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BYTE

A McGRAW-HILL PUBLICATION

TRUE NOTEBOOK MACS!
Lighter, Faster, *Better* Page 50

THE STATE-OF-THE-ART

Momenta

Stylus, keyboard, and a slick new "pen-centric" GUI

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UNDER THE HOOD:

Modular Systems

Understanding Frame Relay

C&T's Single-chip PC

PLUS

DR DOS 6.0
Slate's PenBook
5 Peer-to-Peer LANs
5 New Memory Managers
8 Forms Software Packages
Tandy 3810 HD Notebook
Ensemble 1.2

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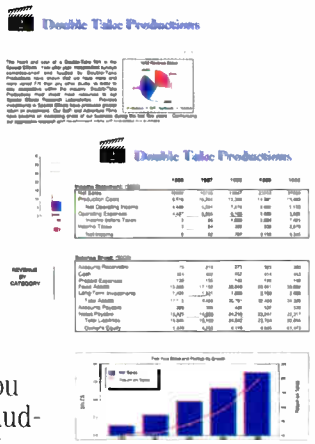
is 1-2-3 for Windows.

With our "zoom in," "zoom out" and fast print preview features, you can refine and perfect your work before you print. Which means your output will always be just what you want it to be. Without any surprises at the printer.



Unlike the Toolbar™ in Microsoft® Excel, 1-2-3 for Windows actually lets you create your own icons for the tasks that are unique to you.

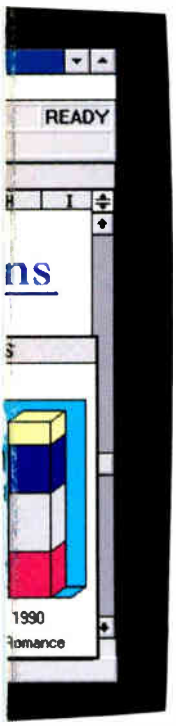
And yes, 1-2-3 for Windows fully exploits the Windows environment. Which means it includes pull down menus, dialog boxes, sizable windows, mouse support, full DDE support and everything else you'd expect in a true Windows application.

What's more, with its interactive graph gallery, you can select by example a wide range of graph types, including true 3D graphs in bar, line, area, stacked bar and pie.

Of course, when you're ready to print, your results will be nothing short of perfection. And thanks to its Auto Compress feature, you can easily make an entire report fit on one page.

Beneath it all, you'll have the complete power of 1-2-3 at work for you. Including 3D worksheets, Solver goal-seeking features and external data access through DataLens.®

And finally, to make the move to Windows a simple one for 1-2-3 users, we've included the 1-2-3 Classic® commands in the program. Where, at the push of the slash key, the familiar 1-2-3 menu will appear, fully functional, on screen. So 1-2-3 for Windows offers you complete file, style, macro and keystroke compatibility with all of the previous versions of 1-2-3.



So see why Lotus 1-2-3 for Windows is more than a great Windows spreadsheet. It's everything you've been looking for in one.

And now, you can upgrade from your current version of 1-2-3 to 1-2-3 for Windows and get both 1-2-3 and Ami Pro 2.0 for just $199.* A suggested retail value of $645. For a free auto demo, or to order your upgrade directly from Lotus,** call **1-800-TRADEUP, ext. 6223.**

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These SmartIcons give you "one-click" shortcuts for your most frequently used tasks, such as opening and saving files and printing.

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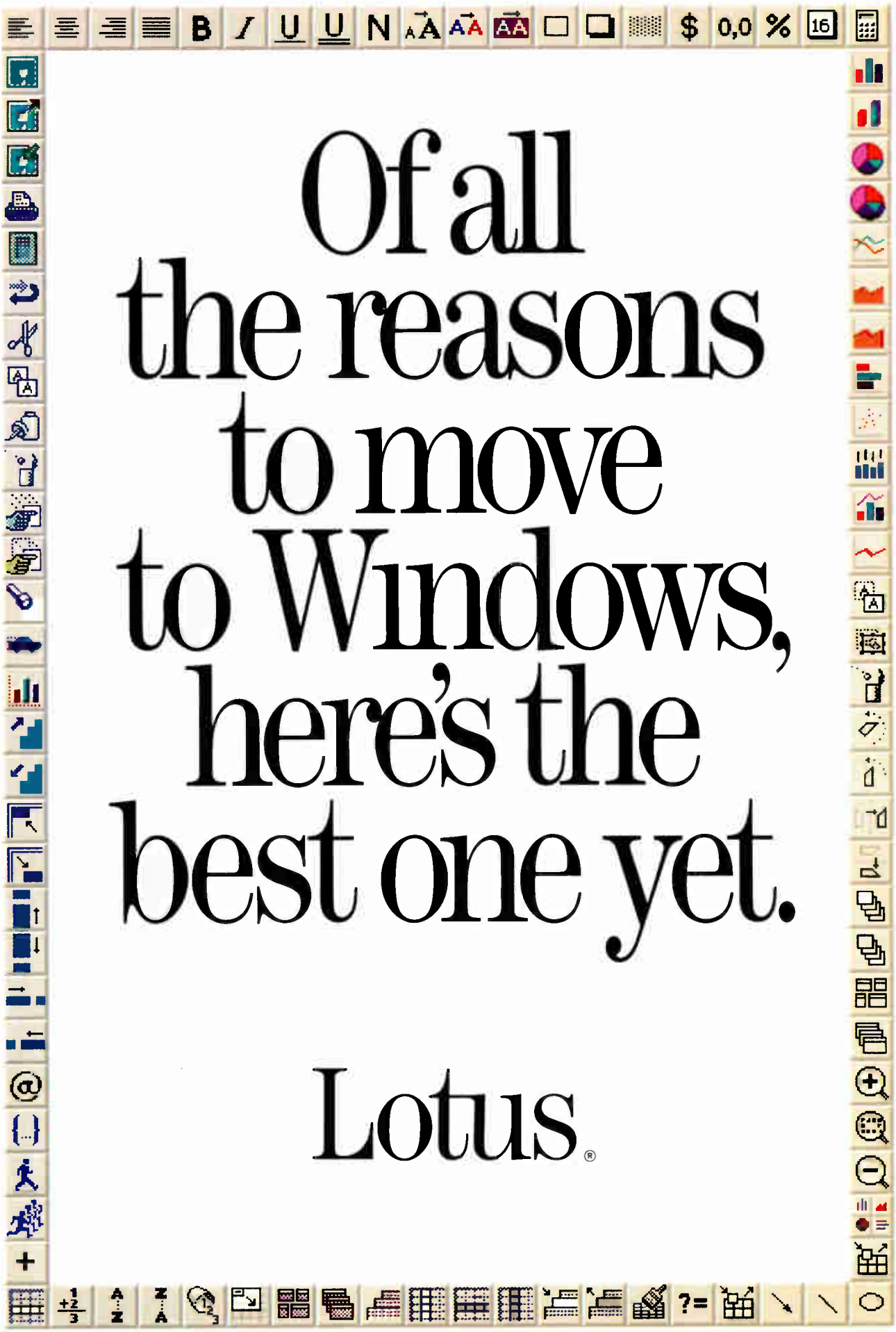

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Introducing Lotu

It's everything a Windows spreadsheet was meant to be.

After listening carefully to what our customers were looking for in a Windows™ spreadsheet, we developed Lotus® 1-2-3® for Windows with three goals in mind.

First, make it a full-fledged Windows application.

Second, introduce innovations that deliver a perfect balance of power and simplicity.

And third, make it fully compatible with all of the earlier versions of 1-2-3 that millions of 1-2-3 users are familiar with.

Well, we've done all this. And a whole lot more. Which, no doubt, is why 1-2-3 for Windows was awarded Byte Magazine's *Best New Windows Application* at Comdex/Spring '91.

For starters, the most exciting part of 1-2-3 for Windows is its SmartIcons,™ an innovative "one-click" approach for automating common spreadsheet tasks and fine tuning your working environment for even greater productivity. You'll also find these SmartIcons in all our Windows products, including Ami Pro™ 2.0, our award-winning word processor.

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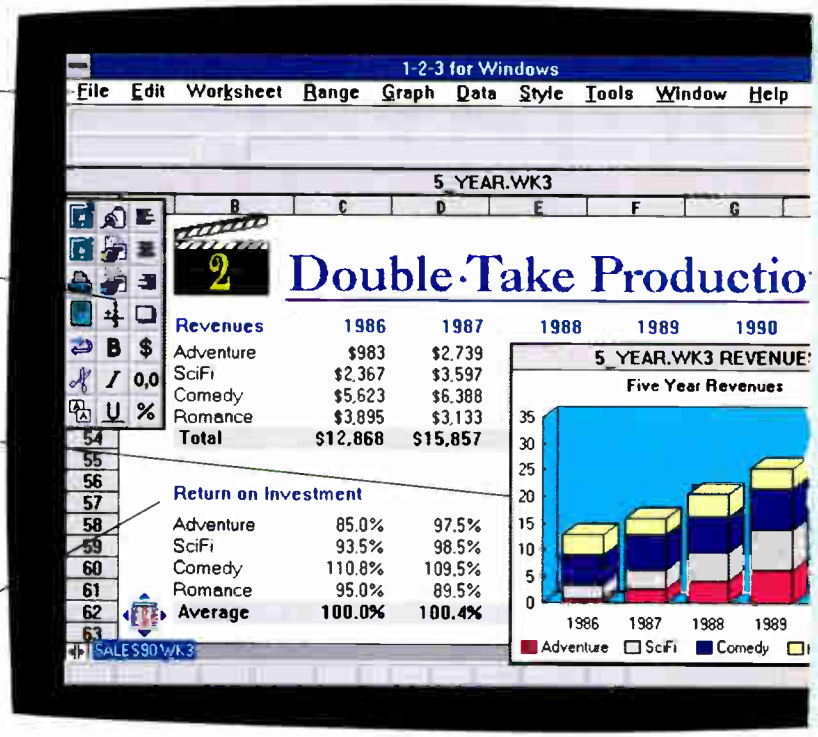

