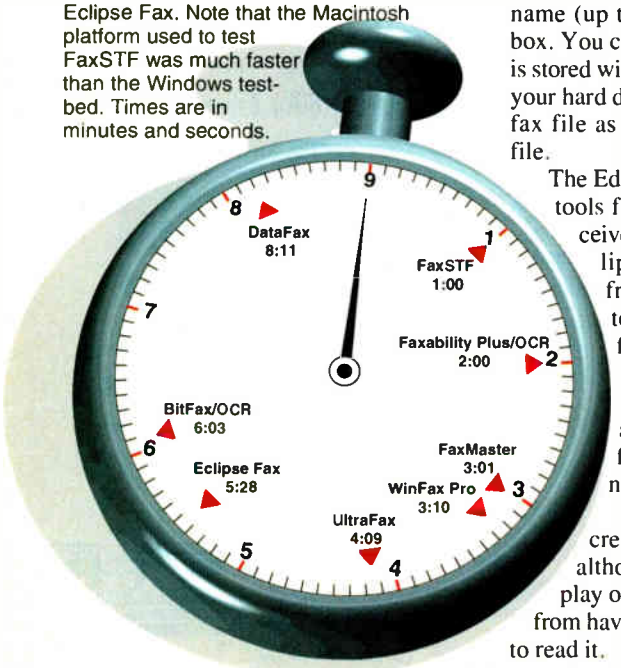


The Intel Faxability Plus desktop opens with the Inbox, a log of received faxes. Across the bottom of the screen are icons for the phone book and the Outbox log, along with an icon for fax-modem status. Faxability Plus lets you customize the view of the Inbox and Outbox logs; you can specify the types of items shown and change the order in which they appear. Faxability Plus doesn't give you the option of printing or viewing faxes on reception; faxes are saved in a queue subdirectory.

In addition to the pull-down menus, there's an icon bar across the top of the screen. You can click on an icon to view, forward, reschedule, save, print, delete, or check the status of a fax. Faxability Plus has the usual list of fax manipulation tools

FAX/OCR Conversion Times

Faxability Plus posted the best conversion performance, but the results were not as accurate as those of the slower BitFax and Eclipse Fax. Note that the Macintosh platform used to test FaxSTF was much faster than the Windows testbed. Times are in minutes and seconds.



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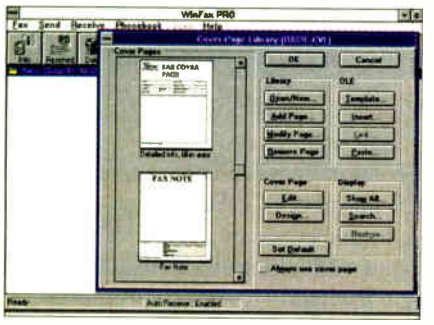
but lacks the advanced features of other

locate the unreadable characters. Optional

Reviews Fax Plus OCR: More Than Meets the Eye

WinFax Pro 3.0



Delrina's WinFax Pro lets you create call groups and multiple phone directories, and the phone book is stored in dBase format, so you can exchange records with other dBase-compatible databases. In fact, you can tap into an external database with WinFax Pro, as long as the database fields are compatible with the phone book database's. You can also use WinFax's DDE and OLE links to interactively exchange data with other Windows applications.

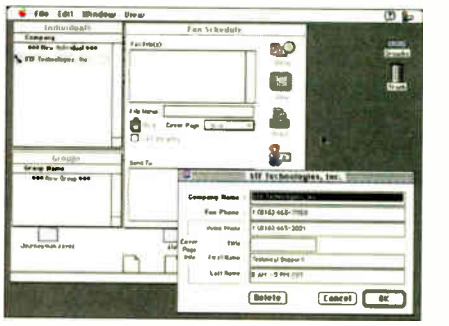
This package has an extensive range of viewing features. You can display up to 10 fax pages on a screen for thumbnail viewing. And you can clean up the received fax to remove any "noise" seen as random specks on the fax.

WinFax has the usual fax manipulation functions (e.g., flip, rotate, and invert), and you can flip all the pages in a multipage fax at once. The image editor comes with a full complement of tools, so you can annotate a received fax and save your changes to a separate file. The integrated text editor includes a dozen typefaces and a full set of justification tools. An impressive clip-art library of 101 cover sheets scales from professional-looking designs to cartoons.

WinFax employs Caere's Anyfax OCR engine, so it has the same text-recognition and proofing features as Caere's FaxMaster. WinFax and FaxMaster offered quite similar performance.

The user interface, with all its options, can be confusing. But the powerful features, such as convenient viewing and editing tools, an advanced phone book, and good document management, make WinFax Pro one of the most effective fax programs available.

FaxSTF and FaxManager Plus 2.2.3



It's not that Mac-based fax/OCR packages are rare, but most Mac fax modems are bundled with a fax software package. STF Technologies' FaxSTF is the first Mac fax/OCR package to be sold for a variety of modems.

You choose names from the FaxSTF phone book by dragging entries into a list. You can create new phone book entries, set the resolution of the fax, choose a cover sheet, and enter a 255-character note on the cover sheet. Then you click on the Send button, and your document is spooled to the disk.

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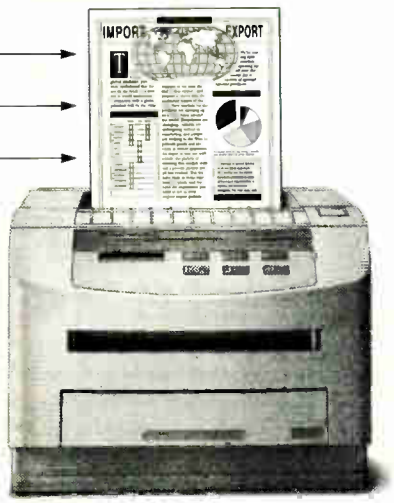

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Reviews Fax Plus OCR: More Than Meets the Eye

FaxSTF offers the usual time-delay features for sending a fax, but you can also use the call-grouping feature. This lets you send a group of faxes, created at different times and with different destinations, to the same fax machine in a single call. It's a convenient feature and reduces phone charges.

The FaxMonitor Extension handles spooled faxes and manages the connection to the fax modem. It works with the Communication ToolBox and Serial Port Arbitrator to take control of the modem when sending a fax. The FaxMonitor can also start the FaxStatus DA (desk accessory) when sending a fax; this displays the progress of your call.

FaxManager Plus is an optional OCR component for FaxSTF. Text conversion took 1 minute on the Mac II with the 40-MHz Radius Rocket accelerator board. Text accuracy varied from very good to fair, except for the first paragraph of Times New Roman at 10 pt; FaxSTF refused to recognize that text.

FaxSTF is easy to use and can work with a wide variety of Mac fax modems. The software is well designed, and the user interface is intuitive.

The Best Fax

Integrating an OCR engine into fax software makes considerable sense. You can save disk space and end up with true text, not an image bit map. Unfortunately, the current crop of fax/OCR packages are limited in their OCR capabilities. They require optimal conditions for accurate conversion.

OCR vendors are now designing engines with computer-based faxing in mind. Once OCR technology improves and people realize the advantages of not having to retype or scan in an incoming fax, you may see the extinction of the stand-alone fax machine.

For overall usefulness, I select Eclipse Fax from Phoenix Technologies as the best PC-based fax/OCR package. Its combination of an easy-to-use phone book, fax indexing, compressed file storage, a large selection of editing tools, and the Clearview option for fax viewing make it one of the best of the bunch. The only disadvantage is its slow OCR conversion times, but that is offset by its accuracy. ■

Stan Wszola is a testing editor for the BYTE Lab. You can reach him on BIX as "stan."

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NextStep for Intel

The black box is an orphan, but Next's GUI operating system lives on in the world of Intel systems

BEN SMITH

Next no longer makes computers. But it continues to do what it has always done best—developing and delivering system software that offers many of the benefits of object orientation that Taligent and Cairo still only promise. Unlike these others, NextStep provides easily customized and easily linked functional modules today, as it has for over four years.

NextStep for Intel Processors brings the NextStep environment to 486- and Pentium-based PCs. Data General, Dell, Epson America, Hewlett-Packard, NEC, and Siemens Nixdorf are the first PC vendors to sign on, and these offer NextStep installed. The end-user version of NextStep for Intel Processors costs $795.

I ran NextStep on an Epson Progression NX with a 66-MHz 486DX2 processor, 36 MB of RAM, and a 525-MB SCSI hard drive. I tested its performance and ran the PC on a network alongside a Nextstation Turbo. It ran well. NextStep brings to PCs the consistency of design Nextstation users have long enjoyed. From system administrative databases, down through graphics resources, through system library functions, even to the kernel level, NextStep is object-oriented. Best of all, there are consistent application elements that can be plugged together to build sophisticated applications. And the performance penalty for all of NextStep's levels of abstraction is minor, if even noticeable.

But NextStep's lack of an established user base, and the consequent lack of shrink-wrapped applications, won't vanish overnight just because the operating system now lives on the most popular hardware platform on earth. These, not any technical issues, are the problems that NextStep will need to overcome to succeed on or off PCs.

NextStep 3.1

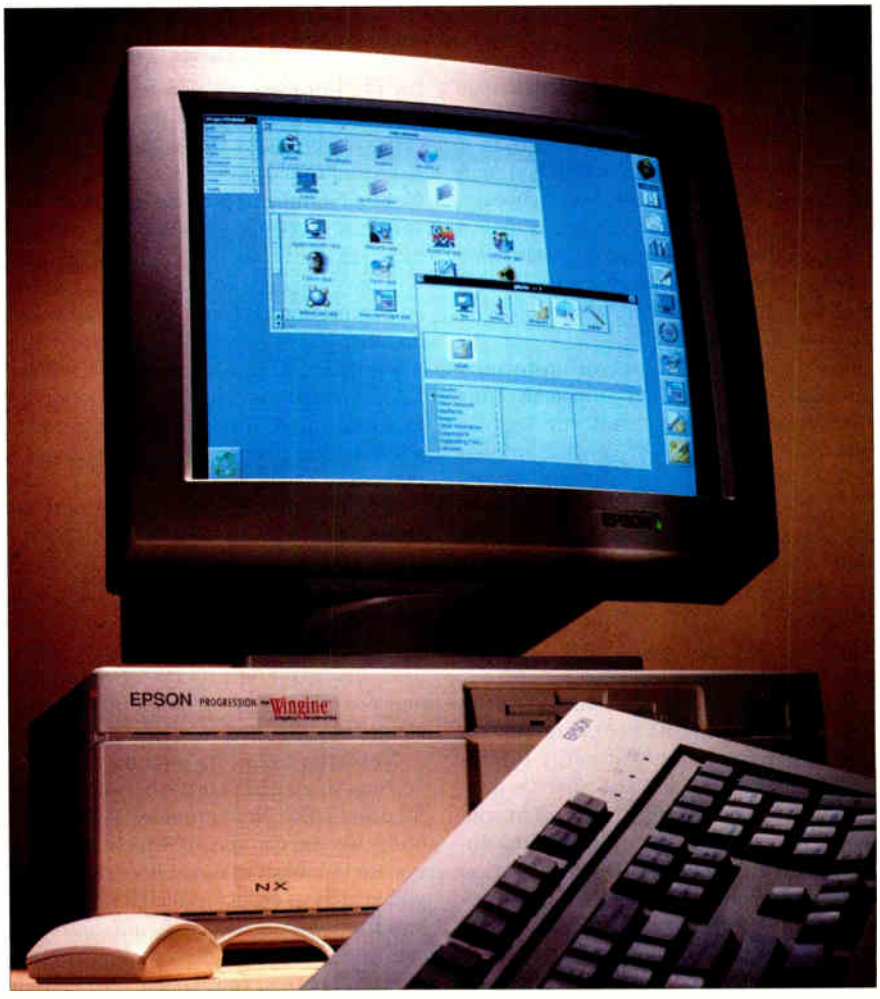
It isn't just the object-oriented design and the Mach-based operating system that have made NextStep so popular with its users and developers; it is also the visual design, the graphical elements that come with the system, and the ease of use that these elements provide the user. Because the interface is so well thought out, developers have little incentive to diverge from the user-interface guidelines. So NextStep applications have the same high level of consistency that you find in Mac applications.

NextStep's application menus and submenus are an example of the quality of design of the interface: The screen remains uncluttered because only the menus of the current application appear on the screen. The graphics and text within a background window remain active. Users can tear often-used submenus from the main menu so that they can be retained on the screen; however, menus and their submenus attract each other when they are in close proximity. Finally, you can easily set command-key equivalents for menus.

NextStep also provides a standard software installer and many other common utilities. By providing commonality among the applications and utilities, Next has made its operating system very easy to learn—despite its Unix underpinnings.

Not-So-Neat PCs

On the Nextstation, Next controlled both sides of the hardware-software equation. The company could provide direct support for all Next hardware in the operating system and ensure that everything worked well together. The integration between software and hardware was well crafted



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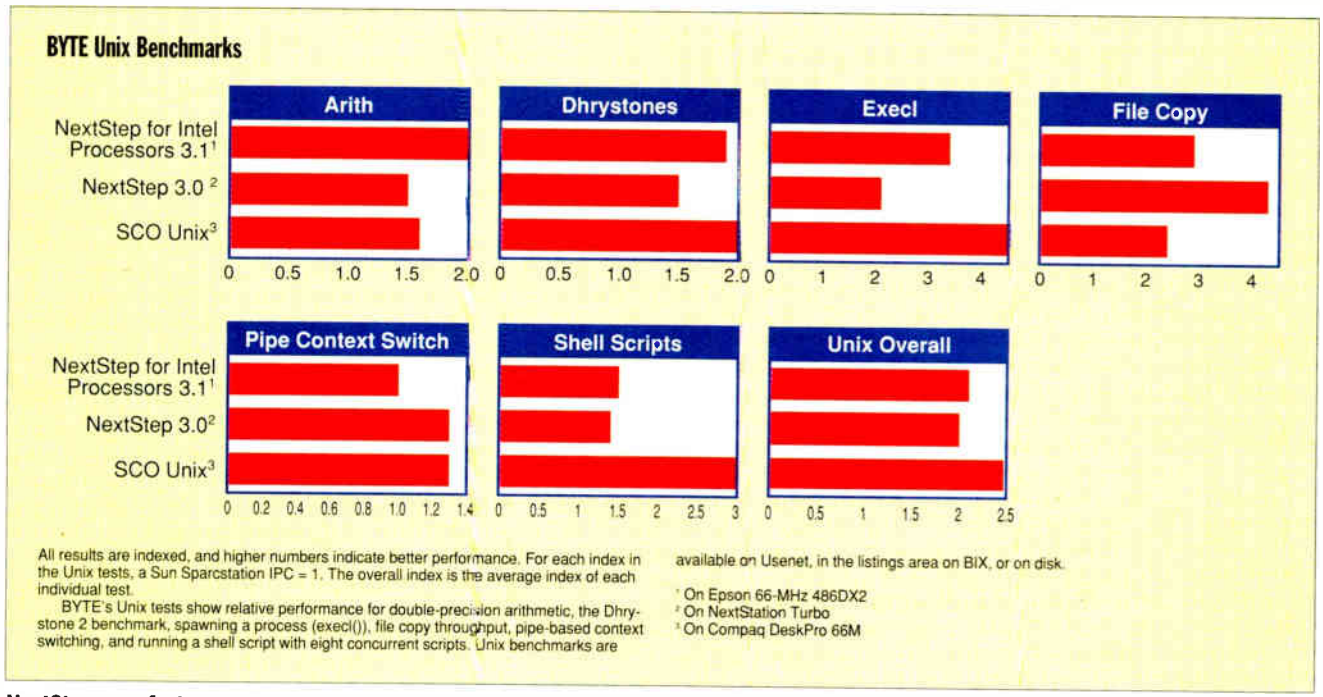

NextStep runs faster on *66-MHz 486DX2 PCs than it does on its native Nextstation Turbo, where it's powered by a 33-MHz Motorola 68040. NextStep for Intel Processors was faster on all tests but File Copy, an indication of the Nextstation's better disk caching and bus design. However, NextStep proved somewhat slower than SCO Unix System V release 4. Note that these tests do not measure display performance. Performance gaps between SCO Unix and NextStep are most pronounced on system functions, so it appears there is still room for kernel and system-call optimizations in NextStep.*

and solid. Setting up a new Nextstation on a network was effortless.

Things are different in the world of PCs, where thousands of vendors sell thousands of peripherals. Configuration is rarely easy; mixing and matching hardware is almost always difficult; and expecting hardware vendors to offer assistance with operating systems other than DOS or Microsoft Windows is unrealistic.

As a result of the lack of uniformity among motherboards and peripherals, Unix implementers on Intel platforms such as Next, SunSoft, and SCO have the arduous task of providing drivers that are general enough to work with most peripherals but specific enough to provide optimizations that can handle the work that Unix demands. What may be high-performance hardware for DOS or Windows may be impossible to configure, or a poor performer, for Unix.

Nonetheless, Next has done an excellent job of moving its operating system. System configuration was never a problem on the Nextstations, and Next has minimized PC system-configuration effort with a new (and now necessary) NextStep application: `configure`. This application more or less automatically sets up the operating system to handle hardware variations, including installing drivers.

When building networks with NextStep for Intel Processors, you have three options, just as you did on the Nextstation. First, you can hook into a Next-based network by just plugging in a cable, relying on Next's NetInfo to provide domain name services. Second, you can connect to a more standard Unix network, although you will have to edit some of the initialization and configuration files, just as you would on other Unix systems. Third, you can run a NextStep PC as a client on a NetWare LAN. Getting the NetWare connection up is a little more difficult than Unix networking, but it's possible to do without a manual.

Since NextStep is distributed on CD-ROM, installation doesn't require very much user interaction. However, you need to be sure that you have followed the brief hardware-compatibility guide or you won't get very far. As I wrote this review, there were drivers for only two SCSI controllers and just a handful of video boards that NextStep supported.

NextStep sits in its own partition, so you can share a hard drive between NextStep and DOS. Next provides a multiboot utility, so you can specify which operating system you wish to run at boot time. And you also have access to the DOS file system from within NextStep, although you can't run DOS or Windows applications directly. For that, you'll need SoftPC from Insignia Solutions. SoftPC for NextStep will ship on the September CD NextStep release but will require a separate license. Besides DOS file-system support, NextStep also supports the Mac file system, so you can read Macintosh floppy disks and Mac volumes on SCSI drives.

Making the Move

Other than the integral DSP (digital signal processor) capabilities of the now-obsolete Nextstation, there is little that the Intel version of NextStep doesn't provide for developers. Next claims that 80 percent of the applications that ran on Next hardware are already recompiled for Intel CPUs. Some of the remaining 20 percent will never make it through the transition, because they were specific to the Motorola hardware or DSP in the Nextstation.

But for applications that used NextStep libraries rather than hardware-specific code, the work is more or less already done by Next. Developers need do little more than recompile their source code and edit their documentation to reflect the difference in keyboards. Among the popular applications that have already completed the move are Altsys Virtuoso (an advanced FreeHand-like drawing program) and Mesa (a spreadsheet from Athena Design). However, some vendors, most notably Adobe, have hesitated to port significant

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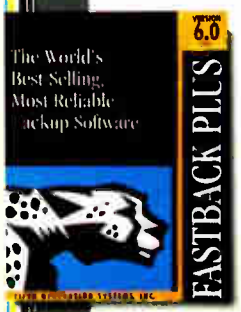

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applications to NextStep for Intel Processors, reluctant to make the move to yet another platform.

Theoretically, developing new device drivers for NextStep is quick and easy using the object-oriented driver architecture and the Driver Kit. Next provides high-level driver objects (e.g., for Ethernet controllers), and hardware vendors need only add the specifics for each device. Since the device drivers can be loaded at run time (rather than being linked into the kernel as in older Unix implementations), peripheral manufacturers can distribute their drivers with their devices, and users can install and configure them easily. NextStep for Intel Processors is still new, and the list of supported hardware is short; it will take time to see how well its driver architecture works in the real world of thousands of hardware providers.

Next has partitioned NextStep into developer and end-user versions. To get the development package, you need to purchase an end-user license plus a $1995 add-on. The add-on contains the Interface Builder, Project Builder, Objective-C compiler, and other tools, all of which the end-user environment lacks.

Windows NT vs. NextStep

Windows NT	NextStep
• Multiuser, multitasking	• Multiuser, multitasking
• Microkernel architecture, but unproven in the hands of end users	• Production operating-system kernel four years in the field.
• Non-GUI environment is MS-DOS	• Non-GUI environment is Unix
• Windows GUI environment provides huge existing base of users already familiar with the interface	• NextStep GUI environment more cleanly integrated with operating system and arguably more intuitive
• Multiple file systems	• Unix file system shared with MS-DOS
• Local and remote interprocess communications	• Local and remote interprocess communications
• Runs 16-bit and 32-bit Windows, and DOS applications	• Runs NextStep applications
• Applications development is difficult	• Applications development is simple
• Object-oriented operating system, and object-oriented languages for development, but little mapping between the two systems	• Object orientation runs from operating system to development tools

Maximum Is Minimum

NextStep runs on Intel platforms—but not wimpy ones. Next's recommendations for a 16-bit-color NextStep system include a 486SX or better processor, 120 MB of available storage, 24 MB of RAM, and a high-end graphics system like Chips & Technologies' Wingine, Dell's DGX, Compaq's QVision, or ATI's Graphics Ultra Pro. The development system wants 330 MB of hard disk space. NextStep's trademark full-window drags (not outlines) require serious graphics hardware, and the very best Intel systems are required to give you smooth performance.

I tested NextStep for Intel Processors on a Wingine-equipped Epson Progression NX, a 66-MHz 486DX2 with 2 MB of VRAM (video RAM) yielding 1024- by 768-pixel resolution at 16-bit color. Screen operations were still smoother on the Nextstation Turbo than they were on the Progression NX. The Progression also included a Media Vision Pro Audio Spectrum sound card for sound support.

As the benchmark graph shows, NextStep for Intel Processors is somewhat slower than SCO Unix running on equivalent machines. However, these benchmarks measure processing and disk I/O only (not graphics), so they aren't measuring one aspect of performance where NextStep should be strongest.

NextStep proved a little faster running on the 66-MHz Intel CPU than on the Nextstation Turbo, at least for simple computations. As shown by the Dhrystone 2 and Arithmetic (floating-point loops) tests, the Intel version is about 30 percent faster, but it lags somewhat on file I/O. Subjectively, NextStep is very quick on PCs.

An important benefit to Next's move to Intel machines is the opportunity that the Pentium offers—multiprocessor multitasking. The Mach kernel is the lowest-level task of the operating system. It is the touchstone of microkernel operating systems. Because Mach provides an abstraction of the processor and its tasks, even many of the operating-system calls and other system services can naturally be distributed over several processors. As a result of the very small elements into which all processes can be broken, Mach can inherently make efficient use of multiprocessor systems independent of the type of communications between processors.

Ironically, Motorola's 680x0 line of processors isn't specifically designed for multiprocessing. The Pentium is designed to support multiprocessor systems, with processor synchronization logic. This is just what NextStep needs, even though it will be a few years before multiprocessor systems will be economical.

New Competition

Back when the Next machine was a workstation, NextStep faced competition from other workstation operating systems: variations of Unix with Motif, SunView, or OpenLook interfaces. Now, NextStep competes on the ultimate open platform and will need to find a space among PC Unix systems and options like OS/2 and Windows NT.

Against Solaris and SCO Unix, NextStep is comparable in performance and superior in its user interface. Its weak spot is that it is not part of the mass movement toward compatible X Window System–based GUIs.

How about Windows NT? It, too, is a microkernel-based, 32-bit, multitasking system for networking environments and requires top-of-the line hardware. But NextStep is more complete, already established by users and VARs, and it is easier to develop applications for NextStep than for NT. NT's interface is Windows, which is already familiar to millions of users. NextStep's interface is better, in my opinion, but it does not come with a large supply of pretrained users.

Next's shift from workstation manufacturer to software vendor was a smart move: NextStep for Intel Processors is a nice system. Those who'll benefit most are large corporations already using Nextstations, because of the ease with which NextStep applications can be built and customized. They will reap the immediate benefit of less-expensive hardware.

Extending NextStep's traditional base may take a little longer. While it's unlikely that an operating system with such a small following and so demanding of system resources will ever come to dominate the huge Intel arena, the move to a platform where even high-end hardware can get real cheap real fast will help to ensure this elegant operating system's future. ■

About the Product

NextStep for Intel Processors 3.1
User package.....$795
Developer add-on ...$1995

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Ben Smith is a BYTE Lab testing editor and the author of Unix Step-by-Step *(Sams, 1990). You can contact him on BIX as "bensmith."*

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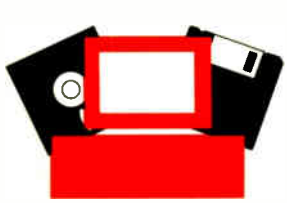

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Mips Inside: The RISC PC

DeskStation Technology's R4400-based machine runs Windows NT with style. But this fast RISC system faces some software hurdles.

RICK GREHAN

DeskStation Technology's new Evolution RISC PC comes ready to run Windows NT: a 50-MHz processor, lots of fast RAM, a SCSI hard drive, six EISA slots, a big tower case, and a big power supply. But you won't find an "Intel Inside" sticker on the faceplate, nor any Intel or Intel-compatible processor in the CPU socket. The Evolution is powered instead by a 64-bit Mips R4400, clocked externally at 50 MHz. Except for its exotic processor, the Evolution is more or less a standard PC system. However, it's designed to run NT exclusively. NT comes from Microsoft built for Mips processors, and NT's HAL (Hardware Abstraction Layer) performs half the magic that allows a high-end RISC machine to coexist with an otherwise ordinary PC.

This is not the first R4000 system for NT. Other vendors that supported the ARC (Advanced RISC Computing) specification, most notably Acer, have built Mips-based PCs before. But tiny DeskStation Technology makes a significant leap by pricing the Evolution squarely against 486 systems: Evolution prices range from $3995 for a reasonable NT system (an R4000 processor, 16 MB of RAM, a 200-MB hard drive, and a high-resolution monitor) to $9995 for a real Cadillac, including an R4400 processor, 64 MB of RAM, a 500-MB SCSI drive, a CD-ROM, accelerated video, and a 21-inch monitor.

I tested a high-end Evolution for performance using BYTE's portable benchmarks, tests under development that measure system speed on several platforms and on several operating systems. The Evolution runs NT faster than any system BYTE has yet tested, including a few 60-MHz Pentium machines. As I write this review, Windows NT is not a shipping operating system. However, DeskStation is currently selling the Evolution to NT developers. The unit I looked at, a close approximation of DeskStation's rPC444e/100 model, lacked the polish of an end-user system. DeskStation plans to add the finishing touches before the commercial release of Windows NT.

EISA technology and Mips processors do not come from the same world. A chip set designed by DeskStation plays a key role in the magic act that takes bus protocols understood by a Mips R4000PC and transforms them into EISA signals. It's a two-way transformation, of course; EISA signals have to be turned into Mips R4000PC-bus signals as well.

The upshot is that any adapter card that runs in an EISA slot will run in the Evolution (provided that the drivers are available). The hardware trickery completely shields the card from the fact that it's being shepherded by a non-Intel CPU.

SCOTT PARKER/AVIS PHOTOGRAPHY © 1993

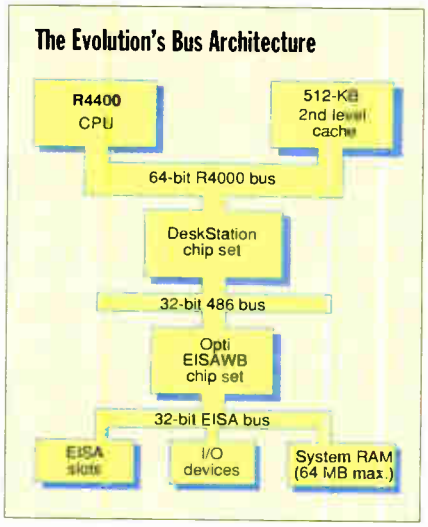
Of course, all this abstraction needs help from software as well. The help comes from the ARC specification (more or less under the ministry of Microsoft). ARC enabled the DeskStation engineers to produce firmware that is oblivious of the operating system and, with the help of a DeskStation-modified ARC HAL, enabled Microsoft engineers to make NT oblivious of the hardware details of the Evolution. When you power up an Evolution, the BIOS firmware loads and executes an OSLOADER.EXE file. This boot program, using ARC-specified calls, turns around and requests the firmware to load the NT kernel and associated drivers. When all that's loaded, OSLOADER jumps into NT and off you go.

Evolution systems (there are eight models) run either Mips R4000PC or Mips R4400PC CPUs. Both of the Mips chips are RISC processors that run internally at twice the external clock rate. Therefore, 50-MHz Evolution systems run the processor at 100 MHz.

An R4400PC differs from an R4000PC in primary cache size; the R4400PC has twice the cache—32 KB total—of an R4000PC. The "PC" suffix on the name indicates that the CPU is "primary-cache only"; that is, there is no on-chip controller for an external secondary cache. All secondary cache control has to be supplied by circuitry on the motherboard.

DeskStation's custom chip set performs the dual work of managing the CPU's external 512-KB write-through cache and acting as a bridge between the R4000's bus and a 486 bus, also on the motherboard (see the figure on page 146). This 486 bus serves as a stepping-stone from the R4000's bus to an EISA bus. Yet another chip set—this one from Opti—transforms the 486 bus protocols into the EISA bus protocols. Currently, there are no additional components on the 486 bus besides the two chip sets, although DeskStation engineers suggested that they may investigate placing peripherals on this bus in the future.

As well as providing the driving signals for the six EISA slots, the Evolution's



The Evolution's motherboard *is home for three buses. A 64-bit-wide R4000 bus connects the CPU to a secondary cache; a 486 bus serves as the interface between the R4000 and PC peripherals; and an EISA bus provides expansion. A DeskStation Technology custom chip set links the R4000 to secondary cache and to the 486 bus, while an Opti chip set links the 486 bus to EISA. System memory hangs off the EISA bus.*

EISA bus acts as the pathway to the Evolution's on-board peripheral I/O devices: the serial ports, parallel port, IDE controller, and floppy drive controller. System memory also connects to the processor through the EISA bus, although it does so via SIMM sockets and not a memory board that would consume an EISA slot. The Evolution accepts up to 4 SIMMs of 4 MB or 16 MB, for a starting memory size of 16 MB and a cap of 64 MB.

Under Scrutiny

The machine I tested was, as I mentioned, built for developers and so lacking in some spots. However, it wasn't underpowered. Its CPU was an R4400PC, and its memory was brimming at 64 MB. Its collection of drives included a 203-MB Maxtor IDE drive, a 1.44-MB floppy drive, and a CD-ROM drive. The hard drive and floppy drive were controlled by a multi-I/O card plugged into the EISA bus, which also handled serial and parallel I/O. An Adaptec SCSI card managed the CD-ROM drive, and video was driven by an Orchid Fahrenheit 1280 feeding a 16-inch Mini-Micro display. An Ethernet card from SMC was in yet another EISA slot; it became the Evolution's connection to BYTE's network and my means of experimenting with NT's network components.

Ultimately, working with the Evolution amounted to working with Windows NT.

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Reviews Mips Inside: The RISC PC

All my testing was done using a March 1993 beta version of NT. I assume that any bugs I encountered (e.g., tasks freezing unexpectedly) will be eradicated in the release version.

As a technical tidbit, you should keep in mind that the R4000 processors are 64-bit processors. They can, however, run in 32-bit mode, which the Evolution's CPU does under Windows NT. Memory fetches can still occur at 64 bits, and the pathway between the processor and primary cache is 64 bits wide. However, since main memory resides on the EISA bus, its access is only 32 bits wide. Until some vendor releases an R4000-based NT system with 64-bit-wide memory access, it's impossible to gauge how the Evolution's placement of system memory affects performance.

Although you probably won't want to run 80x86 DOS programs as your primary applications on the Evolution, my preliminary experimentation with it showed that NT's MS-DOS prompt does a decent job of DOS emulation, in spite of the R4000's emulation of an Intel processor. The system we tested had problems handling some of the more infrequently used graphics modes, and, in text modes, blinking text didn't blink at all. The Evolution ran our low-level DOS benchmarks, which contain a great deal of 80x86 code, as well as plenty of low-level calls to the BIOS, video hardware, and math coprocessor (see the table "BYTE DOS Benchmarks").

Under Intel emulation, the Evolution ran CPU-intensive tasks at about three times the speed of an 8-MHz 286 running DOS, or about 85 percent the performance of a 33-MHz 486. However, its FPU emulation was abysmal, somewhat slower than a real 287. And the Evolution ran at only half the speed of a 66-MHz 486 running benchmarks in the NT DOS box.

It was while running the benchmarks that I discovered that the emulation provided was of a 1-MB 286 system with a 287 math coprocessor. Engineers at DeskStation hinted that work was underway at Microsoft to extend the emulation to 386 levels; whether or not such is the case remains to be seen.

To test the real capabilities of the Evolution's CPU, I installed a preliminary version of the Win32 SDK (Software Development Kit) using the Evolution's CD-ROM drive and compiled an early version of the CPU and FPU portions of BYTE's soon-to-be-released portable benchmarks. These programs ran native R4000 code. The table "BYTE Portable Benchmarks" compares these results against a 60-MHz Pentium and a 66-MHz 486DX2. On every test, the Evolution system ran faster than either Intel unit. As you scan the benchmark figures, be sure to keep in mind that, in both cases, we were running a beta version of the NT operating system.

Worth the RISC?

Although it would be nice to say that the purchase of an Evolution system is simultaneously the acquisition of a fast NT

BYTE DOS BENCHMARKS

Running BYTE's low-level DOS benchmarks in the Evolution's "DOS Box" revealed that the CPU emulation is respectable, but its FPU emulation takes the machine to its knees. All indexes are relative to an 8-MHz 286, because the Evolution emulates only a 286. (Higher numbers are better.)

	DESKSTATION EVOLUTION RISC PC (WINDOWS NT)	66-MHZ 486DX2 (WINDOWS NT)	33-MHZ 486DX (MS-DOS 5.0)
CPU	3.19	7.29	3.75
FPU	0.80	6.78	4.64

BYTE PORTABLE BENCHMARKS: WINDOWS NT

CPU and FPU portions of a preliminary version of BYTE's soon-to-be-released portable benchmarks give a good indication of how much faster the Evolution's 50-MHz R4400PC is when matched against a 66-MHz 486DX2 and a 60-MHz Pentium system (all running a March 1993 beta of Windows NT). The Evolution shows 2 to 2.5 times the performance of a 66-MHz 486DX2 and 1 to 1.5 times the performance of a 60-MHz Pentium. These indexes are scaled against a 33-MHz 486. (Higher numbers are better.)

	DESKSTATION EVOLUTION RISC PC	60-MHZ PENTIUM	66-MHZ 486DX2
Numeric Sort	4.00	3.90	2.35
String Sort	6.60	4.75	2.54
Bitfield	6.20	4.52	2.30
Emulated Floating Point	3.50	1.79	1.17
Simple FPU Test	4.90	4.43	2.33
Transcendental FPU Test	3.90	3.71	2.05

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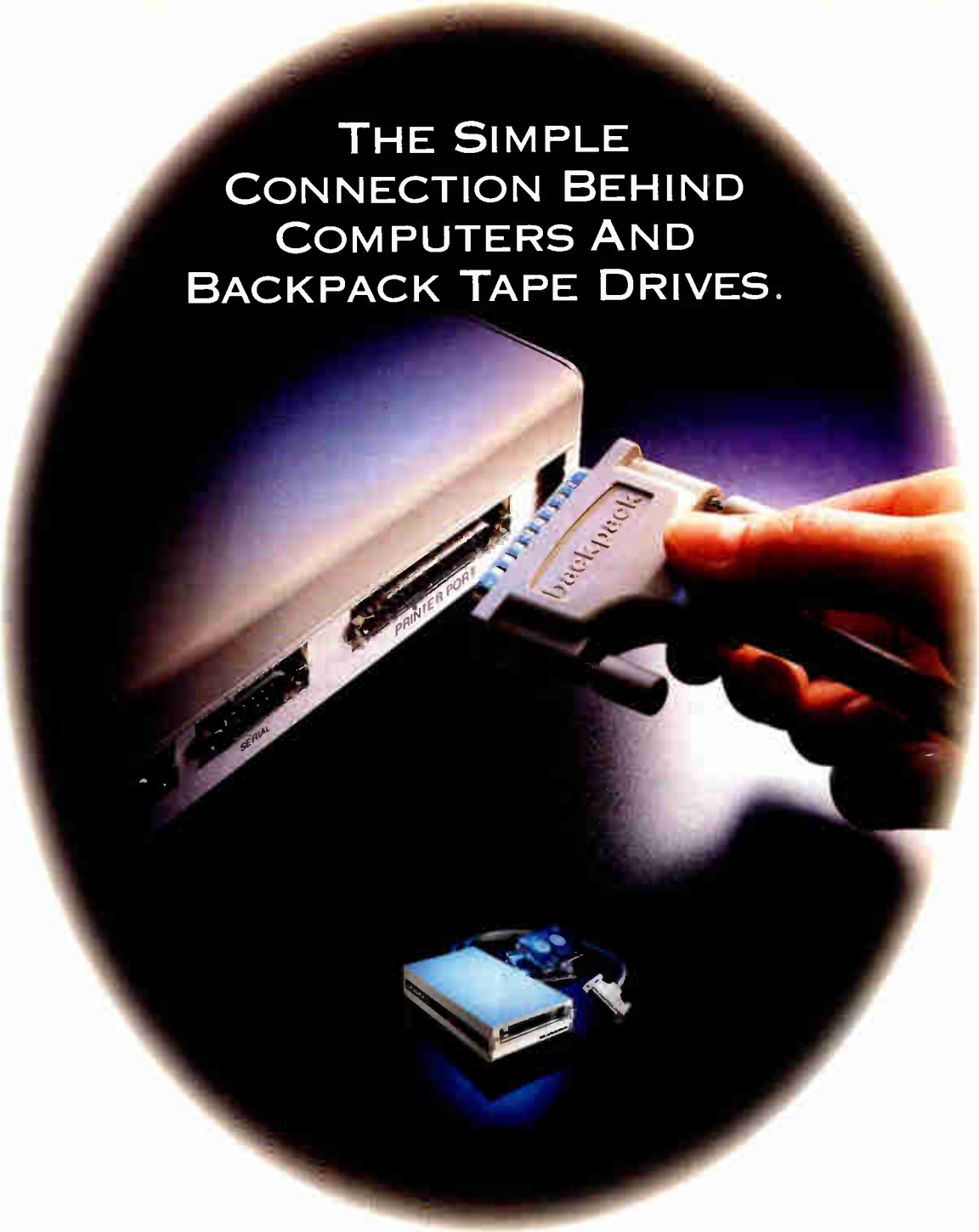

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system and a guaranteed protection of the investment you've placed in all your ISA and EISA cards, things aren't that simple. Some adapter cards have ROMs on them, and 80x86 code sits in those ROMs. And as hard as HAL works to hide the details of the hardware from NT, abstraction only goes so far. The Evolution cannot execute the code in peripheral ROMs. The bottom line: Every card needs a driver for the R4000.

This could be the greatest hurdle the Evolution (and other non-Intel NT machines) faces. For example, suppose you manufacture an Ethernet card that you want to unleash on the NT market. Thanks to HAL, your programmers can write driver code in C with the understanding (and hope) that the source code will work on all NT platforms, regardless of what processor happens to be running the system. But drivers are not "binary portable" across processor lines. If NT continues to advance in its current direction and you intend to thoroughly cover the NT marketplace, you'll have to ship your card with an Intel 80x86/Pentium driver, a Mips R4000 driver, and a DEC Alpha driver.

If you look at this dilemma from the user's side, it becomes more than a matter of whether a card comes with the driver you need. What's also important is whether all the cards you already own will work. It's unclear on whose shoulders will fall the task of porting drivers across processor lines (and verifying that the ports function properly).

About the Product

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The Cost of Evolution

What will an Evolution set you back? The low-end model at $3995 includes a 50-MHz R4000 CPU, 16 MB of RAM, a 14-inch monitor driven by an S3-based video adapter, a 3½-inch floppy drive, and a 200-MB IDE hard drive. Upscale, you'll pay $9995 for a 50-MHz R4400 CPU, 64 MB of RAM, a 21-inch monitor driven by an S3-based video card, a 3½-inch floppy drive, a 500-MB SCSI hard drive, and a Multi-Session CD-ROM drive. This version is much like the system I tested, although mine had a smaller hard drive.

The fate of the Evolution depends primarily on the success of Windows NT. Presuming NT is a smash, getting the most performance out of the Evolution will depend on how rapidly vendors recompile applications into R4000 code, and whether a critical mass of supported peripherals (with drivers) appears. The ARC specification will play only a small role in defining the success of Mips-based systems. Most Mips system vendors, like DeskStation, use ARC only as a starting point.

For now, the outcome is anybody's guess. The Evolution certainly has the price, and the performance under NT. Let's see if it gets the support. ■

Rick Grehan is technical director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in mathematics/computer science. You can reach him on BIX as "rick_g."

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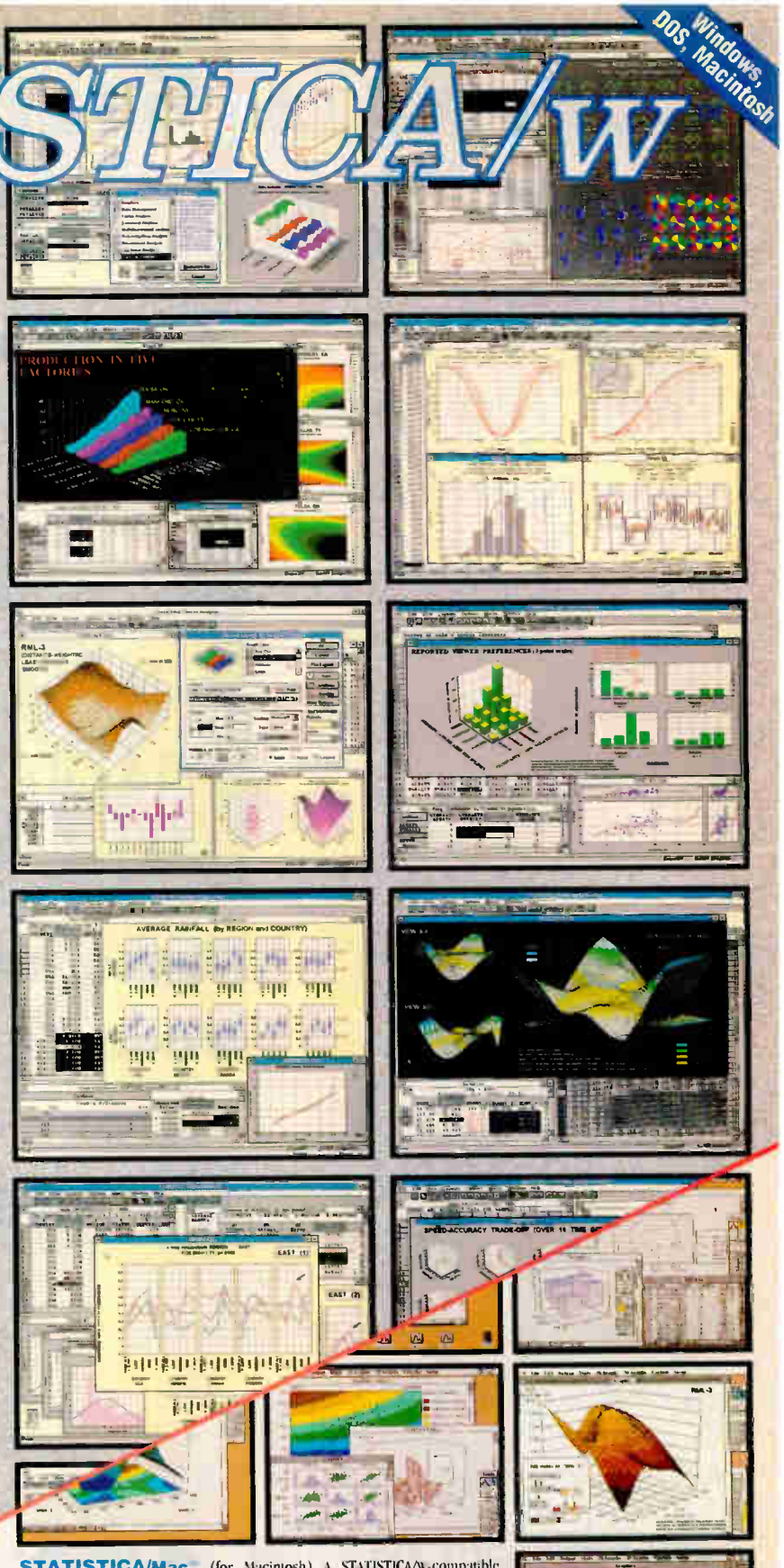

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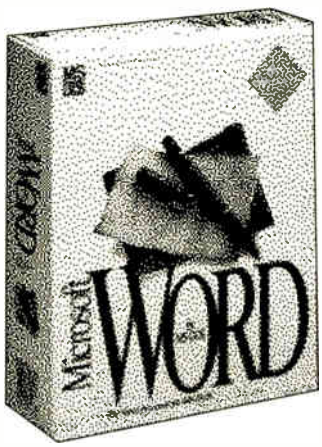

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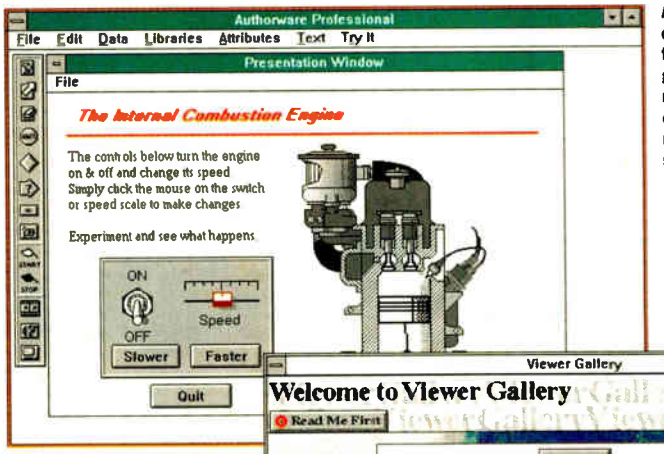
New Authoring Tools for Windows

Two approaches for creating multimedia titles: Macromedia's Authorware Professional and Microsoft's Multimedia Viewer

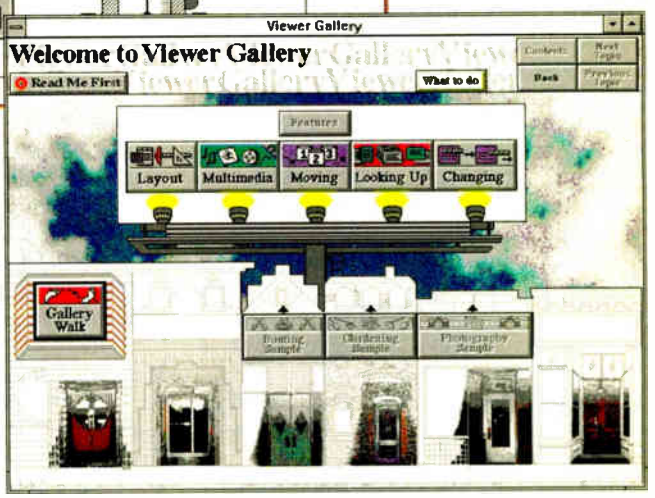
HARRIETT HARDMAN

Virtually every authoring tool on the market today can be categorized by the mind-set of the designer: right brain (focused on pizazz and surface appeal, with less concern for content) and left brain (emphasizing content and having a user interface that ranges from clunky to nice but never spectacular). Macromedia's Authorware Professional was clearly designed by a right brain–oriented person. The animation is slick, the visuals impressive, but text support is minimal—no hypertext links, no searching.