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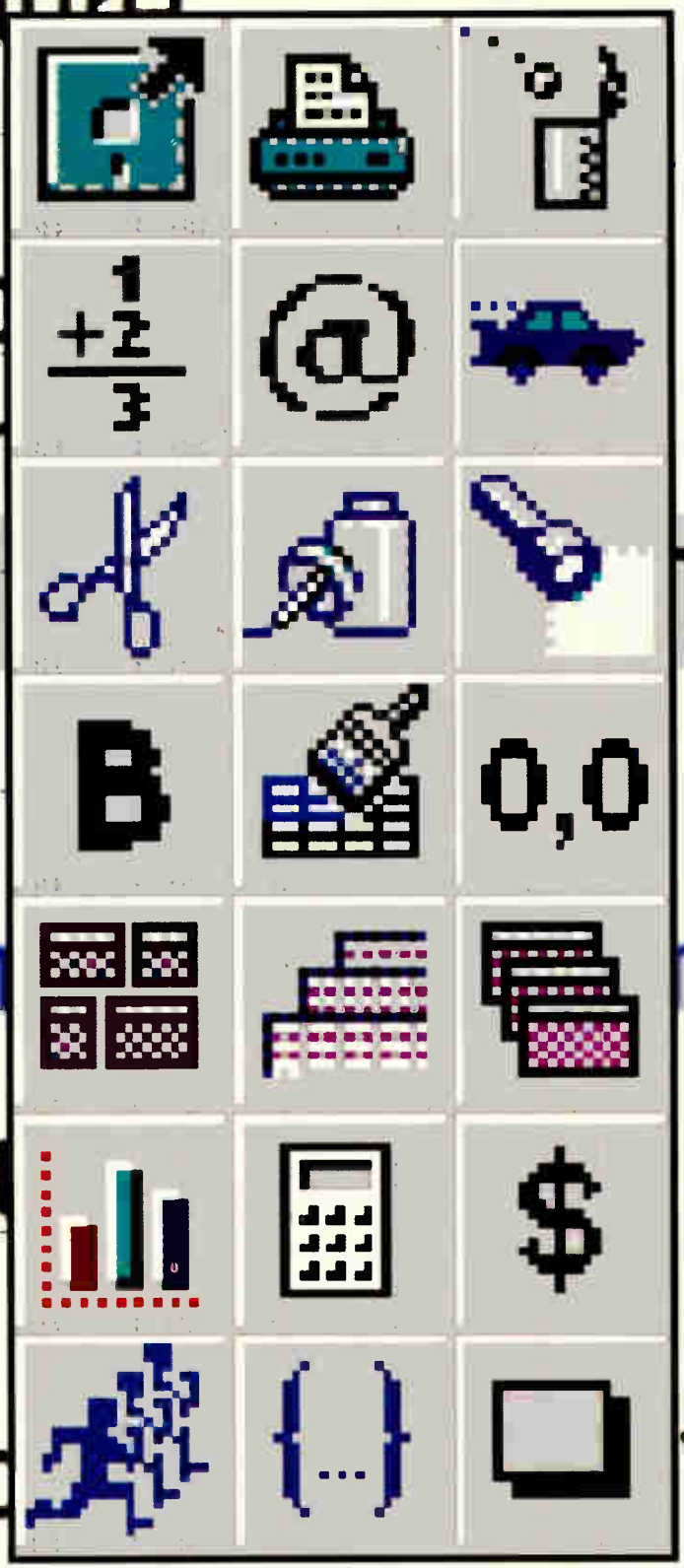

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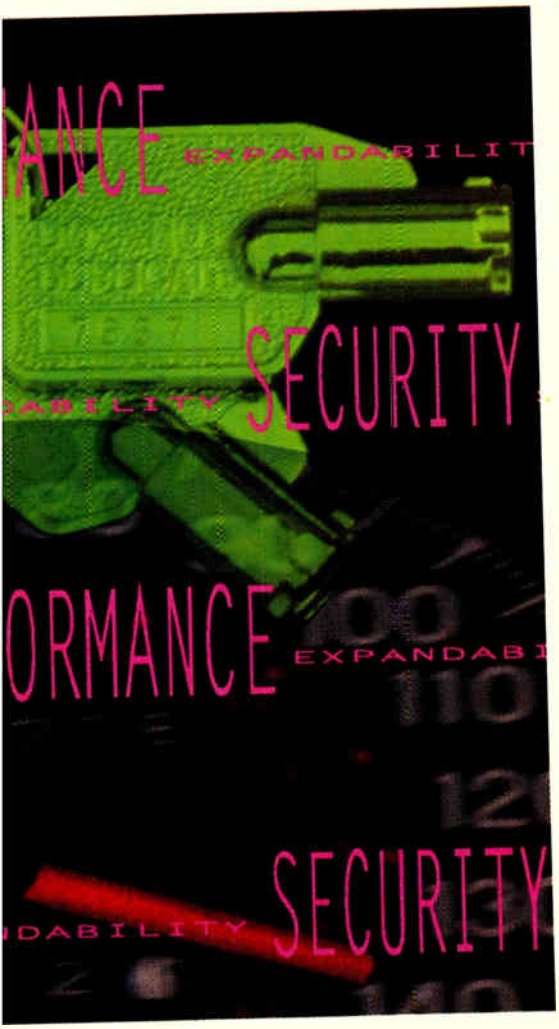

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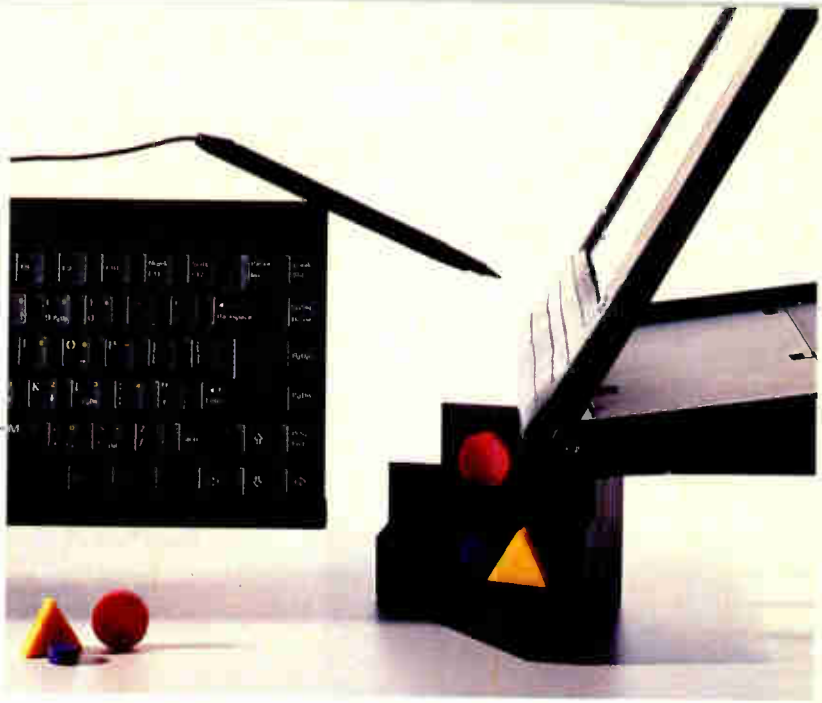

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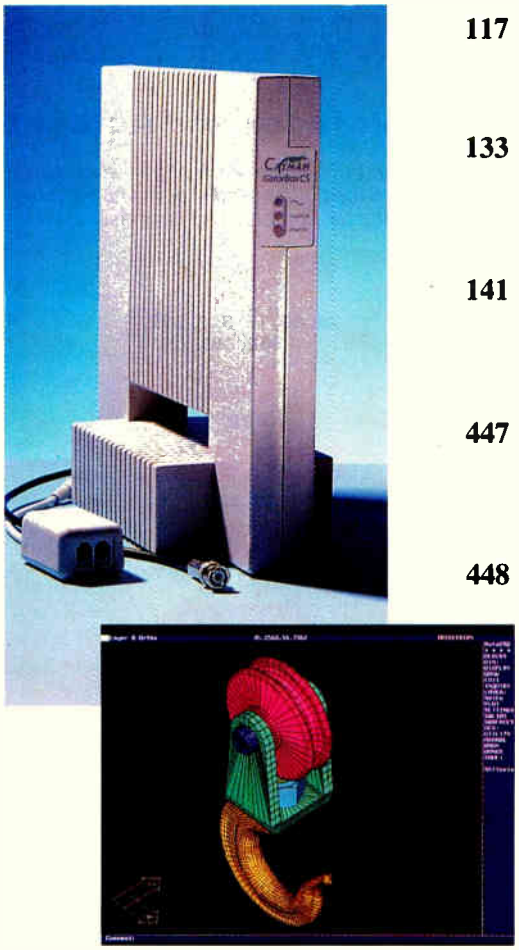

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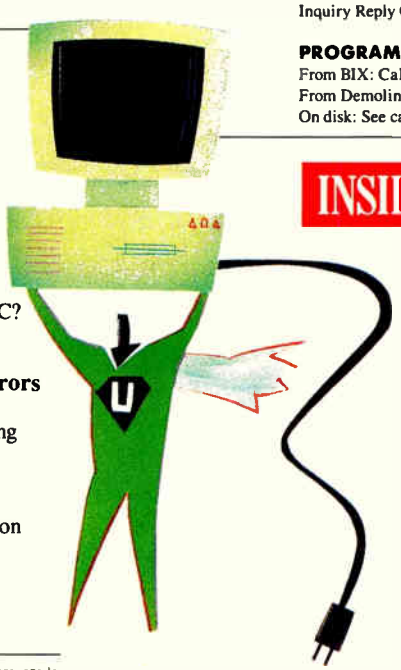

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BYTE (ISSN 0360-5280/91) is published monthly with an additional issue in October by McGraw-Hill, Inc. U.S. subscriber rate $29.95 per year. In Canada and Mexico, $34.95 per year. Single copies $3.50 in the U.S., $4.50 in Canada. Executive, Editorial, Circulation, and Advertising Offices: One Phoenix Mill Lane, Peterborough, NH 03458. Second-class postage paid at Peterborough, NH, and additional mailing offices. Postage paid at Winnipeg, Manitoba. Registration number 9321. Printed in the United States of America. **Postmaster:** Send address changes, USPS Form 3579, and fulfillment questions to BYTE Subscriptions, P.O. Box 551, Hightstown, NJ 08520.