On the other hand, Microsoft's Multimedia Viewer Publishing Toolkit is left brain–focused, intended for organizing large collections of data and presenting the content effectively. It offers terrific hypertext capabilities and plenty of embedded commands. The screen layout, however, is not very simple or flexible.



Authorware Professional delivers exceptional tools for building entertaining graphics and embedded multimedia, but it lacks quality tools for text manipulation. Its price is steep in today's market.



Microsoft Viewer includes a slick application for previewing features and walking through sample titles. Unfortunately, the development tools are not tied together as well as the tutorial components. To create a sample application, I had to run a host of separate executable files: the Project Editor, the Hotspot Editor, Microsoft Word, the Topic Editor, a drawing program, and the Compiler.

Authorware Professional

Macromedia's primary focus with Authorware is educational applications, so in the time-honored tradition, Authorware provides the tools to make the end product fun. Authorware is also suitable for applications like information kiosks and commercial titles that are highly interactive. Whizzy animation and spectacular graphics allow creative designers to make graphical presentations that should keep the interest of the most jaded MTV-era viewer.

Assembling presentations is easy and visual: You simply drag icons from the toolbar onto the "flowline" displayed on the screen (see the screens on page 154). All screen layout is easy and visual, with drag-and-drop icons and dialog boxes to specify parameters. Authorware provides lots of options for setting up user interactions: buttons to select actions, "hot spot" areas that the user can click on, objects that can be dragged, pull-down menus, and dialog boxes where the user's response is checked against a correct answer.

For example, in the demo presentation supplied, the user can click on the shutter of the camera and a snapshot appears. After clicking on the aperture adjustment and then the film-advance lever, the user can click the shutter to "take" another picture (with correspondingly lighter or darker results, depending on the aperture setting). The camera and photograph graphics files were imported, but the buttons, text, and hot-spot definitions were all created on the screen with Authorware.

That educational applications are the target is clear from Authorware's ability to handle multiple-choice questions, respond to specific incorrect answers, and limit the number of tries that the user is allowed before the presentation proceeds to the next topic. Authorware can also cycle through a series of lessons, exiting only when the student's score is satisfactory.

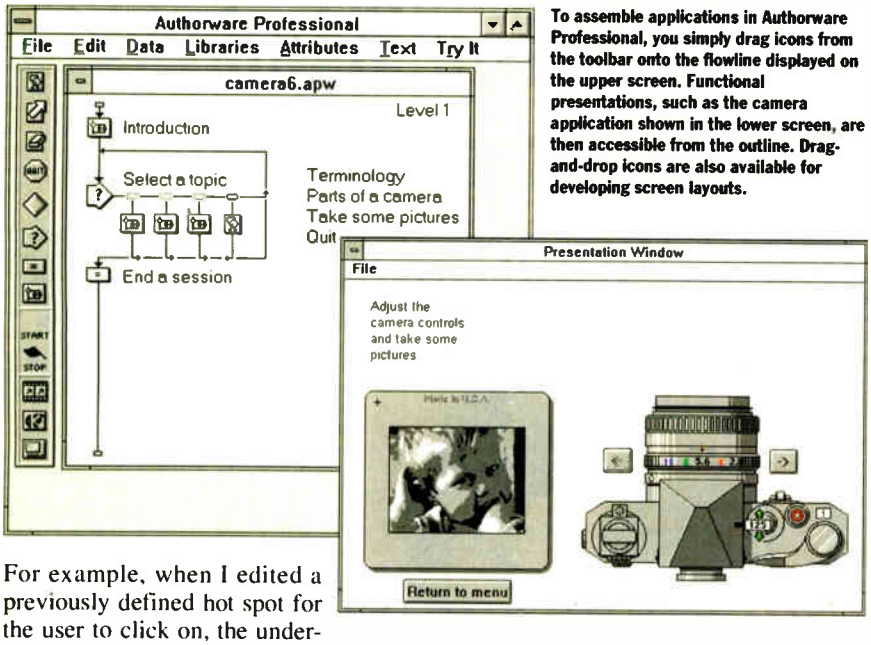
To simplify large presentations, Authorware lets you use map icons (which are analogous to subroutines) that contain additional sequences. This feature allows multiple designers to work on different parts of the presentations. The resulting pieces can be easily glued together.

In lieu of a true scripting language, Authorware provides manipulation of variables. System values (e.g., the date) as well as user-defined computed values can be displayed on-screen. Conditional comparisons and logical variables are also available, but there are no looping controls or true programming commands. File management functions let you create files and store data in them. Authorware can also link to a Windows DLL to incorporate user-defined functions.

Perhaps one of the strongest features of Authorware is its multiplatform support. Presentations developed on the Mac can be easily ported to Windows. (Unfortunately, presentations created in Windows cannot be played on the Mac.)

I was most disappointed by Authorware's lack of maturity. I expected superb screen-manipulation facilities and clear, intuitive controls, comparable to the tools available in desktop publishing packages.

continued



To assemble applications in Authorware Professional, you simply drag icons from the toolbar onto the flowline displayed on the upper screen. Functional presentations, such as the camera application shown in the lower screen, are then accessible from the outline. Drag-and-drop icons are also available for developing screen layouts.

For example, when I edited a previously defined hot spot for the user to click on, the underlying picture was not visible, so it was impossible to align the hot spot. And there is no way to lock the position of an object; simply selecting it often moved the object a few pixels, thereby ruining painstaking alignment.

Another problem is poor text handling. Based on Authorware's market focus, that isn't a real problem, because information kiosks or interactive training sessions typically do not require large searchable databases. But the limitations in text handling mean that Authorware is definitely not a general-purpose multimedia authoring tool. For example, text can be imported only through the Clipboard. On the screen, text can be left-aligned or right-aligned but not fully justified. And when text is pasted in, excess text flows off the bottom of the screen and disappears; no elevator bar is provided to scroll through it. If a lot of text is required, this means lots of finicky cut-and-paste operations to display single screenfuls.

The Authorware software was written when CD-ROM publishers were mainly government and large institutions. Compared with other specialty, niche-market, limited-distribution packages, its $4995 price tag seems reasonable. However, compared with mass-market products that perform similar text and graphics manipulations (e.g., desktop publishing software), it seems vastly overpriced and underpowered.

Adding insult to injury, Authorware requires that you pay a royalty for commercial products you develop. This is not uncommon among the expensive authoring tools. In some ways, perhaps, it makes sense: When you distribute a title, you must also include the authoring software's viewer program so the user can display the presentation. However, as multimedia is more widely disseminated, there will be downward price pressure on the cost of CD-ROM titles, and fewer publishers will be prepared to pay royalties.

Microsoft Multimedia Viewer

At $495, the Microsoft Multimedia Viewer Publishing Toolkit 2.0 is an inexpensive general multimedia authoring tool. Its primary focus is on managing large quantities of text, so its indexing and searching abilities are impressive. The ability to build on-screen animations is not part of Viewer, although you can import files from programs like Autodesk Animator.

Viewer makes extensive use of .RTF (Rich Text Format) files. Using Viewer, the author creates a series of .RTF files with special command strings that pertain only to Viewer. Programmers will have a heyday, especially those who have used the Microsoft Help Compiler, which uses a similar syntax to mark hot spots. The manuals contain an extensive description of how to build DLLs that add functions to Viewer.

This program has a GUI only in the broadest sense of the term. GUI tools are available to specify "baggage" filenames (e.g., text, graphics, sound, and video), but the program revolves around embedded commands in the master project file (see the screen on page 156). Embedding the commands from Microsoft Word (Word is a required adjunct tool when working with Viewer) is not difficult, but the resulting text is very hard to understand and edit. For nonprogrammers, the whole process is baffling and complex.

You compose a screen by creating panes of information. Instead of limiting the display to a single large window with hot spots and pictures, authors can divide the window into multiple views for the most effective display of information.

A hot-spot editor allows clickable buttons to be defined as overlays to a graphics file and saved as a hypergraphic (graphic plus hyperlink information) for use in presentations. Users must create the art (including drawing the button areas) in another program. So, for example, you cannot overlay buttons onto graphical images unless you alter the graphics to have a button drawn at the appropriate spot. Hot spots are rectangles only.

The searching capabilities are impressive, with wild-card, fuzzy, and proximity searches in addition to the usual keyword lookups. Users can search for ranges of dates or customized fields. Developers can also add their own search engines or add foreign-language characters to the character search table to customize the searching abilities.

There are lots of thoughtful goodies bundled with Viewer, including CD-ROM optimization and file compression. With slower CD-ROM drives, using compressed files and decompressing in memory is often faster than doing the necessary disk accesses to retrieve an uncompressed file. And if large graphics files are to be used, space can be tight, even with over 600 MB of storage space to work with. Conversion tools for data include bit-map and palette editors, a waveform editor, and multimedia conversion for audio, bit-map graphics, palette, and MIDI files.

One really interesting aspect of Viewer is its support of the Sony Multimedia CD-ROM Player. The Windows features that are not supported on the Multimedia Player are clearly marked in the manual, and you can embed conditional statements to specify alternative actions for the two environments. Since the Multimedia Player runs MS-DOS rather than Windows, it does not support external DLLs or execution of other applications from within titles. Buttons, menus, and secondary windows must be mapped to function keys on the Player, making development for both platforms fairly complex.

The only other drawback is that Microsoft requires a royalty on titles for the

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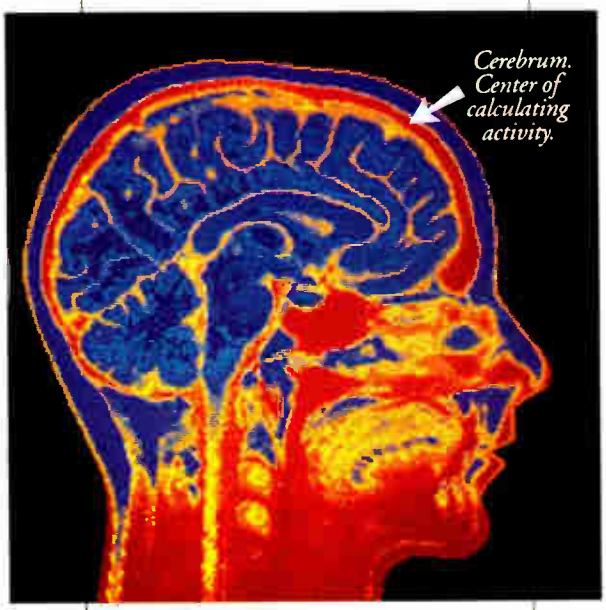

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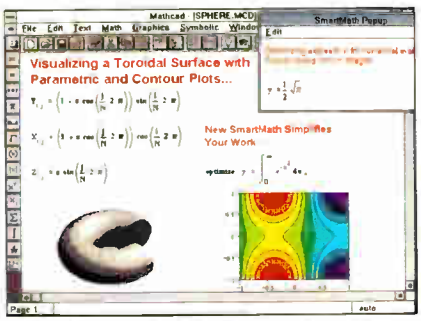

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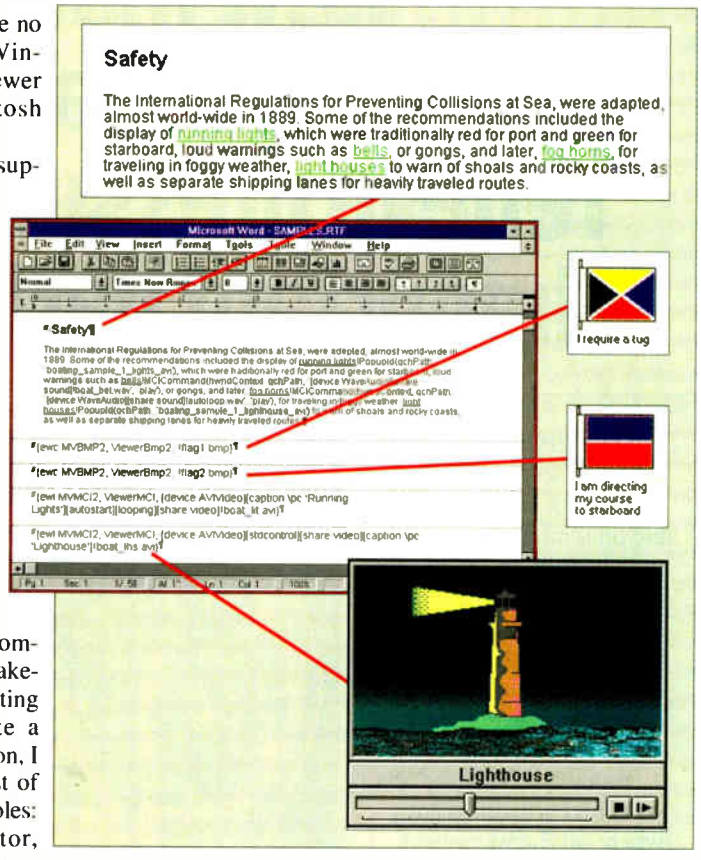
Reviews New Authoring Tools for Windows

Player. There are no royalties for Windows titles. Viewer has no Macintosh support.

Viewer also supports the Tandy VIS (Visual Information System) running Modular Windows, but at the cost of losing 20 percent of the hypertext and searching capabilities. There are no royalties on Tandy VIS titles.

The principal problems with Viewer are its complexity and its makeshift way of creating titles. To create a sample application, I had to run a host of separate executables: the Project Editor, the Hotspot Editor, Microsoft Word, the Topic Editor, a drawing program, and the Compiler. The resulting files included .RTF (containing the topics/text), .SHG (hypertext including art and hot spots), .MVP (project file that lists the files to be included in the presentation), and .EXE compiled results, along with the standard "baggage" files (.AVI videos, .WAV sound files, and .BMP/.TIF/.PCX graphics).



The Microsoft Word screen displays sample Viewer code. Clickable hot spots appear as underlined text in the resulting presentation. Multimedia links include sound, video, and embedded graphics. Notice the commands to place the flag bit maps and the MCI calls for playing sound and for displaying the lighthouse video.

For an inexpensive program that allows royalty-free distribution of Windows presentations, Viewer delivers some impressive features. On the other hand, for applications with even simple graphics, it is barely adequate. And plan on a steep learning curve.

Delivering the Goods

For text-oriented applications where databases of text are to be compiled and presented, consider Viewer. Nonprogrammers beware; it is very complex to work with. If you want integrated animation features but extensive text is not required, consider Authorware, because you can make icons that march across the screen and mesh them seamlessly with text, hot spots, and audio.

If you want both nifty graphics and lots of text, neither of these packages will satisfy you unless you program your own library functions and integrate them with the standard features. In preparing this review, I looked at other authoring tools, and each one seemed to have strong support for either graphics or text but not both. Let's hope that over the next year or so we'll see products that mesh strong text handling with terrific graphics and animation and fill a major hole in the market. ■

About the Product

Authorware Professional $4995
Macromedia, Inc.
600 Townsend St.
San Francisco, CA 94103
(415) 252-2000
fax: (415) 442-0190
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Microsoft Multimedia Viewer Publishing Toolkit 2.0 .....$495
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Harriett Hardman is director of product development for Multimedia Reality, a Silicon Valley multimedia consulting firm. She can be reached on BIX c/o "editors."

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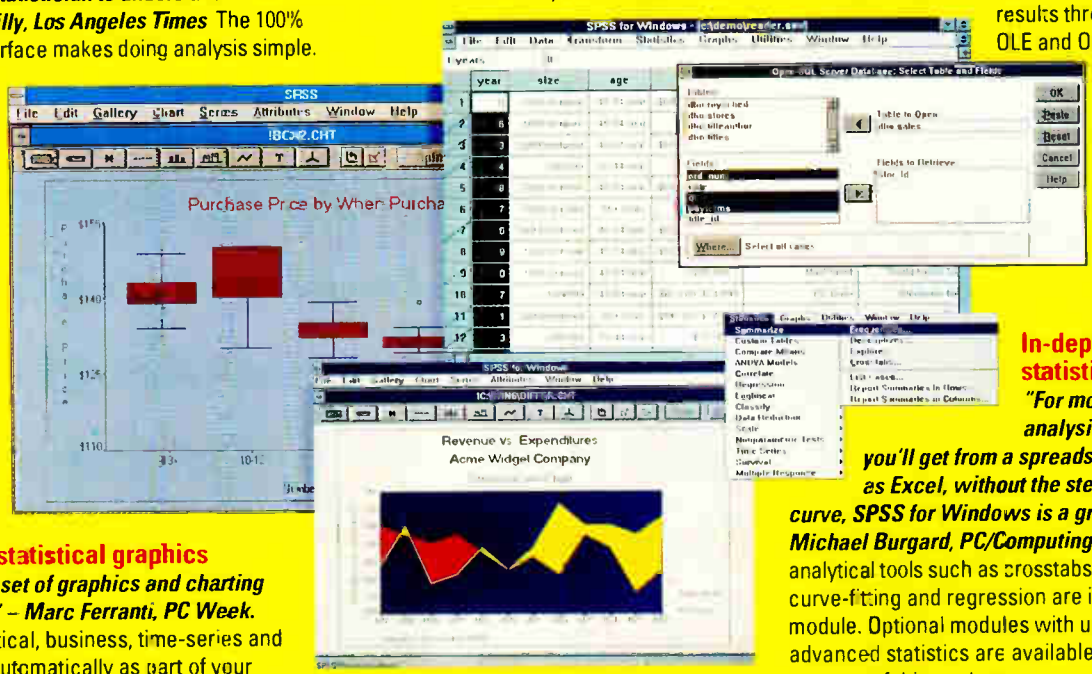

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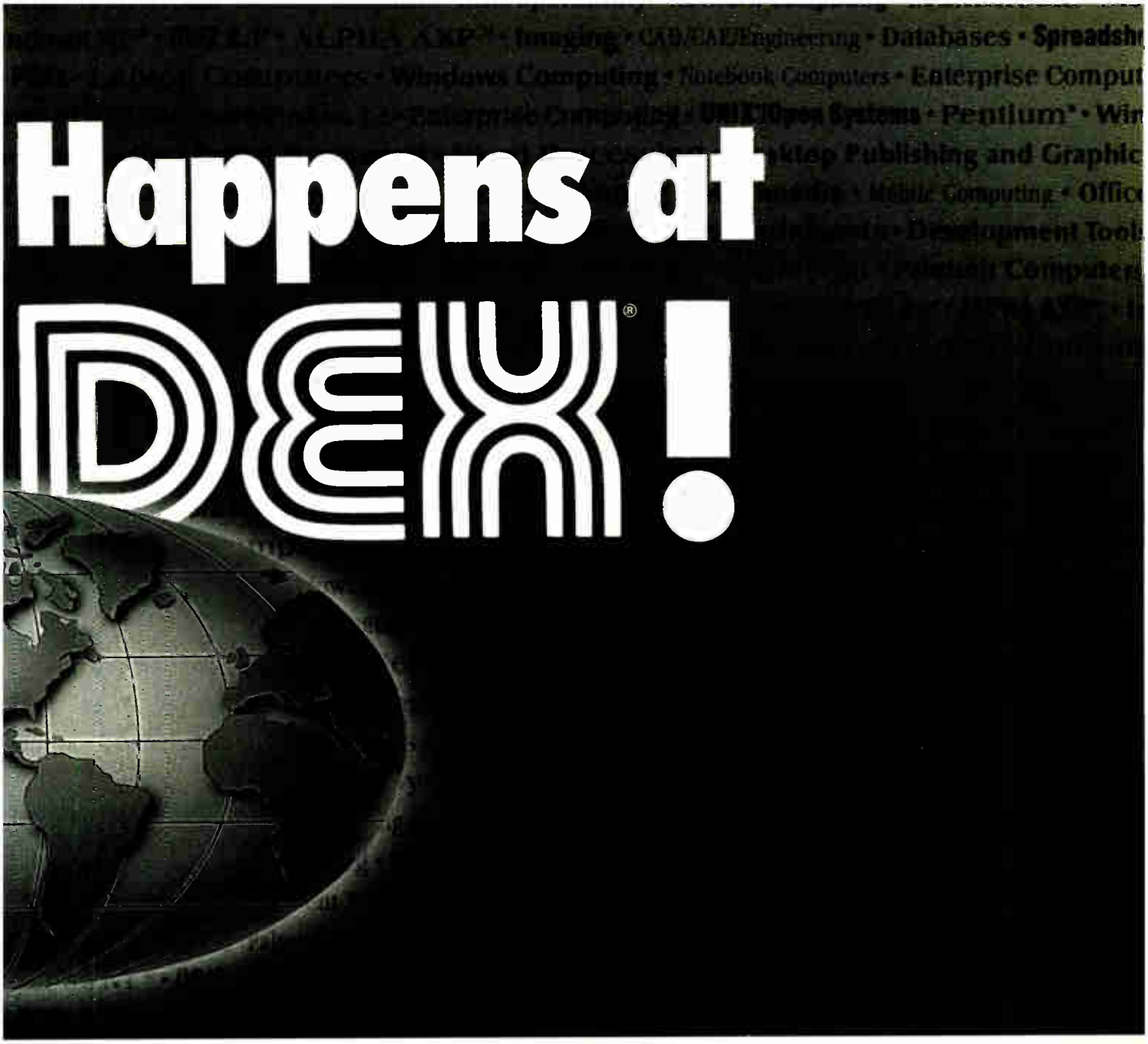

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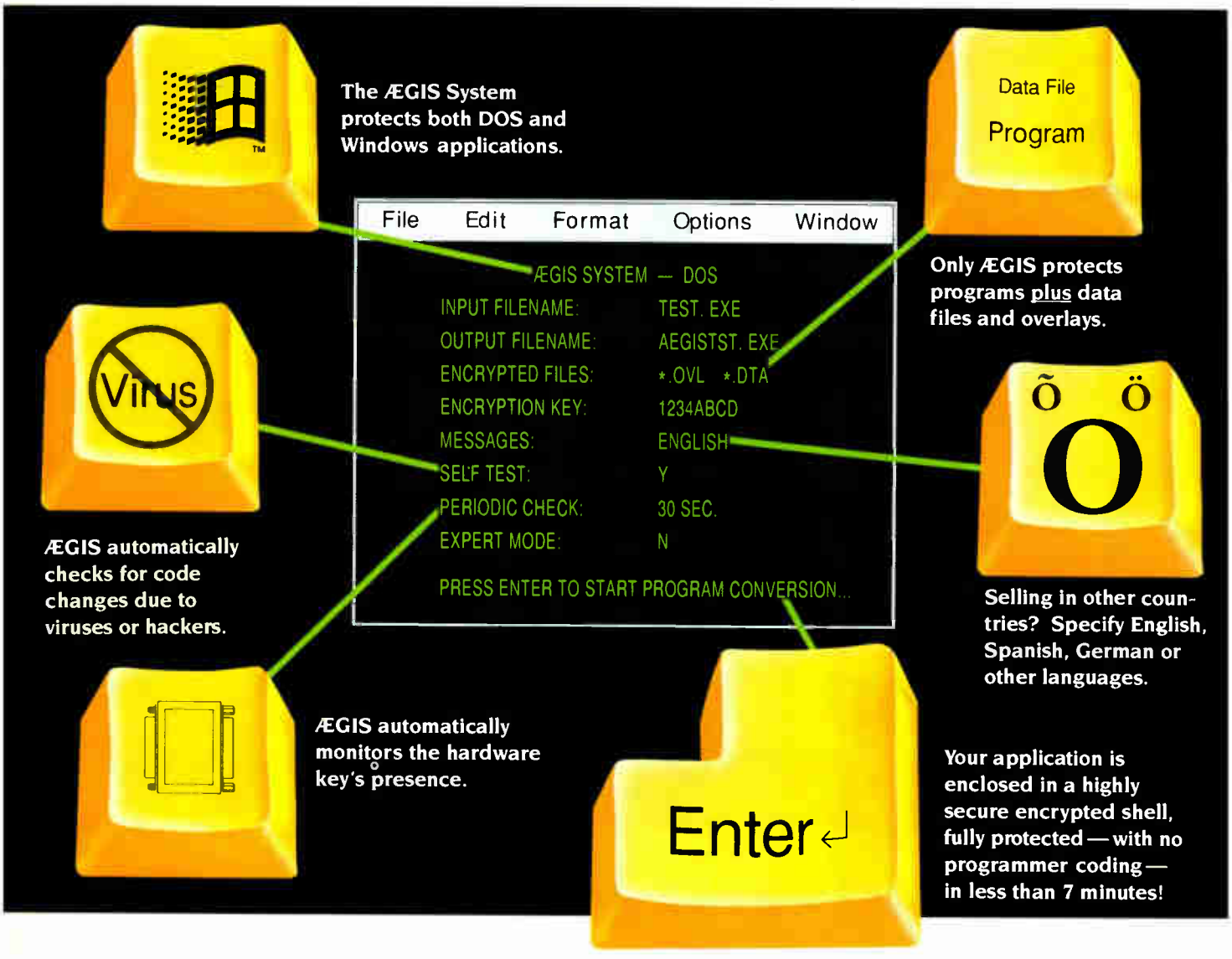

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Amstrad's Modest PDA

The PDA 600 Pen Pad offers only minimal PDA features, but it's inexpensive, light—and first

DICK POUNTAIN

One of today's hottest buzzwords is *PDA*, or Personal Digital Assistant—a pen-based, pocket-size machine to be sold as an electrical appliance like a toaster or a flashlight. Although most major PC manufacturers have announced PDAs, Amstrad's U.K.-designed, Chinese-manufactured PDA 600 Pen Pad is the first to actually ship.

Amstrad is aiming Pen Pad at the modest end of the price and feature range for PDAs, with a $450 price and a less ambitious design: It offers pen input with character recognition, but not the built-in fax communications, voice recording, or AI-based software that Apple and EO promise. Pen Pad merely replaces your pocket organizer, not your secretary. In a year, Pen Pad will look either very tame or very sensible, depending on how well Amstrad's competitors deliver on their promises.

Pen Pad was designed for Amstrad by the U.K.-based Eden Group, using new character-recognition algorithms licensed from Texas Instruments. It uses a wholly proprietary multiprocessor architecture based around three Z80-equivalent 8-bit microcontrollers. The three microcontrollers have separate roles: One handles normal processing tasks, one is dedicated to character recognition, and the third handles power management.

An Electronic Organizer

As a potential replacement for a pocket organizer, Pen Pad easily clears the first hurdle of portability. At 4.5 by 6.3 by 1 inch and 14 ounces, it's actually smaller than typical paper organizers, fitting easily into a jacket pocket. The makers claim 40 hours of operation from three AA alkaline cells, and I certainly didn't flatten the batteries during a week of heavy use; since the power-saving time-out can't be disabled, I couldn't deliberately run down the batteries to verify the claim. A button-size lithium cell provides secondary backup to maintain your data when the main batteries do go.

Pen Pad's smart gray case opens like a book to reveal an LCD screen, with 240- by 320-pixel resolution, surrounded by an opaque border printed to resemble the section dividers and binder rings of a Filofax. These pictures are active, and you can select them with the pen. Their permanence emphasizes that Pen Pad's functions (address book, diary, and so on) are fixed; this is an appliance, not a programmable, customizable device like a palmtop PC. It has no user-accessible operating-system level and no removable mass storage. Everything you enter into Pen Pad just gets stored in battery-backed RAM and persists until you delete it, with no files or explicit saving of data.

At the top of the case is a small, nonstandard serial connector via which you can exchange data with a PC, print to a serial printer, or connect a fax modem. A serial-to-Centronics cable for parallel printing is also in the works. (Neither the special cables nor the PC software were available in time for this review.)

Pen Pad comes with 128 KB of internal, nonvolatile memory, which is enough to store 300 to 500 addresses in ASCII (i.e., character-recognized) form or 25 to 50 pages of bit-mapped scribbles. On the bottom edge of the Pen Pad case is a single PCMCIA Type I slot that accepts memory-expansion cards with capacities of up to 2 MB, or around 5000 more addresses. Although you could potentially add applications through the PCMCIA slot, there aren't any available today. Amstrad plans language phrase books and city hotel guides, among other titles, on PCMCIA cards.

You interact with Pen Pad solely by pointing or writing with the pen, which is stowed in a groove in the back of the case. It's a passive pen, and you could substitute a toothpick or ballpoint pen in a pinch, although two spares are provided. You switch the machine on or off by pressing a

Touching the desk icon pops up a window containing 12 more icons that represent various utilities. The alarm clock function allows you to set up to 10 repeating or one-off alarms. The world clock function lets you enter the local times for five cities or time zones, but it doesn't contain a time zone database like the Psion Series 3. Also contained in the desk are the battery-check utility, the text search, repeated appointment and anniversary functions, and a communications program for connecting to a PC or printer.

The phone/address book looks just like its paper equivalent, displaying nine entries per page with alphabetic index tabs down the right margin. Touching any entry expands it to full-page size, making room for name, address, four phone numbers, and seven lines of notes. Pen Pad will also dial the phone numbers for you by emitting DTMF tones from its loudspeaker. Entries are automatically kept in sorted order, and although a simple text-search facility is available (under the desk icon), you'll mostly locate entries manually via the index tabs, as you would with a paper book.

In the diary section, you can switch between one-day-per-page and one-week-per-page views at a pen touch. The single-day view splits the screen horizontally, using the upper half for single-line appointments (character-recognized) and the lower half as a scribble pad for "digital ink" notes. The diary sorts appointments chronologically and warns if you enter a clashing time. You can set up repeating appointments by day of the month or by date. The anniversary function automatically gives a reminder ("don't forget") one week before. Pen Pad has most of the time management features you'd expect in a PC PIM (personal information manager) program, but it lacks a Year Planner view.

The to-do section is a simple list of one-line reminders, each with a completion date and a box to check once it's completed. This list is loosely integrated with the diary, but I was disappointed that only the message "to do" appears in the diary page rather than the item itself. Equally disappointing is the lack of a nag function; once the completion date is passed, you'll never be reminded again.

The notepad just allows you to scribble freehand diagrams onto a blank page. There's no character recognition or any drawing commands, but you will be able to upload your scribbles into Windows Paintbrush once PC software is available.

The information section consists of four pages, each holding nine pairs of slots. If you write, say, 20 into the slot labeled "mm," then 0.7674, the inches equivalent, appears in the corresponding slot marked "in." These converters are modeless and reversible, so writing into the inches slot gives you millimeters. Three pages are devoted to all the major weight, distance, area, and volume measures, while the fourth page holds blank slots to which you can attach your own labels and conversion factors (e.g., to do currency conversions). You can enter only single multiplicative factors, not complex expressions.

recessed button using the pen, or it will switch itself off after a few minutes of disuse. My only complaint about the Pen Pad hardware is the relatively poor contrast of the display under dim lighting, made worse by the thick and highly reflective digitizer film that covers it.

Pen Interface

The Pen Pad carries its pocket-organizer metaphor into the software. Touching one of the five section dividers with the pen switches the display to the corresponding section, or built-in application: address/phone book, diary, to-do list, notepad, and a unit-conversion utility. Each section is organized in pages, and you turn the page by touching the forward and backward icons above the screen. The seven icons printed across the top of the display activate frequently used utilities. The first adjusts screen contrast; the second creates a new blank page in the currently active section; the third is a pop-up calculator; the fourth, a desk icon, gives access to a dozen more Pen Pad utility functions. Touching the fifth icon, an eraser, causes the pen to delete the next object you touch. The last two icons are the tape recorder–style page-forward and -backward buttons.

All sections apart from the notepad accept handwritten input and convert it to ASCII text (the notepad just stores your scribbles as bit maps). You can delete whole pages from most Pen Pad sections by touching the binder rings down the spine, which causes the page to shrink to a half-size replica that you can throw away by dragging it off the screen area.

When you first switch on the Pen Pad, you have to perform three initialization routines. First you choose a language—from English, French, German, Spanish, or Italian—in which all further system messages will appear. Then you calibrate the pen digitizer by touching small targets at the corners of the screen. Finally, you train Pen Pad's character recognizer by writing the whole alphabet once—uppercase, lowercase, and numerals.

Pen Pad's character recognizer works by incremental retraining; whenever it misses a character you've written, you can instantly pop up a training window and enter four more samples. The recognition accuracy therefore steadily improves with use, at the cost of some inconvenience during the first few days. You can't save or restore recognition libraries outside the Pen Pad, so it is not easily shared with others; once trained to your handwriting, it literally becomes a personal computer.

After some retraining, Pen Pad's recognizer grew capable enough to recognize my handwriting with acceptable accuracy. However, I also needed to train myself to write in a deliberate, childlike manner. The recognizer takes about 1 second to interpret each character.

Pen Pad's recognizer works only on individual characters written into bounding boxes and cannot interpret cursive writing. To enter text onto a Pen Pad page, you touch the desired line with the pen, causing a 3 × 7 grid of boxes to pop up over the lower half of the screen. When all the characters are recognized correctly, you touch a button, the new line of text is

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Circle 158 on Inquiry Card: Call me, I'm interested

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transferred to the page, and the boxes disappear. Most of Pen Pad's applications accept only single lines of text (e.g., appointments and to-do items), but the address book displays a carriage-return button for multiline addresses.

The pen interface is simple compared to that of more ambitious systems like PenPoint, and Pen Pad uses no special gestures apart from the "throw away page" stroke. All you can do with the pen, depending on context, is select something, write a character in a box, make freehand scribbles, or delete something with the eraser. To edit a line of text, you touch it, whereupon it reappears in a grid of boxes.

You can edit only by overwriting characters, and I soon became frustrated by the lack of insert-and-push-right or cut-and-paste capabilities that computer users now take for granted. I also found the pen tedious for entering dates and times, since you must use thumbwheel controls that are too slowly geared; I was reminded of the buttons on those horrible digital wristwatches. Bear in mind that Pen Pad is meant primarily for casual, non-PC users who will not be entering huge volumes of text, and these gripes aside, I found the pen interface to be highly intuitive. There's little about the Pen Pad that a new user couldn't discover in 10 minutes of trial and error.

About the Product

PDA 600 Pen Pad..$450

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Good Enough

While the Pen Pad's character recognition is not perfect, it's good enough to make it useful as a personal organizer, especially for people who can't cope with the tiny keyboards of the Sharp Wizard, Psion Series 3, and their ilk. It's not yet good enough to replace a reporter's notepad for general note taking, but then neither is any other pen system I've tried.

It's hard to make judgments about success or failure in a PDA market that does not yet exist. However, the Pen Pad's small size, low price, and early-to-market status clearly stake out the requirements for a low-end PDA. Now it's up to more visible PDA designs like Apple's and EO's to add more sophistication. ■

Dick Pountain is a BYTE consulting editor based in London. You can reach him on BIX as "dickp."

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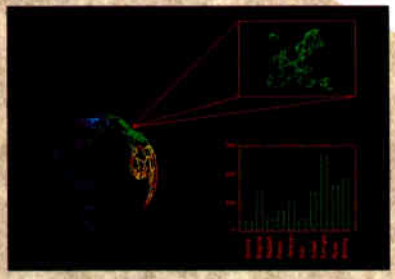

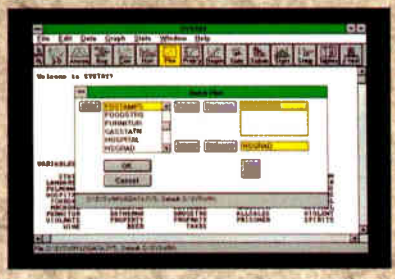

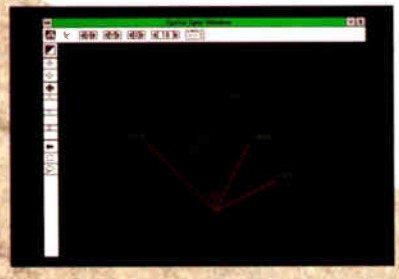

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WorkMan Needs Work

Reach's revolutionary work-flow platform and tools show promise, but the implementation will frustrate applications developers

JON UDELL

Computers and networks have yet to alter the basic currency of the modern office—it's still paper. That's nowhere more evident than at BYTE, where even today the passing of a manila folder heralds the progress of a manuscript through the editorial and production pipelines.

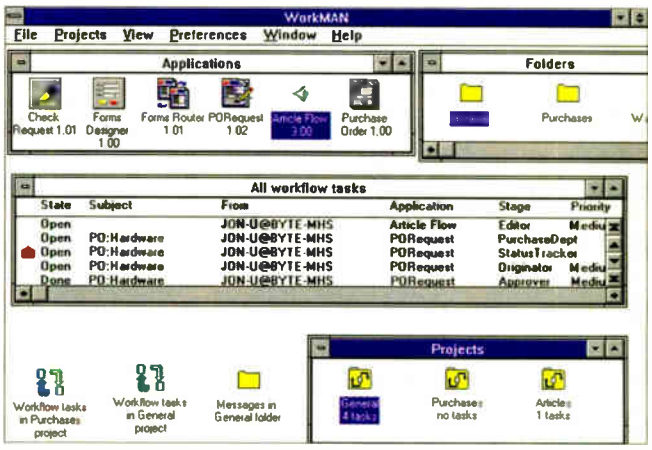
Why paper? The folder's path represents a complex and ever-changing work flow. Reach Software's WorkMan, one of the first of a new breed of tools for building E-mail-enabled software, uniquely and boldly tackles the thorny issue of modeling and automating that flow. Although brilliant in conception, Reach's initial effort is unfortunately buggy and immature. That's disappointing, because the problem that WorkMan attacks is monumental, and no one's closer to a solution than Reach.

WorkMan includes basic E-mail, and like Reach's dedicated E-mail product, MailMan, it runs over two E-mail transports: Banyan's Vines and Novell's MHS (Message Handling System). But interpersonal E-mail is a secondary feature. WorkMan's real mission is to consummate the marriage between Windows and the formal processes of business communication: purchase orders, expense reports, and, more important, the process (in BYTE's case, the production of articles like this one) that defines your business.

Reach shipped me two separate kits: WorkMan Platform and WorkMan Tools. WorkMan Platform hosts work-flow applications built using WorkMan Tools. I tested WorkMan Platform using Novell's MHS 1.5 and Global MHS 2.0. After a frustrating day, I discovered that WorkMan wouldn't cooperate with the NetWare support in Windows for Workgroups (Reach later confirmed that it doesn't certify that configuration), so I switched to a vanilla DOS/Windows 3.1/NetWare setup. That worked. Then I launched the WorkMan desktop and installed the sample applications provided with WorkMan Platform.

All Aboard the Platform

One of the sample applications implements a purchase-order requisition. When you launch the application, WorkMan casts you in the role of initiator and presents a form that you use to request items and quantities from a list of preferred vendors. If Microsoft Excel is available, the work-flow application launches it and extracts the vendor and item information from a spreadsheet using DDE. Once you've completed your wish list, you press the Send button to transmit the request to the person cast in the next role in the work flow—the approver.



The WorkMan desktop organizes work-flow tasks by project and interpersonal E-mail messages by folder. In addition, you can link interpersonal messages to work-flow tasks.

A WorkMan administrator can use a tool called the role manager to map MHS (or Vines) user names to work-flow roles. Alternatively, the programmer can let the user assign the next role at run time, which is handy for testing. Unfortunately, you can't launch WorkMan using an E-mail identity that differs from the user's network identity. (WorkMan, not MHS, imposes this limitation.) Logging out and in again isn't practical in a Windows/NetWare environment, so to wear the multiple hats needed to test or demonstrate a WorkMan application on a single machine, you have to assign all roles to yourself. This works, but it's distracting when you can't see how the application actually appears to each user.

The WorkMan desktop stores interpersonal E-mail in *folders* and work-flow tasks in *projects*. You can create and reorganize both styles of container, but you must do so manually. Although the desktop invited me to create a project for tasks related to the purchase-order application, I couldn't associate the application with that project. All work-flow tasks, regardless of the application that generates them, accumulate in the "general" project until you move them elsewhere. You can also link interpersonal E-mail messages to work-flow tasks, but again, only by manual intervention. Here, too, the desktop led me to an expectation—that interpersonal E-mail messages sent within the context of an active task would link to the task—and then frustrated it.

As the purchase-order form progresses through the stages of work flow, the application enables or disables the fields appropriate to each role. Only the initiator can compile the purchase list by picking vendors and items from drop-downs; only the approver can operate the approve/reject radio buttons; and only the purchase officer can assign a purchase-order number and print the document. The programmer specifies field availability for each role at each stage using an interactive tool that sets fields to be active, read-only, or hidden.

A task represents the users' view of an instance of work flow and begins its life in a state called "new." The state of the task changes as it moves along the chain. For example, when you transmit a purchase-order request to the approver, its state changes to open—from your point of view. From the approver's point of view, the same request appears as a new task that becomes an open task if the approver rubber-stamps the request and sends it to the purchasing officer. That person can assign a purchase-order number to the request and print it. The application uses DDE to launch Microsoft Word and pump the form's data into a Word document. Then it silently relays messages (via E-mail) to all participating instances of the WorkMan platform; the messages toggle

groups of radio buttons to represent a mul-

Circle 97 on Inquiry Card.

Reviews WorkMan Needs Work

which you construct the diagram. To put flesh on the skeleton, you launch another tool that defines states associated with each stage and events associated with state transitions. Each stage has a default initial state. For the technical editor's stage, I added a second state called "InProcess" and an event that connected the initial state to that one. Attributes of an event include an associated message type and link name. By specifying type "Send" and link name "Draft-to-tech-editor," I laid the groundwork necessary for WorkMan to transmit this application's form from an author to a technical editor.

Up to this point, I'd been flying blind. While the documentation for WorkMan Tools goes to great lengths to describe the fairly obvious process of building a form, it's virtually mute on the esoteric technique used to describe a work flow. So I wasn't too surprised when I ran the application and found that it generated no message traffic.

To animate the work flow, you have to write a line of code somewhere (in one of WorkMan's predefined system-event handlers or in user code that you attach to some form object) that toggles an implicit script variable whose name corresponds to the diagram link. This most fundamental aspect of WorkMan programming isn't documented, and I would not have discovered it without calling Reach technical support.

Reach maintains that WorkMan Tools isn't yet an end-user product, and the company doesn't expect people to develop WorkMan applications without first attending a four-day training seminar that's typically bundled with the purchase of WorkMan Tools. That's hard for me to swallow. I don't know any PC development package that requires on-site training to allow a programmer to produce the equivalent of "Hello, world." Training should be an option for advanced developers, not a basic requirement. Reach simply hasn't engineered or documented WorkMan Tools well enough so that a competent programmer can get even minimal results without extensive hand-holding.

The Slippery Slope

Worse, WorkMan Tools is just plain buggy. Once I discovered the secret to animating work flow, I saved my application, ran it, and verified that it would advance the work flow from the first stage to the second. I then added more stages, states, and events and tried again. WorkMan threw a GP (General Protection) fault, and Windows died a horrible death. Why? Another call to Reach revealed that once you modify a work flow, you are supposed to save it under a new name; otherwise, you are guaranteed to corrupt the application. That the company shipped WorkMan Tools with this known problem (a beta tester I spoke with confirmed he had reported it) and expected customers to attend a training seminar to learn the workaround for it astonishes me.