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The first sprea you part of

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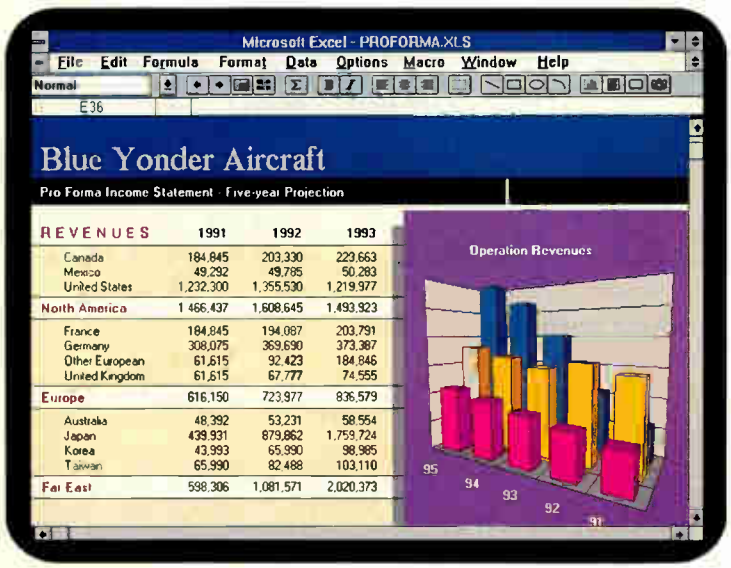

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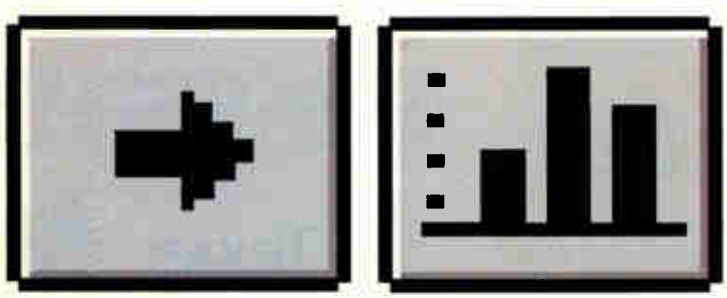

Just a point and a click do the trick: charting, format changes, macros, you name it.

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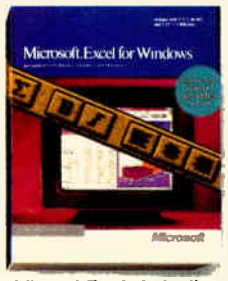
dsheet to make the equation.



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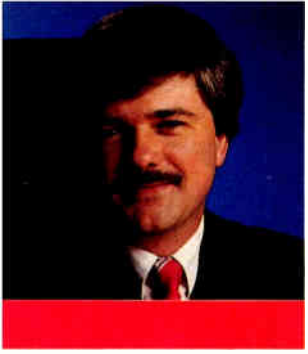

EDITORIAL

FRED
LANGA

THE REAL COMPUTER REVOLUTION

Dispatches from Moscow show the role that PCs played in the failed coup

In late August, like many people the world over, I closely followed news reports from Moscow as the coup took place and events became more and more confused. On first hearing of the coup, I'd repeatedly tried to contact people in the Soviet computer industry, offering what little I could: moral support, and letting them know their friends at BYTE were very concerned. On the second day, I was able to get several faxes through.

During the afternoon of the 21st, radio reports carried the first news of the coup's collapse. National Public Radio said that President Bush had confirmed its collapse in a telephone call to Gorbachev "sometime after noon."

Now look at the MCI timestamp on this message, which I received from the head of the International Computer Club in Moscow:

Date: Wed Aug 21, 1991 11:52 am EST
From: Levon Amdilyan / MCI ID: 439-1034

TO: Frederic S. Langa / MCI ID: 284-5434

My dear friends,

I would like to thank all of you for your deep concern and support in connection with the events we had the last two days here in Moscow and the U.S.S.R.

Now it seems that everything is close to being restored. We hope to see and hear Gorbachev within several hours. The democracy won in our country, and it could only be done with the people who felt what is a real freedom. And for a lot of us, such sense came also from the computer market and the free flow of information. Unfortunately three people died last night trying to defend the Russian government (Yeltsin). Now the putschists escaped from Moscow and troops left the cities. Tomorrow we'll have restored all usual broadcasting and mass media.

Everything is calm in Moscow.

Thank you once again,

Levon Amdilyan

Less than 20 minutes later, I got a voice phone call from Moscow. It was Stepan Pachikov, head of Paragraph, the growing Soviet software company.

"The bandits are gone," he said. "Everything is back to normal. Now, the TV and radio are showing live debate from the Russian Parliament.

"I knew this coup could not last. Only I was wrong: I thought it would take two weeks. Instead, it took two days.

"Our office shut down; no programming for two days. But we were there and very busy. Every few minutes, our fax would receive a new message from Yeltsin's group. We would retransmit the information to as many other faxes as we could and print our hard copy on our laser printer to distribute on the streets. It is as I said before, Fred: The age of informatics has changed everything. Bandits cannot rule our country anymore. We can spread information, and they cannot stop us."

What Amdilyan called the "free flow of information" and Pachikov "the age of informatics" really did have an impact. There, it helped a country shape its future and escape its past. And over here, it meant that individuals could get live, firsthand confirmation of the coup's failure before President Bush did.

Since then, I've also received paper mail from other Soviet friends, including Alexander Beresnev, the chief programmer for Avionica, the company that provides software for the world's largest airline, Aeroflot. Beresnev writes:

"Do you still believe in the possibility of a Russian nuclear attack? No chance; the very thought is gibberish. But some unexpected things may wait for you on the battlefield for the computer software market.

"I would compare Soviet programming potential with a boiling intellect developing inside a rubber balloon. As the intellect develops, the balloon's size increases, and the pressure rises until the balloon bursts—that moment is not far off!—and the liberated intellect flows outside because of differential pressure.

"I do hope—in fact, I'm sure of it—that the world software market will be the only battlefield for American and Soviet programmers, and we'll become friends during this battle, having stopped wasting our intellects on senseless weapon races."

Comments like these show just how much the world has changed. And they highlight the central role that computer technology, and the people involved in the computer field, played in effecting this change.

Perhaps Jerry Pournelle said it best, as he so often does: The events in Moscow this past summer, he said, were the "*real* computer revolution."

—Fred Langa
Editor in Chief
(BIX name "flanga")

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Circle 14 on Inquiry Card (RESELLERS: 15).

If your idea of 386 is getting "out of memory" you don't need

This Manifest memory analysis shows 618K of memory available for DOS programs after running QEMM 6.0. That's enough to avoid the dreaded "out of memory" message.

Here's how you can get more memory. Network drivers, TSRs and other utilities that usually take memory away from your programs have been moved up into high memory, automatically—using QEMM's 'optimize' command.

Manifest, our memory management utility, clearly shows you how your memory is being used.

This example system is a Toshiba, but most 386SX, 386 and 486 IBM® PCs and PS/2s™, and most 100%-compatible 'clones' allow the high memory breakthrough.

QEMM 6.0 Stealth technology 'remaps' ROMs, freeing-up as much as an additional 115K to be used by your favorite programs.

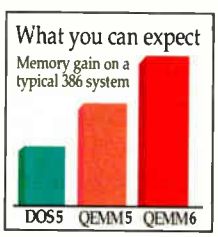
Quarterdeck expanded memory manager—QEMM-386—became the best selling utility in the industry because it does a better job of managing memory.

QEMM solves memory problems smoothly and invisibly. It 'pools' memory so that it's available in whatever form your programs need—expanded or extended. You don't even need to know the difference. QEMM does it all for you. Instantly. All other managers require you to manually allocate memory and re-boot every time you need to change.

Our new version 6 is better still. First, we improved our unique 'optimize' feature. It's still as easy as ever to use: all you have to do is type 'optimize' and QEMM automatically seeks out TSRs and device drivers and moves them out of your PC's conventional memory and into high memory. Now it lets you set up "what-if" scenarios and 'play' with combinations of your own.

Either way, QEMM-386 v6 finds more memory for your programs than any other memory manager. Period.

And QEMM monitors your memory—checking to be sure TSRs and utilities can be moved safely before it does so.

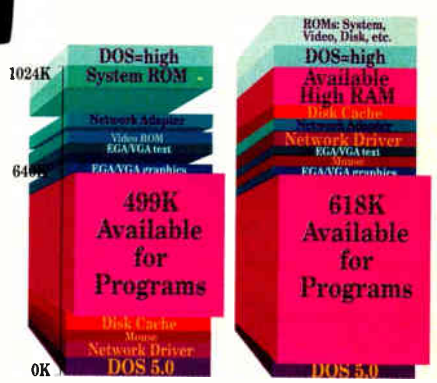


Who'd have thought there'd be another 115K of memory in your PC?

Breakthrough 'Stealth' technology results in a gain of up to 115K of high memory on many PCs by taking advantage of the memory map of most IBM, Compaq and 100% compatible PCs to 'map' ROM into other areas of memory. Only our memory wizards fully understand the technology behind it, but every user can appreciate the huge increase in available memory.

Of course, not every PC has 115K of extra high memory, but every PC can benefit from 'Squeeze'—our new feature to manage all those TSRs that need more memory at start up and less when they're resident. Their memory allocation is temporarily increased at start-up, then squeezed down when it's no longer needed.

QEMM automatically uses idle VidRAM to produce a further 96K gain on EGA and VGA-equipped systems when running character-based programs.



QEMM reorganizes the way your memory is used, filling memory gaps and squeezing every last ounce of performance out of the software you now own.

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/486 performance
ıory" messages faster,
ur new QEMM.

QEMM gives you more memory with less pain.

New breakthroughs aside, QEMM does its basic job better than any other memory manager. For example, the DOS 5.0 EMM uses a manual, trial-and-error process to optimize memory while QEMM does it automatically.

And QEMM 50/60 v6 offers these features (except Stealth) and 'loads high' on IBM PS/2 Models 50 and 60. DOS 5.0 doesn't.

QEMM isn't just for power users. It's for anyone who wants to get the most out of the PC. Whether you're using a PS/2 model 50 and DOS 3.3, a 486 with 5.0, or something in between, we can improve the way it works.

Prior versions of QEMM have won lots of awards—and become the #1 selling utility in the PC industry.

Don't leave DOS without us.

QEMM provides an additional 8-24K of conventional memory to Windows 3 enhanced mode—maximizing memory to help make everything run better.

Our new DESQview-386 version 2.4 incorporates the latest memory-maximizing QEMM technology. That means it provides an even better solution for users who want low-overhead, high performance windowing and multitasking.

While DOS 5.0's EMM isn't even compatible with Windows' Standard Mode!