There were other problems. When you save an application, WorkMan Tools asks you if you want to save a backup of USERFUNC.SCR. Should you? It hardly matters. Choosing yes or no leads to the same result: The backup occurs. Even after I learned to rename each iteration of my application, WorkMan Tools remained wildly unstable. Btrieve errors, WorkMan errors, and Windows GP faults conspired to prevent me from working more than 15 minutes at a stretch.

Right Thing, Wrong Way

WorkMan's problems aren't insurmountable, but they're not superficial, either. I'm convinced that Reach's declarative model for work-flow programming is the right one. Building work-flow software procedurally, which is possible with Notes, BeyondMail, or even Visual Basic and MAPI (Messaging API), looks like a nonstarter to me. I simply don't think I could code and test the necessary state-transition logic fast enough to keep up with BYTE's ever-evolving work flow. But WorkMan's diagram-driven automation of messages is a fundamentally superior approach.

Users will reap the tremendous potential benefits of WorkMan only insofar as developers are willing to tolerate a painfully raw set of tools. For some developers, the gain may outweigh the pain, but for most people, I recommend waiting for a hopefully much-improved version 2. ■

About the Product

WorkMan Platform $2495

WorkMan Tools $995

Developer Starter Bundle $4995
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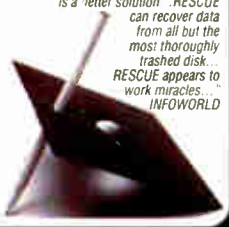

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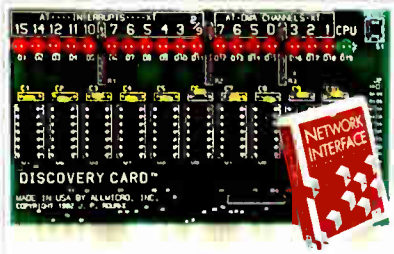

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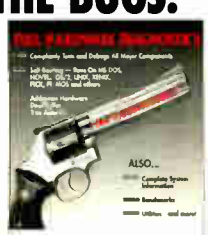

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HANDS-ON TESTING

NETWORK CONNECTIONS:

We test 16-bit and 8-bit PC Ethernet interfaces to find the best cards for large and small networks

RICHARD FOX AND STEPHEN PLATT

If you are designing an Ethernet-based LAN or adding new systems to an existing Ethernet network, read on. We tested 100 16-bit and 8-bit Ethernet NICs (network interface cards) for ISA-bus systems and found the cards are getting smaller, less expensive, and easier to use than NICs introduced even a year ago.

What's more, performance was solid throughout the market: For example, the slowest 16-bit card we tested (Intellicom's Ether Plus-16 C) was only 10 percent slower than the fastest card (the 3Com EtherLink III). In real-world terms, this means that a 120-KB spreadsheet file that takes 10 seconds to load off a network using the EtherLink III takes a negligible 1 second longer to load with the Ether Plus-16 C.

Our tests focused on cards that support Ethernet, because this is the most popular networking scheme. Similarly, ISA remains the dominant bus architecture for PCs. Most computers sold today use a 16-bit bus, with perhaps one or two 8-bit slots. Even for most older computers, many 16-bit cards will operate in an 8-bit slot. So, we examined both 16-bit and 8-bit adapters and compared their performance, features, and usability.

We rated the best Ethernet NICs based on how networks are designed and used. For example, we identify the best 16- and 8-bit cards for workgroups, large networks, and transaction-based networks. We also choose the best low-cost NIC for each application. In each case, we also identify runners-up that performed nearly as well as the leaders.

The 3Com EtherLink III won 14 of the 18 tests. It was the best overall performer in the workgroup, network, and transaction-processing categories. The EtherLink III uses a proprietary controller. All the six closest competitors use an AMD controller. Other NICs using the AMD chip set were the Allied AT-1700BT, Ansel NS 2100-3, Boca Research 10Base T Ethernet, Kingston KNE2121 and KNE2100-T, and Transition Engineering TNIC-1500T. All these boards, except for the Allied, finished among the top 20 performers.

The leading cards also differentiated themselves by their ease of use. The most usable cards were truly plug-

How to use this guide

To find the best NIC for your needs, follow the main headings until you come to the application category that most closely matches yours. Then look to the summary charts (like the example below) to find our choices for best overall, best 8-bit, and best low-cost NIC. We selected cards by choosing the ones with the best mix of performance, features, and price for workgroups, large networks, and transaction processing.

The top NIC in each group. We point out the qualities that made us choose this NIC as the best for this application.

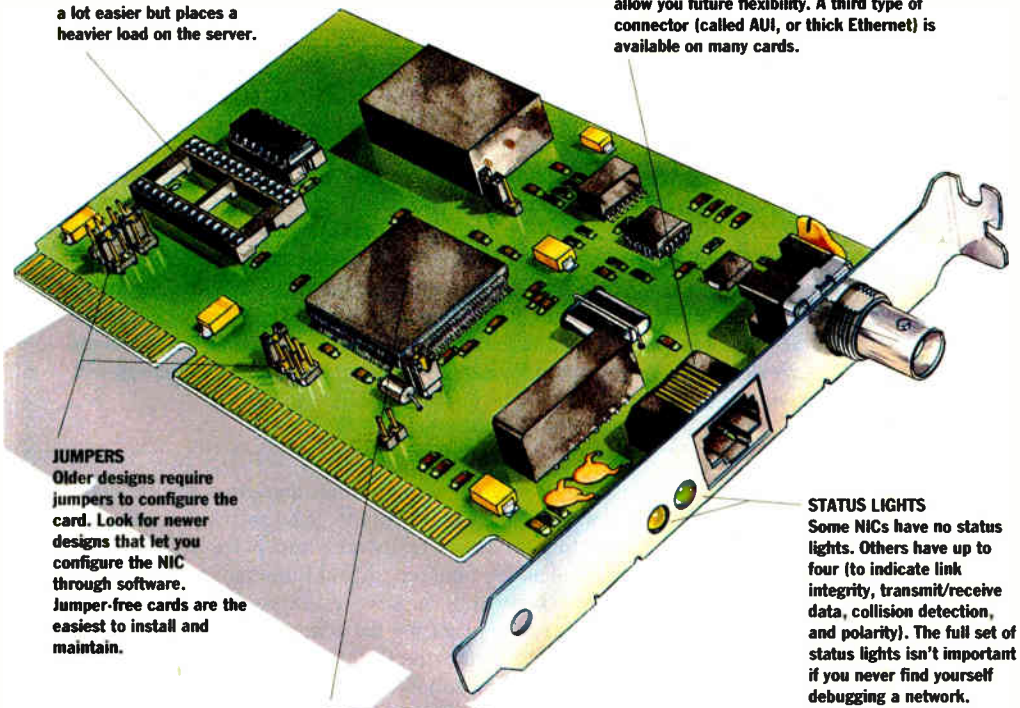
Summary boxes detail the best NIC for each application category. In addition to the top NIC, each summary box gives vital statistics for outstanding runners-up.

The deciding factors for this category. Transactions-per-minute numbers change from application to application because they are calculated based on the tests most appropriate for each category. For example, the tpm score in the workgroup category is based on spreadsheet, word processing, and mail tests run with no background traffic.

These NICs let you set I/O addresses and IRQs without using hardware jumpers—a time-savings benefit.

100 ETHERNET CARDS

What to Look For in a NIC



BOOT ROM SOCKET
With a boot ROM, you can boot a diskless DOS workstation from a network. Keeping DOS and all your software on the network makes software maintenance a lot easier but places a heavier load on the server.

RJ-11 AND BNC JACKS
Most networks use either UTP (unshielded twisted-pair) or coaxial (thin Ethernet) cabling. These cabling schemes can be mixed, since most UTP hubs have a coaxial connection. Buying a NIC with both RJ-11 and BNC connectors will allow you future flexibility. A third type of connector (called AUI, or thick Ethernet) is available on many cards.

JUMPERS
Older designs require jumpers to configure the card. Look for newer designs that let you configure the NIC through software. Jumper-free cards are the easiest to install and maintain.

STATUS LIGHTS
Some NICs have no status lights. Others have up to four (to indicate link integrity, transmit/receive data, collision detection, and polarity). The full set of status lights isn't important if you never find yourself debugging a network. However, if you are in charge of keeping a network running, these lights provide essential information.

CENTRAL PROCESSOR
Most newer cards will use a single-chip NIC processor, which is a cleaner design. We noticed no performance differences between one-chip NICs and older, more complex designs.

and-play: Intel's Ether Express Flash C, for example, comes with a program that automatically configures the card, finds a NetWare server, and downloads drivers from the server. At the other end of the spectrum were cards like the CNet CN650E+, which came with a one-page manual and no drivers or diagnostics.

Prices for our test samples ranged from $56 (for the Lantech Technology PTC-1001SCT) to $449 (for the Cabletron Systems E2112). Although most NICs still sell for over $100, we expect that, with the growth of network installations and production efficiencies, average NIC prices could continue to drop through the rest of the year. As for today's offerings, most of the NICs that are good enough for us to recommend are in the $150-to-$200 range.

AUGUST 1993 BYTE BEST NETWORK INTERFACE CARDS

BEST

WORKGROUPS

3Com EtherLink III

Ranking first in 14 of our 18 performance tests, the EtherLink III was the overall highest-performing NIC we tested. Its performance was especially impressive in our tests for workgroup applications: It achieved the highest scores in five out of six workgroup tests.

However, the card distinguishes itself by more than just raw speed. It comes with a configuration program that automatically detects the best I/O ports and IRQ settings to use and lets you make adjustments through software rather than jumpers.

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LARGE NETWORKS

Alta Research EtherCombo 16 T/C

The EtherCombo 16 T/C benefits large networks through its fast performance and the flexibility it gains from running in either 16-bit or 8-bit buses. This flexibility lets you use the EtherCombo to connect XT-class computers to your network and continue to use it after you've upgraded to faster 16-bit-bus machines. The card can also emulate Novell/Eagle NE2000 or Western Digital/SMC EtherCard adapters. Administrators can quickly install the card using its software-based configuration program.

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TRANSACTION-BASED NETWORKS

Alta Research EtherCombo 16 T/C

Although the EtherCombo ranked near the top in performance for transaction-based networks, other cards beat it for raw performance in this category. What makes the EtherCombo an overall winner is its diagnostic package, which can help administrators quickly find and fix problems by performing diagnostics such as dynamic packet analysis and viewing network transmissions.

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NICS FOR WORKGROUPS

Performance is the most important criterion for workgroups ranging from two to a dozen people, and it accounted for half of our overall evaluation. We combined the application tests (spreadsheet, word processor, and DOS- and Windows-based E-mail) in a lightly loaded network to calculate a workgroup performance score.

The 3Com EtherLink III, which sells for $199, outperformed the rest of the pack by achieving the highest number of transactions per minute on five of the six workgroup tests. The $149 Kingston KNE2102 produced the best results for the sixth test: the Windows-based cc:Mail small-message (2 KB) test. It recorded a score of 51.7 tpm, versus the EtherLink III's 47.3 tpm. The actual performance difference between the EtherLink III's winning 27.6 tpm and the 25.4 tpm achieved by the slowest workgroup runner-up, the Alta Research EtherCombo 16 T/C, is negligible.

The Puredata PDI 8023Plus-16 ranked close behind the EtherLink III in our overall ranking but fell short with a 6.5 percent slower performance and a shorter warranty for a higher $230 price. For $199, the Intel Ether Express Flash C turned in the best ease-of-use score (thanks in part to its bundle of network administrator utilities) but provided marginally worse performance and only a three-year warranty (versus a lifetime warranty for the EtherLink III). The Compex ENET16-P/Combo and the Alta EtherCombo 16 T/C provide performance and usability that are not quite up to the EtherLink III's caliber. However, they are reasonable alternatives with prices of $139 and $149, respectively.

It's unlikely that a full-time network administrator or IS manager would oversee a small workgroup, so it should be easy for you to configure the cards, install drivers, and set up and maintain such a network. Thus, ease-of-use scores accounted for a quarter of our total workgroup evaluation.

Software utilities for adjusting settings such as the base I/O address, IRQ (interrupt request) setting, DMA channel, and RAM address greatly simplify the configuration process by eliminating the need for tedious jumpers and DIP switches. Moreover, software utilities allow you to quickly make modifications without opening up a workstation. As a result, we judged the availability of a software-configuration program as the single most important item for ease of use.

With one exception, all the ranked boards in the best-overall category included software configuration. The exception, the Compex ENET16-P/Combo, used software for the common settings and used hardware jumpers for less-often-used items such as segment length and Ethernet version. Overall, 32 of the 100 network cards we tested provided software as the only means of configuring the adapter. The "Software-Configurable?" column in the Roll Call (see page 188) identifies those adapters that supply a setup utility.

Little more than half of the software-configurable adapters in this review provided an additional program that automatically detects the best IRQ and I/O settings (among others) for various host computers. Without these programs, you need advanced technical knowledge, time, and patience to track down IRQ- or I/O-address conflicts. Of the NICs ranked for use with workgroups, only the Racal InterLan NI 6510-10BT did not offer an automatic configuration option. To see which NICs support automatic configuration, see the "Automatic Configuration Option?" column in the Roll Call.

We rated the Intel Ether Express Flash C as excellent for workgroup ease of use, thanks to an especially helpful set of utilities that solve many configuration headaches. For example, the card's FlashStart program, which is stored in a flash-memory chip, can automatically configure the adapter and download the necessary drivers from the file server without any user intervention.

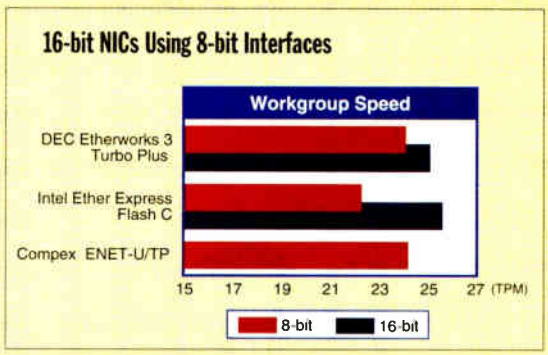
A second utility, called FLDRVCHK, requires the network

ARE DUAL 16-/8-BIT CARDS WORTH THE PRICE?

Half of the 77 16-bit NICs we tested could also function in 8-bit slots. These cards can work equally well in AT-class computers, in either 8- or 16-bit slots, and in older 8-bit XT-class systems.

A 16-bit NIC runs at only a fraction of its speed potential when placed in an 8-bit slot (see the figure). Memory and I/O operations are restricted by the smaller bus width, so getting data to and from the card takes longer. You will also lose many of your interrupt choices in the 8-bit slot. You are restricted to interrupts 2, 3, 4, and 5, and in a heavily loaded system, these may be used by other devices. Many motherboard designs will not allow a 16-bit card to be placed in an 8-bit slot.

Cards designed specifically for 8-bit operation may be faster and less expensive than dual-speed cards. For example, the $79 Compex ENET-U/TP was faster than both the Intel Ether Express Flash C and the Digital Etherworks 3 Turbo Plus. However, if you are planning a system upgrade, a 16-/8-bit adapter protects your investment and provides a performance gain if you go from an XT to an AT.



Eight-bit NICs are faster at 8-bit operations than dual 8- and 16-bit cards.

administrator to update drivers centrally on the file server just once; each workstation then receives updated drivers upon log-in. A third utility, called FLSCAN, eliminates the need to open up a workstation to survey its contents, because it automatically detects and records hardware and software information such as bus architecture, RAM size, and hard drive information. Finally, there is no need to purchase and install separate boot ROMs for Novell NetWare or Microsoft LAN Manager diskless workstations, since the flash-memory chip on the adapter comes preinstalled with boot programs for them.

The Alta Research EtherCombo 16 T/C came with a unique software utility that enables you to view received packets on the fly. It displays each packet's contents, including source address, destination address, and length. This is a handy tool when troubleshooting network problems, especially in a workgroup situation where commercial network analyzers are not a common resource.

Other factors that are important for workgroup ease of use include the quality and comprehensiveness of the user's manuals and whether the vendor provides crucial driver information, such as how to generate a Novell-style IPX driver.

All the winners and runners-up had above-average to excellent documentation. However, this was not the case with all the adapters we reviewed. Several, like the $106 Network Interface EtherPro III and the $199 CNet CN650E+, come with a manual consisting of only a single sheet of paper containing very little information.

Features made up the final quarter of our evaluation score. We judged NICs according to the length of their warranty, whether they included drivers for several different network operating systems, and whether they came with diagnostics software to aid in troubleshooting.

BYTE BEST — WORKGROUPS

Need high speed and easy configuration?

BEST OVERALL — **3Com EtherLink III**

This $199 NIC was the clear performance leader in this category: It turned in the best scores for our workgroup tests. (Overall, the EtherLink III ranked first in 14 of our 18 performance tests for all applications.) This 16-bit network adapter also makes installation and configuration a snap with a software-driven setup program that will have most users attached to a network in a matter of minutes. The manual stood out for its clarity and comprehensiveness: It's full of clear illustrations and screen snapshots and has an appendix of error messages and a helpful glossary. 3Com also provides a lifetime warranty for the EtherLink III.

		PRICE	WORKGROUP SPEED (TPM)	EASE-OF-USE RATING	SOFTWARE-CONFIGURABLE?	AUTOMATIC CONFIGURATION OPTION?	WARRANTY LENGTH (YEARS)	BUS WIDTH (BITS)
BEST	3Com EtherLink III	$199	27.6	Excellent	Yes	Yes	Lifetime	16
RUNNER-UP	Puredata PDI 8023Plus-16	$230	25.8	Excellent	Yes	No	5	16
RUNNER-UP	Intel Ether Express Flash C	$199	25.6	Excellent	Yes	Yes	3	8/16
RUNNER-UP	Compex ENET16-P/Combo	$139	26.1	Good	Partially	Yes	5	8/16
RUNNER-UP	Alta Research EtherCombo 16 T/C	$149	25.4	Good	Yes	Yes	Lifetime	8/16
RUNNER-UP	Racal InterLan NI 6510-10BT	$239	26.5	Good	No	No	Lifetime	16

Need an 8-bit NIC with 16-bit performance?

8-BIT — **Standard Microsystems Ethercard Plus Elite 10T**

The Elite 10T's 24.4-tpm score, which was the second-best workgroup performance score for 8-bit adapters, is comparable to that of several 16-bit adapters we tested. The $179 Elite 10T is one of the few 8-bit NICs we saw that can be configured partially by software, which greatly simplifies installation by avoiding the tedious process of setting hardware jumpers. A diagnostic utility and drivers for many different network operating systems come bundled with the card. Standard Microsystems also provides a five-year warranty and an informative, easy-to-use manual.

		PRICE	WORKGROUP SPEED (TPM)	EASE-OF-USE RATING	SOFTWARE-CONFIGURABLE?	AUTOMATIC CONFIGURATION OPTION?	WARRANTY LENGTH (YEARS)
BEST	SMC Ethercard Plus Elite 10T	$179	24.4	Fair	Partially	No	5
RUNNER-UP	Racal InterLan NI 5210-10BT	$179	22.9	Fair	No	No	Lifetime
RUNNER-UP	AT&T/NCR StarLAN 10 LanPacer NAU	$299	23.9	Fair	Partially	No	3
RUNNER-UP	Cabletron Systems E1112	$349	23.8	Fair	Yes	No	1

Are you cost-conscious?

LOW-COST — **Hewlett-Packard HP J2405A**

In addition to its low list price of $119, this NIC received a composite workgroup performance score of 26.7 tpm, which placed it in the top five for overall workgroup speed. This NIC is flexible enough to support both 8-bit and 16-bit ISA slots. Its intuitive configuration program automatically detects the best settings, so hardware conflicts like IRQ settings don't have to be a worry. The documentation was one of the few that provided extensive, step-by-step troubleshooting information as well as a comprehensive listing of error messages, their meaning, and the appropriate actions to correct specific situations. The HP J2405A comes with a lifetime warranty.

		PRICE	WORKGROUP SPEED (TPM)	EASE-OF-USE RATING	SOFTWARE-CONFIGURABLE?	AUTOMATIC CONFIGURATION OPTION?	WARRANTY LENGTH (YEARS)	BUS WIDTH (BITS)
BEST	Hewlett-Packard HP J2405A	$119	26.7	Fair	Yes	Yes	Lifetime	16
RUNNER-UP	Allied Telesis AT-1500BT	$100	26.4	Fair	Yes	Yes	Lifetime	16
RUNNER-UP	Allied Telesis AT-1700BT	$100	25.6	Good	Yes	Yes	Lifetime	16
RUNNER-UP	Audio Video Computer NW 2000	$88	25.4	Fair	Yes	No	5	8/16

How We Tested

The NICs that we tested were 8-bit and 16-bit ISA Ethernet adapters that directly supported Novell NetWare 386 version 3.11. (Many of these adapters also supported Windows for Workgroups, Microsoft LAN Manager, TCP/IP and NFS [Network File System], and other operating environments.)

We tested the NICs for use as workstation nodes. Because file servers need to transfer data very quickly between their hard disks and the network, a server will normally be a Micro Channel– or EISA-bus-based machine. Clients spend more of their time executing client tasks such as word processing, CAD, and database analysis. They do not have as great a need for high-speed disk/network throughput. PCs based on the ISA bus are ideal for use as clients.

Our NIC test suite consisted of 18 data transfer tests simulating a variety of network-usage patterns and network-load conditions. We ran each of these tests repeatedly to ensure accuracy. Additionally, we examined the NIC, its drivers, and its documentation to obtain scores for features and ease of use.

PERFORMANCE

Our client workstation was a Compaq Deskpro 4/66i with 8 MB of memory; our server was a Compaq Deskpro 66M with 24 MB of memory. The server contained a NetFlex controller, an EISA bus-mastering NIC from Compaq. The NetFlex and the server's memory created a huge buffer, which minimized the server's effect on client/server performance.

All tests were designed to minimize disk usage on the server, since extensive disk accessing could lower throughput and mask performance of the test network card. We designed our test-bed with the fastest computers and server NIC we could find, and we used large amounts of memory on the client and server to virtually eliminate hard disk access during our tests. This meant that any performance bottlenecks that arose during testing would be attributable to the client NIC.

Our performance evaluations used nine tests to simulate six different applications. Five of these tests were Microsoft Windows–based: spreadsheet, word processing, database, and two mail tests. Two additional mail tests, as well as two transactions tests, ran under MS-DOS.

Each test is representative of the network load created by actual applications. We ran the test suite once on a dedicated network consisting only of the server and the client. We then repeated the set of tests after simulating the effects of multiple workstations using the network simultaneously. To do this, we set up a traffic generator to send data packets across the network. We sent enough packets to use 25 percent of the network's bandwidth (approximately 2.5 Mbps).

The first test gives performance figures you would expect for a small workgroup with a light network load. The second test represents a heavily loaded network with several servers. However, to avoid turning this test into a server test, we assumed that all other traffic was directed at other servers, and the server used by the test NIC was able to handle information requests without delay. We repeatedly sent packets to a nonexistent destination on the network. Thus, each network adapter had to check the destination address on each of these packets before discarding them.

The spreadsheet, word processing, database, and mail tests are transaction-based tests. These are high-level transactions; a typical transaction might be "open, read, and write a spreadsheet," or "send a mail message with an attached file." Each test ran for a set period of time, and our automated tests recorded the number of transactions performed. We averaged the results of multiple runs of each test and then computed a composite score of transactions per minute.

We created the spreadsheet test by replicating the file-system access of Microsoft Excel 4.0. We re-created each call (including the file, location in the file, and size of the operation) in detail for the reading and writing of small (20-KB) and large (100-KB) spreadsheets. This test shows how a NIC operates under typical spreadsheet usage.

Testing team (left to right): Siva Kumar, Steve Platt, Rich Fox, and Alan Joch.

We created the word processing test in a similar fashion by replicating file-system operations of WordPerfect for Windows 5.1. Both Excel and WordPerfect read and write their files in 2-KB pieces. However, the order of the reading, as well as each program's technique for handling file-header information, differ greatly.

We also ran two tests using cc:Mail for Windows. Each is an actual cc:Mail application—sending a message with an attached file to a specified user. One test uses a small representative text file attached to the message, while the other uses a larger spreadsheet attached to the message.

The last Windows test is an actual small-scale database application written by NSTL. It reads and writes an indexed database, displaying as needed selected information from the records. We designed the database system to stress the NIC in ways similar to those in which commercial database packages would stress it. This allowed us to see how the NIC functions in a database-intensive environment.

We ran two different transaction-based tests in a pure DOS environment. The tests gauged each NIC's ability to process high-volume transmissions of small packets. These tests create conditions that are comparable to those of many different transaction-based systems, such as computerized cash registers, banking systems, and computerized factories. They also show how well the NIC and its driver operate with frequent small transmissions.

The final two tests were DOS cc:Mail tests. These two tests are similar to the

How We Tested *(continued)*

Windows cc:Mail tests and serve to confirm how well the NIC operates in a DOS environment when manipulating larger files. They are actual cc:Mail applications, and they send small messages with small or large attached files to a specified user.

We categorized each test into one of our three basic application groups—workgroup, large-network, and transaction-based network. The workgroup test score, calculated in transactions per minute, is a composite figure of the word processing, spreadsheet, and mail tests with no background load. The same tests, operating with the 25 percent background traffic, were averaged to produce the large-network performance measurement. All remaining tests, both with and without background traffic, were averaged to produce the transaction-based network transactions-per-minute score.

Note that the transaction-based network score is based on different tests than the other two application groups. Each transaction is much smaller in the transaction-based network suite (e.g., a single record consisting of 128 to 1024 bytes in the transaction-based network tests, versus reading and writing a 100-KB spreadsheet in the workgroup suite), so many more transactions can be completed each minute than in the workgroup and large-network tests. This is why the transaction-based network transactions-per-minute values are much higher for each card.

KEY NIC FEATURES

We chose several features that we considered essential for Ethernet network adapters for all three of the application categories. These features are listed below.

Boot ROM support	We expected each vendor to support boot ROMs (which allow diskless workstations to attach to a network) for at least two different network operating systems (from among Novell NetWare, Microsoft LAN Manager, Banyan Vines, and Unix).
Diagnostic software	This is a valuable tool when resolving adapter-installation and network difficulties.
IRQ settings	We gave full credit to 8-bit adapters that supported more than four different IRQs (interrupt-request lines that are used to notify the system's CPU that the hardware requires CPU time) and 16-bit adapters that could use eight or more unique IRQs. It's easier to avoid IRQ conflicts with other hardware during adapter installation if the NIC has many available IRQ settings.
Drivers that support different network operating systems	An adapter received full credit if network drivers were supplied for more than five different environments (typically, Novell NetWare server, NetWare client, NDIS, Unix, Microsoft LAN Manager, and Microsoft Windows for Workgroups).
Warranty	Only cards from vendors whose service policies include a warranty of five years or more received complete credit.
LED indicators	NICs that had two or more LED indicators for items such as packet transmit/receive, link integrity, and collision detection made problems easier to diagnose when troubleshooting.

EASE OF USE

As we worked with each adapter, we assessed its ease of use in three areas: configuration, network-driver installation, and technical-manual quality.

NICs received points if they could be configured by software rather than tedious jumper settings. A software-configurable adapter with an option that automatically detects and configures the best setting for the system in which it is installed received higher marks than those that required manual selection of the different I/O address and IRQ settings.

We looked for NICs that provided detailed information about driver installation. The overall clarity and comprehensiveness of the manual were also factored into the ease-of-use evaluation. Was the manual well organized and thorough, or was it simply one sheet of paper listing nothing more than possible jumper settings? We graded each adapter in these areas and relied on lab notes to aid in the selection process.

Each adapter received two usability scores: one for its abilities in a workgroup environment and one for its abilities in large-network and transaction-based environments. For instance, driver installation was not scored for large-network and transaction-based networks, but it represented one-eighth of the workgroup rating.

We thought that most workgroup users would require step-by-step instructions on how to create an IPX driver, and we expected boards using ODI drivers to include the proper loading sequence for the four drivers needed to attach to a network. More emphasis was also placed on the documentation for workgroup users. Manuals that provided a glossary, detailed instructions on how to install the adapter in a system, and accessible technical-support information received more points.

Our Test Team

Dave Andrews, *News Editor/BYTE , has covered wireless networking, Ethernet, FDDI, and emerging technologies.*

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Physical Connections

Three main cabling schemes, each using different wiring, cables, and connectors, are used in Ethernet-based networks. These schemes are thick Ethernet (which uses AUI connectors), thin Ethernet (BNC connectors), and twisted-pair (RJ-11 connectors).

Most of the cards we tested had an AUI connection as well as either a BNC or RJ-11 connection. Some, such as the $169 Ansel NS 2100-3 and the $185 DEC Etherworks 3 Turbo Plus, had all three. Others, such as the Boca Research 10Base T Ethernet, had only one. Some vendors, such as D-Link Systems, supplied both BNC and RJ-11 connections.

Most card manufacturers today recognize that LAN wiring schemes vary from site to site. Because of this, they sell several cards that are virtually identical, the only difference among them being the connections on the end of the cards. If the features, usability, and performance of one of the twisted-pair cards we tested look attractive to you but you use thin Ethernet, there's probably a nearly identical BNC version available.

AUI connections are not used in most LANs today. We do not believe that an AUI connector on a NIC is an important feature. Given a choice between two nearly identical cards whose only difference is the presence or absence of an AUI connection, we recommend that you buy the less expensive card.

Thin Ethernet and twisted-pair connections function equally well for small networks consisting of up to several hundred nodes; the choice of thin Ethernet or UTP (unshielded twisted-pair) in these cases is a function of the building design. Except for the need for UTP hubs, the cost and performance of the two are similar.

NETWORK CABLING

Although network performance won't be affected by the type of wiring scheme you use (thin Ethernet, thick Ethernet, or twisted-pair), your approach to network layout does hinge on this choice.

Twisted-pair Ethernet is based on the "star" configuration, with each machine connected to a central hub via a flat cable similar to telephone wire. The hub typically has six to 12 ports (one port for each computer on the network).

Adding a new computer to such a network is as easy as plugging the cable into the hub—the rest of the network is undisturbed by the addition and deletion of individual nodes. When you run out of ports on a hub, additional hubs can be chained together, normally by either twisted-pair or thin Ethernet wiring.

Twisted-pair wiring typically is used when you want a central network-control area (a "wiring closet") with all systems independently wired from that point. Alternatively, you may use twisted-pair if you plan to frequently add or remove single computers from the network, as the integrity of the entire network will not be disturbed. Most twisted-pair hubs have thin Ethernet ports, allowing them to integrate with a thin Ethernet environment. A thin Ethernet port can also be used to chain twisted-pair hubs together to build larger networks.

Thin and thick Ethernet are based on the "bus" configuration: A single wire is strung from computer to computer, and each computer taps into the cable as needed. The cable is not broken at each connection.

Thin Ethernet is a viable alternative to twisted-pair for smaller networks (with 30 or less computers connected). But due to the sensitivity of the cable, one bad connection can bring down the entire network. Thin Ethernet is a great choice for very small networks if point-to-point wiring fits your needs and you don't want the added expense of buying a hub. We also recommend it as a "twisted-pair backbone" to chain-twisted pair hubs to build larger networks.

Thick Ethernet, the oldest form of Ethernet cabling, is able to transmit data the farthest distance, and it allows the greatest number of nodes to be placed on the network. It is also the most expensive and the hardest to install. The cable is large and stiff, and it cannot be wired through mazes of twisty little passages.

Twisted-pair wiring should accommodate most new installations. It is relatively inexpensive and easy to wire, and it simplifies the process of network modification.

NETWORK CABLING WIRING ATTRIBUTES

	TWISTED-PAIR	THIN ETHERNET	THICK ETHERNET
Topology	Star	Bus	Bus
Cable type	24 AWG twisted-pair	RG-58	RG-11
Maximum distance	100 meters, computer to computer	185 meters to next computer	500 meters to next computer
Maximum nodes per network	1024	1024	1024
Maximum nodes per segment*	Limited by hub size, typically four to 16 ports per hub	30	100
Cable cost, 1000 feet	$165	$291	$1012

Additional expenses when connecting a node:
Hub: approximately $40 per computer
BNC T-connector: $5
Cable tap, transceiver, and AUI cable: approximately $60

*Single cable; additional hardware can be used to connect strands on a single network.

OTHER ETHERNET CARDS MAY BE SLOWER BUT THEY SURE DO COST MORE.

The EtheRx Network Interface Cards.
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NICS FOR

LARGE NETWORKS

The complexity of a company network varies with the size of the enterprise and the number of people employed at that location. A medium-size service business, for example, might require only one or two dozen workstations; a large manufacturer could involve 500 users with multiple file servers and several different network protocols. In either case, the presence of a dedicated administrator to maintain such a network is mandatory.

The performance score, which accounted for 50 percent of our large-network rating, was the most important selection criterion for large-network NICs. For our large-network tests, we ran our applications test suite, which simulated nine different types of business applications, but we also ran background network traffic. We did this by sending out a steady volume of traffic on the network wire to a nonexistent network address.

Because of Ethernet's design, many more deferred transmissions and packet collisions occur in such a setting, but the server is still able to instantly respond to requests from the test workstation. Moreover, the test adapter is forced to check the destination address of every packet that passes. Only those tests operating with this network traffic were considered for large-network performance.

Features criteria were worth one-third of our large-network evaluation. The final aspect of our analysis considered each adapter's ease of use. Since the installation and maintenance of these adapters is usually handled by a knowledgeable network administrator, we gave this part of the evaluation the least importance. An experienced network technician is well versed in the intricacies of adapter installation and configuration and most likely does not even refer to the documentation for assistance.

The $149 EtherCombo 16 T/C from Alta Research had a large-network score of 25.2 tpm, a score comparable to those of several of the runners-up, including cards from NDC Communications, Puredata, and Tiara Computer Systems. Although the EtherCombo 16 T/C did not turn in the top performance score, its strong feature set helped boost it to the top of the ratings. This adapter and the Tiara EtherTrek tied for first place in our features scoring, receiving full credit for 80 percent of the items assessed for a features rating.

MONOLITHIC VS. ODI DRIVERS

Workstations may be connected to two or more servers on the same network, and these servers may not be running the same operating system. When a NIC receives a packet, how does it know where it's from and how to process it?

A layered driver, one supporting ODI (Open Data-Link Interface) standards, provides a solution. Each driver is split into layers: The lowest layer deals directly with the NIC, a second layer packs and selects information for the lowest layer, and the highest layers provide services for the different networking protocols. The lowest layer doesn't need to manipulate protocols, only hardware. The highest layer doesn't care about hardware, only protocols. And the middle layer just patches things together.

A network with one NIC and two protocols would have one bottom layer (the ODI driver), one middle layer (called the link-support layer, or LSL), and one or more top layers (e.g., IPX/ODI for Novell [converting IPX to ODI], and TCP ODI drivers for TCP/IP and NFS). The NIC manufacturer needs to supply only the ODI driver; the supplier of the networking software supplies the rest.

The table below compares the performance of four NICs with ODI drivers to that of the same NICs with monolithic IPX (i.e., non-ODI) drivers. Running with ODI drivers will lower the performance of your system.

The performance loss encountered when using ODI drivers instead of monolithic IPX drivers will be minimal. With two of the three cards we tested, the loss was 3 percent or less, meaning that a network-intensive 10-second task using an IPX driver will still take less than 10.5 seconds under an ODI driver.

One test registered a slight performance *improvement* under the ODI drivers. The AT&T/NCR StarLAN 10 LanPacer + NAU was clearly slower when using the ODI drivers. This difference is probably due to fine-tuning of the IPX driver that's not reflected in the StarLAN 10's ODI counterpart.

Simple networks with only one network operating system are best served by IPX drivers. If your network is complex, use ODI drivers. Even then, performance degradation will probably not be noticeable.

MONOLITHIC VS. ODI DRIVER PERFORMANCE

		WORKGROUP TPM	LARGE-NETWORK TPM	TRANSACTION-BASED TPM
DFI DFINET-400	Monolithic	25.5	25.1	415.5
	ODI	25.2	24.8	402.9
	Percent slower	1.4	1.1	3.0
Sureman Etherperfect EP-301	Monolithic	24.4	24.0	396.8
	ODI	24.5	23.8	386.7
	Percent slower	*	0.8	2
AT&T/NCR StarLAN 10 LanPacer + NAU	Monolithic	25.6	24.6	411.8
	ODI	22.1	20.1	357.6
	Percent slower	13.7	15.5	13.2

* Performance showed fractional improvement.

LED indicators for UTP-link integrity, transmit/receive, collision detection, and polarity were all present on the EtherCombo 16 T/C, while most boards provided only one or two of these LEDs. These indicators are especially useful when diagnosing adapter installation difficulties.

You can buy boot ROMs for NetWare for all the ranked NICs except the AT&T/NCR StarLAN 10 LanPacer NAU, the HP J2405A, and the Allied Telesis AT-1700BT. Few vendors (Puredata is one) furnish ROMs for other network operating systems such as Vines and LAN Manager. A network adapter with a boot ROM installed enables users of diskless workstations to attach to a network.

All the ranked NICs also provide several sets of drivers for different uses. Most supply Novell server and client drivers (IPX), as well as ODI, NetBIOS, NDIS, and Unix drivers. Before purchasing a network card, always check to make sure that drivers are supplied for your intended purpose. Most 16-bit adapters can be installed in either a standard 16-bit ISA slot or an 8-bit slot, but expect some degree of performance degradation if the board is not installed in a 16-bit slot.

Regardless of the technical abilities of your network's users, a software-configurable adapter is preferred over hardware-jumper or DIP-switch settings. Software-configurable adapters eliminate the need to find the proper combination of jumpers to select a base I/O address or to enable the BNC connector; you just load the menu-driven software and press a couple of keys. There's no need to take off the system cover and remove the adapter to install or pull jumpers; you just run the software utility.

Another configuration issue concerns IPX driver support for different I/O addresses and IRQs. Intel and 3Com supply either the files for the IPX-generation process that create self-configuring IPX drivers or a driver that supports the Novell JUMPERS utility.

BYTE BEST — LARGE NETWORKS

Need high performance in heavy network traffic?

BEST OVERALL — **Alta Research EtherCombo 16 T/C**

All our top NICs for large networks posted virtually identical performance scores, so features and usability became the most important differentiators. The $149 EtherCombo offers network administrators both hardware and software configuration. It also provides multiple emulations, as well as the ability to function in both 8- and 16-bit slots. This last factor can be important for growing networks, as it allows administrators the freedom of planning for the future.

		PRICE	LARGE-NETWORK SPEED (TPM)	EASE-OF-USE RATING	SOFTWARE-CONFIGURABLE?	DIAGNOSTICS RATING	WARRANTY LENGTH (YEARS)	BUS WIDTH (BITS)
BEST	Alta Research EtherCombo 16 T/C	$149	25.2	Excellent	Yes	Fair	Lifetime	8/16
RUNNER-UP	Puredata PDI 8023Plus-16	$230	25.5	Excellent	Yes	Good	5	16
RUNNER-UP	NDC Communications ND6000-E	$199	25.4	Good	Yes	Fair	6	8/16
RUNNER-UP	Tiara Computer Systems EtherTrek	$149	25.4	Good	Yes	Fair	Lifetime	8/16
RUNNER-UP	3Com EtherLink III	$199	26.6	Excellent	Yes	Fair	Lifetime	16

Want smooth configuration?

8-BIT — **Racal InterLan NI 5210-10BT**

This NIC received a score of 22.3 tpm, which ranked it as one of the top five 8-bit performers. Like most of the 8-bit adapters, the NI 5210-10BT is configurable only by hardware jumpers. However, unlike most of these adapters, the NI 5210-10BT has clear labels on its jumpers, supports 62 unique I/O addresses, and can use any of six different IRQs. The outstanding manual provides all pertinent information in a logical and concise fashion and includes a lengthy chapter on using the diagnostics program to troubleshoot problems. A lifetime warranty also comes standard with this $179 adapter.

		PRICE	LARGE-NETWORK SPEED (TPM)	EASE-OF-USE RATING	SOFTWARE-CONFIGURABLE?	DIAGNOSTICS RATING	WARRANTY LENGTH (YEARS)
BEST	Racal InterLan NI 5210-10BT	$179	22.3	Fair	No	Excellent	Lifetime
RUNNER-UP	Compex ENET-U/TP	$79	23.5	Poor	No	Fair	5
RUNNER-UP	Compulan Technology E500	$129	20.6	Poor	No	Fair	5
RUNNER-UP	Lannet Data Communications LEC-45T	$395	23.9	Poor	Partially	Fair	1
RUNNER-UP	AT&T/NCR StarLAN 10 LanPacer NAU	$299	22.8	Fair	Partially	Fair	3
RUNNER-UP	SMC Ethercard Plus Elite 10T	$179	23.9	Good	Partially	Good	5

Need high speed for under $120?

LOW-COST — **Hewlett-Packard HP J2405A**

The $119 HP J2405A's large-network performance results were within the top five rankings for all adapters. Once this adapter is physically installed in a system, a user only needs to execute the setup program that automatically determines the best configuration before the workstation is ready to attach to the network. If network problems arise, the diagnostics that come with this NIC, teamed with the extensive troubleshooting information in the documentation, are valuable for resolving difficulties.

		PRICE	LARGE-NETWORK SPEED (TPM)	EASE-OF-USE RATING	SOFTWARE-CONFIGURABLE?	DIAGNOSTICS RATING	WARRANTY LENGTH (YEARS)	BUS WIDTH (BITS)
BEST	Hewlett-Packard HP J2405A	$119	26.2	Excellent	Yes	Good	Lifetime	16
RUNNER-UP	Allied Telesis AT-1500BT	$100	25.9	Excellent	Yes	Fair	Lifetime	16
RUNNER-UP	Audio Video Computer NW 2000	$88	25	Good	Yes	Fair	5	8/16
RUNNER-UP	Compex ENET-U/TP	$79	23.5	Poor	No	Fair	5	8
RUNNER-UP	SVEC Computer FD0490I	$99	25.2	Fair	Yes	Fair	5	8/16
RUNNER-UP	Allied Telesis AT-1700BT	$100	25.2	Excellent	Yes	Fair	Lifetime	16

Wireless LAN Adapters

Wireless NICs are an attractive solution for mobile computer users who need to log in to a wired Ethernet client/server network or who want to set up a peer-to-peer LAN among several mobile PCs within a building. They are also useful for networking users at locations where installing network cable is difficult or impossible.

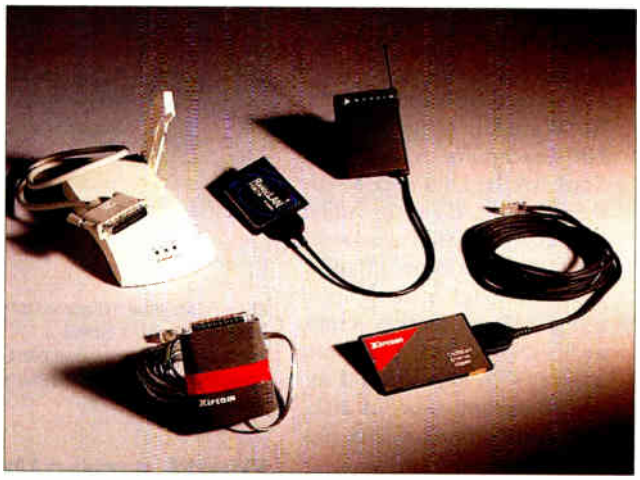
BYTE recently looked at two new products that offer wireless networking using spread-spectrum radio: Proxim's RangeLAN/PCMCIA wireless LAN adapter ($595) and Alps Electric's RadioPort Parallel ($599). With spread-spectrum radio, networked PCs and notebooks don't have to be within sight of each other. As a result, you can network PCs that are up to about 500 feet apart and separated by walls or floors using a spread-spectrum wireless network.

The RangeLAN/PCMCIA supports Type II PCMCIA I/O-card sockets; the RadioPort plugs into the back of your PC's parallel port. Using both adapters, we were able to copy files, read E-mail, and access other network services on computers separated by cubicles, walls, and the BYTE building's thick floors. However, with data rates of 242 Kbps and actual data throughput that, depending on the distances and obstacles between the computers, ranged between 2700 to about 7600 bytes per second, we would not recommend either product for users who are running complex graphics or heavy transactions across a network.

We installed Proxim's RangeLAN/PCMCIA credit-card-size network adapters into the Type II slots in two AST Power Exec 4/25 SL notebook computers. Once we attached the antennas (which resemble tiny walkie-talkies) to the top of the notebooks and installed the network drivers, we were able to communicate from one PC to another. Alps Electric's RadioPort Parallel adapter resembles an oversize mouse with a giant arm that swings up to salute at attention.

In terms of file transfer speed, the two products are comparable. Both adapters can operate on three radio channels, allowing you to have more than one wireless network in the same work location. Both can transmit data at distances of up to about 500 feet indoors and 800 feet outdoors.

Because they are installed inside your computer, PCMCIA adapters are more suitable for notebooks or pen computers that are constantly being moved around, such as in a warehouse inventory or hospital environment. The benefit of the parallel port solution is that you don't have to delve into your PC's operating system and reset IRQ channels and I/O base addresses, which you may be forced to do with a PCMCIA product. And, although PCMCIA is gaining in popularity, there are still many computers on the market that don't have a PCMCIA slot.