QEMM is the best memory manager to use with any multitasking software on the PC. Period.

Quarterdeck Manifest maps your way to the gold.

Our award-winning memory utility gives you complete and clear understanding of how your memory works.

You can actually see where programs, TSRs, network drivers and utilities run. Check memory speed. And find the best way to use all of what you've got.

Manifest is included right on the disk when you buy QEMM or DESQview-386.

New DESQview-386 A performance bonanza for demanding users.

DESQview-386 is our combination of QEMM-386 and DESQview. The result is a simple multitasking environment that works similarly to Windows 3.0, without all the memory and cpu 'overhead' associated with an added-on 'graphical interface.'

Our memory breakthroughs result in real benefits to users with lots of memory demands—especially network users. DESQview-386 lets you run programs in several windows side-by-side while using only about 9K of conventional memory on a typical PC.

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Upgrade from QEMM to DESQview 386 and get Manifest plus a set of DESQview Companions plus a free Special Edition Quattro Pro for $99

Act quickly—quantities limited.

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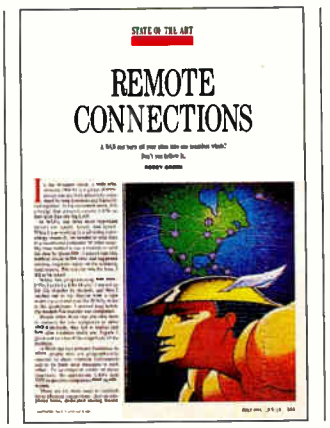

WAN Fans

Roedy Green's article on wide-area networks ("Remote Connections," July) should be compulsory reading for all systems developers operating over any network. Highlighting the limitations of today's "high-speed" WAN (and LAN) systems is key. An application programmer who merely writes to a standard interface without considering the resulting traffic on the network is unlikely to produce a successful product for the bridged and routed local area, never mind the wide area. While some can think about T3 circuits, for many companies T1 and E1 circuits are a major annual investment, so 56,000 bps and 64,000 bps are still likely to be considered "fast."

For all manner of political (and some technical) reasons, the Open Systems Interconnection model above layer "one and a half" [i.e., the physical layer and part of the data-link layer] has so far had very limited success or exploitation in real commercial environments. I would like to see the discussion in BYTE move on from the reference model to the standards that have been developed out of it. The implementers agreements and application programming interfaces, which, for political reasons, are outside the ISO standardization process, are now producing the tools that are finally allowing real products to take shape.

Jim Evans
Chelford, Cheshire, U.K.

As the state-run economies of socialist countries around the world continue their downward spiral, Senator Al Gore ("A National Vision," July) attempts to apply the same ideology to "stimulate" our economy with the National Research and Education Network (NREN). While the construction of a centralized network for exchanging data may seem a positive step toward broader use of computer telecommunications (and it is), the federal government is inherently incapable of defining, building, or operating such a network efficiently. Furthermore, a government institution cannot determine the value of a commercial project (weighing the projected return on investment against the risk), because its actions are driven by political ideology rather than a profit motive.

Under the guise of "infrastructure," what Senator Gore really proposes is socialized computer telecommunications. The funding for the network proposed would be subject to the ebb and flow of political tides rather than economic viability. Like NSFnet, the government may decide to place restrictions (i.e., censorship) on the traffic the network may carry. While the dark clouds of a federal deficit and higher taxes hang over us all, now is not the time to engage in billion-dollar big-government boondoggles such as NREN.

Gary M. Rush
San Diego, CA

WE WANT TO HEAR FROM YOU. *Please double-space your letter on one side of the page and include your name and address. Letters two pages in length or under have a better chance of being published in their entirety. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send letters via BIXmail c/o "editors."*

Your letter will be read, but because of the large volume of mail we receive, we cannot guarantee publication. We also reserve the right to edit letters. It takes about four months from the time we receive a letter until we publish it.

System 7.0 Success

My compliments to Tom Thompson and Owen Linderholm for a job well done explaining Apple's System 7.0 ("Seven's a Success," June). I enjoyed their article and the one by Don Crabb ("System 7.0—Apple Defines Its Future") so much that I ran out and bought System 7.0 for myself. And they are right—System 7.0 is a success. The Macintosh is still head and shoulders above the PC.

Michael Sullivan
Houston, TX

Paint Kudos

I found "Paint for the Pros" (June) to be very accurate and informative. With the exception of Color MacCheese and the PC paint programs, I've used every one of the programs reviewed, and you guys were right on. However, having painted extensively on the Mac IIfx for print and TV, I was surprised that the two most important and powerful paint programs were missing: ColorStudio by Letraset and, more particularly, Photoshop by Adobe are by far the best painting programs currently on the market.

Your authors have a very interesting writing style. Keep up the great work.

C. David Piña
Burbank, CA

We excluded Photoshop and ColorStudio from that roundup because we decided that their image-editing features placed them outside the range of traditional paint packages. Please see our review of the latest versions of these two programs elsewhere in this issue.—Eds.

Paint Exceptions

We at Time Arts commend your thorough testing procedures and benchmarks, and we often rely on this information to help us make informed purchasing decisions. Because of our high regard for BYTE, we were especially disappointed by the errors and omissions in your recent review of our products Oasis and Lumena in "Paint for the Pros" (June).

With regard to Oasis, Roger Goode praises certain features in various Macintosh-platform packages without mentioning that Oasis has all these features.

With regard to Lumena: First of all, our thanks to Cal Vornberger, who teaches people how to use Lumena and knows the depth of its functionality, for

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GO BACK 3 SPACES

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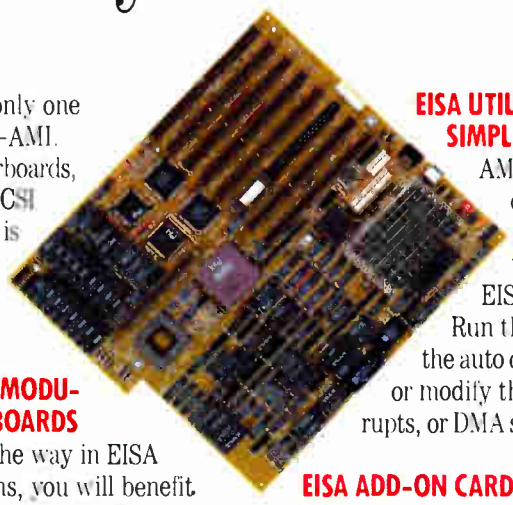

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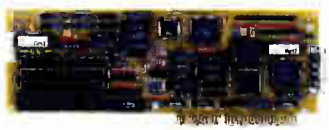

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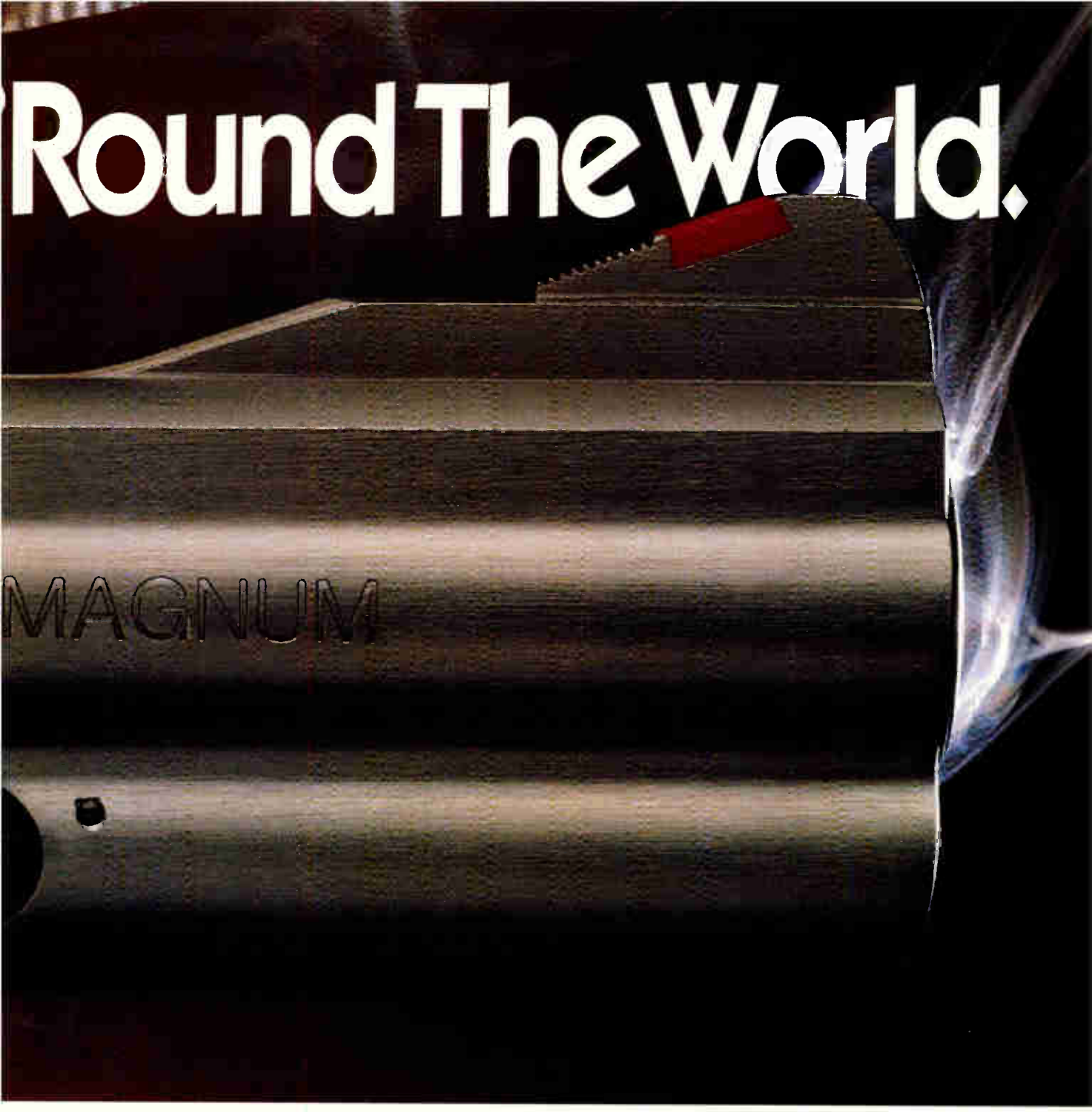

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the accuracy of his appraisal. On the other hand, we think that the BYTE Lab really missed the boat.

The main problem is that they tested Lumena only on the Hercules Graphics Station Card, but Lumena also runs on seven other graphics frame buffers with superior features. For example, the lab compared TIPS on the TARGA+ board to Lumena on a board costing half the price. If they had tried Lumena on a TARGA+ board, they would have found that Lumena has all they wanted and more: zooming "pixels to discernible rectangles," panning and scrolling in zoom, and graphical overlays on live video.

The lab evaluated Lumena with a mouse, but Lumena is designed to work with a pressure-sensitive digitizing tablet and stylus. A mouse is OK for pointing, but a stylus is better for painting. If you haven't tried Lumina with a pressure-sensitive tablet, you can't imagine what you're missing.

A third hardware issue was the EPROM chip. This chip, with the security code, is available already in place on the Graphics Station Card when you buy Hercules Art Dept., which includes Lumena. You don't have to deal with it unless you buy Lumena separately. In that event, which is rare, your dealer should handle such details for you. All other versions of Lumena use an external copy-protection block instead. You just plug it into a serial or parallel port and forget it.

The BYTE Lab disapproved of our two-screen interface. This approach keeps the image unobscured, and a very large assortment of tools is within easy reach, not buried under layers of pull-down menus. This "immediacy" was appreciated by Vornberger.

The BYTE Lab wished for an undo feature. Although it is popular, we think a single level of undo is not worth the cost in time and memory, so we let the artist decide when to preserve the image—very quickly to a temporary buffer or permanently to the hard disk.

In conclusion, let me point out that not all software will be used by every artist in the same way; nor can every package be suited to all individual needs and preferences.

Software like Oasis and Lumena requires more from the artist than the simpler "cut, paste, and fill" packages positioned at the lower end of the market. To perform a satisfactory evaluation, you need to give it a closer look.

Carroll Rotkel
Director, Technical Services
Time Arts, Inc.
Santa Rosa, CA

As you accurately point out, each artist uses paint applications differently—that's why we carried out extensive testing in the BYTE Lab and asked two professional artists to use the packages in their daily work. The resulting descriptions were not meant to cover every feature within each package, just those that the reviewers found most significant. This same subjectivity led to the BYTE Lab's reaction to Lumena's lack of an undo feature.

The combined approach also allowed us to run comments by Vornberger, who uses Lumena with a TARGA board in his work, along with our lab evaluation using the Hercules board.

Perhaps you misread our comments about the mouse: We evaluated Lumena with a digitizing pen and tablet and discussed this in our write-up.

Finally, thank you for your additional comments about Lumena copy protection.—Eds.

Pournelle Potpourri

I enjoy Jerry Pournelle's column each month. I would like to share with him my idea to make the casing for laptop computers out of clear plastic.

The advantage of this would be apparent when traveling through airports. Airport security insists on x-raying laptops to make sure there are no bombs inside. This is, of course, fatal to data on a hard disk and cannot do the computer itself any good. All x-raying would be unnecessary if the security guards could just look inside with their own eyes. It may even be possible to make casings for the power supply and disk drives out of clear plastic.

Marc H. Mehlman
Johnstown, PA

I like your idea. I don't at all mind displaying what my stuff is; clear plastic may be the way to go. We've pretty well determined that it isn't x-rays that do in floppy disks—it's the magnetic pulse from either the conveyer mechanism, the x-ray power supply, or both.

—Jerry Pournelle

Jerry Pournelle's January column on CD-ROMs motivated me to respond. I am writing to get you to complain to the CD-ROM publishers about using proprietary retrieval software. With jukebox and carousel CD-ROM drives, as Jerry seemed to imply, we must occasionally switch retrieval software to access different discs. CD-ROM publishers seem to be sending us down the same road that word processors and graphics programs forced us onto: the road of incompatibility.

CD-ROM publishers should agree on a common format for data structure and images to allow third-party vendors to develop retrieval software that users can choose for their specific environments. These retrieval standards could extend to Unix, networks, and so on, and disks could be exchanged across environments.

Without standards, using multiple disks will become too much of a hassle.

Wade Harman
Woodville, TX

Boy, do I agree. So do the publishers. Quanta desperately wants a retrieval system that is easy to use, is reasonable in licensing fees, can be put on the CD-ROM itself, is fast, works well, and can call in visuals. So does every other publisher I know. Every one of the retrieval packages I have seen has some flaws. We'll get there, but the road is twisty.—Jerry Pournelle ■

FIX

- The correct price of 386/MultiWare ("Journey to Faraway LANs," July) is $595 for five users. It is available from Alloy Computer Products, Inc., 165 Forest St., Marlborough, MA 01752, (508) 481-8500.

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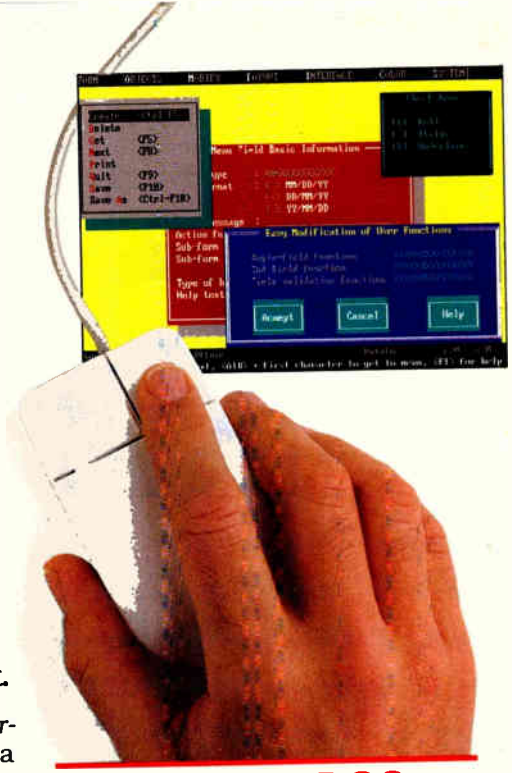

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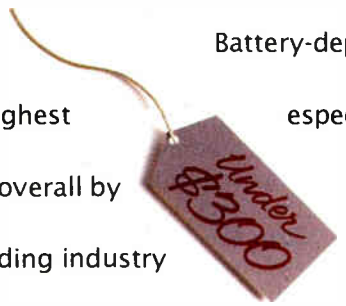

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World Radio History

NEWS

MICROBYTES

Solaris to Bring Intel Machines into Sun's Orbit

Another advanced operating system to think about. The most recently promised operating system for Intel-based computers, SunSoft's Solaris, is crossing over from the land of SPARC. This 32-bit multitasking, multiprocessing, multithreaded, distributed, graphical operating system will run not just on Sun workstations but also on Intel 386/486 machines. SunSoft (Mountain View, CA), the software subsidiary of Sun Microsystems, revealed at its recent developers conference that it has ported to the Intel platform an entire system software environment—from the operating-system kernel, to the development tools, and on up to the user interface and desktop accessories. With this Unix-based operating system, SPARC workstations and Intel machines will basically become software identical twins.

This RISC/CISC software environment is due out in the first half of 1992. SunSoft has already released a SPARC-only version: 1.0. Early beta copies of version 2.0 are in the hands of developers. Developers will be able to migrate source code from 1.0 to 2.0 with a recompilation, Sun says.

Solaris 2.0 is being designed on the SPARC architecture and then ported to Intel's x86 architecture. It will consist of SunOS 5.0—a multiprocessing, multithreaded version of Unix System V release 4.0 (*without* the Berkeley libraries), network interoperability tools, a developer environment, and a revised Open Look user interface. Solaris also incorporates a migration path to a distributed object management facility.

The new environment offers source compatibility between platforms. For SPARC developers, this means that, to carry applications to Intel machines, all you need to do is recompile, SunSoft says. The development environments are identical on both platforms, even to the compiler; only the low-level, instruction-set layer is different. For users, this means that your 386 or 486, outfitted with a hefty hard drive and plenty of memory, can turn into a software version of a SPARC workstation.

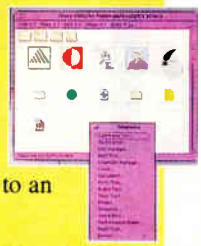
SunSoft's environment is designed to fill what company officials call the

SOLARIS: THE MAIN ATTRACTIONS

- Symmetric multiprocessing
- Multithreading at both the kernel and application levels
- DOS emulation on both platforms, plus Windows 3.0 emulation on the Intel platform; cut-and-paste between DOS/Windows applications and Unix applications
- Ability to perform drop-and-drag operations between applications running anywhere on the network
- Source code to be compatible across Intel and SPARC platforms, says Sun; applications are "ported" by being copied to the other platform and recompiled
- Upgraded version of Open Network Computing (ONC), which provides a protocol and services for applications distributed across heterogeneous networks
- ONC includes NIS+, a hierarchical enterprise naming service; it's designed to offer a user-friendly interface for management of resource locations on a heterogeneous network
- Project DOE (Distributed Objects Everywhere) represents the beginnings of a distributed object management facility, a service for object communications across heterogeneous networks; based on work by Sun and Hewlett-Packard
- Development environment includes ToolTalk, a network-transparent interapplications messaging facility

NANOBYTES

Will **Solaris 2.0** mean fewer sales of Sparcstations for **Sun Microsystems**? Possibly. "There is a very large corporate market out there," Sun president **Scott McNealy** said. He emphasized that offering an Intel version of SunOS simply caters to an existing market. □



SunSoft president **Ed Zander** claims that Sun will benefit from having the Intel platform: "More applications will get more business." Sun will benefit if Solaris could dominate the operating-system market, said SunSoft vice president for marketing, Bill Larson. "We have a two-year lead in the 32-bit, distributed space. This will preempt the need for any other environment in that space." SunSoft, adopting System V release 4.0, would also like to settle the Unix version wars. According to Zander, SVR4 represents 80 percent of the Unix market share. □

For big, "traditional" computer companies to survive, they will have to foster within themselves smaller, intrapreneurial enterprises, **Gordon Bell** told a group at the Stanford Executive Institute. "**Massive intrapreneurism** is the only way traditional computer companies will survive in the nineties," said Bell. "Companies must engage in radical reform where they actually create new and unique, high-margin products—not just serve as purchasing agents and distributors for creative or high-volume products." □

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NEWS

MICROBYTES

"software gap"—the difference between the power of the 386/486 and the relative weakness of current PC operating environments. Speaking of the Mac and DOS, SunSoft vice president Bill Coleman said, "Their foundation is cracked and will have to be replaced."