Xircom's PCMCIA and parallel port network adapters (shown at bottom) provide relatively painless network connections, provided you have an available cable nearby. Alps Electric's (top left) and Proxim's (top right) solutions are slower but solve the "last 500 feet" problem.

As you might expect, neither type of wireless LAN adapter offers the performance of wired solutions such as Xircom's parallel-port-based Pocket Ethernet Adapter III or the new PCMCIA-based CreditCard Ethernet Adapter ($349) for connecting laptops and PCs to standard Ethernet LANs.

To measure the relative performance differences between the RangeLAN/PCMCIA and a more traditional wired solution, we tested Xircom's CreditCard Ethernet Adapter connected to the same AST Power Exec 4/25 SL notebook systems running Windows for Workgroups. We connected the two notebooks with thin Ethernet cable and achieved file transfers at rates that varied between 38,000 and more than 100,000 bytes per second.

Although the actual throughput that you obtain for all these NICs will vary according to your particular network operating system, system configuration, hard drive speed, and processor type, the cabled solution that is offered by Xircom provided user-throughput performance that was roughly 10 times faster than the performance of the wireless solutions. Of course, the benefit of using one of the wireless solutions is that you are freed from the usual constraints of a wired network.

At press time, NCR, which already sells versions of its WaveLAN wireless network cards for Micro Channel and AT-bus systems, was close to releasing WaveLAN/PCMCIA, a product designed for use with Type II PCMCIA slots. NCR says that like the other versions of WaveLAN, the PCMCIA version will offer an effective raw data rate of 2 Mbps and actual user throughput that's roughly one-third that of traditional Ethernet.

If NCR's PCMCIA product delivers performance that's equal to that of other WaveLAN products, the WaveLAN/PCMCIA should offer better performance than the Proxim card. However, NCR expects to sell its PCMCIA card for $695, which is $100 more than what Proxim currently charges.

In addition, San Diego–based Solectek is expected to release sometime this fall a 2-Mbps wireless unit that plugs into a PC parallel port to complement the company's wireless ISA and Micro Channel NICs, hubs, and bridge. Solectek's parallel port version of AirLAN will compete with Alps Electric's and Proxim's wireless parallel port products.

None of the wireless NICs or units that we reviewed for this article appear to pose much of a threat to the traditional LAN. Instead, they should be viewed as useful adjuncts that don't tie you down.

—Dave Andrews

Emulation Speed

Several of the cards we tested were capable of emulating either the NE2000 or Western Digital (Standard Microsystems) 8013 interfaces. The NE2000 and WD8013 use two different approaches to data transfer: The NE2000 uses only I/O ports, while the WD8013 uses a block of shared memory.

Memory-mapped cards contain a small block of memory (typically 8 to 16 KB) that is shared between the main processor and the NIC hardware. To transmit a packet, the host places the data in the shared memory space and sends a small sequence of I/O commands to the NIC. The NIC then reads the data from the shared memory while the processor goes on to perform other computing tasks.

In theory, this can allow faster operation than can be achieved with a pure I/O-port mode. However, this also means that a block of high DOS memory, typically at 0xD0000, needs to be reserved for the card. In a full system, freeing up this window can be a difficult task.

I/O-mapped cards do not share memory between the host and the NIC hardware. Instead, all data is transferred through input and output instructions to the I/O ports on the card. This can be a slower, more cumbersome method of transferring data.

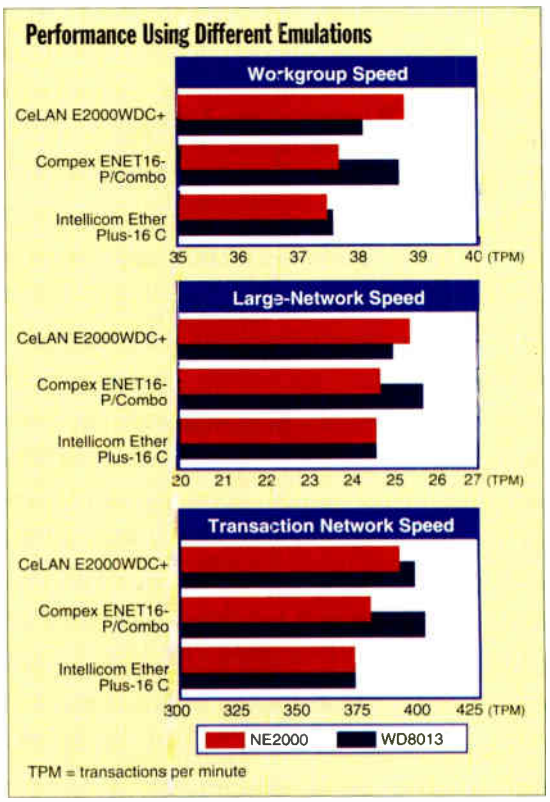
The figure (above right) illustrates the performance results that we obtained from testing three cards that provide both NE2000 and WD8013 emulations. We tested these three representative cards by running our entire suite of workgroup, large-network, and transaction-network performance tests using both emulations.

For two of the three NICs (the CeLAN E2000WDC+ and the Intellicom Ether Plus-16C), there was less than a 2 percent difference in performance between the two modes. One card, the Compex ENET16-P/Combo, showed a 4 percent difference overall. Most of the performance improvement with this card occurred during tests involving larger loads—this was most obvious in the results derived from our transaction-based and large-network tests.

If you are using other types of networks or are considering switching networking schemes, the existence of an additional emulation may give you added flexibility. Historically, most NIC manufacturers automatically supply Novell NetWare drivers.

On the other hand, however, many NIC manufacturers do not supply drivers for Unix. Unix vendors will supply NIC drivers, but the range of drivers tends to be limited. For example, until recently, SCO Unix did not supply NE2000 drivers. Interactive Unix does provide these particular drivers, but the company does not recommend the use of the NE2000 on heavily loaded servers.

Therefore, the presence or absence of multiple emulation modes isn't a significant factor to consider when you are deciding which NIC to purchase. Other factors, such as overall performance, price, the presence or absence of necessary features, and overall usability, should weigh more heavily in your purchasing decision.



Performance differences under NE2000 or WD8013 emulations vary only about 2 percent to 4 percent with most NICs.

Single-Chip NICs

NICs built from one or two chips (bottom) allow for smaller physical designs with no performance change.

NICs are shrinking. Older cards, built from discrete components and custom chips, were frequently three-quarter length and longer. Recently, companies such as Fujitsu, National Semiconductor, and UMC have started producing ICs that contain, essentially, an entire NIC on one or two chips.

The addition of a few external components provides an exceedingly small interface. Boca Research, for example, produces a 6.2- by 2.45-inch NIC that's barely large enough to hold the single-chip NIC, ROM socket, and a few connectors. Other single-chip NICs, such as the 7- by 4-inch HTI Networks HT-NE2000CX, include additional features as well as performance and signal-enhancement circuitry, which results in a slightly larger size.

Are single-chip NICs as fast as full-card NICs? Basically, yes. We have found that single-chip NICs by AMD, National Semiconductor, UMC, and Fujitsu ended up scattered all through our rankings. While some single-chip NICs tend to be faster than others (e.g., AMD-based systems tend to perform very well), there is little relation between performance and the use of a proprietary design. This means you should not assume that custom-logic NICs will be faster.

NICS FOR

TRANSACTION PROCESSING

Transaction-based computing creates unique patterns of network use. For instance, a typical database search involves many small records. Likewise, in a real-time transaction (e.g., a request for an airline ticket), transmissions are fairly small. While transaction-based networks may be small or large, they are all characterized by the nature of the data transmitted.

When we looked at NICs for use with these networks, performance was the most important criterion, accounting for 60 percent of this evaluation. We used only those applications that stressed the NIC with small data packets: the database test and the two low-level tests (which used 128- and 512-byte packets).

We ran each test twice, once with no background traffic (simulating a smaller network) and once with a steady volume of background traffic (simulating a larger real-time environment). Since most networks of this sort are installed and maintained by a knowledgeable administrator, NIC usability and features account for only 40 percent of the total evaluation.

As in the large-network category, we recommend the Alta Research EtherCombo 16 T/C as the best overall transaction-network NIC. Its combination of reasonable performance (414.9 tpm versus 454.6 tpm for the performance-leading 3Com EtherLink III) and excellent features scores pushed it to the top. Administrators might find especially useful the EtherCombo's diagnostic package, which includes dynamic packet analysis and viewing of network transmissions. This was the best diagnostic aid, short of commercial LAN analyzers, that we have seen.

Other leading cards, such as the Intel Ether Express Flash C and Puredata PDI 8023Plus-16, also had features that made them excellent choices for transaction-based networks. All these cards were extremely easy to use and completely software configurable, and they came with a usable set of diagnostics. Many support drivers for a large number of network operating systems—important if you are building a network using a mixture of servers and software environments.

As always, you should check carefully to make sure that the card you choose is compatible with your environment. This means the operating system on the computer (normally DOS)

THE EFFECTS OF NETWORK LOAD

As you add servers and clients to a network, the network load increases. When this happens, even if everyone else on your network is using a different server than you, the throughput rate you see on your workstation will deteriorate. This is because the actual network medium, the cable connecting all the clients to the servers, is shared among all the clients and servers on the network. If someone else is using the network in any manner, your transmissions may be delayed.

We tested the GVC Technologies NIC-1000BT and SIIG E-LAN 200T under varying levels of background traffic to determine the effects of network load. In addition to the 0 percent and 25 percent background levels we ran during our normal testing, we ran our benchmark suite with a background level of 40 percent with these two cards to represent a heavily loaded network. (Due to the design of Ethernet, attaining a constant 25 percent load is unusual and indicates that you need to reorganize your network.)

The results are shown in the table below. The "packets sent" figure is the actual number of packets sent and received by the client system. The "packets deferred" figure shows the percentage of the time that the NIC had to wait to transmit data because someone (in this case, the traffic generator) was currently transmitting. The "application tpm" is the average number of transactions per minute for the word processing, spreadsheet, and mail tests. The application tpm figure with a 0 percent load is actually the workstation tpm figure; with a 25 percent load, it is the large-network tpm figure.

This data indicates that background traffic has very little effect on your server and client, provided they do not need to respond to the traffic. Performance typically drops by around 3 percent when the network goes from an unloaded (0 percent) to an extremely heavily loaded (40 percent) state. This is a negligible amount that would probably go unnoticed by users.

On the other hand, if your server does need to respond to the traffic, you will see a degradation in performance. This happens when other people are using the server, and the exact effect is a function of the server design and organization. The NIC you choose for your client will not affect how your server responds to an additional load.

HOW NETWORK LOAD AFFECTS THROUGHPUT

	NETWORK LOAD (PERCENT)	PACKETS SENT	PACKETS DEFERRED (PERCENT)	APPLICATION SPEED (TPM)
GVC NIC-1000BT	0	325,963	0	20.8
	25	325,100	28	20.4
	40	332,800	43	20.2
SIIG E-LAN 200T	0	324,583	0	25.4
	25	328,100	27	25.2
	40	332,400	43	25.1

should support the NIC and its network drivers (usually for Novell NetWare or Unix).

Real-time networks are frequently the final resting places of older PCs with 8-bit buses. Of the 8-bit cards we tested, all provided an adequate level of performance. The best card in this group was the Standard Microsystems Ethercard Plus Elite 10T. Although slower than the fastest 8-bit NIC, it is partially software configurable, has a five-year warranty, and is fairly easy to use.

The Standard Microsystems cards are quite flexible, supporting more interrupt and memory settings than all but three of the 22 8-bit cards we tested. The presence of four LEDs on each card simplifies debugging of completely nonfunctional networks. Finally, these two cards support most major network protocols—Novell NetWare, Unix, NetBIOS, and a host of others.

You can also use the Alta Research EtherCombo 16 T/C in an older PC if your system allows you to use 16-bit cards in 8-bit slots. If not, you will have to use a dedicated 8-bit card.

Other cards in this group had poor manuals. The Lannet LEC-45T, for example, came with a manual for the LAN 10E/T, its setup program does not support the LEC-45T, and we spent a good deal of time playing around with unlisted and undocumented jumpers. Once running, though, the card worked quite well.

We found that this lack of usability was common among many of the lower-price cards. Eight-bit cards in particular tended to be harder to configure and came with fewer niceties such as diagnostics. Of our recommended 8-bit cards, only one (from Standard Microsystems) was partially configurable, and only two (from Standard Microsystems and Racal InterLan) came with good or better diagnostic programs. Meanwhile, all the top 16-bit NICs were fully software configurable; in addition, all of them were exceptionally easy to use.

Need fast configuration and troubleshooting?

BEST OVERALL — **Alta Research EtherCombo 16 T/C**

Although this NIC was slower than the rival 3Com EtherLink III, its features and usability seem to be designed with the network manager in mind. It is a 16-/8-bit card, it is both hardware and software configurable, and it understands Novell and Western Digital NIC command sets. Finally, the configuration utility doubles as a general network-monitoring tool that helps you monitor and debug entire networks.

		PRICE	TRANSACTION-PROCESSING SPEED (TPM)	EASE-OF-USE RATING	SOFTWARE-CONFIGURABLE?	DIAGNOSTICS RATING	WARRANTY LENGTH (YEARS)	BUS WIDTH (BITS)
BEST	Alta Research EtherCombo 16 T/C	$149	414.9	Excellent	Yes	Fair	Lifetime	8/16
RUNNER-UP	3Com EtherLink III	$199	454.6	Excellent	Yes	Fair	Lifetime	16
RUNNER-UP	Intel Ether Express Flash C	$199	408.2	Excellent	Yes	Good	3	8/16
RUNNER-UP	Puredata PDI 8023Plus-16	$230	408.9	Excellent	Yes	Good	5	16

Don't want to sacrifice ease of use?

8-BIT — **Standard Microsystems Ethercard Plus Elite 10T**

If an EtherCombo NIC won't fit in your old XT, the ideal alternative is the Ethercard Plus Elite 10T. This true 8-bit Ethernet card is based on Standard Microsystems' proprietary chip set. It offers excellent performance coupled with a top-notch set of features. The Ethercard Plus Elite 10T offers two preset I/O/IRQ/RAM address combinations, which should handle most common installation requirements. Alternatively, the EZSETUP utility can be used to completely configure (and reconfigure, if needed at a later date) the card through software. We found the card to be the most usable of all of the 8-bit cards we tested.

		PRICE	TRANSACTION-PROCESSING SPEED (TPM)	EASE-OF-USE RATING	SOFTWARE-CONFIGURABLE?	DIAGNOSTICS RATING	WARRANTY LENGTH (YEARS)
BEST	SMC Ethercard Plus Elite 10T	$179	384.4	Good	Partially	Good	5
RUNNER-UP	Compex ENET-U/TP	$79	387.5	Poor	No	Fair	5
RUNNER-UP	Compulan Technology E500	$129	327.7	Poor	No	Fair	5
RUNNER-UP	Lannet Data Communications LEC-45T	$395	391	Poor	Partially	Fair	1
RUNNER-UP	AT&T/NCR StarLAN 10 LanPacer NAU	$299	375.4	Fair	Partially	Fair	3
RUNNER-UP	Racal InterLan NI 5210-10BT	$179	355.5	Fair	No	Excellent	Lifetime

Need a speed and price leader?

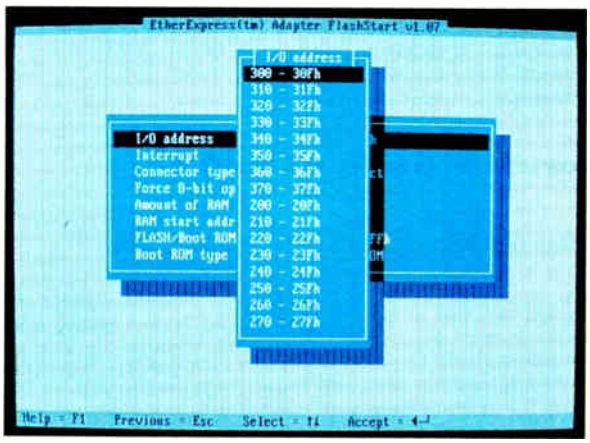
LOW-COST — **Allied Telesis AT-1500BT**

Even though it's priced at only $100, the AT-1500BT posted the second-fastest performance figure, a hair behind the Hewlett-Packard HP J2405A. The AT-1500BT is software configurable with a mouse-driven configuration utility. Curiously, the card comes only with ODI drivers and does not support the older IPX driver format. Other features of the package include a tear-out reference card and a sticker for the NIC, listing the vendor, model, and node address. The last item alone can be a lifesaver to the manager of a large network with many similar nodes.

		PRICE	TRANSACTION-PROCESSING SPEED (TPM)	EASE-OF-USE RATING	SOFTWARE-CONFIGURABLE?	DIAGNOSTICS RATING	WARRANTY LENGTH (YEARS)	BUS WIDTH (BITS)
BEST	Allied Telesis AT-1500BT	$100	429.2	Excellent	Yes	Fair	Lifetime	16
RUNNER-UP	Hewlett-Packard HP J2405A	$119	430.4	Excellent	Yes	Good	Lifetime	16
RUNNER-UP	Allied Telesis AT-1700BT	$100	417.5	Excellent	Yes	Fair	Lifetime	16
RUNNER-UP	Audio Video Computer NW 2000	$88	415.3	Good	Yes	Fair	5	8/16
RUNNER-UP	SVEC Computer FD04901	$99	413.9	Fair	Yes	Fair	5	8/16

HONORABLE MENTIONS

Installation is a breeze with the Intel Ether Express Flash C. A Novell NetWare administrator can preload drivers onto a server, allowing instant configuration of newly installed clients. You just plug the Ether Express into the client and turn the computer on, and the FlashStart program automatically configures the card, downloads the drivers, and connects the workstation to the network.

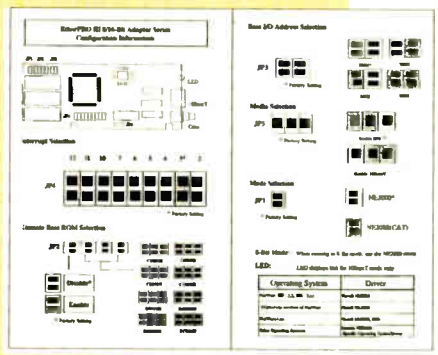


But if you insist on using jumpers, then those on the Compex ENET-U/TP are the easiest to use. Unlike standard jumpers, those on the ENET-U/TP have attached flags. You may need pliers to pull out and reinsert standard jumpers when they are (as is usually the case) very close together. The extensions on the ENET-U/TP's jumpers made them easy to grab and reinsert. Although it's not something you do too often, when it comes to manual setup, every little bit helps.

◀ **A second server program keeps all the Ether Express NICs on the network up-to-date; the presence of newer drivers is automatically detected, and the client automatically downloads the driver updates. For diskless workstations, the Ether Express comes with NetWare and LanMan boot programs that are already installed—additional boot ROMs are not needed. This is truly a card for the masses!**

Dubious Achievements

You had better be a NIC expert if you plan to configure cards with documentation like that of the EtherPro III from Network Interface. The manual, which consists of only one sheet, tells you which jumpers control I/O, which select interrupts, and so on. But it doesn't say why, where, or what to do if you have conflicts with other cards. Its utilities were equally Spartan. ▶



▼ **Have a hacksaw handy** when you install the Intellicom Ether Plus-16 C in your Compaq. Its BNC connector is so close to the top that we needed to partially disassemble our Compaq Deskpro 4/66i to insert the card for testing. Although this was the worst case, we found similar problems with other cards—BNC connectors were too high or too low. If your system is tightly packed, you may not be able to connect the BNC T-adapter at all.

Manufacturers, take note: The BNC connector should be in the middle of the backplate, with the AUI and twisted-pair connectors surrounding it. This will allow enough room to connect using any of the three jacks without impinging on adjacent card connectors.

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Product no.: 41000AOB-80
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Function: 1MB 80ns
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Product no.: JE2020
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ROLL CALL OF NICS TESTED

MANUFACTURER	MODEL	PRICE	SPEED RATINGS (TPM)			EASE OF USE		SOFTWARE-CONFIGURABLE?
			WORKGROUP	LARGE NETWORKS	TRANSACTION-BASED NETWORKS	WORKGROUP	LARGE- AND TRANSACTION-BASED NETWORKS	
Addax Computers	1000 A	$95	20.8	20.5	324.8	Poor	Poor	No
Addax Computers	2000 A	$125	25.3	24.8	404.1	Poor	Poor	No
Addtron Technology Co., Ltd.	AE-200STA	$129	25.3	24.8	412.7	Poor	Poor	No
Addtron Technology Co., Ltd.	ET-100ST	$99	20.7	17.7	301.4	Poor	Poor	No
Advanced Interlink Corp.	Ether 16/8 CT	$109	25.9	25.5	424.4	Fair	Good	Yes
Allied Telesis, Inc.	AT-1500BT	$100	26.4	25.9	429.2	Fair	Excellent	Yes
Allied Telesis, Inc.	AT-1700BT	$100	25.6	25.2	417.5	Good	Excellent	Yes
BYTE Alta Research Corp.	EtherCombo 16 T/C	$149	25.4	25.2	414.9	Good	Excellent	Yes
Ansel Communications	M 2000-3	$169	25.2	24.9	407.2	Poor	Poor	No
Ansel Communications	NS 2000-3	$149	25.3	24.8	404.3	Fair	Fair	Yes
Ansel Communications	NS 2100-	$169	26.4	25.9	428.9	Fair	Good	Yes
Arco Electronics, Inc.	AC-9000S	$150	26.2	25.9	419.4	Fair	Poor	Yes
Artisoft, Inc.	AE-1/T	$199	20.	20.3	327.1	Poor	Poor	No
Artisoft, Inc.	NodeRunner 2000/C	$259	25.8	25.5	421.3	Fair	Good	Yes
AT&T/NCR Corp.	StarLAN 10 LanPacer NAU	$299	23.9	22.8	375.4	Fair	Fair	Partially
AT&T/NCR Corp.	StarLAN 10 LanPacer + NAU	$399	25.6	24.6	411.8	Fair	Fair	Partially
Audio Video Computer	L 2000	$78	25.	25.5	419.6	Poor	Poor	No
Audio Video Computer	NW 2000	$88	25.4	25	415.3	Fair	Good	Yes
Boca Research, Inc.	10Base T Ethernet	$129	26.3	25.7	431	Fair	Fair	No
BusLogic, Inc.	BT-560T	$249	26.3	25.8	430.5	Poor	Poor	No
Cabletron Systems, Inc.	E1112	$349	23.8	23.3	373.9	Fair	Fair	Yes
Cabletron Systems, Inc.	E2112	$449	25.6	25.4	415	Fair	Fair	Yes
CeLAN Technology	E2000WDC+	$169	25.	25	423.8	Good	Excellent	Yes
CNet Technology	CN100E	$89	21.1	20.6	327.8	Poor	Poor	No
CNet Technology	CN650E+	$199	25.8	25.5	424	Fair	Good	Yes
CNet Technology	CN888E	$299	25.9	25.5	414	Fair	Good	Yes
Compex, Inc.	ENET-U/TP	$79	24.2	23.5	387.5	Poo	Poor	No
Compex, Inc.	ENET16-P/Combo	$139	26.1	25.7	426.2	Good	Excellent	Partially
Compulan Technology, Inc.	E500	$129	21.1	20.6	327.7	Poor	Poor	No
Compulan Technology, Inc.	E650Plus	$169	12.7	12.7	406.8	Good	Excellent	Yes
Computer Lab International	Ether-16TP	$165	26.1	25.7	423.8	Fair	Fair	Yes
Danpex Corp.	EN-1000B	$85	20.8	20.5	324.9	Poor	Poor	No
Danpex Corp.	EN-2000B	$99	25.5	25.2	413.1	Poor	Poor	No
Digital Equipment Corp.	Etherworks 3 Turbo Plus	$185	25.1	24.6	397.4	Fair	Good	Yes
DFI, Inc.	DFINET-400	$89	25.5	25.1	415.5	Poor	Poor	No
DFI, Inc.	DFINET-400EC	$89	25.5	25	415.1	Poor	Poor	No
DFI, Inc.	DFINET-400ECT	$111	25.4	25	415.3	Poor	Poor	No
DFI, Inc.	DFINET-400ET	$95	25.4	25	415.4	Poor	Poor	No
D-Link Systems, I	DE-220CT	$225	26.3	26	423.6	Fair	Good	Yes
Eagle Technology	NE1000	$148	21.1	20.5	327.3	Poor	Poor	No
Eagle Technology	NE2000 Plus 3	$229	25.5	25	415.2	Fair	Good	Yes
Edimax Computer Co.	2000A	$74	25.6	25.3	413.8	Poor	Poor	No
Edimax Computer Co	EN-7008	$74	20.8	20.3	326.4	Poor	Poor	No
Elisa Technology, Inc.	ETI-LAN002 Combo	$85	25.4	25.1	416.5	Poor	Poor	No
GVC Technologies, Inc.	NIC-1000BT	$185	20.8	20.4	325.1	Poor	Poor	No
GVC Technologies, Inc.	NIC-2000BT	$194	25.4	25	416.9	Poor	Poor	No
Hewlett-Packard Co.	HP J2405A	$11	26.7	26.2	430.4	Fair	Excellent	Yes
HTI Networks	HT-NE1000CX	$110	21	20.6	327.3	Poor	Poor	No
HTI Networks	HT-NE1000TP	$11	20.8	20.3	327.2	Poor	Poor	No
HTI Networks	HT-NE2000CX	$125	25.6	25.1	414.7	Poor	Poor	No
HTI Networks	HT-NE2000TP	$12	25.8	25.6	414.4	Poor	Poor	No

BYTE = BYTE Best.

AUTOMATIC CONFIGURATION OPTION?	FEATURES SCORE	BUS WIDTH 8 BITS	BUS WIDTH 16 BITS	EMULATIONS SUPPORTED 3COM	NOVELL NE1000/ NE2000	SMC/ WESTERN DIGITAL	PROPRIETARY	WARRANTY LENGTH (YEARS)	PHONE	TOLL-FREE PHONE	INQUIRY NO.
No	5.7	✔	✔		✔			5	(408) 245-2144	(800) 800-19	1105
No	5.7	✔			✔			5	(408) 245-2144	(800) 800-1977	1106
No	5		✔		✔			5	(510) 770-0120	(800) 998-4638	1107
No	4.7	✔			✔			5	(510) 770-0120	(800) 998-4638	1108
No	7.1		✔		✔			5	(714) 894-1675	None	1109
Yes	5.9		✔		✔			Lifetime	(415) 964-2771	(800) 424-4284	1110
Yes	5.1		✔				✔	Lifetime	(415) 964-2771	(800) 424-4284	1111
Yes	9.1	✔	✔		✔	✔		Lifetime	(305) 428-8535	(800) 423-8535	1112
No	4.		✔		✔			5	(408) 452-5041	(800) 998-2675	1113
No	7.4	✔	✔		✔	✔		5	(408) 452-5041	(800) 998-2675	1114
No	6.3		✔		✔			5	(408) 452-5041	800) 998-2675	1115
No	7.6		✔				✔	5	(305) 925-2688	(800) 458-1666	1116
No	6.	✔			✔	✔		5	(602) 670-7100	800) 846-9726	1117
No	6.9	✔	✔		✔	✔		5	(602) 670-7100	(800) 846-9726	1118
No	6.2	4					4	3	(612) 638-7625	(800) 637-2600	1119
No	6.8	✔	✔				✔	3	(612) 638-7625	(800) 637-2600	1120
No	6		✔				✔		(510) 651-1831	None	1121
No	6.5	✔	✔		✔	✔		5	(510) 651-1831	None	1122
No	5.4		✔		✔			5	(407) 997-622	None	1123
No	5.3		✔				✔	1	(408) 492-9090	None	1124
No	4.9	✔					✔	1	(603) 332-9400	None	1125
No	6	✔	✔				✔	1	(603) 332-9400	None	1126
Yes	6.8		✔		✔				(408) 434-6888	None	1127
No	7.1	✔			✔			Lifetime	(408) 954-8000	(800) 486-2638	1128
No	7.2		✔		✔			Lifetime	(408) 954-8000	(800) 486-2638	1129
No	8.8		✔		✔	✔		Lifetime	(408) 954-8000	(800) 486-2638	1130
No	8.2	✔			✔	✔	✔	5	(714) 630-7302	None	1346
Yes	8.2	✔	✔		✔	✔	✔	5	(714) 630-7302	None	1347
No	7.6	✔			✔			5	(408) 432-8899	(800) 486-8810	1348
Yes	7.2	✔	✔		✔			5	(408) 432-8899	(800) 486-8810	1349
No	7.1	✔	✔		✔			5	(714) 572-8000	(800) 727-5250	1350
No	6.3	✔			✔			5	(408) 437-7557	(800) 452-1551	1351
No	7.1		✔		✔			5	(408) 437-7557	(800) 452-1551	352
Yes	5		✔		✔	✔		1	(508) 493-5111	(800) 344-4825	1353
No	2.8		✔		✔			1	(916) 568-1234	None	1354
No	2.8		✔		✔			1	(916) 568-1234	None	1355
No	2.8		✔		✔			1	(916) 568-1234	None	135
No	2.8		✔		✔			1	(916) 568-1234	None	1357
es	7.1	✔	✔		✔			5	(714) 455-1688	(800) 326-1688	135
No	4.7	✔			✔			5	(408) 441-4003	(800) 733-2453	1359
No	6.5		✔		✔			5	(408) 441-4003	(800) 733-2453	1360
No	5.7	✔	✔		✔			5	(408) 496-1105	None	1361
No	5.7	✔			✔			5	(408) 496-1105	None	1362
No	7.5		✔		✔			5	(510) 651-5817	None	1363
No	7.1	✔			✔			5	(201) 579-3630	(800) 289-4821	1364
No	7.5	✔	✔		✔			5	(201) 579-3630	(800) 289-4821	1365
Yes	6.6		✔		✔			Lifetime	None	(800) 752-0900	1366
No	4.7	✔			✔			5	(408) 745-0100	None	1367
No	4.4	✔			✔			5	(408) 745-0100	None	1368
No	4.3	✔	✔		✔			5	(408) 745-0100	None	1369
No	4	✔	✔		✔			5	(408) 745-0100	None	1370

ROLL CALL OF NICS TESTED

MANUFACTURER	MODEL	PRICE	SPEED RATINGS (TPM)			EASE OF USE		SOFTWARE-CONFIGURABLE?
			WORKGROUP	LARGE NETWORKS	TRANSACTION-BASED NETWORKS	WORKGROUP	LARGE- AND TRANSACTION-BASED NETWORKS	
IBM Corp.	IBM LAN Adapter for Ethernet ISA Bus	$155	25.5	25	414.5	Fair	Good	Yes
IBM Corp.	IBM LAN Adapter for Ethernet TP	$125	25.7	25.5	414.4	Fair	Good	Yes
Intel Corp.	Ether Express Flash C	$199	25.6	25.3	408.2	Excellent	Excellent	Yes
Intellicom, Inc.	Ether Plus-16 C	$193	25.1	24.6	396.9	Good	Excellent	Yes
Kingston Technology Corp.	KNE2100-T	$129	26.6	26	435.8	Poor	Poor	No
Kingston Technology Corp.	KNE2102	$149	26.9	26.3	436.9	Poor	Poor	No
Kingston Technology Corp.	KNE2121	$169	26.5	26	435.9	Poor	Poor	No
Lancast Technology Corp.	ENC-4105	$12	20.8	20.4	324.5	Fai	Poor	No
Lancast Technology Corp.	ENC-4106	$150	25.4	25	415.6	Poor	Poor	No
Lannet Data Communications	LEC-45T	$39	24.5	23.9	391	P	Poor	Partially
Lantech Technology Corp.	PTC-1001SCT	$56	25.9	25.5	413.9	Poor	Poor	No
Lodestar Technology, Inc.	LS-2000S	$190	25.5	25.2	14.	P	Poor	Y
Lodestar Technology, Inc.	LS-2000ST	$205	25.3	24.9	414.7	Poor	Poor	Yes
Microdyne Corp.	NE1000	$148	20.9		327.2	P	Poor	Ye
Microdyne Corp.	NE2000plus3	$229	25.2	24.9	405.8	Fair	Excellent	Yes
Multi-Tech Systems, Inc.	EN 301 TP16	$349	25.6	25.3	420	Fai	Fair	No
NDC Communications, Inc.	ND4113-E	$195	25.5	25	415.7	Poor	Poor	No
NDC Communications, Inc.	ND6000-E	$199	25.5	25.4	410	Fa	ood	Ye
Network Interface Corp.	EtherPro III	$106	25.8	25.5	414.4	Poor	Poor	No
NetWorth, Inc.	UTP8-A	$179	20.8	20.5	324.5	Poor	Poor	No
NetWorth, Inc.	UTP16-B	$169	25.5	25.2	414.3	Fair	Fair	Yes
Ocean Information Systems, Inc.	Ethernet 2100	$75	27	26.4	440.4	Poor	Poor	Yes
Puredata, Inc.	PDI 7023-16	$170	26.2	25.7	416.5	Poor	Poor	No
Puredata, Inc.	PDI 8023Plus-1	$230	25.8	25.5	408.9	Excellent	Excellent	Yes
Racal InterLan	Interlan AT TP	$179	26	25.8	413	Fair	Fair	No
Racal InterLan	NI 5210-10BT	$179	22.9	22.3	355.5	Fair	Fair	No
Racal InterLan	NI 6510-10BT	$239	26.5	26	422.8	Good	Good	No
SIIG, Inc.	E-LAN 100	$159	21.1	20.5	327.3	Poor	Poor	No
SIIG, Inc.	E-LAN 200T	$179	25.4	25.2	413.5	Poor	Poor	No
SIIG, Inc.	E-LAN 300	$199	25.9	25.6	414.3	Poor	Poor	Yes
Solid Technologies	Ethernet 2000	$269	23.8	24.4	375.6	Poor	Poor	No
Standard Microsystems Corp. (SMC)	Ethercard Plus Elite 10T	$179	24.4	23.9	384.4	Fair	Good	Partially
Standard Microsystems Corp. (SMC)	Ethercard Plus Elite 16T	$199	26.2	25.8	425.4	Fair	Good	Partially
Sureman Computer Corp.	Etherperfect EP-30	$139	4.4		396.8	air	Good	Yes
Sureman Computer Corp.	Etherperfect NE-12CT	$89	25.5	25.1	415.2	Poor	Poor	No
SVEC Computer Corp.	FD0421A	$129	26.8	26.2	431.8	P	Poor	No
SVEC Computer Corp.	FD0490I	$99	25.5	25.2	413.9	Fair	Fair	Yes
Thomas-Conrad Corp.	TC5043-2	$259	25.5	25	15.8	Poor	Poor	No
Thomas-Conrad Corp.	TC5045-TIO	$319	26	25.5	425	Fair	Fair	No
Thomas-Conrad Corp.	TC5143-T	$159	25.5	25.1	415.1	Good	Excellent	Yes
3Com Corp.	**EtherLink III**	**$199**	**27.6**	**26.6**	**454.6**	**Excellent**	**Excellent**	**Yes**
Tiara Computer Systems, Inc.	EtherTrek	$149	25.7	25.4	413.7	Fair	Good	Yes
Top Microsystems	TOP RE-301	$99	21.1	20.6	327.4	Poor	Poor	No
Top Microsystems	OP RE-301T	$99	20.8	20.4	324.8	Poor	Poor	No
Top Microsystems	TOP RE-321	$120	25.5	25	415.5	Poor	Poor	No
Top Microsystems	TOP RE-321T	$120	25.4	25.1	415.1	Poor	Poor	No
Top Microsystems	TOP RE-3210	$137	25.5	25	415.5	Poor	Poor	No
Transition Engineering	TNIC-1500T	$99	26.2	25.7	426.5	Poor	Fair	No
Xinetron, Inc.	Xi 321TC	$99	25.6	25.2	413.5	Poor	Poor	No

= BYTE Best.

AUTOMATIC CONFIGURATION OPTION?	FEATURES SCORE	BUS WIDTH 8 BITS	BUS WIDTH 16 BITS	EMULATIONS SUPPORTED 3COM	EMULATIONS SUPPORTED NOVELL NE1000/ NE2000	EMULATIONS SUPPORTED SMC/ WESTERN DIGITAL	EMULATIONS SUPPORTED PROPRIETARY	WARRANTY LENGTH (YEARS)	PHONE	TOLL-FREE PHONE	INQUIRY NO.
Yes	7.2	✔	✔		✔			5	None	(800) PS2-2227	1371
Yes	7.2	✔	✔		✔			5	None	(800) PS2-2227	1372
Yes	7.2	✔	✔				✔	3	(503) 629-7402	(800) 538-3373	1373
Yes	8.8	✔	✔		✔	✔		Lifetime	(818) 407-3900	(800) 992-2882	1374
No	5.4		✔		✔			5	(714) 435-2600	(800) 835-6575	1375
No	5.4		✔		✔			5	(714) 435-2600	(800) 835-6575	376
No	5.4		✔		✔			5	(714) 435-2600	(800) 835-6575	1377
No	6.5	✔							(603) 880-1833	(800) 752-2768	1378
No	6.9	✔	✔		✔			3	(603) 880-1833	(800) 752-2768	1379
es	7.4	✔		✔	✔	✔	✔		(714) 891-5580	None	1380
No	5.7	✔	✔		✔			1	(714) 668-9550	None	1381
No	6	✔	✔		✔			2	(407) 895-088	None	1382
No	6.6	✔	✔		✔			2	(407) 895-0881	None	1383
No	5.3	✔			✔			Lifetime	(703) 329-3700	(800) 255-3967	384
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No	6.8	✔	✔					6	(408) 428-9108	(800) 323-7325	1387
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No	4.9		✔		✔			2	(612) 941-7600	(800) 325-2725	1418
No	5.4	✔	✔		✔			3	(408) 727-5509	(800) 345-4415	1419

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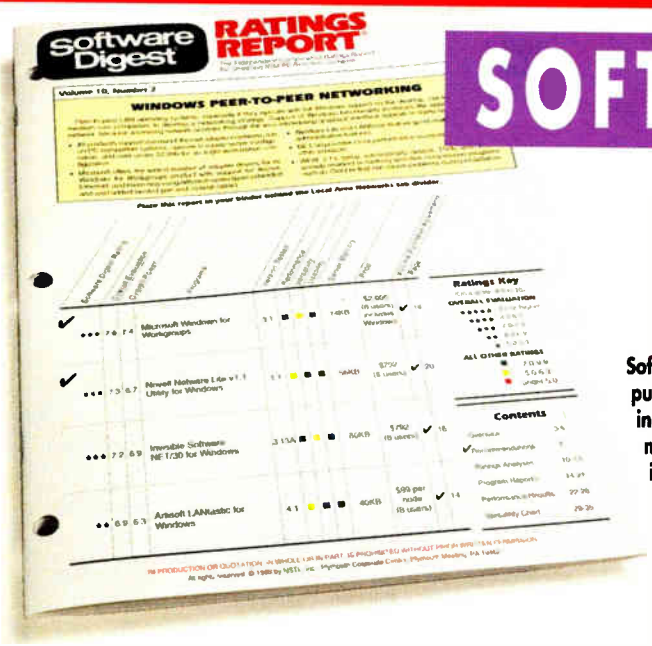

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Multimedia Infrastructures

A developer's view of Microsoft's Windows Multimedia Extensions and IBM's MMPM/2 for OS/2 architecture

THOMAS JEFFRIES

Multimedia applications and presentations make enormous demands on any computer's hardware and software resources. These applications use huge amounts of data, often in multiple concurrent streams that must be coordinated to within a fraction of a second. Despite these challenges, users expect multimedia programs to be instantly accessible, so the user interface must be highly intuitive.

Microsoft and IBM have responded by extending Windows and OS/2 with the Windows Multimedia Extensions and MMPM/2, respectively. Outward appearances notwithstanding, the products take different approaches to handling multimedia. Supporting multimedia at the operating-system level could eliminate a world of headaches for applications software developers, who are otherwise forced to reinvent ways to handle all the myriad complexities involved in writing multimedia software.

The Challenge

Ideally, an operating system designed for multimedia work should provide preemptive multitasking, easy extensibility, and format-independent data access. It should be object-oriented, be capable of synchronizing data streams, and provide support for an intuitive user interface. Most of all, it should be flexible enough to handle the demands that future applications will make. Providing such functionality while giving programmers complete, easy, and consistent access to it is a formidable task.

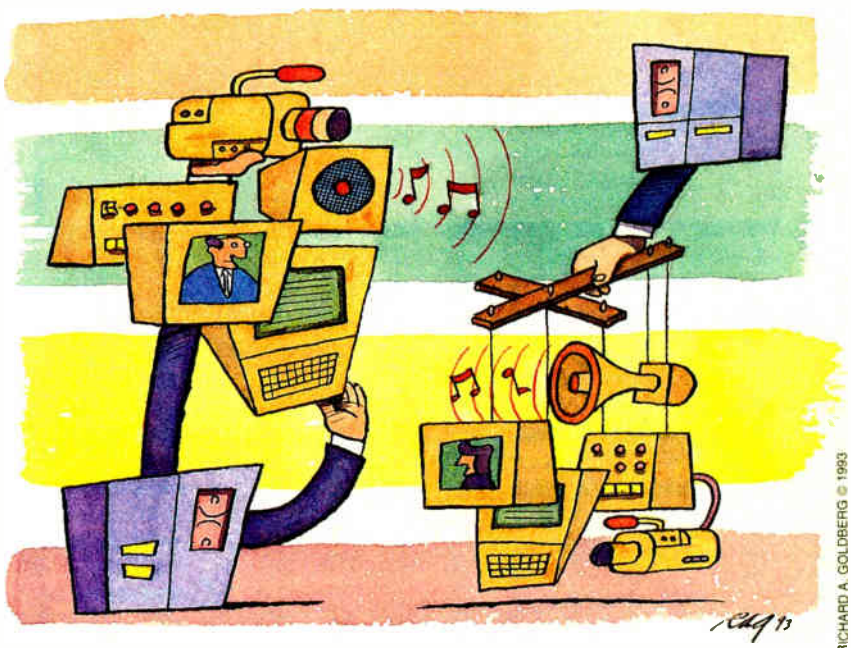
IBM and Microsoft have each introduced operating systems with multimedia capabilities either built in or offered as extensions to the basic package. They have spent considerable effort on these extensions and on the interface that they present to programmers. The results differ in concept and implementation.

IBM has a strong advantage in its base platform, which offers fully preemptive multitasking, multithreading, and 32-bit linear addressing. It has leveraged these advantages by creating an object-oriented architecture for its multimedia subsystem.

The limitations of MS-DOS (on which Windows relies for basic services) forced Microsoft to take a simpler approach. Neither Windows' cooperative multitasking nor the segmented addressing modes that Windows uses are completely adequate for the demands of multimedia programs. Despite these limitations, the company has created multimedia extensions that are quite serviceable for most uses.

The Microsoft and IBM designs have much in common. Both use multiple layers to provide as much hardware independence as possible. Each makes extensive use of callback functions within multimedia applications. And both allow applications to access the multimedia subsystems via strings or commands.

Even the terminology used in the Windows Multimedia Extensions and MMPM/2 is similar. For example, both products use the term *media control interface*, or MCI. Such similarities are helpful, but the terms sometimes carry different meanings. For example, Microsoft defines *MMTIME* as the structure it uses to contain timing information in several different possible formats, while IBM uses the term to refer to one specific format based on a time unit of 1/3000 second.



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Basic Structures

Both systems have multiple layers of system code between the application and the hardware. Under Windows,

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the DLL MMSYSTEM contains the API invoked by applications. MMSYSTEM then invokes either an MCI driver or a multimedia device driver to do further processing. "The Architecture of Windows Multimedia Extensions" shows the relationships.

Windows MCI drivers (sometimes referred to as device handlers) give the system its high-level functionality. They also provide a way to extend the standard API. They can either call the actual hardware device drivers to execute commands or talk directly to the hardware themselves. Commands to a Windows MCI driver include MCI_PLAY (play a wave file or MIDI sequence), MCI_RECORD (record a wave file or MIDI sequence), and MCI_STATUS (return information about the current status of a device).

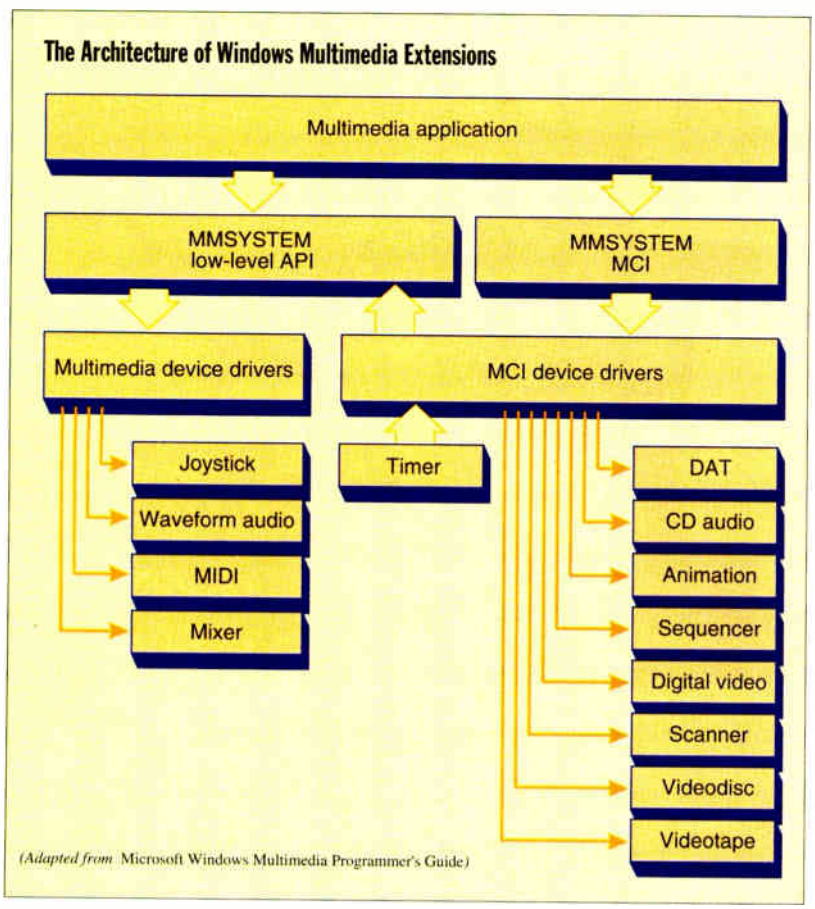
Windows multimedia device drivers (i.e., the hardware device drivers) implement a standard set of functions defined for each type of multimedia hardware. These functions include opening and closing devices, sending or receiving buffers of wave data and single MIDI messages, setting the volume on a device, and other basic functions. Under Windows, it is often necessary for an application to make calls to the multimedia device driver (through the MMSYSTEM) to have sufficient control over data and synchronization. There is always at least one level of MMSYSTEM code between the application and the device driver; applications never call device drivers directly.

Applications access IBM's MMPM/2 multimedia subsystem through the MDM (Media Device Manager) or the MMIO (Multimedia I/O) Manager. The MDM sends commands to the multimedia device drivers, which are the equivalent of Windows' MCI drivers. "MMPM/2 Architecture" shows how the parts fit together.

The MDM also handles issues like device contention. For example, if the PCM (pulse code modulation) audio-output device supports playback of two simultaneous asynchronous PCM samples, the MDM keeps track of the number of samples that are playing and allows only two to sound at any given time. If a sound must be suspended to let another sound play, the device drivers save the state of the suspended sound and resume playing it when a voice is free. Niceties like this show the power of both preemptive multitasking and the underlying object orientation of MMPM/2.

Under MMPM/2, PDDs (physical device drivers) control the actual hardware devices. Applications do not communicate directly with a PDD. Commands are passed through the MDM to a multimedia device driver and then to a PDD (often with the help of a stream handler), or through the MMIO Manager, a stream handler, and then to the PDD.

Microsoft's and IBM's goal is to insulate applications from device-specific information. The variety and nonstandardization of multimedia hardware preclude achieving this goal completely. However, both Microsoft and IBM have succeeded in developing systems that require much less knowledge of the underlying hardware than was needed under MS-DOS.



Under Windows, *applications talk to MMSYSTEM, which invokes either a low-level multimedia device driver or an MCI driver, such as the sequencer. MCI drivers may either control the hardware directly or call on a multimedia device driver to control the hardware.*

Scripting

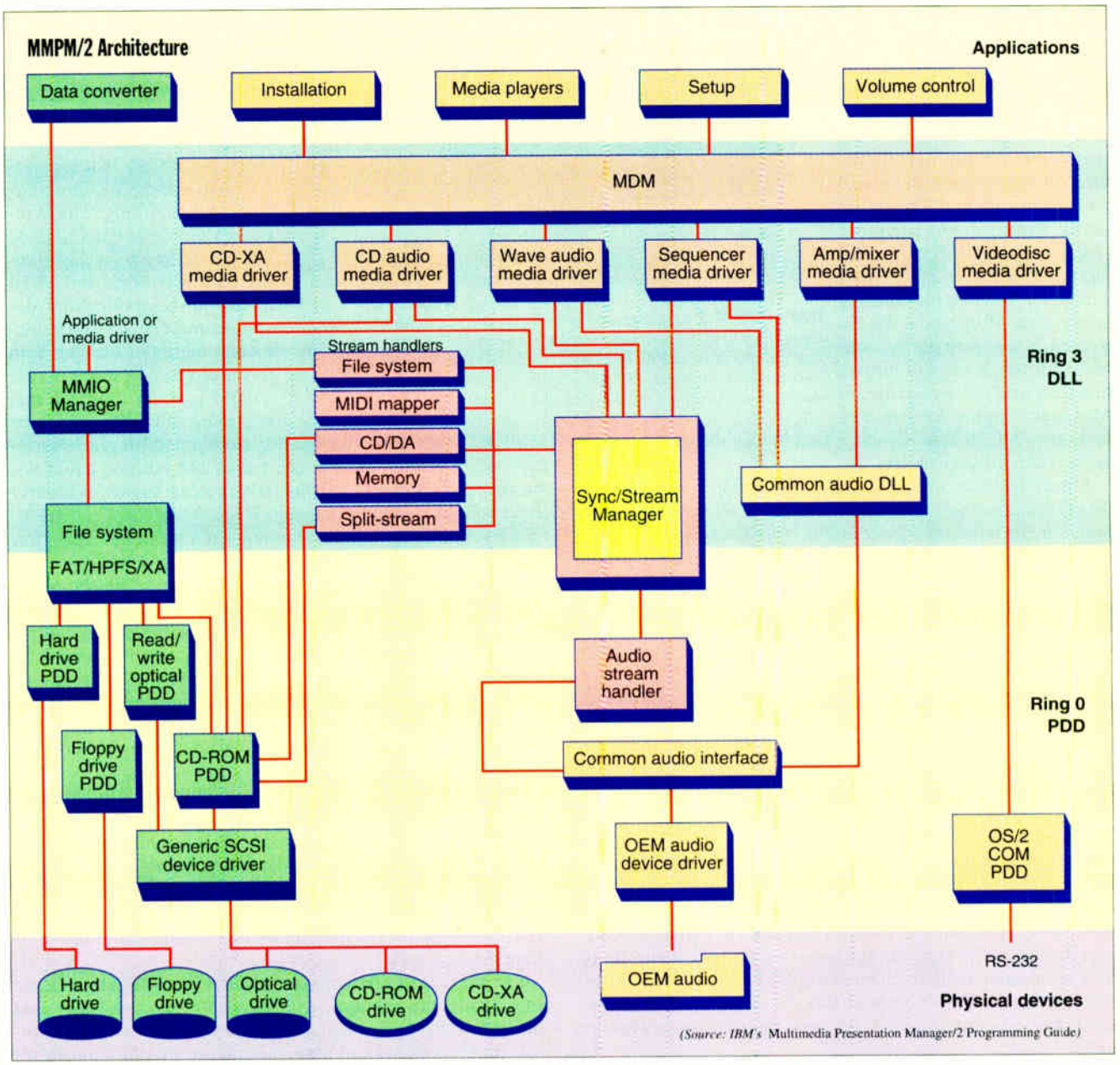
Many multimedia authoring systems provide some form of scripting capability, so that the user can enter or edit a series of text strings defining events that will happen in a given sequence. The closer the script language is to written English, the easier it is for the end user to create and modify the script. However, such script languages pose some serious problems for the programmer who has to provide code that quickly and accurately parses the script into instructions for the computer.

To make the programmer's job easier, IBM and Microsoft have provided string-based interfaces to their multimedia subsystems. Both systems provide commands to play, record, pause, resume, stop, open, close, get the status of a device, and return information about the capabilities of a device. MMPM/2 also includes commands for setting up connectors between data sources and devices and for dealing with cue points in the data streams.

Under Windows, these commands are parsed by MCI drivers. Microsoft provides a basic set of MCI drivers to cover the most common uses of a string command interface; driver developers can add support for additional commands by writing an MCI driver. Under MMPM/2, each media driver must support all relevant parts of the string command interfaces.

Dealing with Files

Multimedia is data intensive, so data handling is a critical part of any multimedia subsystem. Ideally,



Under MMPM/2, *applications rely on the MDM (brown boxes) for most services. If they require more direct control of the file system (green boxes), they can work through the MMIO Manager. Both the MDM and the MMIO depend on the Sync/Stream Manager (red boxes) to handle throughput.*

this subsystem will provide applications with ways to handle huge amounts of data in a device-independent fashion. The less the application has to know about the exact nature of the data and the hardware to which the data is sent, the easier it is for applications developers to concentrate on the content and quality of the presentation.

Windows offers two approaches to data handling. The MCI drivers take care of loading files and feeding them a little at a time to the device drivers. Data files are referred to as data elements, and the MCI drivers understand a variety of file extensions and formats.

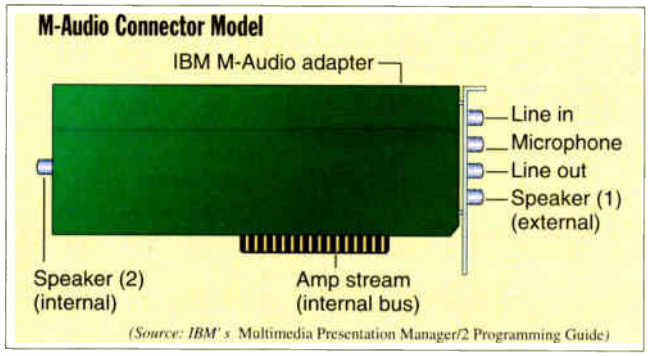
An application simply passes to the MCI drivers the device type (e.g., wave audio, MIDI sequencer, or CD), the name of the device element (e.g., the data file), and a command to play, record, stop, or pause. The MCI drivers take care of the involved process of reading the file from disk and sending it to the multimedia device drivers in buffers appropriately sized for the output device. However, the MCI drivers do not provide any facilities for synchronizing data streams.

Applications that need synchronization or finer control of the playback or recording process must work at a lower level, handling the details of translating data formats and allocating data buffers and locking them in memory so that they will not be swapped out to disk.

Because Windows uses 80x86 memory segments, each buffer must be less than 64 KB in size. As a file is played or recorded,

the application must continually add buffers to the system. Windows allows the application to control this process by means of messages and callback functions or by polling a bit in the data structures. The multimedia device drivers perform the actual transfer of data to the hardware device, usually during interrupts.

In designing MMPM/2, IBM had the advantage of starting with a more sophisticated file-handling subsystem. Multimedia data is treated as a stream and is controlled through a set of stream handlers and the Sync/Stream Manager. Applications invoke high-level MCI functions, which then invoke the services of the appropriate stream handlers.



IBM's MMPM/2 *uses connectors to indicate the way in which data is transferred between devices internal and external to the computer. This figure shows how each of the physical connections is represented in software as a connector. The amp stream connector represents the flow of data between the board and the personal computer.*

Stream handlers are provided for both source devices (e.g., data files and memory) and target devices (usually device drivers). Some stream handlers operate at ring 0 privilege levels, forming a direct connection to a physical device driver; others, like the file system stream handler, are able to operate at ring 3, since they can also call ring 3 functions. Stream handlers are responsible for maintaining the data flow, leaving the application free to deal with high-level control and the user interface.

IBM's MMIO services give the application more direct access to data than MCI does, while maintaining the insulation of the application from the specific file formats. The MMIO Manager includes a facility for translating one format to another without the intervention of the application, allowing an application to read and write files developed for other platforms.

Synchronization

One of the most critical issues in any multimedia architecture is the synchronization of the various outputs. When the soundtrack of a movie gets out of sync with the video, the effectiveness of the sound effects is lost, and the movie is not very enjoyable, except as a joke. The same holds true for multimedia applications. Synchronization is an excellent example of a function that a system should provide. Doing so makes the job of the applications developer easier and enables different applications to work together.

IBM and Microsoft chose widely divergent approaches to synchronization. The only built-in way to synchronize video and audio in Windows is through the AVI (Audio Video Interleave) format. AVI is similar to Apple's QuickTime. (For more information on QuickTime, see "The Mac Goes to the Movies," February BYTE.) After the audio and video data have been prepared separately, they are interspersed in a single file. Each frame has both audio and video information, which is directed, in real time, to the audio and video hardware.

Interleaved formats are useful for short clips, but they are difficult to edit and are not suitable for extended multimedia presentations. Many applications developers have chosen to avoid AVI, writing their own sync code instead. This forces the application to control playback or recording at the lowest possible level. The application must take over the whole multimedia subsystem, constantly polling the device drivers to get the current position and adjust accordingly.

Applications that mix video and audio aren't the only programs affected by Windows' lack of sync support. Take, for example, music editing (i.e., authoring) software that supports both MIDI and waveform playback and recording. The Windows Multimedia Extensions do not provide any good way to coordinate waveform and MIDI audio, so the applications developer must devise and implement a means of keeping both forms of audio in sync.

IBM took an approach that was more sophisticated. Under MMPM/2, there are two basic ways to accomplish synchronization within a single thread: cue points and position callbacks. An application can set cue points within a data stream. Whenever a cue point is reached, a message is sent to the application. Alternatively, the application can request a message every time there is a change in position within the data stream.

The Sync/Stream Manager provides a means of synchronizing events in different threads or even applications. Through calls to the Sync/Stream Manager, the application designates a group of data streams, establishing one data stream as the master and the others as slaves. The master generates sync pulses; the Sync/Stream Manager keeps track of the slaves and issues a sync pulse when one of them gets out of sync. All elements of the group maintaining sync are kept paged into main memory to avoid delays from reloading code or data.

The motion-picture industry long ago found a solution to the problem of synchronization in the form of a time code adapted by the Society of Motion Picture and Television Engineers. The SMPTE time code is a serial data stream that is recorded on tape and then used as a reference point for the video and audio portions of a movie. As with MMPM/2's Sync/Stream Manager, a number of devices may act as slaves to the device that is issuing the time code.

It's surprising that the computer industry has not made more use of the SMPTE time code, since it is an established and widely used standard. Both Microsoft and IBM allow the use of SMPTE formats for keeping track of time; they do not provide a means for a SMPTE device (either external hardware or an internal driver) to be used as the timing standard for all playback and recording devices.

Connections

One of the more interesting concepts in MMPM/2 is connectors—methods, in software, of connecting the different elements of a multimedia setup and presentation by means of the stream handlers. The analog in the real world is the cables that go between the different components of a home entertainment system. IBM has defined 17 different kinds of connectors, including MIDI stream, CD stream, wave stream, amp stream, headphones, speakers, microphone, line in, video in, video out, phone, and a universal connector that you can use to access device-dependent functions.

Connectors are a part of the stream management subsystem.

continued

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Nanao, the technical leader in monitors has done it again. In addition to being the top choice of today's graphics professionals and Windows users, Nanao's award-winning FlexScan F-Series monitors now have a remarkable energy-saving system — Power Save.

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They operate between data sources and data targets. They are established automatically when a multimedia device driver is opened, but the application can alter them.

Connectors solve a conundrum that has created sizable problems in using the Microsoft Multimedia Extensions: How do you handle audio (and video) mixing? Microsoft has defined a few mixing parameters, main volume, synthesizer volume, and waveform volume, that can be set in a piecemeal fashion using the AUX (auxiliary), MIDI, and wave drivers. However, there is no consistent or orthogonal way to incorporate mixing capabilities into an audio-board driver. MMPM/2 uses connectors to define an amplifier/mixer device that can control stereo volume for different devices, equalization (treble and bass controls), balance (panning), and signal routing.

Given the overall lack of standardized hardware, it would be too much to expect either Microsoft or IBM to develop a comprehensive, all-purpose software standard for video.

Digital Video

The Windows Multimedia Extensions and MMPM/2 support video from a variety of sources, including animation, digital video, videotape, analog video overlay, and videodisc. However, the required high data rates for digital video make it a problem area for microcomputers. To play back digital audio consisting of 16-bit samples in stereo at 44.1 kHz (CD audio quality), the computer requires a throughput of 172 KBps. Full-screen digital video at a resolution of 640 by 480 pixels with 256 colors and a frame rate of 15 frames per second requires a throughput of 4.5 MBps; additional colors, pixels, or frames per second push the requirements even higher. Some form of compression is required to accommodate this magnitude of data. A number of approaches are in use, including MPEG and JPEG, but no single standard has emerged.

Microsoft provides the ICM (Installable Compression Manager) to deal with this need. Applications access the ICM, which then accesses a codec driver that performs compression and decompression using hardware resources, if available. This affords a great deal of flexibility, since you can set up the host computer to take full advantage of the available hardware. However, it also means that multimedia applications developers cannot assume that any given type or level of compression will be available at the target computer.

IBM developed its own codec algorithm and includes it as part of its Ultimotion software. Ultimotion compresses frames at a ratio of up to 16 to 1 and will scale the size, frame rate, and number of colors to fit the speed of the target computer.

Given the overall lack of standardized hardware, it would be too much to expect either Microsoft or IBM to develop a comprehensive, all-purpose software standard for video. They have done their best to provide extensible architectures that will be able to accommodate the standards that will eventually emerge.

IBM's Playlists and Controls

MMPM/2 has the capability to control complex multimedia operations with a data structure that is called a *playlist*, an array of instructions and data. Windows MCI has no analog for this function.

A playlist's format is similar to that of machine code: It has a 32-bit op code that defines the kind of function to be performed, followed by three 32-bit operands that define the parameters or provide data. Operations allowed include branching, calling, looping, setting a cue point, specifying a data buffer, and returning a message to an application at a specific point in playlist processing. You can modify playlists dynamically, giving the application the ability to respond to user input. In effect, playlists form a small interpreted language for multimedia control.

IBM provides special controls designed specifically for multimedia applications. Unique among these are circular sliders, which look like the volume-control knobs on a stereo receiver. The same attention to detail shown in other parts of the MMPM/2 design is in evidence here. All circular controls can scroll the value up and down; however, the programmer can set up the control to allow or disallow the ability to change the value immediately. The company's reasoning is that allowing a volume control to go from 0 percent to 100 percent too quickly could damage either the user's equipment or ears. People who work with computer-controlled sound appreciate such thoughtfulness.

MMPM/2 Is a Good Start

Computer-based multimedia is in its infancy; an operating system with a mature, well-rounded, easily extensible multimedia subsystem would be too much to expect at this point, although IBM has made a good start. MMPM/2 contains the necessary elements to be a highly usable platform for professional multimedia and desktop video projects.

Microsoft, hobbled by MS-DOS, has created a more limited product, oriented toward adding sound effects and audio/video clips to documents. It's possible to develop a good multimedia application using the tools that the Windows Multimedia Extensions provide, but such a project is likely to require considerably more effort than a similar project under MMPM/2.

Windows NT, Microsoft's fully preemptive multitasking operating system, holds promise. But Microsoft says it has no immediate plans to give NT multimedia capabilities beyond those found in the 16-bit versions of Windows. Meanwhile, IBM and Apple are participating in several joint ventures, including Kaleida, a project specifically aimed at multimedia.

Ultimately, it seems likely that competitive pressures will force Microsoft to at least provide better facilities for data streaming and synchronization. Until then, MMPM/2 is in a class of its own. While it isn't perfect, MMPM/2 is the richer, more mature environment for multimedia applications development. ■

Thomas Jeffries is president of Singing Electrons, a Lopez, Washington–based company specializing in multimedia audio products and services. You can reach him on BIX as "tjeffries" or on the Internet at tjeffries@bix.com.

Exploring NetDDE

Windows for Workgroups' flexible and powerful NetDDE capability is an underappreciated gem

JON UDELL

Last night I dialed into the BYTE LAN and pulled some data from a FoxPro server running on my office PC into a Word document on my home PC. That's a neat trick, because FoxPro isn't a client-server database. It's useless without high-speed local or network access to database files.

One solution is to run a Windows-savvy remote-control program like Ocean Isle Software's ReachOut or Avalan Technology's Remotely Possible/Dial. These tools can pull FoxPro's interface through a phone link while leaving the data on the far side, where FoxPro's engine can get at it.

However, I took a very different approach that exploits NetDDE, the network DDE protocol introduced in Windows for Workgroups. Running FoxPro for Windows as a DDE server, I used NetDDE to ship queries and results across a WFW network that, thanks to Shiva's NetModem/E, can extend to my home.

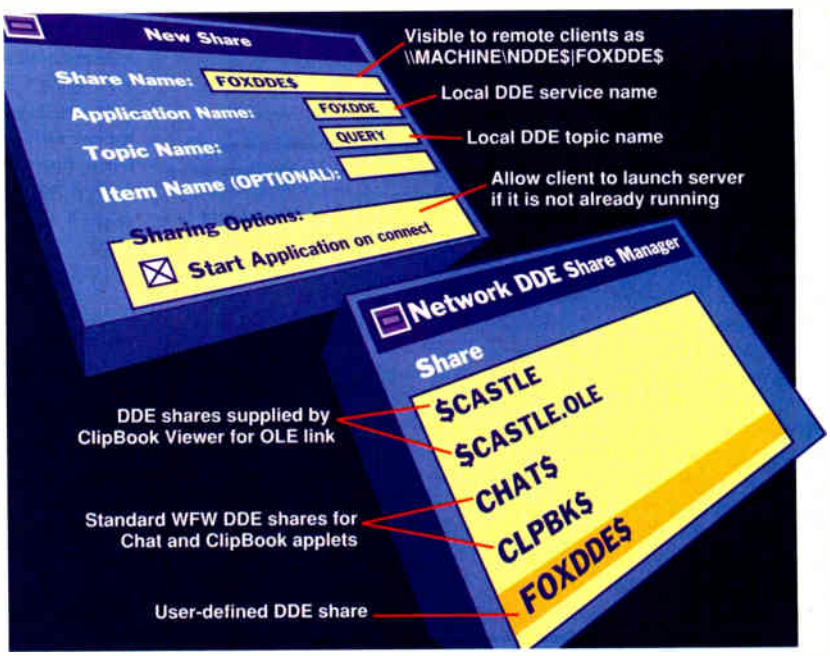
While this experiment hardly qualifies FoxPro for the database-server big leagues, it does showcase one of WFW's underappreciated gems. Most WFW users know that the Chat applet and the Hearts game use the NetDDE protocol for live peer-to-peer communication, as does the ClipBook Viewer. But not everyone realizes that you can do this sort of thing with any old DDE server and client. With my FoxPro example, I proved this concept using the sample DDE client that comes with the Windows 3.1 Software Development Kit, and I then refined it using Word.

Step by Step

Here's a review of the steps involved. Creating a custom DDE server is normally an arcane task, but FoxPro for Windows makes the job a ridiculously easy one. The FOXDDE listing on page 200 shows the setup code that defines a DDE service named FOXDDE, configures it to accept EXECUTE and POKE transactions from DDE clients, and associates the service with a FoxPro routine (FOXSERV) that implements the DDE service.

The FOXSERV.PRG listing on page 200 shows the service routine. When the client performs an EXECUTE transaction, the accompanying data—which might be "select * from authors" or "skip 1"—executes as a FoxPro command. To fetch data, the client does a POKE transaction on the DDE item FIELD to set the name of the desired field and then performs a REQUEST transaction on the item DATA to retrieve the value of that field. The WinWord listing on page 200 shows a WinWord macro that connects to the server, issues a query, and inserts a piece of retrieved data into the current document.

The DDE protocol organizes transactions using a three-tiered protocol: service, topic, and item. A local client of the DDE service shown in this listing connects to service FOXDDE and topic QUERY and then manipulates items FIELD and DATA in the context of POKE and REQUEST transactions.



The Network DDE Share Manager, *not included with Windows for Workgroups, is the missing link that you need to establish conversations between DDE clients and servers over a network using the NetDDE protocol.*

How does a remote client exploit NetDDE to use this same service? The machine that's running the DDE server must publish a share name that identifies the service. The good news is that a tool called the Network DDE Share Manager can add these names to the WFW shares

database (saving you the trouble of coding to the NetDDE API). The bad news is that Microsoft didn't ship DDESHARE with WFW. However, you can get the source code on CompuServe in the WINEXT forum. DDESHARE itself comes with the WFW Resource Kit.

Once I defined the DDE share name FOXDDE$, I could connect to my FoxPro server from remote WFW clients. The mechanism differs for the remote client, however. While the local client connects to FOXDDE|QUERY, the remote one connects to \\JON\NDDE$|FOXDDE$, where \\JON identifies the server machine, NDDE$ denotes the NetDDE subsystem on that machine, and FOXDDE$ encapsulates the actual DDE service and topic names.

Redirection on both ends of the NetDDE pipe fools the client into thinking it's talking to a local server and vice versa. I could then connect to the FoxPro server from other WFW machines in the office and from my WFW machine at home. I could also connect to it from machines running the March beta copy of Windows NT, which incorporates all the workgroup features of WFW, including NetDDE.

Communication between a DDE client running on a Deskstation Technology R4400-based Evolution RISC PC and a DDE server running on a Swan 386/25 was an impressive demonstration of interoperability.

The FOXDDE server setup

```
public sField
=ddesetservice('FOXDDE','DEFINE')
=ddesetservice('FOXDDE','EXECUTE',.T.)
=ddesetservice('FOXDDE','POKE',.T.)
=ddesettopic('FOXDDE','QUERY','FOXSERV')
```

FOXSERV.PRG, the callback routine for a FoxPro DDE server

```
parameters iChannel, sAction, sItem, ;
           sData, sFormat, iStatus
=DDEEnabled(.F.)
do case
  case sAction = 'EXECUTE'
    &sData
  case sAction = 'POKE'
    if sItem = 'FIELD'
      sField = sData
    endif
  case sAction = 'REQUEST'
    if sItem = 'DATA'
      =DDEPoke(iChannel,'DATA',eval(sField))
    endif
endcase
=DDEEnabled(.T.)
return
```

The WinWord DDE client

```
Sub MAIN
chan = DDEInitiate("\\jon\ndde$", "foxdde$")
DDEExecute(chan, "select * from articles")
DDEPoke(chan, "FIELD", "rsTitle")
Insert DDERequest$(chan, "DATA")
DDETerminate(chan)
End Sub
```

NetDDE and OLE

OLE 1.0, the version that's in Windows 3.1 and WFW, isn't network-aware. Version 2.0, which improves OLE's performance and usability, doesn't tackle networking, either. Microsoft's official story is that you won't be able to build distributed, compound documents until the debut in 1994 of a next-generation Windows system called Cairo. Cairo's object-oriented file system will be an extension of the Windows NT file system, and its third-generation OLE technology will build on the RPC (remote procedure call) mechanism that's in Windows NT today.

Vaporware aside, you can network OLE today using NetDDE. WFW's ClipBook Viewer, which replaces the Windows 3.1 Clipboard Viewer, conspires with NetDDE to make this trick possible. ClipBook Viewer resembles the Macintosh Scrapbook. You can save chunks of Clipboard data there, name them, view them in several formats, and then restore them to the Clipboard.

ClipBook Viewer is much more powerful than the Mac Scrapbook, though, because you can also share the things you store there. (The Mac's System 7 has another mechanism, Publish/Subscribe, for this kind of sharing.)

ClipBook Viewer is so powerful, in fact, that I no longer use it for ordinary Clipboard tasks. The new toolbar and the multiple document windows just get in the way when I simply want to copy data from one local application and paste it into another. So, I've reinstated the old, elegantly simple Clipboard Viewer and use the new one only for local or shared ClipBook tasks.

Given that WFW supports E-mail with attachments in addition to file sharing, why bother to share Clipboard data? There are distinct advantages. E-mail pushes data across the network, but sometimes it's better to pull than to push. For example, suppose I've got a file on my machine that changes weekly. You may or may not care about the latest update. Rather than clutter up your inbox with junk mail, I'd like to empower you to just take the information when you need it.

I could share the directory containing that file, but WFW's share-level security won't let me vary permissions for individual files in that directory. The shared Clipboard, which handles per-item permissions, offers more precise control. It also supports long, descriptive names that help browsers of your ClipBook understand what you're publishing and why.

What's more, you can share an OLE link to the data. Consider the stand-alone case first. If you copy data from an OLE server application to the Clipboard, you can paste a link to the donor document into an OLE client, which then receives updates automatically. The network scenario involves more steps. To share a link, you copy from an OLE server to the Clipboard and paste the data onto a new ClipBook page and elect to share it.

On the other end, I reverse the process. I connect to your Clipboard, locate the ClipBook page, copy its data to my Clipboard, and then paste a link into an OLE client. NetDDE redirects the DDE traffic that underlies the object-linking protocol. It's easier than the do-it-yourself setup I've shown you, because the server-side ClipBook Viewer creates the necessary entries in the DDE shares database, and the client-side ClipBook Viewer interprets them transparently.

A Few Limitations

This is great stuff, but it only goes so far. Remote clients can view a linked object and receive updates to it, but they can't activate the object's server to edit it. In the stand-alone case, an OLE client launches an OLE server using a DDE service name

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that specifies the linked object's OLE class (e.g., PBrush) and a DDE topic name that refers to the linked file (e.g., D:\JON\IMAGE.BMP).

In the network case, those names differ. The class name is always \\MACHINE-NAME\NDDE$, and the topic name refers only indirectly to the linked document by way of the server-side DDE shares database. The OLE client doesn't understand these names, so it shrugs when you double-click on the linked object.

What should happen in the NetDDE case? That's an interesting question. Suppose the system knew how to recover the object's class name and then map it to an application. The client could then launch its copy of the server application (say, Paintbrush) when the user activated the linked object.

But what document should it feed to that application? There's the rub. The document name that travels with the link refers to the server's file system, not the client's. Extending WFW's file-sharing model to permit file access in such cases might have worked, but would have also introduced complications that Microsoft chose—probably wisely—to avoid.

There are other complications. While DDE servers can carry on multiple conversations with several clients, local and remote clients have trouble connecting simultaneously to the same service-topic pair. Transaction timing, already a tricky matter in DDE, gets even trickier in NetDDE, and throughput is nothing to write home about.

More generally, the future of DDE itself appears cloudy. OLE 2.0 has abandoned it in favor of an RPC protocol that will be faster than DDE and will play into the RPC mechanism that's fundamental to Windows NT and Cairo.

Despite its flexibility and power, NetDDE seems destined to become an orphan. As applications standardize on OLE 2.0 and higher, they'll tend to abandon straight-up DDE support. Interprocess communications across a network will use either RPCs—Windows NT utilities such as Print Manager already do this today—or a version of OLE built on RPCs instead of DDE.

Don't write DDE's obituary yet, though. Remember that Microsoft is always two versions ahead of reality. NetDDE is here today, and you can do interesting and useful things with it. Nor is it limited to WFW. Wonderware, from whom Microsoft licensed the NetDDE code in WFW, markets NetDDE for Windows 3.1 on NetBIOS and TCP/IP networks and sells tools you can use to build DDE servers for VMS. Symbiotics' Networks Connect delivers a NetDDE-like capability to Windows 3.1 on NetBIOS, SPX/IPX, and TCP/IP networks, and the company is developing an OS/2 version as well.

Many applications support DDE today, and they'll continue to do so for a long while. The ability to route that DDE traffic across a network opens up a fascinating new dimension for advanced users and system integrators. ■

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Elegant Windows Dialog Boxes

The inventor of RoboHelp shows you how reusable classes simplify the creation of this special type of Windows dialog box

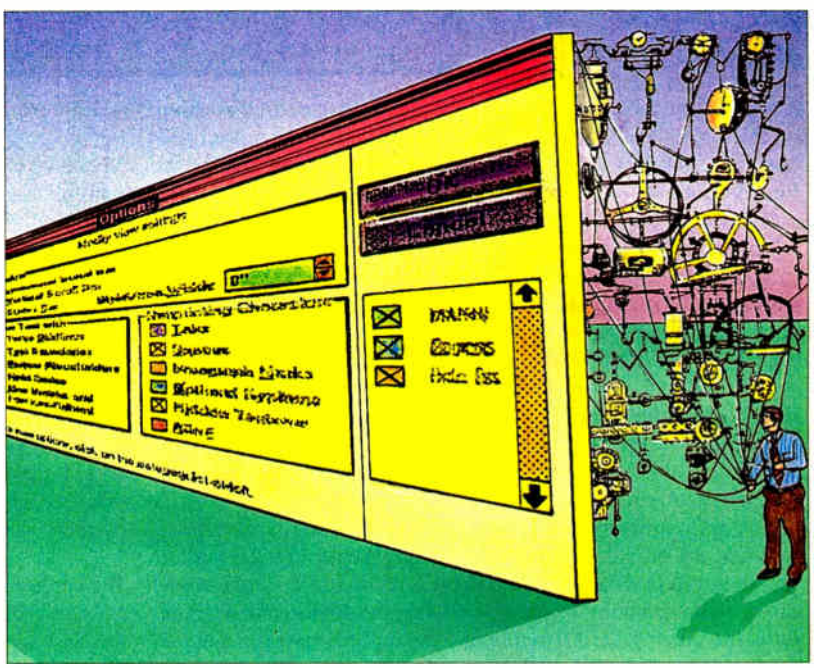
GEN KIYOOKA

Programming Microsoft Windows in C or C++ is a great deal easier than it used to be. But even in today's world of increasingly powerful tools and libraries, developing Windows applications, drivers, and DLLs can still be a daunting task. What's more, Microsoft's Applications Group continues to up the ante with a constant stream of new interface ideas.

One such interface enhancement is Microsoft Word for Windows 2.0's elegant Word Options dialog box. Along the left side of this box are icons that represent the option categories. When you select an icon, the option lists on the right side of the box change to reflect the set of child-window controls appropriate for that option. I'd seen this type of switching dialog box in other application programs before, but none had achieved this level of design elegance. I knew then that I had to build one.

Variations on this design appear in different software applications under Windows and other platforms. The OS/2 Workplace Shell, for instance, introduces a tabbed dialog-box control that is in essence a virtual notebook. Quattro Pro for Windows provides a variation on this theme; it has tabbed dialog boxes that aren't so realistic in their visual rendering but provide other conveniences, such as when the color of the tab changes to indicate whether you've altered any of the settings on a particular page. No matter what application's visual style you wish to emulate, you'll find the classes below provide a solid foundation for your development activities.

The solution in my sample program uses a basic hypermedia design principle, derived from the notion that a user feels more comfortable with movement through a complex body of information if there is a visually evident "home base" that remains stable. In the case of the Word Options dialog box, the graphical list of options on the left side provides that stability, allowing the content of the right side, or *subview*, to take on an arbitrary amount of complex transformations.



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Design Goals

My propensity for reusable design kept me from rushing into a premature implementation. I had to have a reusable technique that would be available for any number of particular implementations.

To achieve maximum reusability, you need to design by thinking in the large—that is, by considering and weighing a large number of requirements, many more than are needed just for the particular implementation. By weighing all these requirements, you can then distill the basic repetitive patterns that make up the core classes that inevitably form the root of the inheritance hierarchy, or foundation types (in an object-based implementation).

I had several design goals for creating switchable dialog boxes. The implementation had to be no more difficult than that of a regular dialog box. The dialog box's controller (the active agent that switches the control sets) could not be limited to a listbox control, but could be a listbox, combo box, radio button, or other control. Switchable dialog boxes had to work comfortably within C++ application frameworks and with code generators such as WindowsMaker Professional. And they could not preclude the use of visual design tools for designing the layout of the child-window controls in the dialog box. The various subviews presented in the dialog box had to be capable of being represented internally as completely independent classes, not forced into a single, monolithic

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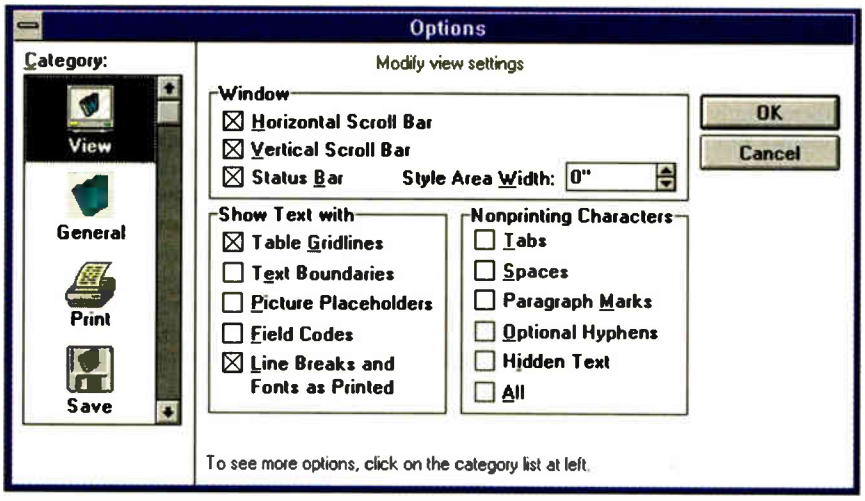
dialog-box implementation. Finally, the solution had to allow for an arbitrarily large number of available views, permitting the actual implementation of subviews to be contained in external DLL packages.

The Design's Evolution

To implement a basic dialog box that contains multiple control sets, you create a single dialog-box template with a dialog-box editor. You place every control on the surface of the dialog box, and then, during the processing of the WM_INITDIALOG message, you hide the controls that aren't in the visible subset using `ShowWindow`.

Unfortunately, not only is the activity of designing a dialog box with multiple layers of controls difficult, but the Windows dialog-box manager has a limit of 255 controls per dialog box. That limit places a low upper bound on the number of subviews that you can have. Most often, you would kludge together the textual resource-script representations of several dialog boxes, manually altering the offsets of the various controls to set their position on the dialog box. The only situation where this approach works, however, is when you've got a client who's paying you on an hourly basis.



The foundation of a reusable solution is simply the automation of the manual technique. The logical approach is to create the multiple subviews as separate dialog-box templates and then use a reusable subdialog manager to dynamically load and create the subviews. I came up with four candidate classes: DialogTemplate, DialogControl, DialogUnit, and SubDialog.

DialogTemplate provides an opaque, convenient interface to the dialog-box template resource. This interface hides the vulgarities of dealing with packed structures, and it's responsible for providing an enumeration of the control-item definitions in a dialog-box template resource.

DialogControl represents a single item in a dialog-box template resource and provides a means for creating the item on the surface of a dialog-box window. DialogUnit is responsible for the coordinate transformations required between the device-independent units (i.e., dialog units) used by the dialog-box manager and the device-dependent units that the window manager uses.

SubDialog represents a single view that consists of a set of controls that can be independently created, destroyed, shown, and hidden. It's responsible for locating and loading the dialog-box template resource and for attaching an identifying property to the property list of each control in the set.

You achieve true reusability by making classes small. In my environment, reusability has some stringent definitions. Generally, to be able to reuse a class or type, you shouldn't need to make any modifications to the source for that class; rather, you should simply include an appropriate interface definition and then put the class to work. My implementation of the above classes follows that model.

The three classes or types related to the dialog-box template are encapsulated in a single pair of source files: interface (DLGTEMP.H) and implementation (DLGTEMP.C). The remaining class (SubDialog) has its own pair of files (SUBDLG.H and SUBDLG.C). You should be able to simply add these files to your C or C++ project and immediately put the classes to use.

I've also included two sample programs developed with this set of four classes. The first program is a standard C application, developed using WindowsMaker Professional; it implements a switchable dialog box that's similar to the Word Options dialog box in Microsoft Word. The second program is a C++ application, developed using Microsoft Visual C++, that uses the Microsoft Foundation Class library 2.0. In the C++ sample program, the switchable dialog box emulates the spiral-bound notebook look and feel currently popular in the OS/2 Workplace Shell.

I debated whether to provide a full implementation in C++, but the goal of C++ is to provide an easy migration path from C. My intent was to satisfy both the reader who is actively using C++ and the reader intending to move to C++. Therefore, the foundations of the switchable dialog box are object-based solutions implemented in standard C. I say "object-based" because the code is uniformly designed to wrap a collection of methods around a structure definition that serves as the definition of the class's private data. Each of the classes has constructor and destructor functions where appropriate.

If you'd like to wrap a true C++ class around my solution, it should be a relatively simple undertaking. Curiously, by habit, I have standardized on the use of `Self` to refer to the instance on which a particular method is operating. For C++ enthusiasts, `Self` (a Smalltalk term) is directly analogous to the C++ `this` pointer.

The Implementation

Most of the grunt work involved in switchable dialog boxes is in the classes pertaining to the dialog-box template. Essentially, a dialog-box template is a resource bound into an executable module. Consider the new executable format to be a database containing binary records of arbitrary size and type. Code and data segments are simply records in the database, as are any graphics, string tables, dialog boxes, and menu resources.

The Windows API provides one consistent API for accessing the typed resource records, via `FindResource`, `LoadResource`, `FreeResource`, `LockResource`, and several APIs specific to certain kinds of resources. The resource-loading mechanism can easily be extended through the inclusion of resource

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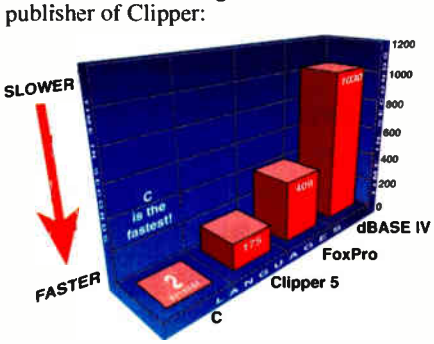

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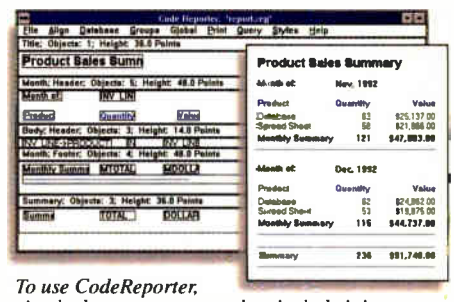

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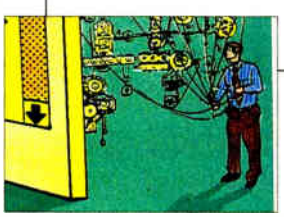
handler functions. These allow user-defined resources to behave in a manner consistent with the standard resource types.

The resource compiler takes the script resource definition for a dialog box and packs it into a byte-aligned (Win16) binary structure that must be walked sequentially from the header in order to access the data members contained within. The `LockResource` function returns a 32-bit void pointer that points to the beginning of the packed structure's header. The header is documented in the Windows Software Development Kit and on the Microsoft Developer Network CD-ROM.

The SDK documentation is incomplete, however, and is annotated via a Microsoft Knowledgebase article (Q88680), which describes the private data area available to each control item. Thankfully, you'll never need to walk this structure yourself, since the DialogTemplate object type cleanly encapsulates the format of the packed resource. It provides enumeration and information functions that let you query the contents of the header with normal structure definitions.

To maintain device independence, the control-item definitions in a dialog-box resource contain dimensions and location coordinates in special dialog-box units. These units are not related to physical pixels on the display screen but, rather, are relative to the size of the font in the dialog box. The SDK documentation gives a simplistic formula for performing the transformation on the coordinates. In practice, the simple formula does not yield results that are identical to the workings of the dialog manager.

The assertion that property lists are slow under Windows 3.1 is a myth.



After some tweaking, I was able to have the DialogUnit object type implement methods to transform any point from one coordinate system to another, with results consistent with the Windows dialog manager. The DialogUnit class exports two constructor functions; one takes the window handle of an existing dialog box, and the other takes a pointer to a dialog-box template. As only the former was needed for this implementation, the body of the latter function contains only a stub that asserts on a zero—a gentle reminder that it should be fleshed out before use.

In true object-oriented spirit, the objects implemented in the DLGTEMP.C file contain no understanding of switchable dialog boxes. Instead, they concern themselves exclusively with the format of the dialog-box resource template and the relationship of the data in that resource to the manifestation of a Windows dialog box. I plan to expand and reuse the behavior in these classes during the implementation of a dialog-box editor later this year.

The SubDialog object-based class, as implemented by SUBDLG.C, contains the behavior specific to switchable dialog boxes. I thought it was important to completely hide the details of dialog-box templates from consumers of SubDialog, especially since the format of the packed dialog-box template will differ slightly with Unicode (and more stringent data-alignment regulations) under Windows NT and Win32s.

SubDialog is relatively straightforward. Two constructor functions are provided: One takes a handle to an already-loaded dialog-box template resource, and the other takes a module handle and resource name. Using the second constructor, you can create an architecture that stores the subview dialog-box templates (and associated message-processing procedures) in external DLLs, providing an elegant visible interface to an architecture for an arbitrary type of application extension.

The SubDialog object-based class uses Windows property lists to track the set of controls that belong to a particular view. Using property lists in this manner makes for a simpler implementation than, say, creating and maintaining a linked list or array of window handles.

The assertion that property lists are slow under Windows 3.1 is a myth. Managing the subviews in this manner allows multiple views to be open simultaneously within the context of a single parent dialog box, the requirement being that each subview must have a unique name (given by an argument to the constructor function).

The life cycle of a SubDialog closely follows object-oriented conventions. The object is instantiated by way of a call to a constructor function. The programmer can then call either of the `OpenView` functions to enumerate the control items in the template and create the child windows on a particular dialog box.

A variant method, `OpenViewAt`, takes the identifier of a preexisting child window as an argument. The idea is that you probably want to open a view of controls at some location other than the origin of the dialog box. The easiest way to do this is to use the rectangle of an existing child control on the dialog box to provide a context for the new view. When designing the host dialog box (the stable portion of a switchable dialog box), simply include a static control at the coordinates where you'd like the subviews to appear. You can use the control itself to visually delineate the subview (as I've done in the C++ example), or you can simply hide the control before the dialog box is displayed (as in the standard C example).