Like the proposed Advanced Computing Environment, Windows NT, OS/2 2.0, and the Apple/IBM project, Solaris is another wait-and-see affair for users. Sun's last foray into Intel software, a SunOS for the Sun 386i, wasn't exactly a smash; this time, though, the company has the help of Interactive Systems, experienced in porting Unix to x86.

But will most 386-based PCs have the resources to run an operating system as big as Solaris? Or will Solaris find its Intel base in 486-powered servers? Will PC users just stick with a Microsoft operating system, or an IBM operating system? Stay tuned.

—**Ellen Ullman**

NANOBYTES

Last we heard, "**OS/2 2.0** is moving right along" toward final shipment, according to **Lee Reiswig**, assistant general manager of programming in IBM's Personal Systems Division. "The most significant change" IBM showed in

its latest demonstrations was the ability to run

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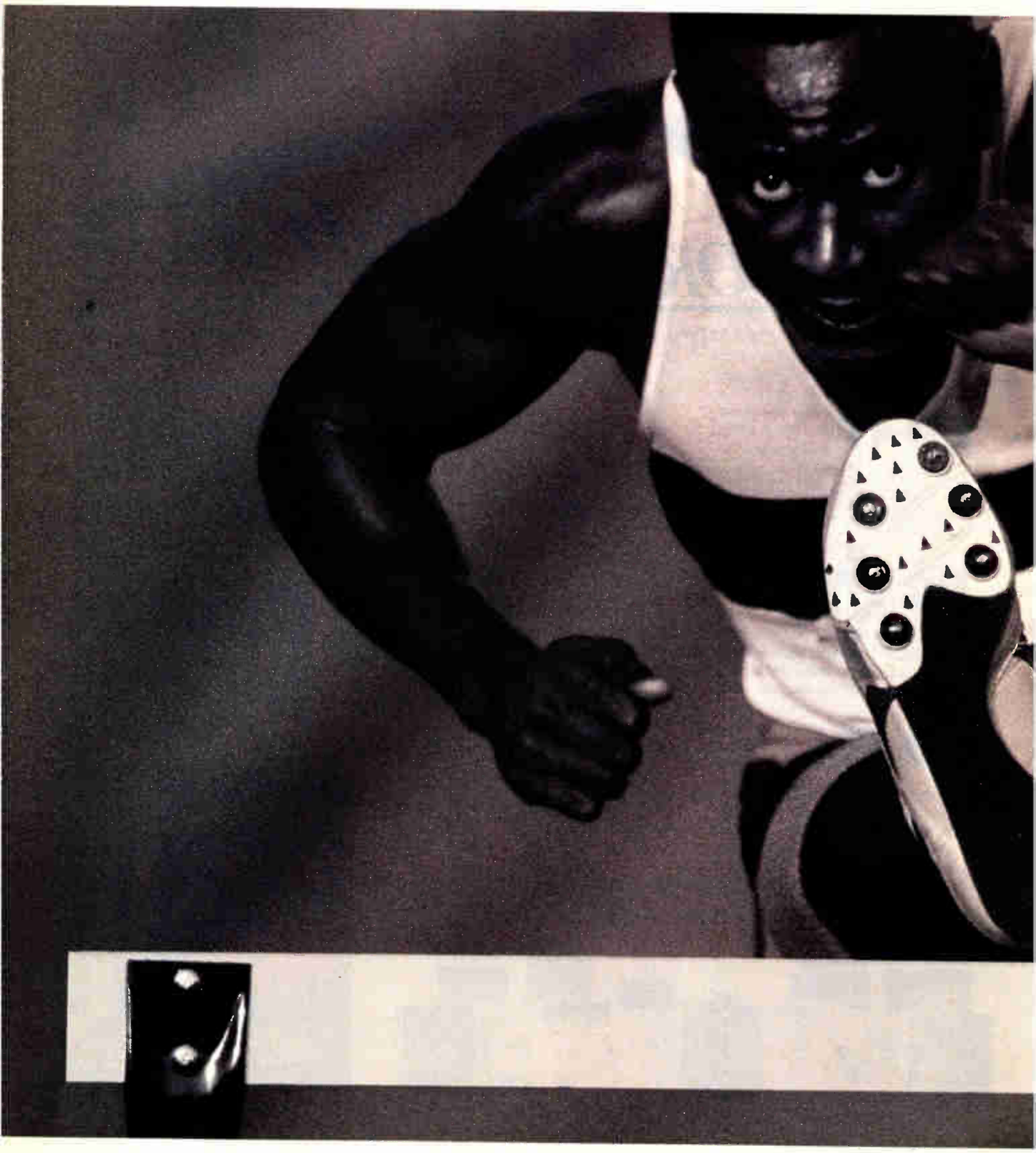

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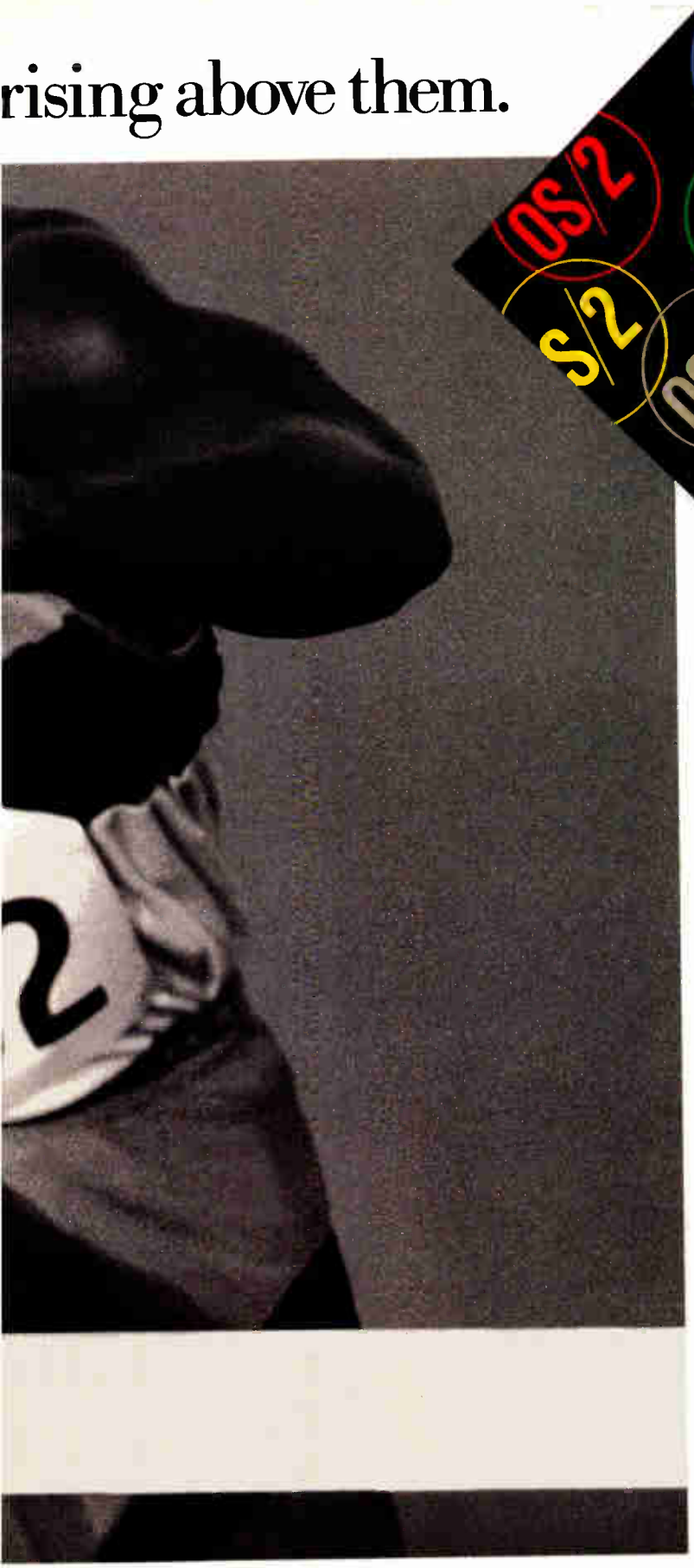

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preliminary BYTE Lab benchmark tests on another early adopter of the 25-MHz 486SX, Compaq's Deskpro 486s/25, indicated that systems using the new CPU are slightly faster than the 20-MHz machines. The Deskpro 486s/25 registered a CPU benchmark 15 percent better than that of an Everex Step 486SX/20 but almost twice as fast as that of a Deskpro with a 25-MHz 386 CPU.

Toshiba says that it has addressed the problem of cracking laptops by building the T4400 into a case made of carbon-fiber-reinforced plastic, which is supposed to be as strong as aluminum but lighter. We haven't yet had a chance to drop one from a taxi at LaGuardia.

—D. Barker

New Version of Mac OS Yields Faster Number Crunching, BYTE Tests Reveal

BYTE Lab benchmark tests show that the first revision to Apple's System 7 operating system yields dramatic improvement in Macintosh floating-point performance. System 7.0.1's new number-crunching prowess was detected when the preliminary floating-point test results of the new PowerBook 170's 25-MHz 68882 FPU easily outpaced those of the 40-MHz 68882 FPU in the Mac IIfx.

We ran a beta version of 7.0.1, which ships with the new Macs, on a Mac IIfx and IIci, along with the BYTE floating-point benchmarks, to observe if the new operating system was responsible for the performance boost—indeed it was. Floating-point performance on both computers jumped by as much as three to five times. In realistic terms, test timings were abbreviated by as little as 16 seconds or as much as 55 seconds. Apple confirmed that System 7.0.1 has built-in enhancements that improve the performance of the Standard Apple Numeric Environment (SANE) calls.

SANE supplies a library of hardware-independent math routines for use by applications that perform complex calculations. On Macs without FPUs, such as the Classic and the PowerBook 100 and 140, SANE performs its computations in software. On Macs with FPUs, these computations are handed off to them. Unfortunately, SANE was notoriously slow in conversing with the FPU: Some spreadsheets and CAD packages bypass SANE and access the hardware directly to improve performance. Unfortunately, this meant that the software broke when new Macs were introduced, either because the address of the FPU changed, or it disappeared, as in the case of the Mac LC and IIsi.