SubDialog's enumeration method actually creates the child window based on the definition from the template (`SUBDLG_CreateItem`). This method switches off the WS_VISIBLE bit in the style doubleword of the control-item definition. This allows tighter control over the way the subviews are shown (or not shown) on the screen and reduces screen flicker. The `SUBDLG_CreateItem` method also sets the control's font to the default font for the dialog box.

Using Foundation Objects

Using switchable dialog boxes in your own application should be relatively easy. To begin, you need to design a host dialog box to house the switchable sets of subviews. Use your dialog-box or resource-editing tool to create a dialog-box definition. Chances are that you'll want the subviews to appear in a position other than the upper left corner (origin in MM_TEXT) of the dialog-box definition, so you need to place a static control with a rectangle equal to the largest of your subviews.

On this host dialog box, include any buttons that are to appear stable throughout the life of the dialog box. The host dialog box normally contains some sort of active agent that can be used to determine which subview is currently selected. In the samples provided, both the MFC and C implementations make use of

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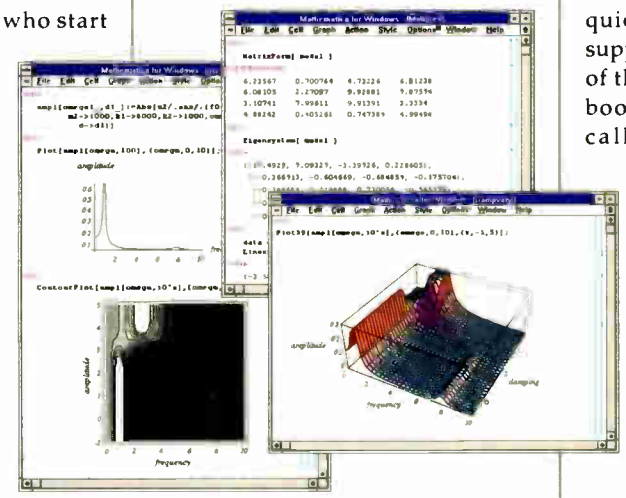

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owner-draw listboxes, but this requirement can be filled by any combination box, listbox, group of radio buttons, or custom control that you desire.

Next, you need to create one dialog-box template for each of the subviews you're potentially going to open on the surface of your host dialog box. The font, class, and horizontal and vertical extents of the dialog box will be ignored when the subview is opened, and the controls in the subview will take on the characteristics of the host dialog box. However, nothing's stopping you from using these dialog-box templates elsewhere in the program, so you might like to set the views accordingly.

Once you have the basic visible elements for the subview, you need to create some internal structures for manipulating a set of SUBDLG objects—one for each subview that will be displayed in the dialog box. At this point, you must decide which of two approaches you are going to take.

The easiest approach is to create and open one subview for each of the possible views that are going to be used in the host dialog box. Depending on the selection in your controlling agent, you'll show one of these possible views. This means instantiating all the SUBDLG objects during the processing of WM_INITDIALOG and destructing them in WM_DESTROY. The standard C example uses this technique. The advantage to this first approach is that the invisible control sets maintain their state even when not visible on the screen and, in essence, act just as if a single dialog-box template had been cobbled together by hand. This is by far the more convenient of the two approaches.

The second approach is more extensible and can be used to implement a switchable dialog box in the event that unexpected subclasses may be entering the system at some point. In addition, the second approach consumes fewer system resources than the first, since only the items in the visible view have associated window handles. Unfortunately, since the controls on the view are destroyed during switches, you'll need to define some additional events in your host dialog box that allow for saving and restoring the state of all the controls in each of the views on your dialog box.

Although the C++ example uses this second technique, I have not included the code to save and restore the state of the controls. It's likely that the same code used to fetch the contents of the controls on receiving a WM_COMMAND message from the IDOK button could be modified to handle the saving and restoring of control states.

Using this second technique, you can maintain regular dialog-box equivalents for each of the subviews in a switchable dialog box. Conceptually, each of the subviews is simply a subclass or a specialized derivative of the host dialog box. You could derive a dialog-box class from your base dialog class to handle the control items in the subview and simply attach to the host dialog box via a dynamic subclass. When switching views, you could detach from the host and attach the class for the new view in place. The possibilities are limitless.

Improvements

When you download the code, you may notice a proliferation of `assert` statements in the implementation. Each of these `assert` statements is paired with a conditional statement designed to halt execution on detection of an exceptional condition. Even during release builds, when the `assert` statements are benign, the conditionals prevent the program from walking into undesirable state space.

To make the design even more robust, I suggest designing additional, more thorough preconditions. Two obvious ones spring to mind: You'll want to prevent duplicate control identifiers from being present on the same dialog-box definition. It's likely that your resource editor already ensures the uniqueness of control identifiers globally within your application, but adding such a requirement ensures early detection of any such scenarios. It's also a good idea to make dialog-box Alt-key accelerators unique. This requirement could form another precondition to the `SUBDLG_CreateItem` method.

Another idea pertains to the tab-key order of the host dialog box. As an interface designer, I might wish to have the subview fit somewhere inside the tab order of the host dialog box. For instance, in both the C and C++ samples, you'll find OK, Cancel, and Help buttons on the host dialog-box template. You might want the tab order to go from the controlling agents through the subview and on to the standard buttons.

As a paean to the proliferation of standards, it would be just and fair for me to undertake the design and construction of a further example illustrating a simulated Borland look, as perpetuated by Quattro Pro for Windows. Presumably, OWL would be the framework du jour, and I promise to create such a mythical beast and have it ready by the time this article goes to print (and the eager reader sets forth to download the code).

My last idea for improvement was not implemented because of the divergence in C++ application frameworks. Essentially, you need a SubDialog manager class hierarchy derived from the Dialog base class in each of the MFC, OWL, zApp, and Zinc class libraries. I can envision at least two abstract levels before reaching the point of instantiations: One layer handle would manage a controlling agent and provide some virtual functions for switching sets, and the other might provide two different inheritance branches vis à vis the two different techniques for implementing the switchable dialog box. A third class, derived from the implementation that shows and hides controls between switches, might provide a superclass for dialog boxes that use owner-draw listboxes, making implementation even more convenient.

You should be able to deploy the reusable foundation object types I created for switchable dialog boxes in an arbitrary C or C++ project without modifying them. I'm curious as to what extent I've achieved this end, and I welcome reader feedback and bug reports. This project is more than just an exercise: I plan to use these object types in several new products that I'm developing. ■

Editor's note: *The complete listings for programs mentioned in this article are available electronically. See page 5 for details.*

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Gen Kiyooka is the founder of Electron Image and inventor of Blue Sky Software's RoboHelp and BugMan programming tools. He is based in San Diego, California. You can reach him on BIX c/o "editors," or on CompuServe at 76376,43.

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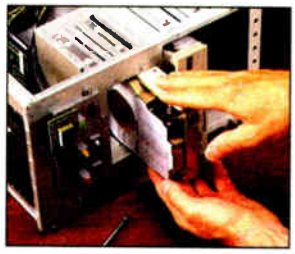

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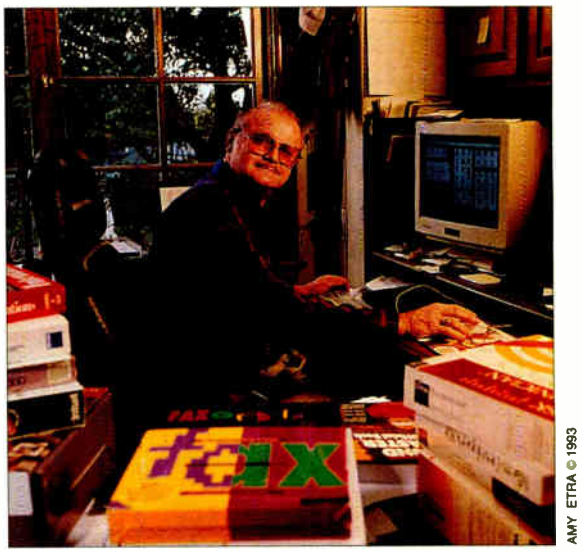


AMY ETRA © 1993

For quick-and-dirty do-it-yourself applications, or even serious business-oriented applications, nothing beats BASIC

I've been doing a bit of serious programming this month; it's proven to be a humbling experience. I also found what is a king-size bug in Microsoft's QuickBasic Compiler.

It all started when I ran out of printed checks. Back in February 1982, I wrote a program that would take my journal files, look for entries against the checking account, and write those checks. I also bought several thousand tractor-feed checks. All this was for a NEC Spinwriter, which replaced my original Diablo daisy-wheel printer, and it occurs to me that many of you won't have the foggiest notion of what I'm talking about.

The Diablo and NEC Spinwriter were letter-quality printers back in the "dark ages." In contrast to the horrible output of the dot-matrix printers current at the time, letter-quality printers produced output indistinguishable from that of a typewriter. That isn't surprising because they're as much automatic typewriters as printers: they have a hammer that strikes keys that strike a typewriter ribbon to produce text.

When Hewlett-Packard brought out the LaserJet, the first affordable laser printer, Bill Godbout of CompuPro arranged for me to buy one of the very first ones on the market. It was 10 times as fast as the Spinwriter and quiet, and I did all my printing with it until (in 1992!) I replaced it with an HP LaserJet III and the Kyocera Ecosys. Incidentally, that original LaserJet is still in use at Notre Dame High School in Sherman Oaks. It has needed about $350 of work in all that time. HP built that thing like a tank. But for all those years, the Spinwriter sat in the cable room, and once a month I'd roll it out to print my checks.

I never had any trouble with that Spinwriter, but last month I ran out of tractor-feed checks. I thought for a moment of buying more, but that was absurd; it was much better to retire the Spinwriter and liberate that big area in the cable room. Intuit includes a catalog of various kinds of checks you can buy with every copy of Quicken, so finding a source of laser-printable checks was no problem. I just faxed an order, complete with a copy of one of my bank checks. My new checks arrived within a week.

Quicken knows how to print those checks, and I contemplated changing my bookkeeping system over to Quicken and having done with it. Everyone I know who uses Quicken is happy with it. However, I've been using my bookkeeping program for a dozen years, and I'm used to it. Surely, thought I, it would be harder to change bookkeeping systems than to reformat the output of my check-writing program.

I originally wrote my check-writing program in CBASIC, a compiled BASIC that grew out of Gordon Eubanks' thesis at the Naval Post Graduate School. CBASIC for CP/M was the major product of his Structured Systems Group. That company was acquired by Digital Research, which produced CP/M and PC-DOS versions of CBASIC. It still works. I recently used the CBASIC compiler to change the dimensions of a couple of arrays in my journal program. However, when Eubanks left Digital Research to found Symantec, CBASIC became an unsupported orphan, and this looked

ILLUSTRATION: BETHANY GULLY © 1993

like a good opportunity to convert my program to QuickBasic.

It was also an opportunity to refamiliarize myself with QB: I've promised Roberta that I'll jazz up her reading program with some new graphics. My check-writing program uses no graphics, but converting it from CBASIC would give me some practice on QB syntax. If you program in QB, you really need the Crescent tools, which not only do things faster and with smaller code, but also give you capabilities you just can't get in plain QB. I'll need those when I tackle Roberta's program, so the check-writing program was a chance to get familiar with the latest in Crescent's QuickPak Professional and other BASIC toolkits.

That was the theory. What happened was something else again.

CBASIC has a much less complex—and much more reasonable—syntax for declaring variables. When I began programming, I hated languages that require you to declare variables before you can use them. As soon as I began to write large and complex routines, however, I learned better. When programs get complex, mandatory declarations become essential for keeping track of what you are doing. One of the neat features of CBASIC is that although you *can* write programs without declarations, you can also tell the compiler to complain if it finds any undeclared variables. Alas, QB doesn't have that feature. Worse, it doesn't have declarations at all.

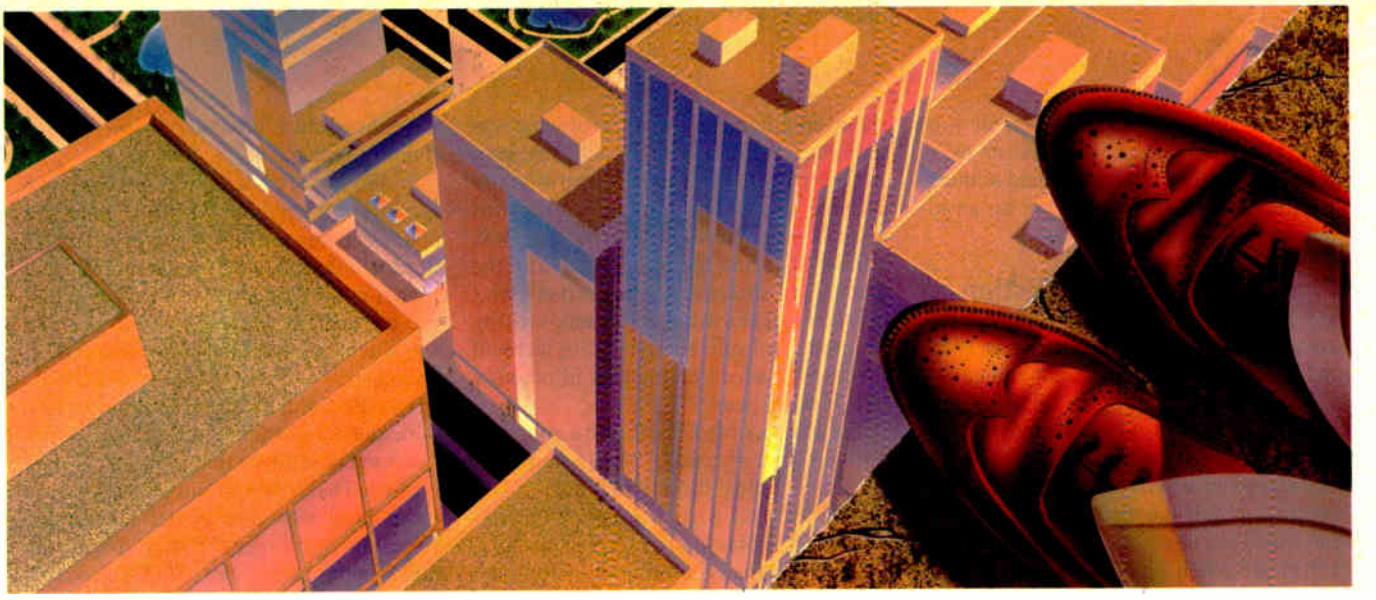
When you declare a variable, you tell the compiler the variable's data type. When you stop to think about it, this is something the compiler needs to know, since it has to treat ASCII characters, floating-point numbers, and integers in entirely different ways. In CBASIC, you say INTEGER FOO to declare that FOO is an integer. QB lets you declare that every variable that begins with a given letter is an integer (or a string, a floating-point number, and so forth); but to declare an individual variable, you use the dimension statement (DIM FOO AS STRING). I suppose this makes sense (you can think of a variable as a zero-dimension array), but it's not intuitive.

Anyway, eventually I converted my variable declarations. Alas, you can't declare certain variables at all, so I just had to live with them as undeclared. There were other syntax problems, but none too serious. Then it was time to choose a font. The checks are small—there are three plus a stub on each sheet of 8½- by 11-inch paper—so it would have to be a small font. Times Roman 8-point looked just right for the job, and I have it on the Microsoft Z font cartridge that's permanently installed on the LaserJet III, so there'd be no problem with that.

To tell a LaserJet what font to use, you send it a complicated sequence headed by an escape character (ASCII character 27), but all that's explained quite well in the LaserJet III documents. My converted code was already reading in my data files correctly, so all I had to do was format the output, which meant telling it on what line to print dates, to whom paid, how much, and how far to tab over for each item. This looked like a snap, and I was quite proud of myself.

Alas, I crowed a bit soon. The Times Roman 8-point font is smaller than standard Courier 10 or 12, meaning that I'd have to tab out to position 130 or so—and it just wouldn't do that. Instead, it wrapped down to the next line. Infuriating.

I looked through the printer documents seeking some way to tell the printer I was using more than 80 columns to the page—



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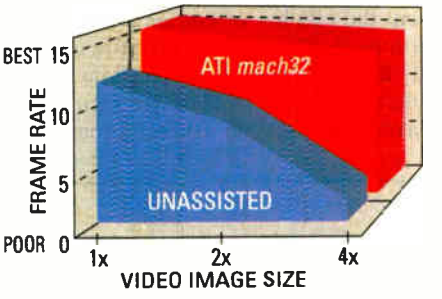

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and found absolutely nothing on the subject. I also had a couple of books on using LaserJet printers, but I still found nothing. By then it was 3:00 a.m. I put up an inquiry on BIX and went to bed.

Normally if I ask a question on BIX any time day or night, I'll have an answer in a couple of hours. But at 10:00 the next morning I didn't have one, so I called HP technical support. I'd never done that before.

The first thing that happens is you go through an enormous electronic voice-mail routine. It's all relevant, and not particularly difficult to use, but I for one become infuriated when I have a dialogue with a computer for more than a couple of minutes, especially when it's a toll call. On the other hand, their electronic tutorials, each tailored to a specific product, are pretty good, and they're likely to answer perhaps two-thirds of the questions people have. It was pretty clear, however, that I wasn't going to get the answer to my question from that system.

Eventually I got a human being, a polite (and very patient) woman named Barbara, who listened to my tale of woe and said she hadn't the foggiest notion of what was going on, because it ought not to be necessary to tell the LaserJet how many columns it would be printing. She dictated a small program to write using the DOS editor. That had the effect of telling the LaserJet to show all control codes it was receiving. Then I ran my check-writing program, and sure enough, there were all kinds of linefeed characters in places I didn't want them.

I sent a fax of that sheet, and a couple of minutes later she said, "Well, your software is sending those linefeeds...." At which point all was clear, since QB defaults to 80-column lines for line printing. I'd rather stupidly left out converting the WIDTH statement in my conversion from CBASIC. After that it was clear sailing, and in an hour or so, I had my check writing formatted.

The test runs worked just fine. Of course, I was testing it with real data printed on blank paper, and to save paper, I'd cut the number of entries down to five (three checks to a page). You're not really finished with software until you test it at the extremes, so I told the program to print a real journal, some 80 checks from a journal containing a hundred or so items; and it didn't work.

It didn't work because Times Roman 8 is a proportional-spacing font, and if a check is being written to a firm spelled in uppercase letters, it takes a lot more spaces than if it's to someone with a name in uppercase and lowercase. The result was that some items went off the right-hand edge of the paper.

I could fix that by programming in a table that knows the width of every character and consulting that table each time I printed. That seemed a lot of work just to make the checks look prettier. I could also fix things by jiggering around with the horizontal motion index, which would effectively convert Times Roman 8 into a fixed- rather than proportional-spacing font; but it was easier to go to a fixed-spacing font (Lineprinter) and have done with it. I did the test again, and Lo!, all was well, which just goes to show that sometimes it's valuable to have some fixed-spacing fonts.

When you write a QB program, it's easiest to work in the QB environment. That environment lets you run a program

from right within the editor, and if there's a problem, it tries to take you right to that point in the source code. There's on-line help available; the help files aren't a substitute for something such as the Waite Group's *QuickBasic Bible* (which I recommend highly), but they'll take care of the simple reminders. All told, then, the QB environment is one of the best features of the language, and I had done the program using it.

You can also make a stand-alone version of the program from within the environment, but that makes larger and slower code than if you exit QB and compile from the DOS command prompt. All this is explained in the QB documents and the QuickPak Professional manuals, and it's not at all difficult.

Of course, I found some ways to make it difficult. First, I ran the compiler program from within Norton Commander. I'm running Norton Commander as a DOS application under Windows for Workgroups. The program compiled just fine, but when I ran it, it went completely insane. Oddly enough, it printed my checks all right; but when it came time to terminate, the program threw tons of garbage on my screen and eventually died horribly while telling me that it had encountered an unprintable error.

I also got a Windows error message, telling me something had violated system integrity (could that have been what was so obscene that it was unprintable?) and I ought to close everything down and exit Windows. Mind you, I was more amused than annoyed; it probably was a bit much to run a DOS compiler through Norton Commander running as a DOS application under Windows for Workgroups.

I duly closed out Windows, reset the machine, and brought it up in DOS. While in DOS, I recompiled the program direct from the command line. That worked fine, and when I tested the program, it terminated properly without unprintable errors—but it didn't work properly. At this point I *was* becoming annoyed. I went back into the QB environment and tested the program. Worked fine. Exited. Compiled again. Did not work properly.

I really was getting a different result in the environment than in the compiled stand-alone version; and that's a Microsoft bug. The Crescent toolkit works just fine.

What it did was this: as part of the program, I read some files into arrays. Two of those arrays are TO$(I) and AMOUNT(I), which are who gets paid and how much. I then do LPRINT TAB(2) TO$(I) and LPRINT TAB(40) TO$(I); the first item prints on the stub, the second on the check. There's only one problem: the second item doesn't print on the check. Nothing prints there. The same for the amount: LPRINT TAB(2) AMOUNT(I) prints fine, but the statement LPRINT TAB(60) AMOUNT(I) prints nothing at all.

Could this be the Crescent toolkit? None of their routines were being used anywhere near this section of the program, but just in case, I took the Crescent routines out and tried again. Same result. I really was getting a different result in the environment than in the compiled stand-alone version; and that's a Microsoft bug. The Crescent toolkit works just fine.

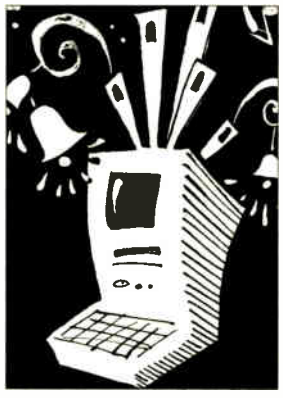
It took less time to devise a workaround than to convince myself I'd need one. The

solution is to say WHOTOPAY = TO$(I) and print the variable WHOTOPAY in the proper places; similarly, use AMOUNTTOPAY = AMOUNT(I). Once I did that, everything worked the same in both the environment and the compiled stand-alone version; but I sure wasted some good cusswords on that bug.

The moral of the story is that you can do good programs in QB. Even with that bug and others, I find I can produce a great deal more working code with QB than with any other language. Note too that I went back to a program I wrote in 1982, which was revised a bit by Alex in 1985, and untouched by either of us for eight years; but in a couple of days, with interruptions, phone calls, mail to answer, compiler bugs, and an inadequate understanding of the printer, I was able to get this running just fine.

On the other hand, once you have your program running fine in the QB environment, you'd better do complete testing on the stand-alone compiled version, because you may not be through debugging. I'd still rather use QB than C.

I could have converted the program to Visual Basic, which has a lot better tools for handling fonts; but that wouldn't have given me practice with QB for DOS, and QB is what we wrote Roberta's reading program in. For those few of you who don't know: her reading program will teach just about anyone age 4 and up to read English in 75 or fewer 20-minute lessons. It has been tried thousands of times, and as far as we know, it has always worked.



She's just finishing a Mac version that has lots of new bells and whistles. The DOS version has been around for years now, and it works fine on just about any old machine, from an original 64-KB floppy-drive-only PC to the latest and fanciest 486s. However, the graphics are monochrome CGA, the lessons are all character-based, and it looks old-fashioned and hokey.

Roberta thinks it needs a face-lift to help sales. I suppose she's right, but the only changes will be cosmetic. That's my next programming project, and I'm sure you'll hear about it soon enough. When I finish that, I'll convert her program to Visual Basic, and we'll have a slam-bang Windows version. Of course, it can't teach kids to read better than the one we have—how can you improve something that works every time?—but it will look an awful lot prettier.

In previous years I used MacInTax, but this year I used TurboTax for Windows. Both of them are published by Chipsoft. I've always thought highly of MacInTax, but it hasn't always been convenient to do all my accounting on my DOS/Windows machines, print out the results, and enter it all into MacInTax on the Mac. Miraculously, I got started early in April this year, so it seemed a good time to try a Windows tax program.

I didn't like TurboTax at first. Nothing specific, just that the approach is a bit different from what I'd got used to with MacInTax; but since I hate doing taxes anyway, the minor irritations added up until I was cursing the program. It didn't help that I looked to be paying a lot more in taxes than I had expected to.

Then I entered my Schedule K investments. Because I have to be careful not to invest in companies I might have to write about, I tend to put my investment money in energy partnerships and real estate holdings that generate tax credits. The only trouble is that they generate tax returns of such complexity that I can't comprehend them. Prudential dutifully sends me full reports and suggestions on how to fill out tax returns, but I don't understand those either.

This year it was different. TurboTax asked me all kinds of specific questions, every one of them answerable by consulting the reports Prudential had sent: and Lo!, there were all my investments reported properly—and since that included various tax credits and depletion allowances, the result was to save me a fair amount of money. Alex says the transformation was astounding: one minute I was in here muttering curses, and the next I was telling him how much I liked TurboTax.

And indeed I did, enough that TurboTax is now the official Chaos Manor tax program. It is highly recommended.

I continue to dither over word processors, although I'm slowly drifting toward Word for Windows. The problems are speed and ease of use. When all I want to do is create text for stories, articles, and columns, there's absolutely *nothing* that can beat the old Symantec Q&A Write, whether run in DOS, under Desqview, in a DOS window, or on a laptop.

I like everything about Q&A Write: the white-on-blue text on-screen, which is easy to see and restful to the eyes. The on-screen characters are easy to read and aesthetically pleasing. I am very fond of the search capability, which lets you search for "@cr" to find carriage returns and "@it" to find italic text. The way the Home and End keys work: strike End once and it goes to the end of the line; a second time to the end of the paragraph; a third time to get to the bottom right position on-screen; a fourth time and you're at the end of the text. Home works the same way in reverse. That's a wonderful way to move around through text. And the word-count feature in Q&A Write is terrific.

Q&A Write has Microlytics' Word Finder Plus thesaurus built in, and it works just fine with Definitions Plus. This gives me, in DOS and even on laptops, both a thesaurus and *The American Heritage Dictionary* right within my word processor, and all this works on my Gateway 2000 HandBook notebook. Q&A Write has all the old WordStar control commands (Control-T to delete the next word, that sort of thing), which some of us have memorized down to the cellular level in our fingers. There are some nifty macro capabilities. And finally, there is no editor that's easier to teach someone to use. Sit a novice down with Q&A Write and get out of the way; you'll soon have text.

There are limits. Being a character-based editor, Q&A Write must use conventions (color changes, mostly) to show that text is boldface, underlined, italic, or in a different font, since it can't just draw the changes on-screen; but since these columns are sent in ASCII over BIX, I'm accustomed to using conventions for indicating text formats.

A more severe limit is file size: Q&A Write gets most of its speed through holding all text in memory. Thus, anything with more than 50,000 words in it has to be broken into more than one file, which means we can't put an entire novel in Q&A Write and do global searches and replacements. It's even more limited in printing large documents.

Q&A Write is no longer available as a stand-alone product. To get it, you must

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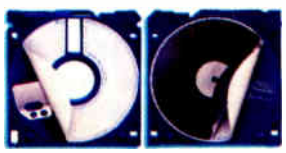

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Circle 239 on Inquiry Card.

buy the Q&A 4.0 database program. That has considerable merit: Q&A is still the easiest-to-use flat-file database on the market. Version 4.0 works fine, and the Q&A 4.0/Q&A Write combination, while simple, is the most powerful mail-merge tool I know of. On the other hand, Q&A takes up lots of memory, limiting the editing space to about 30,000 words.

The bottom line is that Q&A Write was the best available word processor in its day, and it's still useful for text creation; but the computer world has advanced considerably since it was written, and it hasn't kept up. It needs, for instance, the Phar Lap extensions so that it can use more than 640 KB of memory. It can use a means of converting from character-based draft mode to editing WYSIWYG mode. None of that should be hard to add to it.

Thus my excitement when I learned there was a new version, Q&A Write for Windows. It reads, and will save, Q&A Write files; and it's supposed to read and save files in other formats. For a golden moment, I thought I had the answer to all my problems. I could continue to use the DOS version to create text and then read it all into a giant Q&A Write for Windows file. Furthermore, I'd be able to read in Word for Windows files and work on them in the Q&A Write environment.

Alas, it was too good to be true. The new Q&A Write for Windows is a Word for Windows knockoff. It's a pretty good knockoff, but it retains almost nothing of the DOS version of Q&A Write. Gone are the wonderful word-count and search-and-replace features. The Home and End keys don't do anything important. When I tried to read in a big file—the Word for Windows version of *The Gripping Hand*, 850 KB, about 125,000 words—it took 4 minutes plus and then blew up with an unrecoverable error and a violation of system integrity. Feh.

I understand what Symantec intended. They wanted a pretty good editor that would fit on one floppy disk yet have a spelling checker and a thesaurus; and they achieved that. However, if they'd taken Q&A Write with all its great features and updated it for Windows they'd have had a better product with an important niche. Instead they chose to clone Word for Windows, remove some features, and compete on price. This puts them head-to-head with Microsoft's advertising and PR team, and worse, with Chris Peters and his world-class Word software development team; and that, I'd think, is an exceedingly unwise thing to do.

For the record, Q&A Write for Windows is a pretty good subset of Microsoft Word. Alas, I'm still waiting for a word processor that has a fast character-based draft mode, white letters on a blue background, with the search-and-replace, word-count, and macro capabilities of old Q&A Write; is able to read in and operate with large files; and can then convert to WYSIWYG and fonts when you're done creating and want to do editing and formatting. It doesn't look like I'll get such a product from Symantec.

The old chain-gang song begins, "If you ever go to Houston..."

Well, I did, and I was utterly defeated by a Hilton hotel's telephone system.

I was in Houston as guest of honor at a small science fiction and space-support convention. It had originally been scheduled for another hotel, and at the last minute it ended up at this Hilton. The telephone system was one I'd seen before at a Hilton in San Jose. There are two lines

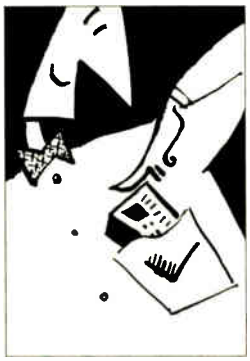
into the unit, which has about a zillion buttons on it and connects to a voice-mail system. That all works: it's a very efficient phone system.

However, there's no data port, and if you unplug either of the lines from the wall, the whole system goes dead; restore the connection, and it takes about 5 minutes before you get a dial tone. I restored it using a little phone-jack doubler that let me connect my modem downstream of the phone unit. I figured that even if I couldn't make this thing dial, I could manually dial the number and then lock on to that.

Alas, it didn't work. It hadn't worked in San Jose either, but there when I called the front desk, they sent up an engineer who installed an adapter box with a data-port outlet. Houston is apparently a bit behind the times: they suggested that there was a data port on the public pay phone downstairs.

This would be the time I came with the Gateway 2000 Nomad 486. It's a wonderful Windows laptop, but the one I have has no internal modem. They make one for it, of course; I just never bothered to get one, because I've got in the habit of carrying the Supra 14,400-bps external modem. It's small, and it gives me an error-correcting connection, which most internal modems can't do. Alas, the public pay phone in the Houston Hilton Plaza is miles from the nearest electrical outlet; and the security people would not let me string either a phone or a power line across the off-lobby hallway.

All this was a little astonishing because the Houston Hilton Plaza is in the middle of the Houston medical-center district and is set up for conventions, presumably of physicians. Apparently, physicians who attend conventions in Houston can live without electronic communications, because nothing I could do, including trying to connect through the handset, would work.



If you ever go to Houston and need to access E-mail, try to find somewhere to stay other than the Houston Hilton Plaza. An alternative would be to use RadioMail, a hardware and software setup that lets you receive E-mail by way of a radio modem service. I've got one, which works, and some people swear by it; more on that next month.

There's increasing interest in PDAs (Personal Digital Assistants). This is the term Apple uses to describe the Newton. At the moment, the most popular models seem to be the Sharp Wizard and Casio's Boss. Real fanatics carry the HP 95LX or the newer HP 100LX, which are full DOS-compatible computers. My Navy son carries the Fujitsu Personal Systems Poqet. When I went to Russia a few years ago, I carried an Atari Portfolio.

All these suffer from the same problems. It's difficult to make them small enough to carry and still have an adequate keyboard. There's the memory problem: they just don't hold enough programs and data. There are difficulties communicating with printers, other computers, and each other.

All these problems have solutions, although some are easier than others. HP has an elegant means of communication:

For More Information

Need a shower gift for a computer nerd? **B.A.B.Y.** (Birth and Baby Years: A Computerized Guide) lets you track the growth and development of your baby. It's available for DOS systems only and sells for $59.95 from **Software Marketing Corp.**, 9830 South 51st St., Suite A-131, Phoenix, AZ 85044, (602) 893-3377. **Circle 1146 on Inquiry Card.**

Battles of Destiny is a successor to the game Empire. I had some frustrations with the user interface of this DOS program, but if you want to handle enormous armies and try your hand at air/land battle planning, this will do it. $59.95 from **Quantum Quality Productions, Inc.**, 1046 River Ave., Flemington, NJ 08822, (908) 788-2799. **Circle 1147.**

The **HP DeskJet** ink-jet printers set the standard for high-quality, low-cost copy. In addition to the **DeskJet Portable** ($479), HP offers the color **DeskJet 1200C/PS** ($2399), which includes a PostScript interpreter. **Hewlett-Packard Co.**, Direct Marketing Organization, P.O. Box 58059, MS511L-SJ, Santa Clara, CA 95051, (800) 752-0900. **Circle 1148.**

Traveling Software's latest file transfer programs, **LapLink V for DOS** ($99.95) and **LapLink V for NetWare** (single-workstation license, $129.95; five-workstation license, $499.95), now feature peer-to-peer file transfer across NetWare networks and automated file transfers. They operate in the background under Windows. **Traveling Software**, 18702 North Creek Pkwy., Bothell, WA 98011, (206) 483-8088; fax (206) 487-1284. **Circle 1149.**

Point of Attack ($54.95) is a tactical-level simulation of modern warfare in the Middle East. The package, for DOS systems, sells for $54.95. **HPS Simulations**, P.O. Box 3245, Santa Clara, CA 95055, (408) 554-8381. **Circle 1150.**

Symantec's new word processor, **Q&A Write for Windows** ($69.95), is more like Word for Windows than its DOS counterpart. The DOS version of Q&A Write has some great features, but it's available only in a package deal with the Q&A 4.0 database program ($399). **Symantec Corp.**, 10201 Torre Ave., Cupertino, CA 95014, (408) 253-9600. **Circle 1151.**

Microsoft's **QuickBasic Compiler** for MS-DOS is an easy-to-use programming environment that lets you compile your BASIC programs into executable files. It's $199 from **Microsoft Corp.**, 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080. **Circle 1152.**

Everyone I know who uses **Quicken** is happy with this personal financial management and checkbook program. The DOS and Windows versions are both $69.95. **Intuit, Inc.**, 155 Linfield Ave., Menlo Park, CA 94026, (415) 329-3052. **Circle 1153.**

Crescent's **QuickPak Professional** toolkit for DOS or Windows provides you with a library of subroutines, functions, and custom controls for use in your QuickBasic programs. It sells for $199 from **Crescent Software, Inc.**, 11 Baily Ave., Ridgefield, CT 06877, (203) 438-5300. **Circle 1154.**

RadioMail is a combination hardware, software, and service package. The hardware, an Ericsson-GE Mobidem radio modem ($795), and software work with your Mac, DOS portable, or HP 95LX to let you receive E-mail messages and data via a radio service. The radio service charge is $99 for a start-up fee and a monthly fee based on usage. **RadioMail Corp.**, P.O. Box 1206, San Mateo, CA 94026, (415) 328-5615. **Circle 1155.**

The **SmartDock** docking stations connect the HP 95LX palmtop to a variety of peripheral devices. The **PrintStation** ($169.95) provides parallel and serial ports. The **ComStation** ($399.95) is a 2400-bps fax modem complete with software. Available from **Sparcom Corp.**, 897 Northwest Grant Ave., Corvallis, OR 97330, (800) 827-8416 or (503) 757-8416. **Circle 1156.**

TurboTax for Windows, TurboTax for DOS, and **MacInTax** ($79.95 for 1040 version; $49.95 for individual state versions) help you quickly prepare your federal and state income-tax returns. **Chipsoft, Inc.**, 6330 Nancy Ridge Dr., Suite 103, San Diego, CA 92121, (619) 453-8722. **Circle 1157.**

the HP 95LX has a built-in IR (infrared) data port. At the moment those aren't common on desktop systems, but they might well catch on. There are also docking stations for the HP 95LX. One of these, Sparcom's SmartDock, includes Mac, serial, and parallel ports, as well as a fax handler. As I mentioned above, there's also a RadioMail modem for the HP 95LX (actually, it will work with any PC, but used with the HP 95LX, it makes a package that is about the size of a large hardbound book).

The memory problem is likely to be solved with mini-CDs. There is a recordable disk format for audio players; can't that be adapted for PDAs? Given those, you could carry your entire office environment in a shirt pocket and still have room on the disc for the electronic version of a couple of books you've been meaning to read.

I have a dream: one day I'll have a gadget not much larger than the HP 95LX. It will accept mini-CDs and be able to read and write data to them. It will also have a microphone: I'll be able to control it with voice commands and also dictate notes that it will record. It will have the ability to send and receive both ASCII and fax messages by RadioMail. It will have my calendar and schedule, and I will be able to use RadioMail to communicate with my home system to get schedule updates. It will even be my FM radio, so I can plug in earphones to get the latest news or some Beethoven, and for that matter, I ought to be able to move my science conference tapes over to it.

Some people will want more. It will be their nationwide beeper, possibly even their pocket telephone.

There's no reason we won't see this well before the end of the century. The key will be read/write mini-CDs; after all, those exist now, they're already digital, and they're cheap, because silicon is cheaper than iron.

If you know anyone expecting a child and you're stuck for a shower gift, try B.A.B.Y. Useful physiological information, including health, diet, and various norm statistics; pediatric data, including a scheduler for appointments; name lists; and places to record all kinds of information. Nothing you can't live without, but it's interesting and informative.

The book of the month is *The Millennial Project* by Marshall T. Savage (Empyrean Publishing). This is a coherent plan to get humanity moving to the stars in the next thousand years; and while you can quibble with details, there's both vision and practical plan here. Mr. Savage was at the Houston convention I mentioned above. If you're interested in the future, get this book, and you can write him on the Internet at mtsavage@delphi.com.

The game of the month is Point of Attack from HPS Simulations. This is a tactical-level simulation of modern warfare in the Middle East. Want to know why the Israelis win over there? Interested in how the Russian equipment might fare if employed by better tacticians and strategists? This is a pretty good way to find out. More simulation than game, but I like that sort of thing.

I thought I would have to withdraw a recommendation. Battles of Destiny from Quantum Quality Productions remains an enjoyable game, but it's buggy. I played four different games to the point where they were interesting, only to have the game crash; this with bare 486 systems, no resident software except a mouse driver. However, there is a fix: turn off the animations, which turn out to be more bugs than features. Given that, it plays all right.

I'm still collecting network equipment and software, and I hope to report next month on using Artisoft's LANtastic to network Windows, OS/2, and Mac systems. I know I promised to tell you why you ought to run out and get Traveling Software's LapLink V, but there's no room. Just take my word for it, if you do much file transfer to and from portables, you need this.

The HP DeskJet remains the standard printer you ought to buy for your college student; Richard is in love with his, and so are all his roommates. He has the new color version. Full report next month, because I told him if I don't get his report, I'll repossess the printer. We also have a couple of other color printers, which, in combination with a good scanner, can be used to make the most interesting business cards you ever saw.

And there's lots more neat stuff piling up; we live in interesting times. ■

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

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What's New Hardware

DATA/VOICE SERVER

The MICOM Communications (Simi Valley, CA) Marathon 10K Data/Voice Network Server (network feeder, from $3950; network node, $5500) integrates remote-office communications. Over leased lines you can send data, voice, fax, and LAN communications at speeds ranging from 96,000 bps to 128,000 bps. The 10K supports up to 12 WAN links, 12 synchronous and 41 asynchronous user channels, eight voice/fax channels, and two 64-user remote-terminal Ethernet connections.

Phone: (805) 583-8600.

Circle 1283 on Inquiry Card.

VIDEO CAPTURE AND COMPRESSION

The Video Zipper ($449) from Metheus (Beaverton, OR) captures video directly to the hard drive at 30 frames per second while doing on-the-fly compression. The board takes 1 minute to capture and compress 1 minute of video. The compression capability of up to 20-to-1 squeezes 1 minute of video into 8 MB of hard drive space. Playback speeds on a 25-MHz 486SX are at 30 fps at resolutions of up to 640 by 480 pixels.

Phone: (503) 690-1550.

Circle 1287 on Inquiry Card.

POWER-SAVER TERMINALS

Qume Peripherals' (Milpitas, CA) four terminals in its new Series II line (from $494) consist of keyboards and 14-inch flat-screen CRT monitors. Series II terminals (monitor and keyboard) consume 18 W of power during their energy-saver operation, well under the EPA's 30-W maximum.

Phone: (800) 457-4447 or (408) 942-4000.

Circle 1137 on Inquiry Card.

COMBO-BUS PCS FROM DEC

DEC's (Maynard, MA) new DECpc MTE systems (from $2649) have 32-bit EISA and VESA Local Buses for fast data transfer and video/SCSI. The 486-based systems are available in several processor/RAM/hard drive combinations, are upgradable for Pentium OverDrive processors, and include four video card options, six EISA slots, two PCMCIA drive options, and one VL-Bus slot.

Phone: (800) 722-9332 or (508) 264-7546.

Circle 1135 on Inquiry Card.

VIDEO CAPTURE CARD

The Captivator video capture card (from $349) from VideoLogic (Cambridge, MA) lets you record AVI (Audio Video Interleave) movie sequences and capture full-motion video or real-time single frames from standard video devices such as cameras, VCRs, and laserdisc players in composite video and S-Video with autosense NTSC/PAL. Image sizes range from 32 by 32 to 640 by 480 pixels. The card has a minimum system requirement of a 20-MHz 386, 4 MB of RAM, Windows 3.1, and Video for Windows 1.0.

Phone: (617) 494-0530.

Circle 1136 on Inquiry Card.

VESA LOCAL-BUS GRAPHICS CARD

The Celsius/VLB card (1-MB VRAM version, $349) from Orchid Technology (Fremont, CA) is a 32-bit VESA Local Bus graphics accelerator card. Orchid says the card can speed up Windows applications by up to 200 percent. The Celsius/VLB includes color dithering, polygon fill, polygon window mask, image stretching, image scaling, and other internal graphics options. Drivers are included for Windows 3.1 and AutoCAD.

Phone: (510) 683-0300.

Circle 1138 on Inquiry Card.

UPS FOR WORKGROUPS

The OnGuard PC-500 VA ($999) from Clary (Monrovia, CA) on-line UPS (uninterruptible power supply) for small LAN- and midrange-system workgroups provides 4 minutes of backup power at full load and 10 minutes at half load. Audible alarm controls include utility interruption, low battery, overload, and summary alarm.

Phone: (800) 442-5279 or (818) 359-4486.

Circle 1139 on Inquiry Card.

NOTEBOOK HARD DRIVE

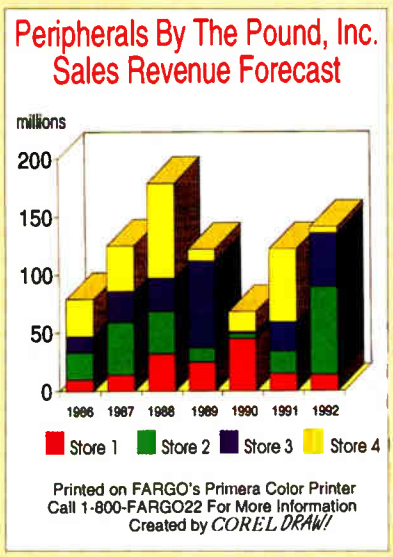
A 260-MB notebook hard drive upgrade ($1495) is available from Laptop Solutions (Houston, TX). The guaranteed 48-hour turnaround service includes hard drive; installation; 24-hour burn-in; test; and a one-year parts-and-labor warranty. The 2.5-inch hard drive has access times below 12 ms. Laptop Solutions also does laptop hard drive upgrades of up to 1 GB.

Phone: (800) 683-6839 or (708) 291-1616.

Circle 1298 on Inquiry Card.

THERMAL COLOR PRINTER

A new low-cost thermal-transfer color printer, the Primera Color Printer ($995) uses a wax-based thermal ink ribbon for color printing; a monochrome ribbon is also available. The printer can produce a full page in about 2 minutes, according to the company. Cost per page is about 45 cents. The Primera works with Windows 3.1 and TrueType fonts. A Windows 3.1 software driver is included, which can print on letter-size and A4 paper and transparencies.



Contact: Fargo Electronics, Inc., Eden Prairie, MN, (800) 327-4622 or (612) 941-9470.

Circle 1131 on Inquiry Card.

Hardware

COMMUNICATIONS PROCESSORS

Fault-tolerant capabilities head the list of features in the new DCP600 family (from $175,000) of intelligent network processors from Unisys (Blue Bell, PA). The DCPs, with Telcon software, provide peer support for IBM SNA networks. Additionally, new intelligent line modules based on the 68040 provide high-speed LAN connectivity while off-loading the DCP main processors. Unisys also announced several new dual-bus line modules.

Phone: (215) 986-4788.

Circle 1140 on Inquiry Card.