System 7.0.1 does away with the math-performance bottleneck that got the Mac branded by some as unsuitable for use as a CAD workstation. A long-term benefit is that with SANE's improved computing power, all application developers will use the SANE calls for math processing. Such applications will run faster on any Mac. This eliminates the hassle of upgrading applications with each new Mac introduced.

—Tom Thompson

NuMesh: Interconnecting Like Legos

A group at MIT is working on a way to connect computers based on the packaging technology known as multichip modules. The NuMesh specification could define the basis for building high-performance computers with mix-and-match, off-the-shelf components.

"The idea behind the current NuMesh project," says MIT professor Steve Ward, "is to make a combined packaging and communications interconnect standard that works like Legos." Using a basic programmable communications "substrate," each node in a NuMesh computer would have a common logic "preprogrammed to implement a wide and arbitrarily complex variety of communication patterns," Ward says.

Multichip modules, currently used in mainframes from DEC, IBM, NEC, and others, allow electronic packaging of ICs at about 30 times the density of conventional printed circuit boards, providing much faster data transfer and signal propagation speeds. Existing multichip modules use different, proprietary interconnect specifications and are incompatible with each other. NuMesh would provide a common set of specifications and protocols that could be used by hardware vendors to produce compatible chip modules. "Technically, it's feasible," says Ward. "Politically, there is the usual set of complications."

continued

NANOBYTES

Peter Norton had a few good quotes for federal computer users at the recent Fed Micro conference in Washington, D.C. On the proposed **Apple/IBM alliance**: "[The alliance] is a brief marriage of convenience. It smells like a desperation move." On **Unix**: "I don't like it. But it's here, especially in government, and being used. It's here to stay, for better or worse.... We don't need a proliferation of operating systems. The good part is that it offers compatibility across hardware. That's an illusion, but better than nothing. It's a necessary evil, like OS/2." □

With its new Modem 2400+, **Intel** is taking advantage of the new **PCMCIA specification** for PC cards, offering a modem that's just a little bigger than a credit card. Intel is offering two models of the 2400-bps Hayes-compatible MNP device: one for the U.S./Canadian market and one for Japan. The modem has a line adapter, which is an Intel proprietary connection between the card and the telephone line. The adapter has a small, flat plug that connects to the card and a standard telephone connector on the other end, with a short length of cable between the connectors. □

Insignia Solutions, maker of the SoftPC emulator, has signed a licensing deal that will let **Microsoft** incorporate its **x86 emulation technology** in future products. Insiders indicate that Insignia's Intel x86 emulation software will be used for the "DOS Box" in Microsoft's upcoming NT operating system when running on non-Intel platforms. □

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Andy Rifkin
Time Customer Service

Gateway 2000 has stood the rigorous tests of Time Customer Service in Tampa, Florida. TCS now has over 250 Gateway systems in use. Some of the Gateways are used in mission critical business applications such as Target Select. Target Select is a process whereby a magazine is built and customized with inkjet printing at bindery time. But TCS's Andy Rifkin, Director of Advanced Technologies, didn't buy all those Gateways without careful consideration.

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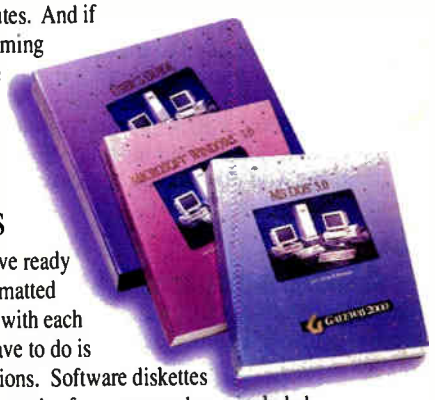

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Each NuMesh node would be a multichip module measuring about 2 inches on each side. The basic idea is to eliminate the conventional linear data transfer mechanism of backplane buses and printed circuit boards and replace it with a three-dimensional interface consisting of modules arranged in a cube, thus allowing the exchange of data with multiple nodes simultaneously.

Ward and his group have developed some prototype systems based on the NuMesh specification using standard printed circuit boards. "We've realized some supercomputer performance on some of these prototypes," says Ward.

Although Ward doesn't anticipate a complete specification for mechanical and logic protocols for another three years, specifications are already available for the prototype systems, and the research team, which earlier worked on the NuBus specification, is hoping to attract industry partners to begin developing NuMesh-based designs. For more information, contact Professor Ward at MIT, Room NE43-624A, 77 Massachusetts Ave., Cambridge, MA 02139, (617) 253-6036.

—Nick Baran

Farallon to Get Macs and Windows Talking

Farallon (Emeryville, CA) is working on a new product based on Timbuktu, its software for remotely controlling Macs, that will offer similar access to PCs running Microsoft Windows 3.0. In a recent demonstration, Farallon showed the upcoming product working with a Mac hooked to a DOS laptop (via Ethernet) running Windows 3.0. You got the same view of the laptop screen in the Mac window, with accurate reproduction of colors, icons, and menus. Not only that, but you could control the Windows machine from the Mac, and the Mac from the Windows machine. Farallon says that it has spent three years on the software that translates QuickDraw calls to Windows' GDI and back.

The Mac/Windows link will probably be available in the second quarter of next year, a Farallon spokesperson said. The company also plans to port its DiskPaper and MediaTracks products to Windows. The new products will be able to use Mac files, and, conversely, the Mac applications will be able to use files created by the Windows products, Farallon says.

—Tom Thompson

Microsoft Lets Developers Peek at Windows NT

Although some jokesters are saying that NT really stands for "not there," Microsoft has been giving select developers a look at alpha code for Windows NT, or Win32, its next-generation, 32-bit operating system. NT, based on a totally new kernel, will be a preemptive, multithreaded operating system intended to run on high-end PCs and servers or RISC and multiprocessor systems.

From the programmer's perspective, each NT application gets a 2-gigabyte linear address space with virtually no limits on system resources such as window handles or threads. Enhancements will include pen and multimedia support, memory-mapped files, and a new, fully recoverable file system that's similar to an object-oriented database. Workstation-type functions, such as integrated E-mail and remote procedure call capability, will be built in.

NT can currently run DOS, Win16, Win32, Posix, and OS/2 applications, Microsoft representatives say (some sources say the 16-bit capability isn't there yet). At Microsoft's recent developers conference, a demonstration of multiple programs running under NT on a Northgate 486 PC included about 100 threads between 28 processes. These programs were drawing Bézier splines, animating colored blocks, building an application, and showing the system-process status. Although NT cosmetically resembles Windows 3.0, hourglasses quickly disappeared, indicating significant differences underneath.

Win32 will have a "mapping layer" that supports Windows 3.x calls that are not native to NT Windows application programming interfaces, said Eric Fogelin, product manager, systems architecture. Fogelin requests that all developers tell the company "if you are using undocumented calls so we can put them in the mapping layer." Microsoft promises binary compatibility and source code portability between Windows 3.1 and Win32.

The Win32 Software Developers Kit is scheduled for release by the end of this year, Microsoft officials said.

—Matt Trask

NANOBYTES

Their "divorce" has been front-page news, but **IBM** and **Microsoft** are still seeing each other. They still have **rights to each other's code**, including components of their 32-bit operating systems of the future. In Microsoft's case, that's NT. "We are still looking at NT as a key technology," said **John Soyring**, IBM's director of OS/2 software development support. "NT is one of the technology alternatives we are looking at, and if it meets our goals, we will take advantage of it." Those goals are the requirements that IBM says must be part of an OS/2 of the future: It must be portable, support symmetric multiprocessing, and meet Department of Defense security requirements.

And even though Microsoft's **Jon Lazarus**, manager of system software marketing, said that "sometimes you have to tell the kids that mommy and daddy aren't going to get back together," Microsoft is "still willing" to work with IBM on an OS/2 that can run 32-bit Windows and Presentation Manager programs. "Our current position is we're still willing to do the work if IBM is ready to work with us," Lazarus said. □

Most Unix shops are also running DOS, according to the latest membership survey taken by **UniForum**, the International Association of Unix Systems Users. Of 600 polled members, 81.1 percent said that they "still run MS-DOS." As for the hardware they use, the IBM PC topped the list with 44.5 percent, followed by Sun (38.6 percent) and Compaq (36.1 percent). The survey indicated remarkable growth in the use of **SCO Unix**, The Santa Cruz Operation's version for Intel-based systems. In the 1990 survey, SCO Unix was last in the "other" category; this year, 37 percent said they're using SCO Unix, which puts it ahead of SunOS. □

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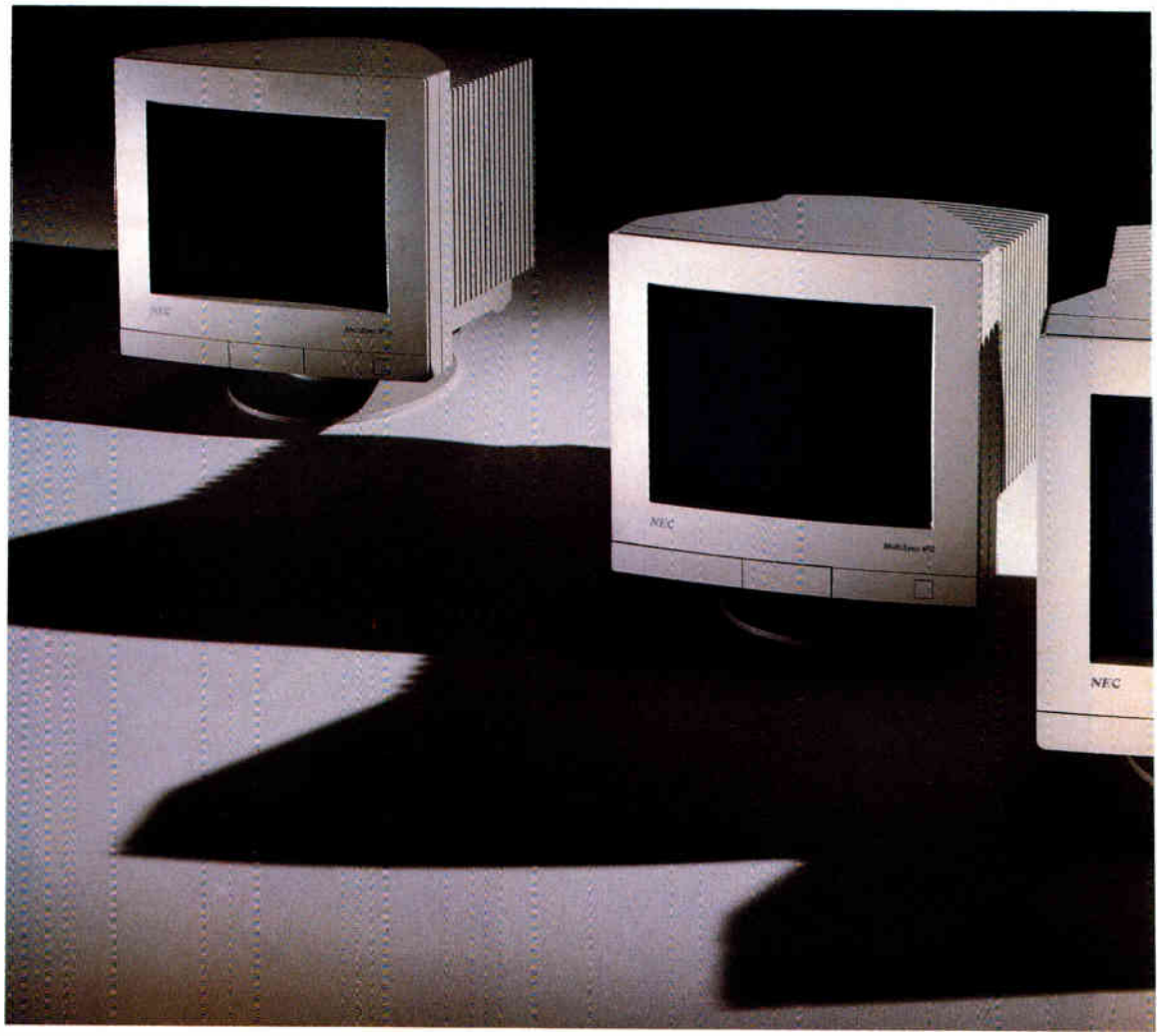