▲ 10BASE-T ETHERNET MODULE

M.L. Electro-Optics (Chadderton, Oldham, U.K.) is distributing a new Plexnet 8024SX module ($1595; £1400) from Plexcom that is designed to fit into a Plexnet chassis. Twelve 10Base-T nodes are provided via RJ-45 connectors in the 8024SX, and each port has full repeater functionality. Visual indicators show link status and node fault conditions, and you can configure an extra, thirteenth port with an AUI, BNX, FOIRL, or RJ-45 socket. Plexview Network Management software provides control in addition to graphical and statistical management information.

Phone: +61 678 0121.

Circle 1141 on Inquiry Card.

FIRST UTP FDDI ADAPTERS

FDDI-over-UTP network adapters (from $995) from Network Peripherals (Milpitas, CA) meet the FDDI UTP standard that was recently adopted by the working group of the ANSI X3T9.5 committee. These FDDI-over-UTP modules can operate at the 100-Mbps bandwidth required in heavy-traffic server networks, and they are available for SBus, AT, EISA, and Micro Channel buses.

Phone: (408) 321-7300.

Circle 1142 on Inquiry Card.

WINDOWS APPLICATION SERVERS

From i Corp. (Boston, MA), two WAMi (Windows application multiuser information) servers work with older, slower ATs to upgrade system capabilities and performance. Costs per user average $1395 for an eight-user system that includes an 80-MHz 486, 1 MB of CPU SRAM (static RAM), 80 MB of DRAM, and 1.2 GB of mass storage. A dual-processor WAMi server is available as a fault-tolerant LAN system, with one 486 running applications and the other doing RAID functions.

Phone: (617) 424-7080.

Circle 1144 on Inquiry Card.

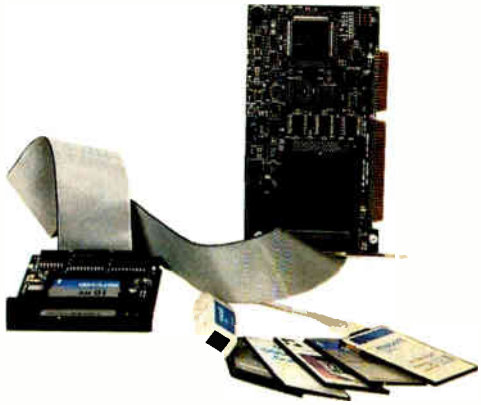
DATA/FAX MODEMS FOR PORTABLES

The 14,000-/14,400-bps Internal Data/Fax Modem ($329) for Apple PowerBook notebooks is available from Megahertz (Salt Lake City, UT). It includes communications software and uses the Hayes AT command set. The modem is compatible with the 100, 140, 145, 160, 165c, 170, and 180 PowerBook models. Megahertz also announced that its line of PCMCIA high-speed modems (from $379) will now provide support for the Hewlett-Packard 100LX.

Phone: (801) 272-6000.

Circle 1145 on Inquiry Card.

TWO PCMCIA ADAPTERS FOR DESKTOPS ▶



You can use the ROMdisk computer accessory products from Curtis (St. Paul, MN) to interface PCMCIA memory and I/O cards to ISA-bus computers. The ROMdisk PCM1-SU (from $249) is a single-slot card into which you insert a PCMCIA card. The PCM1-FA consists of a host adapter card and an internal or external PCMCIA floppy drive adapter. PCMCIA types 1, 2, and 3 are supported.

Phone: (612) 631-9512.

Circle 1284 on Inquiry Card.

TWISTED-PAIR TOKEN-RING MODULES

LanOptics' (Migdal Ha-Emek, Israel) family of 12-port Token Ring Lobe Modules (from $100 per port) let you add workstations to your 4-/16-Mbps token-ring network via shielded or unshielded twisted-pair wiring. Network jitter is completely eliminated, added network adapters are flagged if their speed is improperly set, faulty ports are automatically disconnected, and user access is maintained during power interruptions.

Phone: +972 6 546222.

Circle 1271 on Inquiry Card.

LOCAL-BUS VIDEO CARD

Featuring the Cirrus GD5426 accelerator chip, the VL-Bus SuperX VGA add-in card from Boca Research (Boca Raton, FL) enhances GUI performance. Two versions are available: a standard 1-MB version, the VGAXL1 ($345), and a 2-MB version, the VGAXL2 ($445). Hardware graphics cursor and BitBlt functions with 32-bit VESA Local Bus interface are included.

Phone: (407) 997-6227.

Circle 1272 on Inquiry Card.

HIGH-CAPACITY PCMCIA DRIVE

A 105-MB, 1.8-inch PCMCIA Type III hard drive, the removable MXL-105-III ($499) has more than twice the capacity of previously available Type III drives. Weighing only 2.5 ounces, it's designed for use in mobile and desktop systems that have PCMCIA Type III slots. The drive consumes less than 2 W of power at maximum use and as little as 25 mW when the unit is in sleep mode.

Contact: Maxtor Corp., San Jose, CA, (800) 262-9867 or (408) 432-4461.

Circle 1133 on Inquiry Card.

What's New Hardware

ALLEGRO V.FAST MODEMS

The Allegro series of high-speed modems from Octocom Systems (Chelmsford, MA) includes the V.fast standard for data transmission rates higher than 14,400 bps. Operating at throughputs of up to 115,200 bps using V.42bis or MNP 5 data compression, the 8830 and 8840 multimode models (from $1295) include flash memory.

Phone: (508) 441-2181.

Circle 1291 on Inquiry Card.

SINGLE-SLOT MICRO CHANNEL I/O CONTROLLER

The One Slot MC ($249) serial/parallel I/O controller consists of a single-slot Type 3 half-card, a shielded cable, and a remote connector panel. The remote panel has four full-duplex serial and three Centronics parallel ports. Each port can be disabled via switch selection. From Star Gate Technologies (Solon, OH), the PS/2-compatible unit has programmable data rates of from 50 to 115 Kbps.

Phone: (800) 782-7428 or (216) 349-1860.

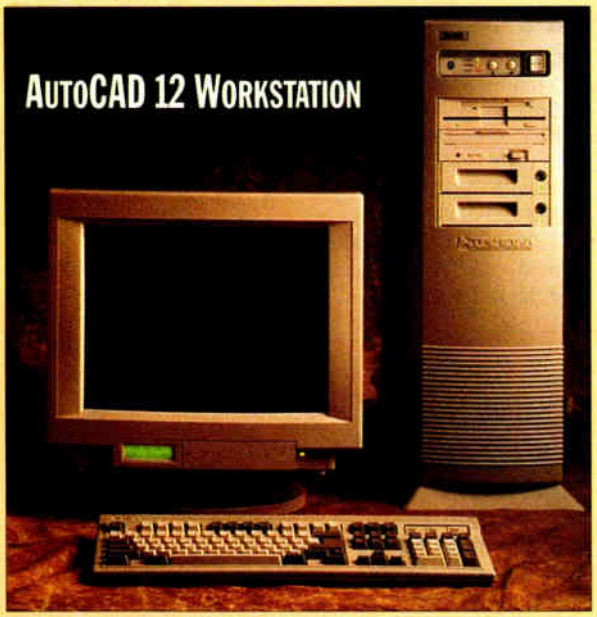
Circle 1288 on Inquiry Card.

MACHINE-VISION SYSTEM

Designed to plug into any AT-bus system, the 68030-based Cognex 5000 ($10,000) uses a single slot and includes a frame grabber and local memory. Available from Cognex (Needham, MA), the unit uses custom vision coprocesor chips that provide on-board gray-scale image analysis and image-processing capabilities. A companion VGA graphics board mixes monochrome or RGB vision output video in a window of a VGA display.

Phone: (617) 449-6030.

Circle 1276 on Inquiry Card.



The new Tri-CAD 486 66-MHz VL-Station (from $3595) targets the enhancements of AutoCAD release 12 for Windows. The workstation includes an IDE cache controller with 2 MB of RAM, a Weitek P9000–based VL-Bus accelerator with 2 MB of RAM, and support for noninterlaced resolutions of up to 1280 by 1024 pixels with 24 colors. The standard configuration includes 8 MB of RAM, a 340-MB hard drive, a 17-inch monitor, a 12- by 12-inch digitizer, and a cordless 16-button cursor.

Contact: Tri-Star Computer Corp., Chandler, AZ, (602) 961-3401.

Circle 1134 on Inquiry Card.

VALUE ETHERNET CARDS

The first products in its Value Line of high-speed Ethernet network interface cards are now available from Compex (Anaheim, CA). The ENET-V/16 TP 10Base-T card ($109) and the ENET-V/16 for 10Base-2 card ($129) are also available in five-pack units (from $89). With data throughput rates in excess of 1 MBps and compatible with drivers for Novell and Western Digital Ethernet adapters, the cards auto-configure to 8- or 16-bit systems.

Phone: (714) 630-7302.

Circle 1273 on Inquiry Card.

STACKABLE 10BASE-T HUB

Three Series 500 stackable 10Base-T hubs (from $995) from Penril DataComm Networks (Gaithersburg, MD) have 12 10Base-T ports with either 12 RJ-45 or one telco connector and built-in transceivers. Included is flash EPROM for local or remote hub software upgrading and support. Only one Master SNMP node is needed for every 60 devices.

Phone: (301) 921-8600.

Circle 1274 on Inquiry Card.

MAC/PC VIDEO SPLITTERS

The Scene Double (Edgware, Middlesex, U.K.) SD2+2X external video splitter lets you replicate nondistorted PC or Macintosh images on four external monitors up to 100 meters away. Resolutions of up to 1600 by 1200 pixels (noninterlaced) are supported. The SD2+2X (about $460; £299) has a 200-MHz bandwidth and splits the

output of a PC Super VGA or Mac system without software drivers and regardless of applications software or operating system.

Phone: +81 958 3639.

Circle 1297 on Inquiry Card.

VGA CARDS AND SOFTWARE

Vermont Microsystems (Winooski, VT) has two new versions of its Design Master VGA cards (ISA/EISA, $495; VESA Local Bus, $550) targeted for high-performance DOS- or Windows-based CAD. Each board uses the latest generation of S3 graphics chips. Included are a megabyte of DRAM, drivers for Windows and many CAD packages, and Vermont Microsystems' Auto-Mate/Pro enhancement software for AutoCAD. Each card supports true-color and high-color standards.

Phone: (800) 354-0055 or (802) 655-2860.

Circle 1277 on Inquiry Card.

SPEEDY 64-BIT GRAPHICS CARD

Designed to provide fast graphics for 64-bit RISC-based PC systems, the Jaguar GX ($1895) graphics accelerator card uses a 64-bit video controller chip and an on-board RISC processor. Carrera Computers (Laguna Hills, CA) claims that the Jaguar GX provides a text scroll rate of 100,000 lines per second, which is 10 times faster than the rate of a 50-MHz 486 local-bus video card.

Phone: (714) 707-5051.

Circle 1286 on Inquiry Card.

Hardware

PORTABLE PAGE SCANNER

Measuring 300 by 73 by 65 mm and weighing 1.3 kg, the Sicos Personal Page Scanner (about $836; £555) provides up to 256 levels of gray scale at resolutions of from 25 to 400 dpi. You plug the scanner into your computer's bidirectional parallel port. Data formats are TIFF, compressed or uncompressed PCX, or BMP. Using the included nickel-cadmium batteries or 220-VAC power supply, the Sicos Computer Accessories scanner can scan up to five pages with its optional sheet feeder. Scan time is 2 ms per line. You can also use the scanner as a motorized hand scanner by removing the base plate. System requirements are Windows 3.1 with 4 MB of RAM, a hard drive, and a bidirectional parallel interface port. No interface card is required.

Contact: GHS Office Media , Colchester, Essex, U.K., +206 760760.

Circle 1132 on Inquiry Card.

SPARC-COMPATIBLE GRAPHICS

Two graphics cards from Integrix (Newbury Park, CA) accelerate and enhance graphics performance in SPARC-compatible workstations. The double-buffered SGX220 graphics accelerator card ($2995) occupies a single slot and requires no device drivers when used in SPARC-compatible workstations. The S20V color frame buffer card ($495) provides VESA-compliant monitor timing, enabling a Super VGA PC monitor to work with workstation resolutions of 1024 by 768 pixels or 1152 by 900 pixels.

Phone: (805) 375-1055.

Circle 1282 on Inquiry Card.

FAST NETWORK PRINT SERVER

From Eagle Technology (San Jose, CA), the NPE400 Pocket Print Server ($599) connects a printer's parallel port to coaxial or twisted-pair Ethernet cabling. The NPE400 provides high-speed printer sharing and management in NetWare environments.

Phone: (408) 441-4003.

Circle 1279 on Inquiry Card.

24-BIT GRAPHICS ACCELERATOR

From STB Systems (Richardson, TX), the Pegasus VL24+ VESA Local Bus graphics accelerator card is based on the S3 86C928 video controller. Two configurations are available: one with 2 MB of VRAM and resolutions of up to 1280 by 1024 pixels at 256 colors ($799), and a second with 4 MB and 65,000 colors at a resolution of 1280 by 1024 pixels ($999). A Winstall utility lets you change color settings and monitor resolution via icons. Drivers are included for Windows 3.x and NT, OS/2, SCO Open Desktop, Uniware, X Window System, and major CAD/CAM platforms.

Phone: (214) 234-8750.

Circle 1302 on Inquiry Card.

STEREO PROCESSOR BOARDS

The AudioMax series of stereo audio processor and multiplexer boards (from $795) plug into PC/XT/AT bus slots to control signal processing and mixing from multiple sources. The MaxMedia (Lake Bluff, IL) processor board has a bandwidth of 20 to 20,000 Hz and includes source, input/output mode, volume, balance, bass, and treble control. The multiplexer board selects one of up to 12 stereo inputs; bandwidth is 300 kHz.

Phone: (708) 234-8840.

Circle 1280 on Inquiry Card.

PRINT CACHE BOARD

From SMJ Electronics (Concord, CA), the Cache Port ($449) removes the print-function burden from the CPU, letting you work on other tasks while large print jobs are in progress. The Cache Port plugs into an 8- or 16-bit ISA slot and replaces the standard PC parallel printer port. The card includes 1 MB of RAM, is expandable to 16 MB, and can be configured as LPT1 or LPT2.

Phone: (510) 672-3885.

Circle 1281 on Inquiry Card.

PORTABLE DIGITAL VOICE RECORDER

Assist ($249), from PCvoice (Roswell, GA), is a portable digital voice recorder that you can

use as a stand-alone unit or connected to a PC via the serial port. Used with DOS and Windows 3.1 OLE voice-annotation capabilities, Assist stores audio information digitally for transfer and storage on floppy or hard disks.

Phone: (404) 343-8201.

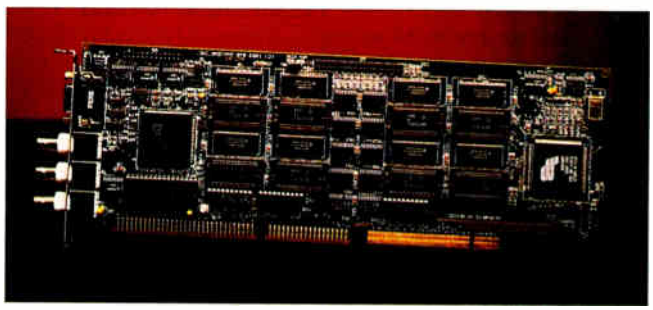
Circle 1292 on Inquiry Card.

16-BIT STEREO SOUND FAMILY

Cardinal Technologies' (Lancaster, PA) Digital Sound Pro 16 Series of stereo audio products support most sound standards, including Windows Sound System, Compaq Business Audio, MPC, and Sound Blaster. The Digital Sound Pro 16 ($159) records and plays back at a 48-kHz sampling rate and includes an 11-voice stereo music synthesis feature. The Digital Sound Pro 16 Plus ($229) includes an on-board SCSI CD-ROM interface. Both products come with a Voyetra Technologies software bundle.

Phone: (717) 293-3000.

Circle 1285 on Inquiry Card.



What's New Software

Design Your Own Virtual Reality

You can build your own virtual reality applications with the Cyberspace Developer Kit ($2495), a toolkit for 3-D visualization and simulation. From the Multimedia Division of Autodesk, the CDK is a comprehensive set of C libraries to help you build PC-based virtual reality applications. With the CDK, programmers can import, export, create, or manipulate 3-D objects with full support of Autodesk's 3D Studio software and its AutoCAD .DXF file formats. The toolkit includes the C class libraries, full documentation, diagnostic utilities, and sample applications with source code.

Contact: Autodesk, Inc., Sausalito, CA, (800) 879-4233 or (415) 332-2344.

Circle 1303 on Inquiry Card.

Relieve Windows' COM Port Contention

KingCOM COM Port Manager ($49.95) from OTC (Tustin, CA) integrates fax and data communications on the software level and allows you to set up Windows communications programs to share one or more hardware devices without contention problems. It provides a driver that replaces Windows' asynchronous communications driver and allows installation of up to nine communications programs on KingCOM's virtual ports.

Phone: (800) 769-6344 or (714) 832-4833.

Circle 1313 on Inquiry Card.

Document Indexer

Virginia Systems' (Midlothian, VA) Windows 3.1–compatible Sonar Bookends ($129.95) generates quickly an index and table of contents for file formats such as QuarkXPress and Word for Windows. Indexes can be based on word frequency, a list of user-supplied words and phrases stored in a text file, a list of proper nouns created with the product, or any combination of these methods.

Phone: (804) 739-3200.

Circle 1307 on Inquiry Card.

Presentations for Less

Bravo ($79) from Alpha Software (Burlington, MA) is designed for creating low-cost Windows presentations using a host of drawing tools that include Bézier curve support. The Smart Datapictures feature allows Bravo's clip-art images to automatically change as you manipulate them. Bravo comes with a built-in slide sorter, an outliner, an automatic slide-show player, DDE support, and full OLE support for sound and animations.

Phone: (617) 229-2924.

Circle 1316 on Inquiry Card.

Get Graphical Views of Spreadsheets

Freeing you from the traditional cell-type approach to spreadsheets, DS Lab Pro ($995) offers "visual spreadsheet" modeling for professionals who need to simulate large, complex financial-decision or process models. It imports existing spreadsheets, such as Microsoft Excel, and manipulates the spreadsheet data into models that use flowcharts and other visual representations. DS Group (Greenwich, CT) also offers the entry-level DS Lab ($195).

Phone: (800) 828-8760 or (203) 861-1833.

Contact 1309 on Inquiry Card.

Library of the Future on Windows

World Library's (Garden Grove, CA) Library of the Future, Second Edition ($299), is a CD-ROM that contains the complete text of more than 2000 literary works. Library of the Future enables cutting and pasting from titles into Windows word processors. The Library features an extensive search-and-retrieval system that allows word, author, or Boolean-type searches on keyword combinations.

Phone: (800) 443-0238 or (714) 748-7197.

Circle 1330 on Inquiry Card.

Scientific Font

Engineers writing equations can create fractions and scientific formulas with FEBTechnical ($59.95), a TrueType and PostScript font specially designed for technical users. Famous Engineer Brand Software's (Richmond, VA) FEBTechnical font lets scientists and engineers enter chemical formulas into cells of spreadsheets or other applications that do not support subscript and superscript numerals.

Phone: (804) 222-2215.

Circle 1310 on Inquiry Card.

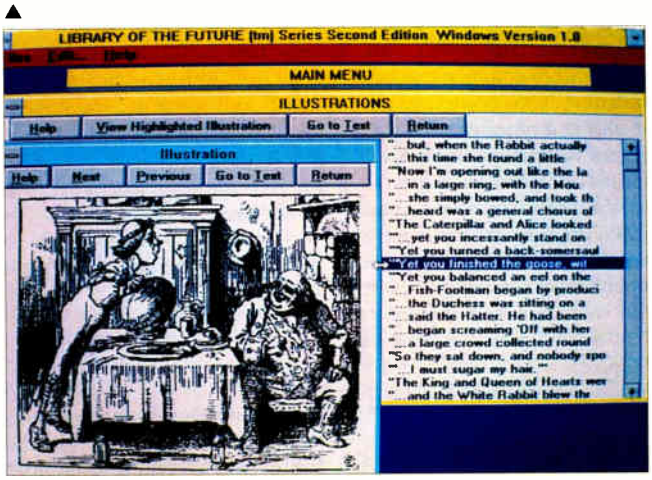
Simulate TrueType and PostScript Fonts

FontChameleon ($295.95) from Ares Software (Foster City, CA) lets you create many fonts from one master outline. With FontChameleon's synthetic font technology, you click on a font name, specifying either Windows TrueType or PostScript Type 1 for Macintosh, and FontChameleon builds a font from a description file that instructs the master "outline" to mimic the requested font. Each descriptor file takes up only about 2 KB of space.

Phone: (800) 783-2737 or (415) 578-9090.

Circle 1328 on Inquiry Card.

▲



Software

▲ LOW-COST 2-D DRAFTING MADE EASIER

TurboCAD for Windows ($149) from International Microcomputer Software, Inc. (IMSI, San Rafael, CA), features easy 2-D drafting with its "smartcursor," which changes into textual cues while held over the toolbar. With precision drawing in up to 256 layers, TurboCAD imports AutoCAD .DXF drawings, has 18 snap modes, and offers spline and Bézier curves as well as automatic double-line drawing.

Phone: (415) 454-7101.

Circle 1308 on Inquiry Card.

NOTABLE LINKS MOBILE USERS

Mobile Access ($195) from Notable Technologies (Oakland, CA) allows users of Go Corp.'s PenPoint-based personal communicators to link their mobile computers to host-based systems. Designed for use with AT&T Hobbit–based or Intel-based systems, it uses PenPoint's graphical interface, which lets you use gestures for common actions and menu commands for less-common actions. Mobile Access uses text/ASCII; X-, Y-, and ZMODEM; and Kermit protocols.

Phone: (510) 208-4400.

Circle 1318 on Inquiry Card.

COMPUTERIZED HIEROGLYPHICS

LinguaDOS Nubi (about $325; £210) from LinguaTech (London, U.K.) allows academics and researchers to process two ancient Egyptian languages—Nubian and Coptic—without modifying standard PCs or word processors. You can generate laser fonts that are faithful to the originals. The multilingual extension to MS-DOS and DR DOS is compatible with popular word processors. An enhanced version (about $480; £310) also supports French and German.

Phone: +44 81 964 4142.

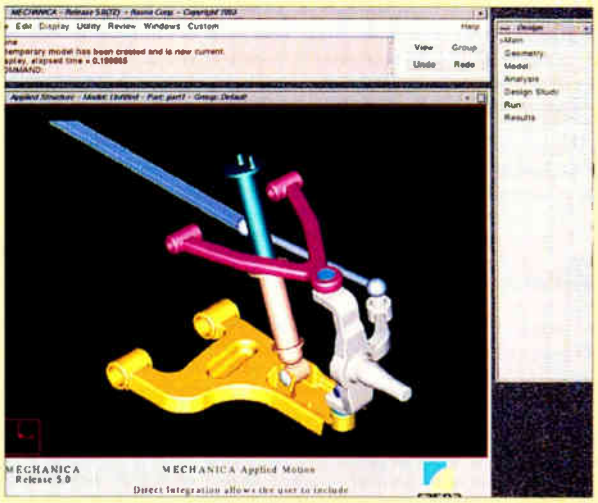
Circle 1333 on Inquiry Card.

RASNA'S MECHANICA REFINES CAD MODELS

Mechanica 5 (for DOS, from $7995; for Unix, from $15,000), a suite of modeling tools, lets engineers optimize the shapes of their product designs using Mechanica's shape-optimization technology. Designed to complement existing CAD packages, such as AutoCAD, Mechanica 5 consists of five integrated applications for DOS- and Unix-based workstations. The Mechanica components include Applied Structure, a structural-engineering optimization package with Rasna's Geometric Element Modeling and Analysis (GEM/GEA) technology; Applied Thermal, an extension for heat-transfer analysis; and Applied Vibration, an optimizer for designs subjected to dynamic loads.

Contact: Rasna Corp., San Jose, CA, (408) 922-6833.

Circle 1304 on Inquiry Card.



AFFORDABLE MAC CALCULUS

Calculus T/L II ($75) from Brooks/Cole Publishing (Pacific Grove, CA) lets students explore mathematical ideas and solve problems. Among its features are simplified master control buttons, new palettes for creating mathematical objects, new 3-D and improved 2-D graphs, and capabilities in univariable and multivariable calculus, linear algebra, and related courses.

Phone: (800) 354-9706 or (408) 373-0728.

Circle 1327 on Inquiry Card.

CUSTOMIZE SPREADSHEET SCHEDULES

Spreadsheet Scheduler ($199) from User Solutions (South Lyon, MI) offers several spreadsheet-enhancement templates designed to improve customer deliveries, manage projects more efficiently, and minimize work-in-process times. The 14 specialty templates offer the capability to do what-if analysis to accommodate changes without missing deadlines, to generate Gantt charts, and to track tasks through the software's Critical-Path-Method project management function.

Phone: (800) 321-8737 or (313) 486-1934.

Circle 1332 on Inquiry Card.

Software Update

AutoManager WorkFlow 3.1 (single-user, $795), Cyco International (Atlanta, GA), adds support for new vector, raster, and text file formats; direct links to Generic CADD and MicroStation; and out-of-the-box support for AutoCAD release 12–compatible software.

Phone: (404) 634-3302.

Circle 1162 on Inquiry Card.

FEMAP 4.0 for Windows (from $195 to $1495), Enterprise Software Products (Harleysville, PA), adds automatic mesh generation and support for isotropic, orthotropic, and anisotropic materials.

Phone: (215) 256-1829.

Circle 1166 on Inquiry Card.

Risk*Assistant 2.0 ($395), Thistle Publishing (Alexandria, VA), adds software tools that let you predict concentrations of air pollutants and assess chemical exposures and risks.

Phone: (703) 684-5203.

Circle 1345 on Inquiry Card.

PSI:Origen 3.0 ($495 per server), Preferred Systems (Trumbull, CT), lets LAN managers cut, paste, modify, and selectively combine NetWare 2.x, 3.x, and 4.x server templates throughout an enterprise.

Phone: (203) 459-1115.

Circle 1172 on Inquiry Card.

Qualitas' (Bethesda, MD) **386Max 7** ($99.95) provides up to 100 KB more of DOS conventional memory under Windows than is available in a native DOS environment.

Phone: (301) 907-6700.

Circle 1170 on Inquiry Card.

What's New Software

▲ CD-ROM ILLUMINATES MULTIMEDIA

The Guided Tour of Multimedia ($49.95) is a CD-ROM packed with answers to questions about multimedia. From Zone Publishing (Irvine, CA), The Guided Tour comes on a CD-ROM for PCs and is filled with audio and video clips, graphics, and animations. Included on the CD are profiles of the hardware and software components that make up multimedia technology.

Phone: (714) 833-3838.

Circle 1319 on Inquiry Card.

REMOTE ACCESS OF LOTUS NOTES WITHOUT A PC

Remark PhoneClient ($2850) is a workgroup package that links into Lotus Notes databases with a Touch-Tone phone; it does not require a PC. From Simpact Associates (San Diego, CA), it is the first in a series of products to link mobile or remote users to a Remark voice and telephone server and record or play back voice information contained in Notes databases. You can annotate Windows applications that support OLE or DDE.

Phone: (619) 565-8165.

Circle 1321 on Inquiry Card.

NETWORK WITHOUT AN NOS

Net Solution ($199) from Connexperts (Dallas, TX) is a high-performance network that plugs into any PC without user configuration. It includes Windows and DOS software that offers printer sharing, file transfer, and E-mail at 12 MBps over UTP (unshielded twisted-pair) cable without an NOS (network operating system). To share data files over the network, you can add NetWare, LANtastic, Windows for Workgroups, or Connexperts' own Net Solution NOS. Net Solution can support up to 255 users over an unlimited distance (32 users per 600-foot segment, with repeaters to connect segments).

Phone: (214) 233-8800.

Circle 1341 on Inquiry Card.

ADD 3-D MENUS TO WINDOWS

ProMenu Library 1.0 ($150 through August 31; $250 thereafter) customizes Windows 3.1 programs by adding 2-D and 3-D graphical menus. From ProSoft (Colorado Springs, CO), ProMenu Library is a DLL that features 50 functions and 22 real-time messages such as context-sensitive cursors, which support floating 3-D graphical menus.

Phone: (800) 793-2246 or (617) 556-9294.

Circle 1320 on Inquiry Card.

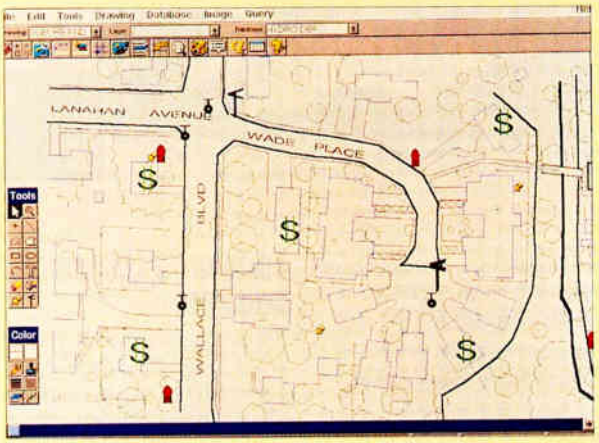
SPEED UP WITH PC2PC

Remote Access's (Blue Point, NY) pc2pc ($99) is a file transfer package that uses on-line data compression to reduce transmission times by up to 85 percent. Designed to work with remote communications packages, it incorporates automatic error correction and adjusts to line noise levels for maximum efficiency even under poor line conditions. An auto-restart feature lets you pick up where you left off with no loss of data should a file transfer be interrupted for any reason.

Phone: (800) 225-8420 or (516) 363-4719.

Circle 1339 on Inquiry Card.

HOLD A GIS IN YOUR HAND



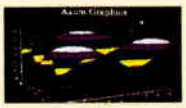
FieldNotes ($895) is a Windows for Pen Computing application that connects mobile users to host-based GISes (geographical information systems). Ideally suited as a front end to large GIS applications on host systems for utilities and facilities management installations, FieldNotes integrates graphical information and drawings with geographic data contained in GIS databases. It supports file interchange with GIS applications that use AutoCAD's .DXF file format as well as information from databases in either .DBF or ASCII formats.

Contact: PenMetrics, Inc., Corvallis, OR, (800) 537-3322 or (503) 757-3076.

Circle 1305 on Inquiry Card.

Software Update

Axum 3.0 ($495), TriMetrix (Seattle, WA), lets you do

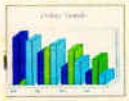


nonlinear regression, create user-defined functions, plot 3-D mesh surfaces and contours, and automatically calculate error bars.

Phone: (800) 548-5653 or (206) 527-1801.

Circle 1178 on Inquiry Card.

Defect Control System 2.0 ($695), The Software Edge



(Colorado Springs, CO), adds security features that let you set up different views into a project by controlling who can access and modify each defect field.

Phone: (719) 598-3713.

Circle 1168 on Inquiry Card.

SmartForecasts 3 Turbo Batch Edition ($7995), Smart Software (Belmont, MA), adds 32-bit DOS protected-mode technology for enhanced speed and data capacity in solving massive forecasting problems.

Phone: (800) 762-7899 or (617) 489-2743.

Circle 1160 on Inquiry Card.

Iconic Query 1.1 ($290), IntelligenceWare (Los Angeles, CA), adds report-writer features that simulate a word processor; Hyper Notes, which let you apply notes on any database entry; and automatic SQL union operations.

Phone: (310) 216-6177.

Circle 1169 on Inquiry Card.

vxBase 3.0 ($195), Abacus Systems (Minot, ND), adds 15 enhancements, the ability to create subindexes, and a method of tracking errors outside the vxBase program.

Phone: (800) 992-0616 or (701) 838-4686.

Circle 1342 on Inquiry Card.

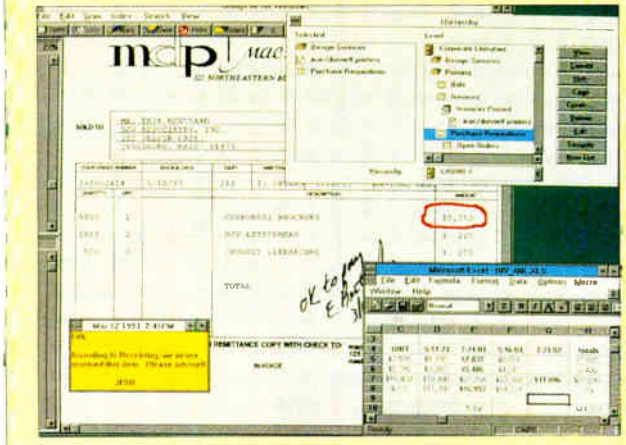
Software

GROUPFILE FOR DOCUMENT MANAGEMENT

GroupFile for Windows (single-user license, $499) is a document management package designed to capture, organize, display, and manipulate documents of any type. The software, which runs in stand-alone PC or LAN environments, includes a built-in structure of folders, drawers, and cabinets for organizing scanned images and other files generated from Windows applications. A GroupFile Network Edition (from $8990 for five users to $19,875 for 20 users) is also available. It uses Microsoft's SQL Server RDBMS (relational database management system) and supports Novell NetWare.

Contact: LaserData, Inc., Tyngsboro, MA, (508) 649-4600.

Circle 1306 on Inquiry Card.



WINDOWS WORKGROUP CALENDARING

Epoch 1.0 (five-user LAN, $129; 10-user, $895) is an OLE-based personal and workgroup calendaring package from Raindrop Software (Richardson, TX) for Novell Networks, Windows for Workgroups, and other Windows-compatible networks. With OLE client/server support, Epoch provides calendaring conflict and resolution capabilities and three levels of to-do-list priorities.

Phone: (214) 234-2611.

Circle 1317 on Inquiry Card.

DATA ACQUISITION FOR THE MAC

SuperScope II ($1490) is a waveform acquisition, analysis, and presentation package. From GW Instruments (Somerville, MA), it lets users with little or no programming experience build computer-based instruments. Features include creating virtual instruments with displays, text windows, meters, knobs, lights, and thermometers. The software lets you digitize, analyze, plot, and store continuous streams or discrete blocks of waveform data.

Phone: (617) 625-4096.

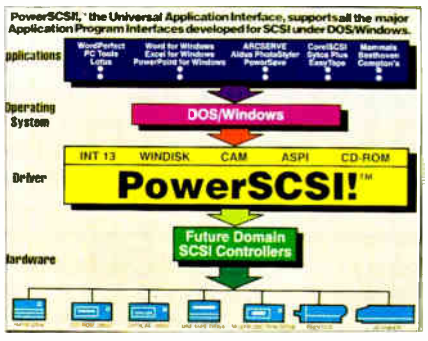
Circle 1326 on Inquiry Card.

POWERSCSI INTERFACE ▼

PowerSCSI (disk, $25; free on BBS) from Future Domain (Irvine, CA) is a universal application interface that is aimed at eliminating some of the incompatibility problems that are associated with SCSI. Drivers written to any SCSI connection can be used with any Future Domain host adapter. The interface builds on the development of common access method by the ANSI committee of SCSI manufacturers.

Phone: (800) 879-7599 or (714) 253-0400.

Circle 1338 on Inquiry Card.



SPEECH-RECOGNITION CONTROL

Speech Systems (Boulder, CO) has introduced a custom-control facility, Spot/VBX, for adding speech-recognition features to Windows applications developed with Visual Basic or Visual C++. Available as part of Speech Systems' software tools suite called the PE400 System Development Kit ($1495), Spot/VBX lets application developers add speaker-independent, continuous speech-recognition features to existing applications.

Phone: (303) 449-0481.

Circle 1334 on Inquiry Card.

NETWORK CD-ROM PUBLISHING

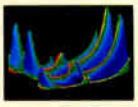
Meridian Data (Scotts Valley, CA) and Eastman Kodak Co. (Rochester, NY) have jointly developed a turnkey CD-recordable publishing system, Netscribe 1000 version 1.0 ($13,995), that combines Meridian's Netscribe Access client software and Kodak's PCD Writer 200 over Novell NetWare and peer-to-peer networks. With Netscribe, you can publish data sent over networks to the Kodak CD recorder with point-and-click ease. Additional Netscribe Access clients are available in 10-user ($495) and 50-user ($1495) licenses.

Phone: (408) 438-3100.

Circle 1311 on Inquiry Card.

Software Update

PV-Wave Advantage (single floating license, $6995), Visual Numerics (Boulder, CO), adds a widget toolkit that lets you customize your GUI for faster application development.



Phone: (303) 530-9000.

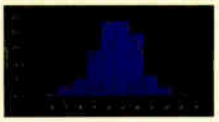
Circle 1175 on Inquiry Card.

Paper Keyboard ICR ($6995), Datacap (Tarrytown, NY), adds image enhancement, forms-image removal, and bar code recognition.

Phone: (914) 332-7515.

Circle 1161 on Inquiry Card.

Minitab Statistical Software for Windows release 9 ($895), Minitab (State College, PA), adds advances in graphics, general statistics, industrial statistics, and macros.



Phone: (800) 448-3555 or (814) 238-3280.

Circle 1158 on Inquiry Card.

OptiDoc 4.0 (single-user, $4995), Advanced Technology Services (Atlanta, GA), adds referential, constrained, range-checking, and computational validation features; group mail functions; and direct markup annotation.

Phone: (404) 843-3921.

Circle 1344 on Inquiry Card.

Shany's (Mountain View, CA) **AlertView 2.1** ($935) includes automatic timers that perform LAN housekeeping operations on workstations.

Phone: (415) 694-7410.

Circle 1177 on Inquiry Card.

CoSession LAN II 6.2 (up to 25 users, $295), Triton Technologies (Iselin, NJ), provides NetBIOS support.

Phone: (908) 855-9440.

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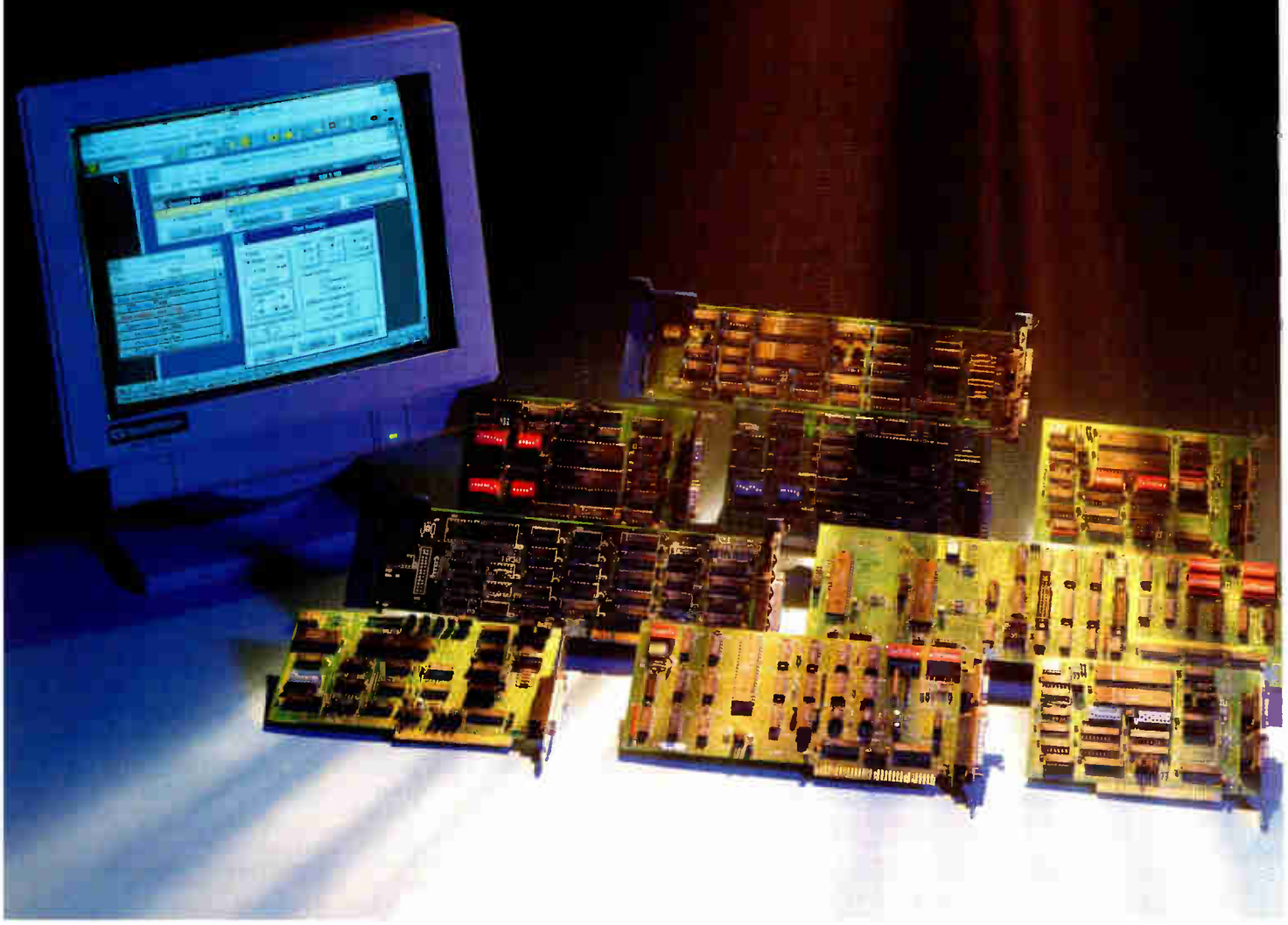

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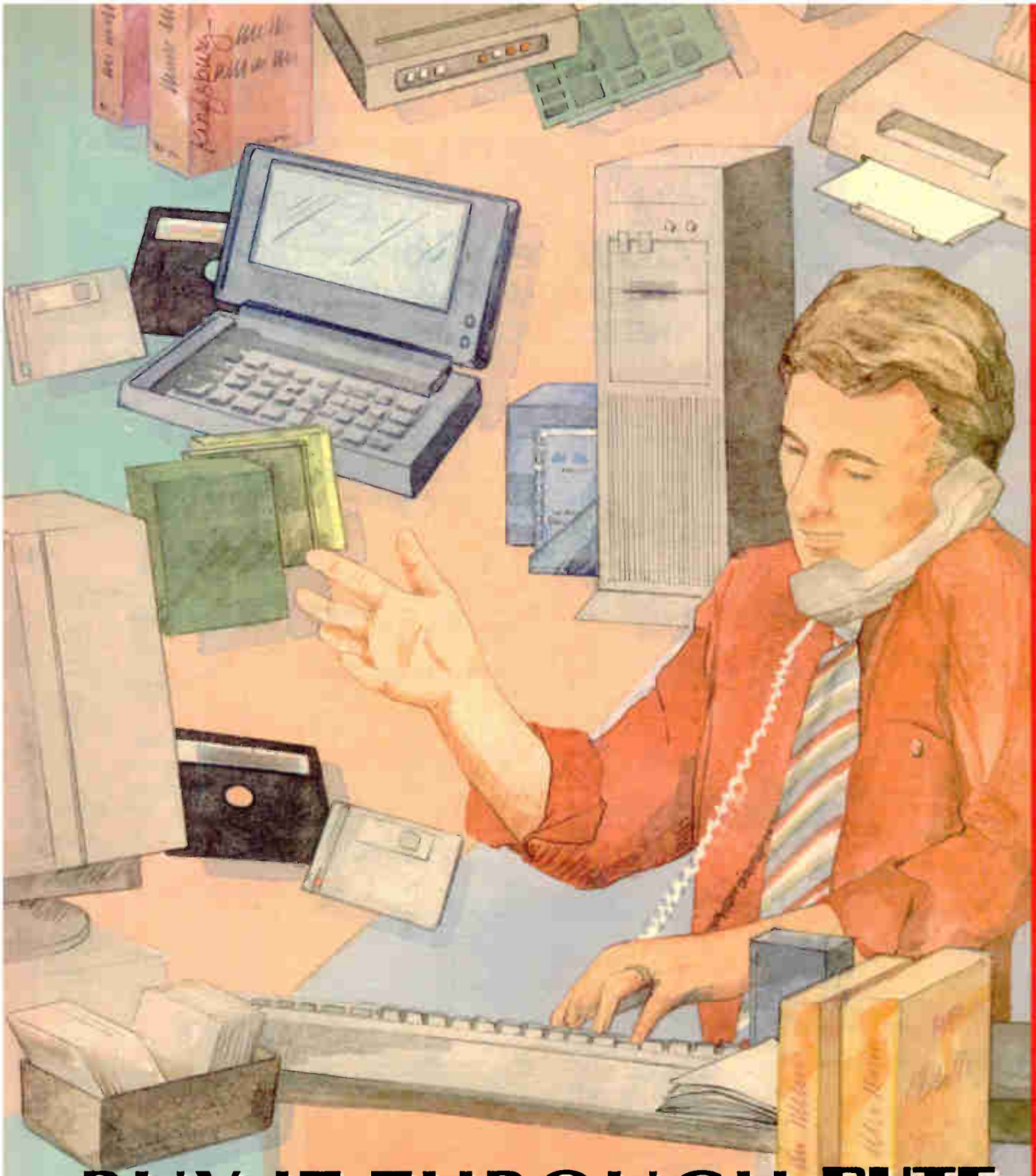

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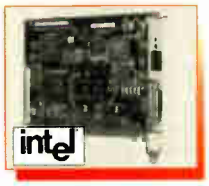

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T4400SXC/120	3339.13	T6400C/200	5459.23

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POWEREXEC EL 3/25 120HD	1768.42
POWEREXEC EL 3/25 Color No HD	1815.43
POWEREXEC 3/25SL 4MB, 160HD, Color	2947.92
POWEREXEC 3/25SL 4MB, 120HD	1936.43
POWEREXEC 3/25SL Active Color, 200HD	3354.84
POWEREXEC 486/25SL Mono	1515.00
Premmia 4/33SX/4/33D 8MB 170HD	2099.29/2479.41
Premmia 4/50D/4/66D 8MB 340HD	2898.53/3198.50
SE 4/33 EISA Server 8MB,1 Floppy	[illegible]
SE 4/50 EISA Server 16MB,1 Floppy	[illegible]
SE 4/66 EISA Server 16MB,1 Floppy	[illegible]
Bravo 3/33 / 4/25S 4MB 120HD	969.28/1049.10
Bravo 4/33 / 4/66d 4MB 120HD	1377.12/1879.31
Bravo 4/50d, 2MB, VGA, DOS	1587.85

Canon

Notejet 4/25 180 HD Notebook w/ built in ptr	2817.65
Notejet 4/25, 135HD Notebook w/ built in ptr.	2590.59
Notejet 4/25, 85HD Notebook w/ built in ptr	2364.21
INNOVA 486DX/33 Desktop 4 MB 210HD	1438.14
INNOVA 486DX/66 Desktop 4 MB 245HD	1929.32
INNOVA 386SX/25 Notebook 4 MB 120HD FX Modem	1549.00

DTK Grafika

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NEC Ready 486DX/33, 4 MB, 170 MB, 2 Floppies	1479.29
NEC Ready 486DX2/66, 8 MB, 240 HD, 2 Floppies	1999.27
Versa 486/25, 4MB, 120 HD	2679.39
Versa 486/25C Color 4MB, 180 HD	3928.22
Versa 486/20C Color 4MB, 120 HD	3579.16

Texas Instruments

486 WIN SX25, 120HD, 4 MB VGA	1898.48
[illegible]	[illegible]
[illegible]	[illegible]
486 WIN DX50 color, 200HD	3089.15
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TI microLaser TurboPlus PS 9PPM RISC	1378.55

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MCP2112 1000MB, 10MS 3.5" HH, SCSI-2	1288.22
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CP30084E 84 MB, 19MS, 3.5" HH, IDE	189.76
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LOGITECH Mouseman Cordless	79.33
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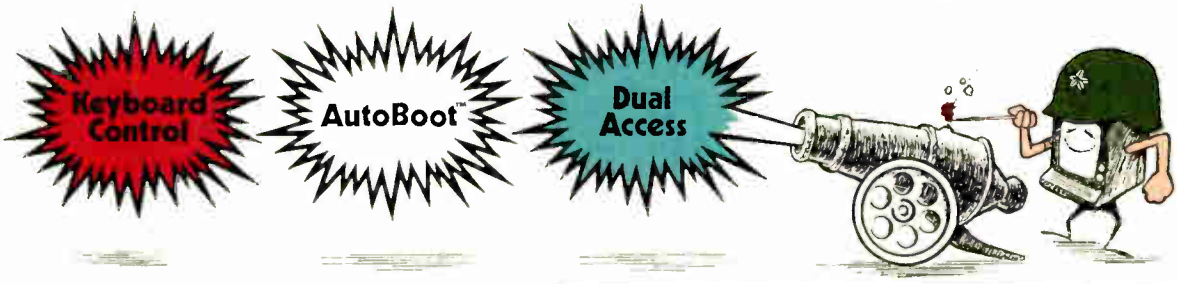

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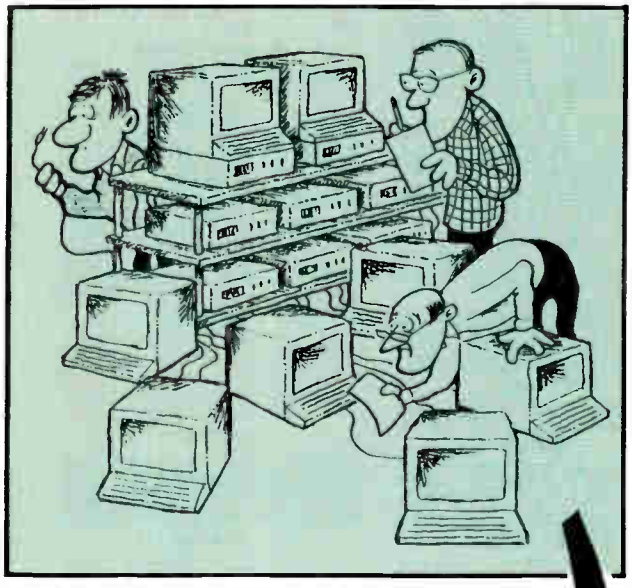

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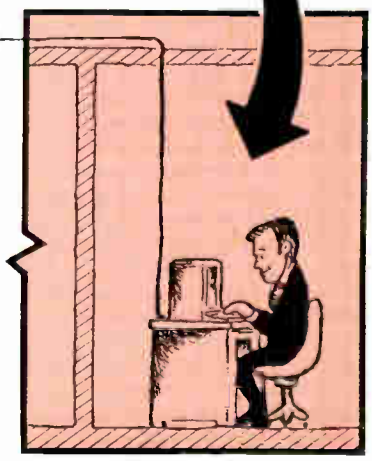

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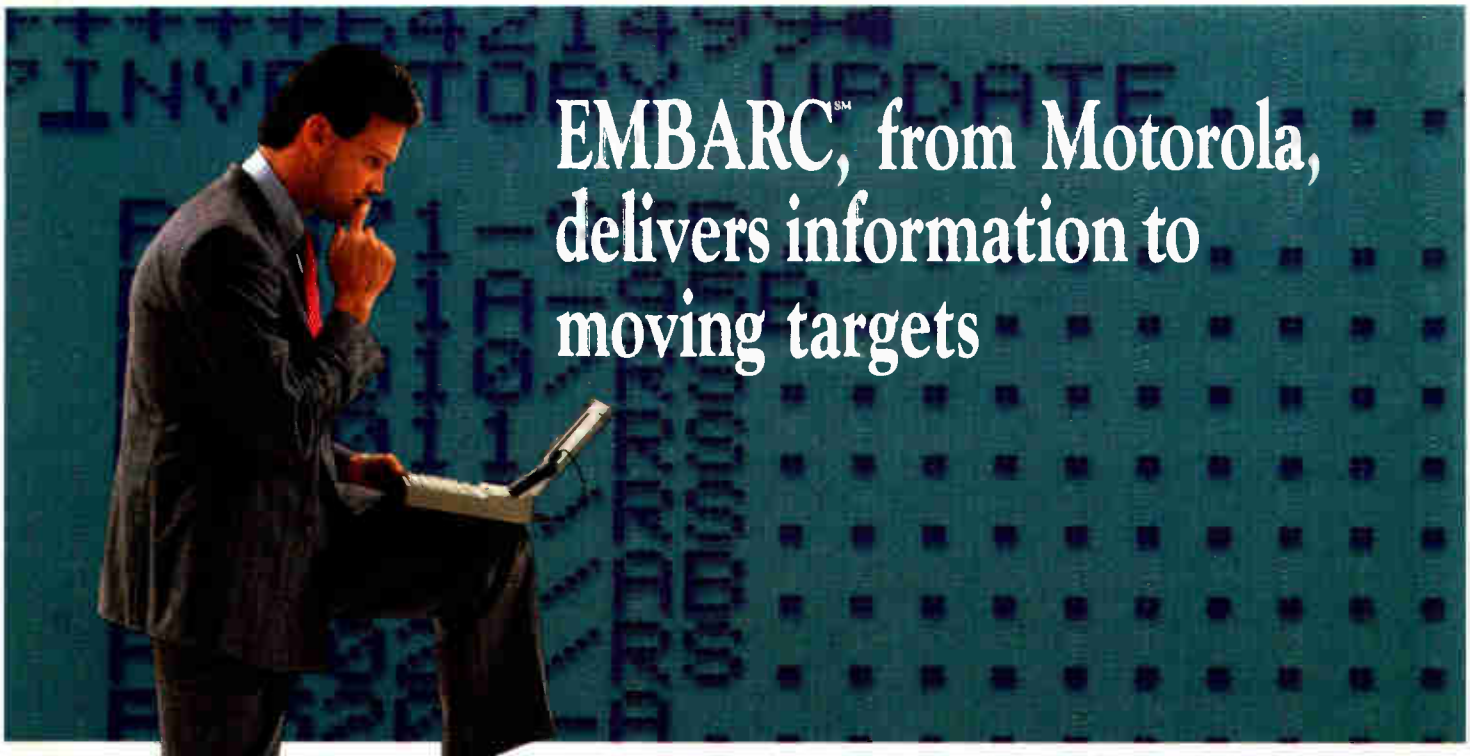

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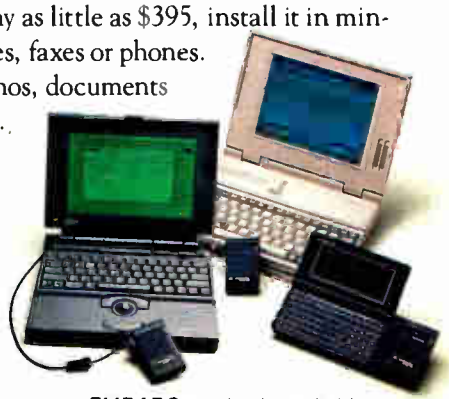

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ST3243A	213MB	15MS	IDE 3.5"	$259
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ST3550A	452MB	12MS	IDE 3.5"	$599
ST4766N	660MB	15MS	SCSI/FH	$899
ST41200N	1037MB	15MS	SCSI/FH	$1148

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MODEL	SIZE	SPEED	TYPE	PRICE
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CP30104 (1" high)	120MB	19MS	IDE	$208
CP30174A (1" high)	170MB	17MS	IDE	$248
CP30254 (1" high)	209MB	12MS	IDE	$308
CP3540	540MB	12MS	SCSI	$858
CP3544A	540MB	15MS	IDE	$858

Maxtor

MODEL	SIZE	SPEED	TYPE	PRICE
7131A (1" high)	130MB	15MS	IDE	$218
7213A (1" high)	213MB	15MS	IDE	$268
7213S (1" high)	213MB	13MS	SCSI	$341
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2625S (FH)	1750MB	11MS	SCSI	$1978
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SCSI	Adaptec 1742A 32 BIT	$418
SCSI	Adaptec 1542 Bus Mastering	$219
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	4MB	92F9694	$159
PS/2 30/286,25/286; Adpt Brd 1497259	512K	30F5348	$30
	2MB	30F5360	$84
PS/2 55SX, LS 40SX,70-E61, 061, 121 Adpt Brd 6450609, 34F3011, 34F3077, 502 55SX, 6555X, P70, 55LS, 65LS XStation 120 & 130	1MB	6450603	$49
	2MB	6450604	$79
PS2 50, 50Z, 55SX, 60, 65SX	2-8MB	1497259	$259
	2-16MB	6450609	$308
2-8 MB FOR PS/2 50 & 60, 2MB $99, 4MB $159, 8MB $289			
PS/1 Consultant, Essentials & Expert models x43, x44 & PS/Valuepoint all models except Cxx series	4MB	N/A	$159
	16MB	N/A	$699
PS/2 70 A21, A61, B21, B61, PS/1 Consultant, Essential & Expert models x11, x13 & x14, PS/Valuepoint Cxx series	1MB	6450603	$49
	2MB	6450608	$84
PS/2 35SX; LS, 40SX, 55SX, LS, 65SX;	4MB	34F2933	$168
PS/2 90 XP, 95 XP, P75 (Pairs), 56 57 (all) 76, 77, PS/1 Pro 2123	2MB	6450902	$88
PS2 90, 95 XP, P75 (Pairs) 56, 57, (all) PS/1 Consultant, Essential, Expert x11, x13 & x14, PS/1 Pro 2123, RS/6000	4MB	6450128	$158
	8MB	6450130	$318
PS/2 / 35SX, LS, 40SX	8MB	6450129	$298
PS2 70's and 80's	2 8MB	6450605	$249
32 BIT BOARDS	2 14MB	34F3077	$288
32 BIT BOARDS	4 16MB	34F3011	$348
PS/2 80 A21, A31, A61	4MB	6451060	$198
PS/2 80-041	1MB	6450375	$88
PS/2 80 111, 311, 121, 321, 081, 161	2MB	6450379	$98
ValuePoint 425SX/25/DX33 & 66	1MB	96F9290	$58
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	4MB	53G6959	$238
	8MB	53G6960	$399
PS/2 MD CL57SX Color, Notebook	2MB	07G1419	$168
Thinkpad 700, 700C	4MB	07G1420	$219
	8MB	07G1421	$359
PS/Note N45	2MB	92F8804	$98
PS/2 Model N51, Notebook SLC, SX	2MB	07G1826	$98
	4MB	07G1827	$168
	8MB	07G1828	$308
Laptop N33SX, L40SX & N82	2MB	79F0999	$98
	4MB	79F1000	$168
L40SX ONLY	8MB	79F1001	$388

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T2000 / T2000SX	2MB CARD	PA8317U	$84
T2000SX/T1000 LE	4MB CARD	PA8314U	$168
	8MB CARD	PA8315U	$308
T1200 XE	2MB BOARD	PA8306U	$92
T1600	2MB BOARD	PA8302U	$85
T2000 SXE/T2200SX/T1800 T1850, C	2MB CARD	PA2000U	$89
	4MB CARD	PA2001U	$168
	8MB CARD	PA2002U	$328
T3100	2MB MOD	PA7135E	$158
T3100 E	2MB MOD	PA8341U	$88
T3100 SX	2MB BOARD	PA8308U	$88
	4MB BOARD	PA8310U	$164
T3200 SX	2MB MOD	PA8307U	$88
	4MB MOD	PA8309U	$164
T3200 SXC	2MB MOD	PA8318U	$88
	4MB MOD	PA8319U	$164
T3200	3MB BOARD	PA7137U	$164
T3300SL	2MB CARD	PA2006U	$98
	4MB CARD	PA2007U	$168
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T4400 SX, SXC, T6400 SXC, DXC	2MB CARD	PA2003U	$125
	4MB CARD	PA2004U	$168
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T4500C	4MB	PA2012U	$188
	8MB	PA2013U	$328
	16MB	PA2017	$798
T5100	2MB BOARD	PA8301U	$88
T5200/T5200C/T8500	2MB MOD	PA8304U	$99
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MODEL	MEMORY	PART#	PRICE
Deskpro 386/16	1 2MB	108069-001	$238
	2MB	108069W71	$348
	4-8MB	108070-001	$398
Deskpro 286E; 386 20, 20E, 25, 25E	1MB	113131-001	$59
	4MB	113132-001	$173
Deskpro 386S	4MB Board	113634-001	$219
	4MB Module	112534-001	$174
Deskpro 386 20E, 25E	4MB	113645-001	$219
Deskpro 386/33, 386/33I, 486/25, 33I;50L, Systempro	2MB	115144-001	$98
	8MB	116561-001	$369
	32MB	116568-001	$1478
Systempro, Deskpro 6 SKT EXP BRD W/2MB		116569-001	$299
Compaq "M"	2-64MB	129160-001	$348
Deskpro 2MH, 386N, 386SX/20, 20N, Portable 486c, Deskpro M, Systempro LT Series 129160-001, Compaq Pro Signia	1MB	118688-001	$49
	2MB	118689-001	$85
	4MB	118690-001	$158
	8MB	128877-001	$318
Prolina 3/25 & 25Z	2MB	141738-001	$89
	8MB	141742-001	$299
Prolina 4/25si, 4/33, 4/50	2MB Module	141683-001	$98
	4MB Module	141684-001	$168
	8MB Module	141685-001	$318
Compaq Pro Signia	16MB	149320-001	$995
	32MB	149147-001	$2395

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Contura 320, 325	2MB	139497-001	$98
	4MB	139498-001	$168
	8MB	139499-001	$318
Contura 4/25CX	4BM	146520-001	$228
	8MB	146521-001	$388
	16MB	146522-001	$848
SLT/286	1MEG MOD	110235-001	$79
	4MEG MOD	110237-001	$208
SLT386	1MEG MOD	118303-001	$79
	2MEG MOD	118304-001	$108
	4MEG MOD	118305-001	$169
Lte 286	1MEG BRD	117081-001	$79
	2MEG BRD	117081-002	$99
	4MEG BRD	117081-003	$218
Lte 386S/20	1MEG BRD	121125-001	$98
	4MEG BRD	121125-002	$179
Lte Lite/20, 25, 25C	2MEG BRD	129769-001	$138
	4MEG BRD	129769-002	$198
	8MEG BRD	129769-003	$349
	16MEG BRD		$1395
LTE Lite/20 & Lite/25,25C	16MB Card	N/A	$1045
Compaq Lite 486/25C	4MB Card	142337-002	$219
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1MEG X 9	$31	$37	$40	$44	$49	58
4MEG X 9		$144	$149	$179		
16MEG X 9 (36 CHIP)			$699			
256X36 1MEG (72 Pin)		$50				
512X36 2MEG (72 Pin)		$85	$95			
1X36 4MEG (72 Pin)		$149	$159	$189		
2X36 8MEG (72 Pin)		$299	$318	$379		
4X36 16MEG (72 Pin)		$649	$699	$749		
8X36 32MEG (72 PIN)		$1400	$1450			

D-Ram Chips

DESCRIPTION	150NS	120NS	100NS	80NS	70NS	60NS
64 X 4	$1.95	$2.25	$2.45	$2.95		
256X1 STATIC				$1.95	$2.25	
256 X 1	$1.05	$1.45	$1.90	$2.00	$2.05	$2.20
256 X 4			$4.45	$4.95	$5.45	$5.95
1MEG X 1			$3.50	$4.75	$5.45	$5.75
1MEGX1 STATIC				$4.95	$5.25	
4MEGX4				$17.00	$20.00	$24.00

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	15ns	20ns	25ns
8KX8	4.95	4.45	3.95
32X8	8.95	7.75	
64x1	7.95	8.45	
64x4	9.95	8.95	7.95
16x4	8.95	5.45	4.95
128x8	49.00	39.00	

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MODULE	1MEG	2MEG	3MEG	4MEG	5MEG	8MEG
Brother HL 8, 8E, 8D, 8V	$99	$149		$249		
Canon LBP4, 4 Lite & +	$128	$174				
Compaq Pagemark 15 & 20				$319		$638
Epson Action Laser II, 8000	$95		$163		$229	
Epson + 6000 and many more		$103		$168		
Fujitsu 7100 & 7200	$199	$279				
HP Deskjet 500, 500C and 550C		$59 (256K)				
HP2, 2D,		$89	$146			
3, 3D, 3P, 2P, 2P+		$103	$159			
HPIII SI	$50		$158			
HP Laser Jet 4, 111Si, XL300				$158		$298
IBM Laser 4019, 4019E (3.5MB)				$169		
IBM Laser 4029				$149		
NEC 90, 290		$118				
NEC 95		$98				
OKI 400		$99				
Packard Bell PB9500		$125		$178		
Panasonic 4410/4430		$119		$188		
Panasonic 4420/4450I	$89	$118		$188		
Panasonic 4450	$105					
Panasonic 4455		$139				
QMS 410	$119	$159		$249		
Star LS04	$129	$179		$269		
StarScript 4	$128	$178		$258		
Tosiba Page Laser 6		$119		$178		
TI XL/PS17/PS35	$48					

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Bondwell B-310	1MB	23050-09100	$128
Dec pc 320 Notebook	2MB Mod	FR-PCIMA-BA	$149
	4MB Mod	FR-PCIMA-BB	$298
	8MB Mod	FR-PCIMA-BD	$345
Dell Laptop 212, 320N, 320N+	1MB Mod	310-3203	$79
	2MB Mod	310-3204	$109
Dell 325NT, NC, Notebook P.C.	2MB Mod	310-3210	$119
Dell NL20 & NL25 NTBK	2MB Mod	310-3213	$148
Epson NB-3 Notebook	4MB	A808511	$198
Epson NB-5L/20,25	2MB Mod	A808771	$138
25C Notebook	4MB Mod	A808781	$228
Everex Tempo LX, LX20	2MB	00160	$87
Everex Carrier	2MB	00263-00	$97
Grid 1500	4MB	52587	$198
Grid 1450SX	2MB	6200203	$148
Goldstar GS520, 386SX16	1MB	N/A	$98
	4MB	N/A	$248
NCR 3120 Notebook	4MB Mod	3120-K104	$299
NCR 3170 Notebook	4MB Mod	3123-K104	$399
Packard Bell, Magnavox, Mitsuba	1MB	N/A	$88
	4MB	N/A	$198
Panasonic CF170/270/370	1MB	CF-BA165	$64
Samsung Notemaster 386S	2MB	SNM002	$195
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Sanyo 17NB, 18NB & ZEOS	2MB	MBC-NBMEM2	$88
Sharp 6220	1MB	CE-6218	$88
Sharp 6640	2MB	N/A	$198
Sharp 4700MZ-200	1MB	CE-471	$198
Sharp 8501 Colorstar	2MB	N/A	$398
TI Travelmate 2000	1MB	2568034-0011	$88
TI Travelmate 3000SX, WINSX	2MB	2566996-0001	$98
TI Travelmate 4000, WINDX/25 SX/16, SX25	4MB	2581265-001	$208
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POWER EXEC 3/25SL 3/25SL-C	4MB MOD	500984-001	$168
	16MB MOD		$1298
AST POWER EXECL EL	2MB MOD	500984-004	$99
	4MB MOD	500984-001	$169
	8MB MOD	500984-002	$399
	16MB MOD	500984-003	$1245
POWER PREMIUM 486/50D	8MB EXP KIT	500780-001	$348
4/33, 3/33, 4/66D PREMUM II	16MB EXP KIT		$598
386/25, 33, 486/33 SX20 4-32 MB EXP BRD		500818-001	$348
AST PREMIUM 386C/386 16	4MB KIT	500510-008	$179
AST PREMIUM 386	4MB KIT	500510-004	$198
AST PREMIUM II, 386SX/16, 386SX/20, 486 33 & 33T	4MB MOD	500780-004	$168
BRAVO LC 4255, 4/33S, 4/50D, 4/66D	2MB KIT	500987-001	$98
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Zenith Z-386SX/20, 286LP+, Z-LS
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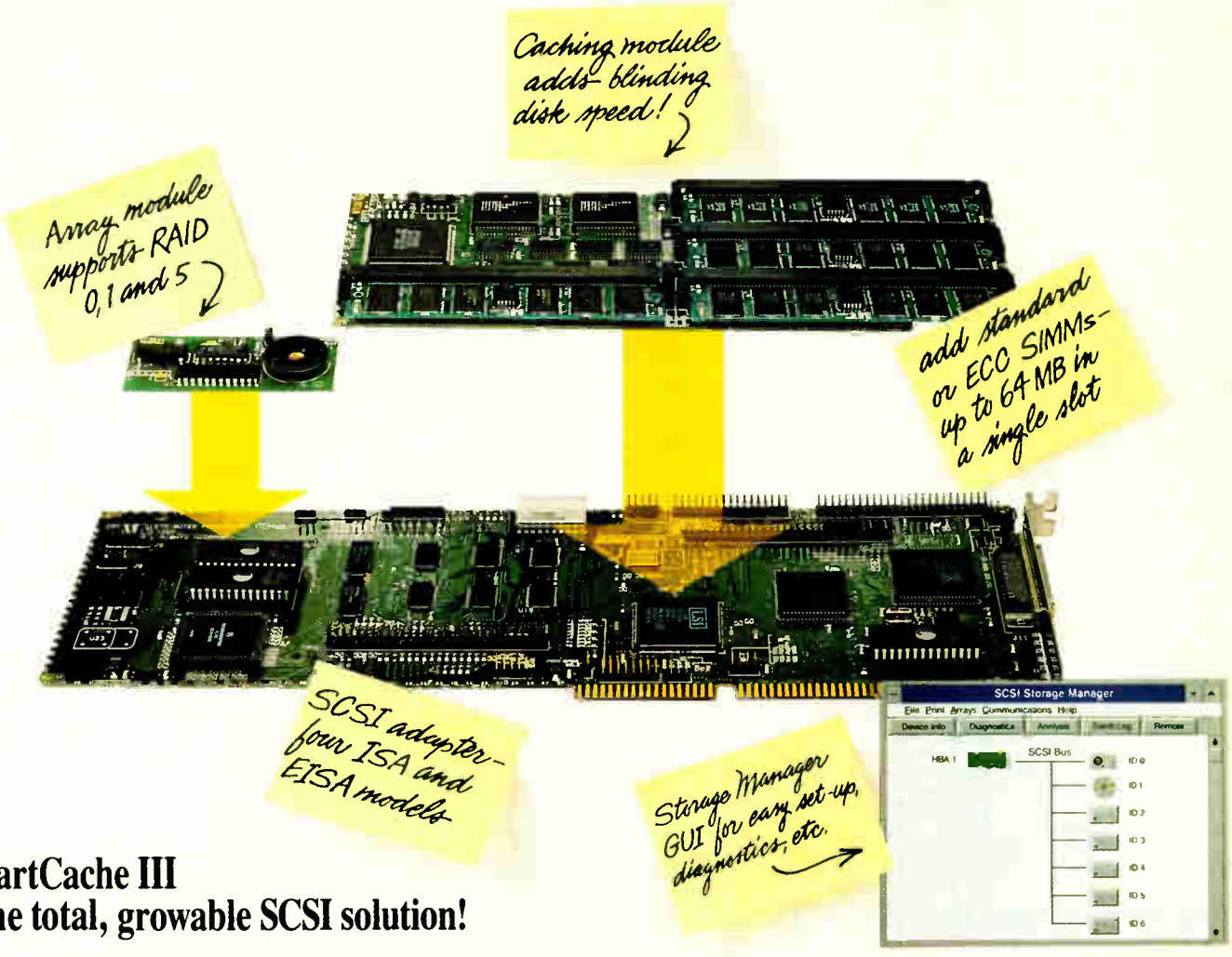

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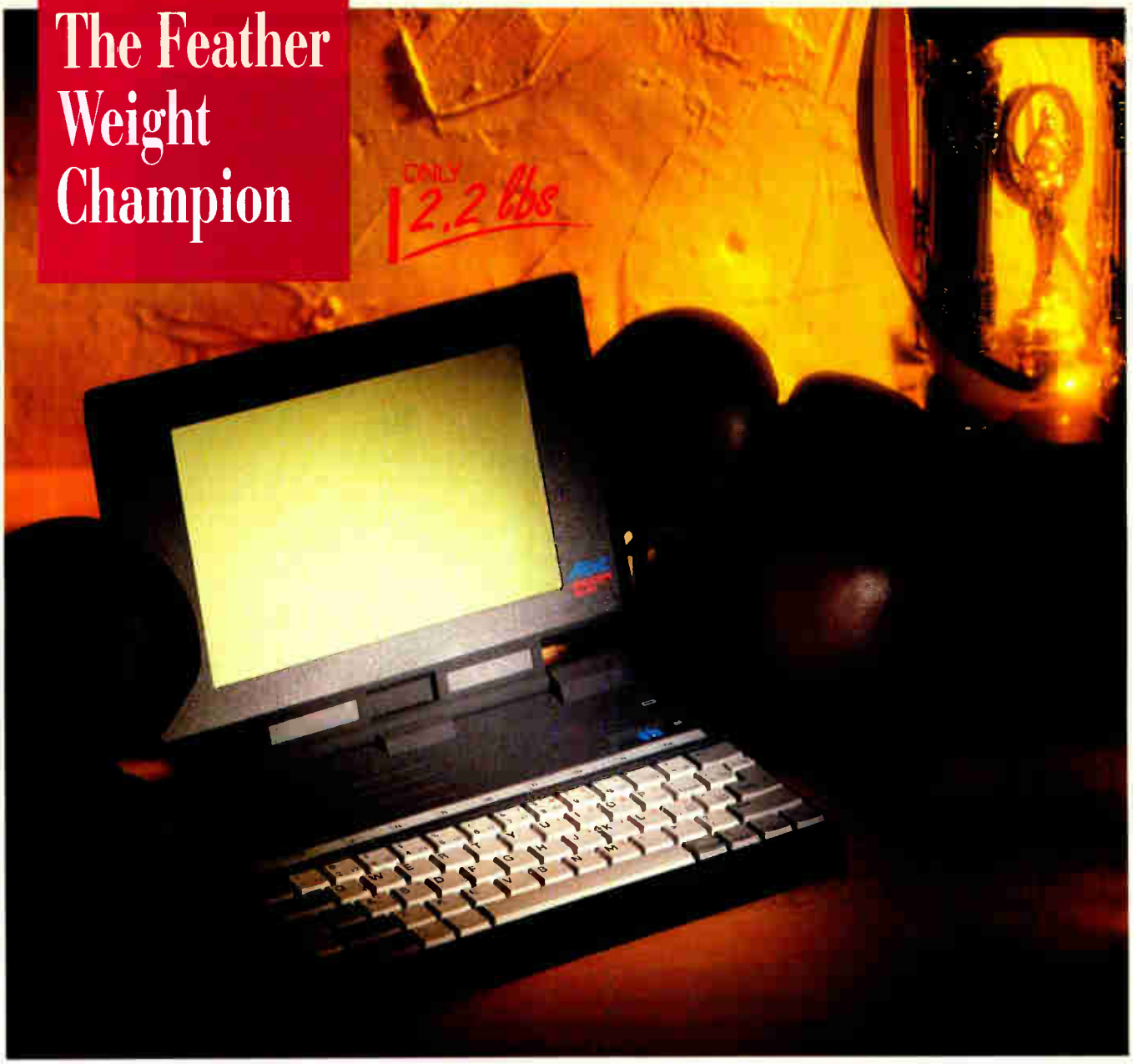

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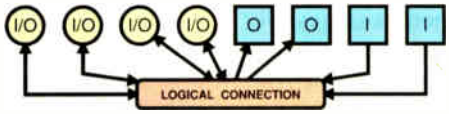

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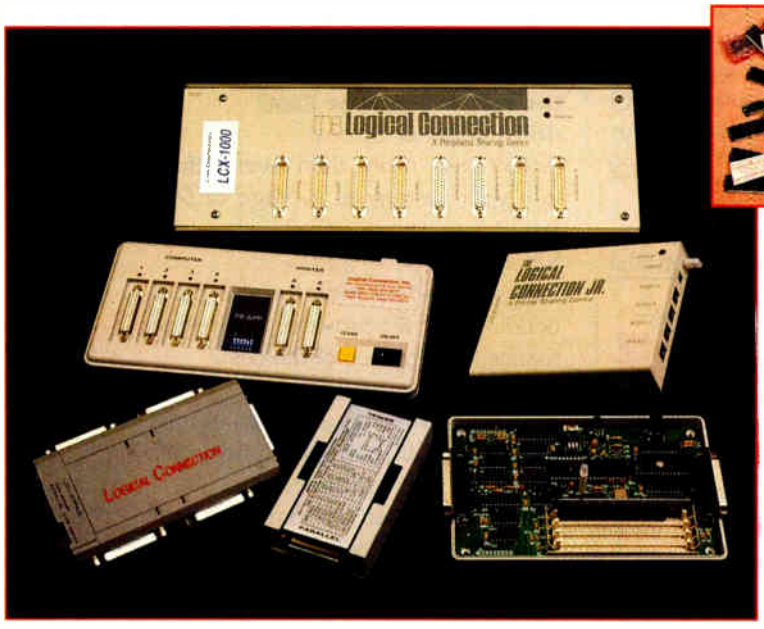

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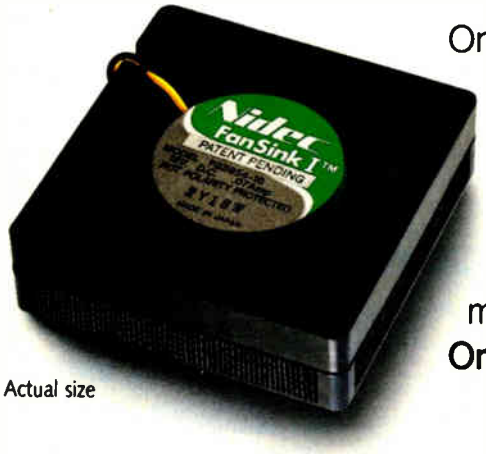

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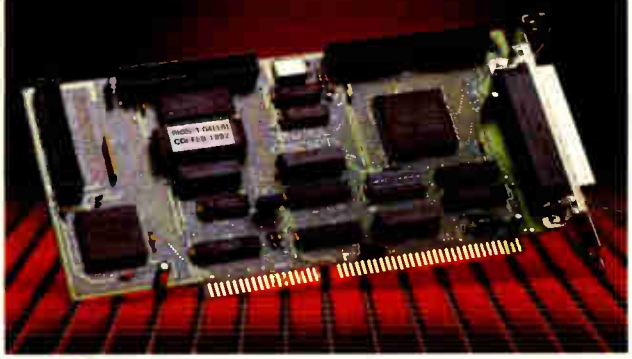

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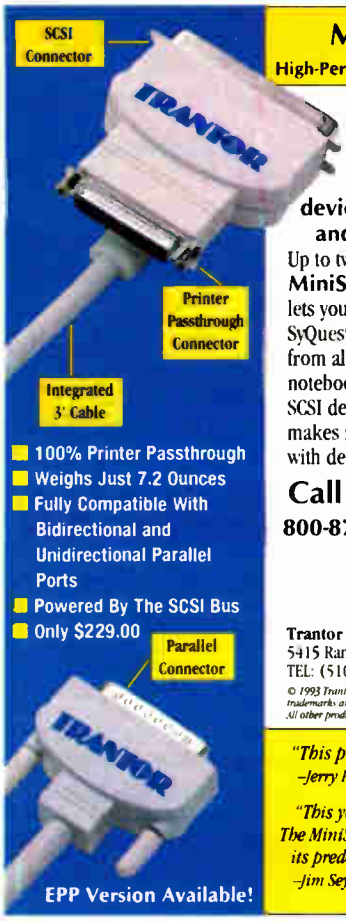

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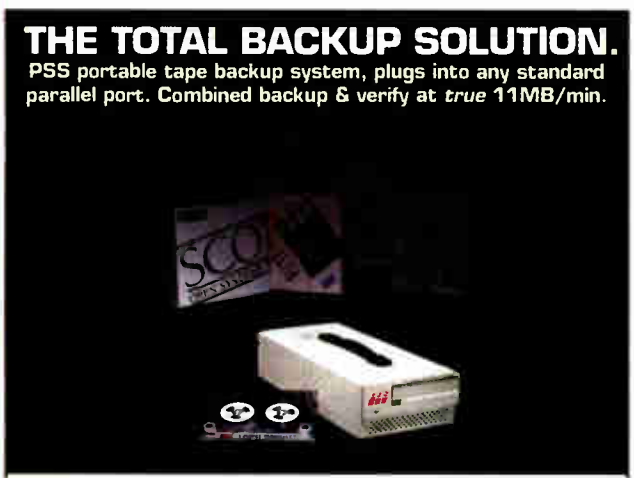

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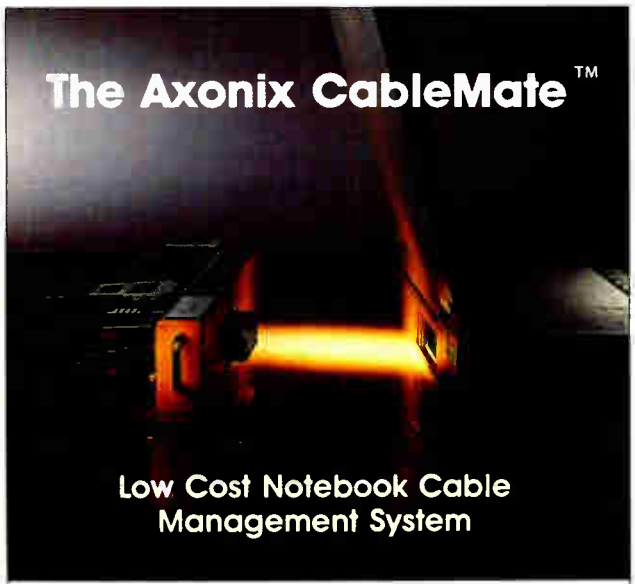

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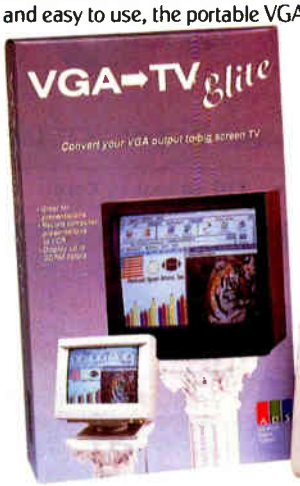

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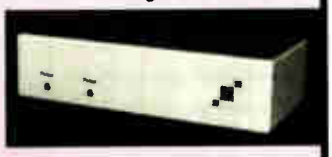

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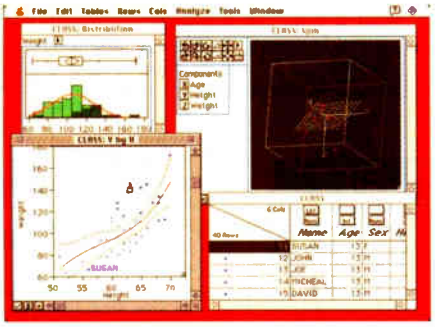

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DEADLINE: Ad copy is due approximately 2 months prior to issue date. For example: November issue closes on September 8. Send your copy and payment to: THE BUYER'S MART, BYTE Magazine, 1 Phoenix Mill Lane, Peterborough, NH 03458. For more information call: Margot Gnade at 603-924-2656. FAX: 603-924-2683.

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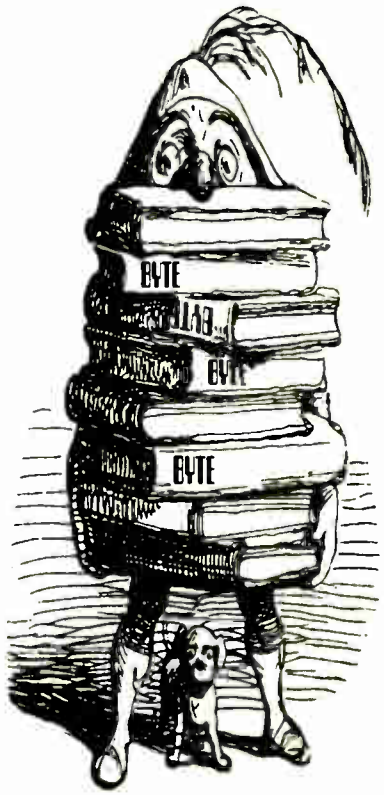

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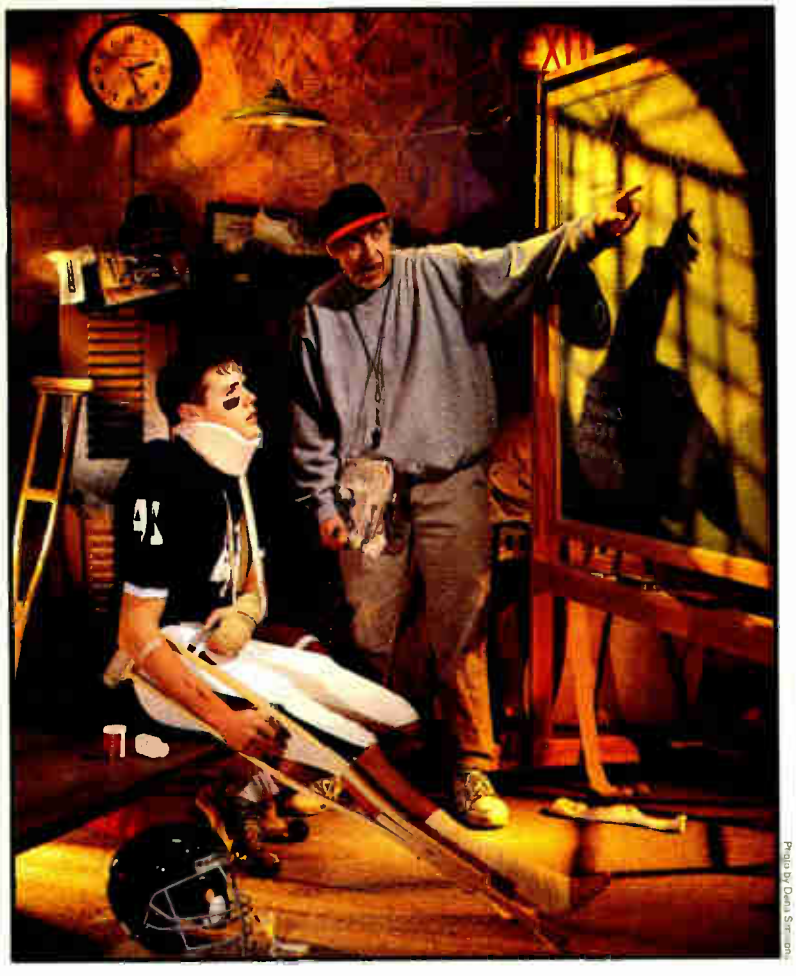

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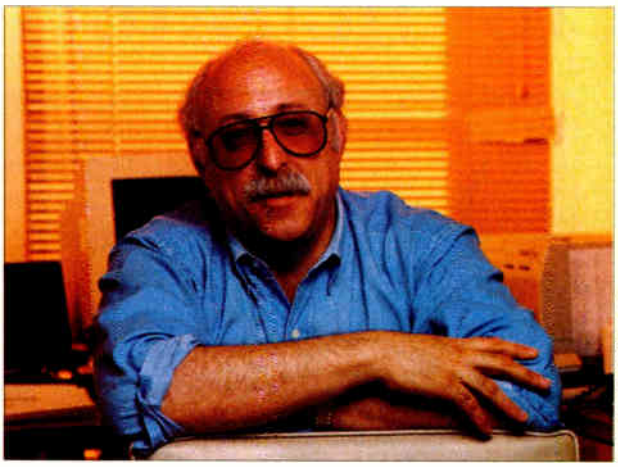
They Just Don't Get It

Any businessperson will tell you that personal computers are still too difficult to use. Why can't people inside the industry see that?



WALTER CALAHAN © 1993

Personal computers are just too hard to use, and it's not the fault of the people who use them.

That was my opening thought in the very first Personal Technology column I wrote for the *Wall Street Journal* in October 1991. This conviction has helped make the feature one of the most popular that paper has ever run.

Why has a column that is strongly proconsumer and highly skeptical of the PC industry struck such a chord among readers of the bible of American business? Because millions of people are frustrated and disappointed with the PC. To get the much-touted benefits of personal computing, they have learned, requires far more time, effort, and money than they expected. Their disaffection is a signal that the PC industry is out of step with two big trends: the changing structure of the U.S. economy, and changing attitudes among computer users.

Big corporations are a declining source of jobs—and of desktops for PCs. The engine of growth in our economy now consists of small- and medium-size businesses, small professional firms, and even people working out of their homes. Unlike giant companies, these organizations can't afford and often don't want the large IS (information services) departments that support personal computers in the Fortune 500—the priests who care for and control PCs.

But IBM-compatible computers and software too often still seem mainly designed and marketed to please the corporate computer priesthood and consultants. These folks, in many cases, depend on the complexity of computers to justify their existence.

The base configurations of these compatibles don't include things like SCSI ports, networking, modems, and even decent video and sound. You can order all these at purchase time, of course, but only if you know in advance what to ask for. If you don't, you'll eventually learn that you can't easily expand or configure the typical PC without opening the cover, inserting cards, and fiddling with switches and jumpers—often for hours—to resolve potential hardware conflicts that nobody should have to worry about.

Only Apple makes real plug-and-play computers today, although the Mac is still overpriced. But surely some IBM-compatible manufacturer can build a base-level PC configured like a Mac. I suspect folks would pay a few hundred dollars more for such a box than for today's base-level "commodity" PC.

The industry's lame response has been SOHO (small office/home office) machines—usually lower-power boxes bundled with dumbed-down software and maybe modems, but built on the same complicated architecture. The customer deserves more.

The software situation is better, mostly due to the advent of Windows, which has standardized user interfaces, printer and video drivers, communications, and fonts. But even here, there's too much complexity. The corporate priests like checklists of features, so software publishers cram in scores of them, many buried deep in the program, where average users rarely find them. The priesthood runs training classes, so it thinks nothing of buying software that requires such classes.

If the basic structure of business is becoming less hospitable for hardware and software that require technical knowledge, a second shift will reinforce that trend. Computer users are becoming much less reverent of the PC, and they're much more impatient about its complexity. People are tired of computer companies making them feel stupid or lazy or guilty. They're smart and hard-working in their own businesses and simply don't want to have to learn the PC business just to get productive use out of a business tool.

These trends show that we're leaving the first great era of personal computing. It was a Model A sort of period in which you had to know what happened under the hood to get much driving done. We are finally entering the era of the PC as a real business tool, at least from the perspective of consumers. Companies that figure that out and capitalize on it will prove to be the big winners as the 1990s unfold. ■

Walter S. Mossberg writes the Personal Technology column in the Wall Street Journal. *He has been a reporter for more than 20 years and has owned and worked with PCs since 1982. He can be reached on BIX c/o "editors," on MCI Mail at WMOSSBERG, or on the Internet at wmossberg@mcimail.com.*

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