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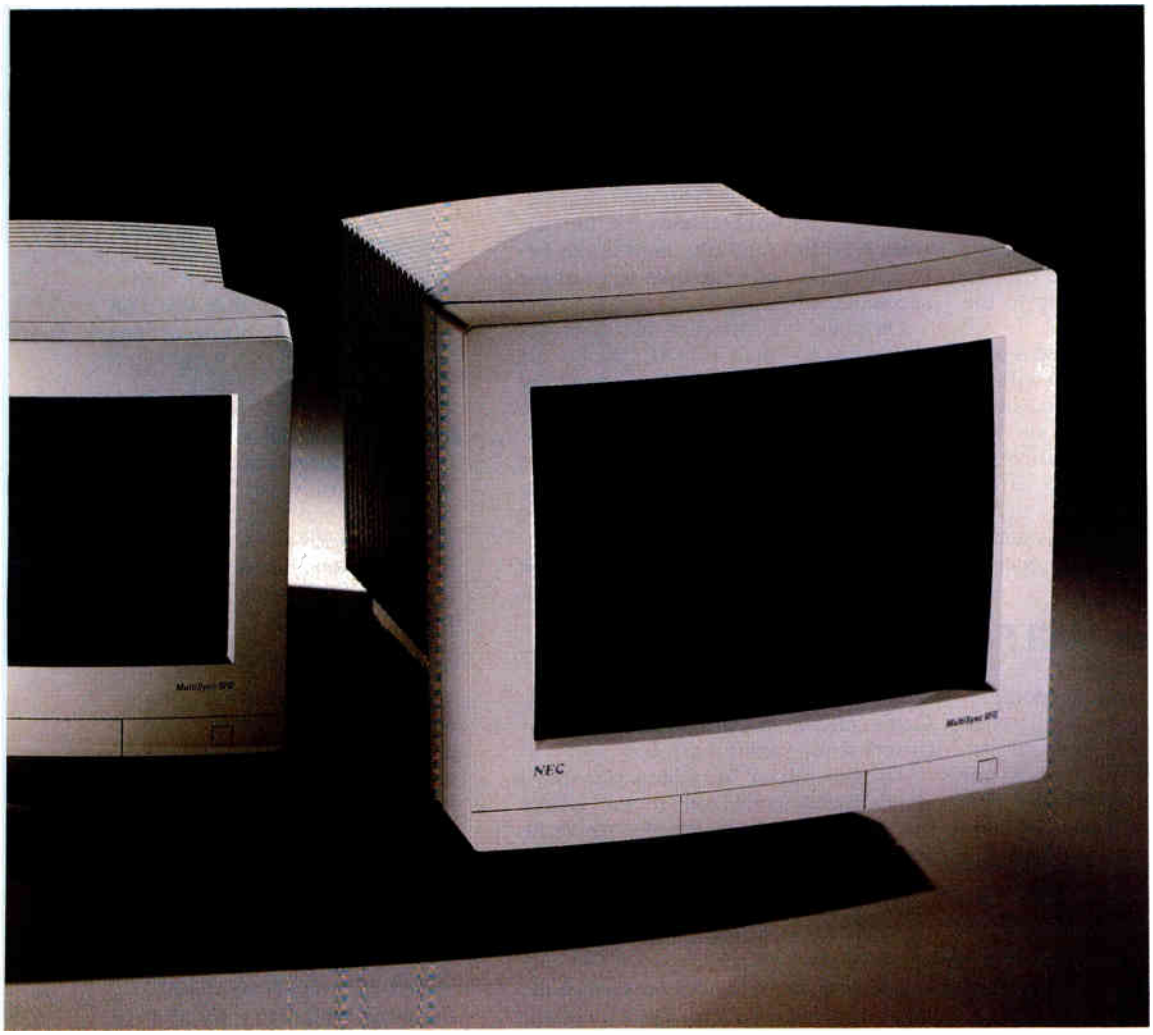

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NEWS

MICROBYTES

Radius Rocket Blasts Mac Quadra into Multiprocessing

Now that Apple has announced its own line of 68040-based systems, what about the Radius Rocket, an accelerator board that turns the Mac II into an 040 machine? The answer for Radius: Use the Rocket with the Quadra CPU to bring a form of multiprocessing to the new Mac line.

At Comdex, Radius introduced a software upgrade for the Rocket that will enable the use of the Mac CPU and Rocket 040 in the same system. Applications that utilize System 7.0's Interapplication Communication will be able to handle multiprocessing operations by using the Rocket processor as if it were another machine on the network. IAC enables distribution over a network, but the relatively slow speed of the LAN makes that an impractical medium for multiprocessing. With the Rocket, however, the network is NuBus, and communications between applications can take place at the speed of the bus.

On standard software that does not make use of System 7.0 IAC, the Rocket will show up on the desktop, appearing as another desktop. You can activate the second processor via the Mac Desktop. The software upgrade for the Radius Rocket will be available in early January, Radius said. Pricing was still not settled at press time.

—Ellen Ullman

Little PC Cards Will Further Pocketize PCs

The Personal Computer Memory Card International Association has approved a new "PC card" standard that should go a long way toward effecting the pocketization of computing power. The new PCMCIA 2.0 specification will enable OEMs to build even smaller computers and promises data interchangeability between equipment ranging from digital cameras to home appliances.

Two things possible with version 2.0 that were not specified under 1.0 are being able to execute programs in place (XIP) and use the card port as a generalized I/O device. XIP saves RAM in the system by executing programs from the PC card without transferring them into RAM. In effect, the system treats the card's memory as one more chunk of main memory. The cards use semiconductor memory, which is faster than hard or floppy drives but usually somewhat slower than system RAM. XIP's ability to act as extended/expanded memory in multimegabyte chunks is attractive. Cards can store not just programs but entire computing environments.

The generalized I/O feature provides a standardized attachment to the system bus for a host of peripherals. Anything from a modem—such as Intel's new modem card—to a LAN card to a hard drive can be plugged into the card port. The system treats anything in the card port as a fast I/O device.

The new standard does not change the features specified in 1.0. The card is still the size of four credit cards stacked on top of each other, with 68 pins on one narrow end.

PCMCIA 2.0 was developed in close cooperation with the Japan Electronic Industry Development Association and is compatible with JEIDA memory-card standards. PCMCIA has some 150 members, including heavyweights IBM, Hewlett-Packard, Fujitsu, and Lotus.

—Rick Cook

New Bus Could Standardize I/O Connections

DEC and Philips' Signetics division has developed a new open specification for a serial-device interface that could simplify plugging in new I/O devices. The Access.bus approach could eliminate the need for system vendors to support differing implementations of an I/O device (e.g., Microsoft Mouse, PS/2 bus mouse, and Mouse Systems mouse). This could also help users avoid frustration by providing a single connector type and device driver.

The Access.bus operates at 80 kbps and can connect up to 14 I/O accessories in series, making it appropriate for devices such as keyboards, mice, trackballs, hand trackers, or tablets. DEC says that it will offer the Access.bus as an option in all its future desktop systems, including PCs and RISC-based workstations.

—Andy Reinhardt

NANOBYTES

Tadpole Technology (Austin, TX) planned to have its **SPARC-compatible notebook computer** at Fall Comdex (as well as an upcoming color SPARC notebook). Tadpole says that its Sparcbook 1 weighs in at about 7 pounds, including batteries, and measures 11.8 by 8.5 by 1.9 inches. It will come with SunOS 5.0 and a DOS emulator, a modem, an Ethernet interface, hard and floppy drives, a VGA-style LCD, and a mouse-key pointing device. Because SPARC components have no power management built into their design, Tadpole engineers interfaced the M-bus with AT-bus peripheral controllers. The machine will run for about 4 hours on batteries. Prices for the Sparcbook 1 will start at around $5950. □

A new service announced by **Metropolitan Fiber Systems** (Oakbrook Terrace, IL) will allow computers to be interconnected on urban **fiber-optic highways** with data rates of up to 100 Mbps. In effect, the service can extend a high-speed Fiber Distributed Data Interface LAN beyond the walls of a company and throughout a city. Houston gets the service first. During the next year, MFS says, the network will come to Baltimore, Boston, Chicago, New York, Dallas, Minneapolis, Philadelphia, Pittsburgh, San Francisco, and LA. □

Sales of Windows applications skyrocketed in the second quarter, according to figures from the **Software Publishers Association**. The SPA figures indicate that sales of Windows programs zoomed 208 percent compared to the same quarter a year ago (when Windows 3.0 was fresh). Windows programs now have the same share of the personal computer market as Macintosh applications: about 15 percent, the SPA says. □

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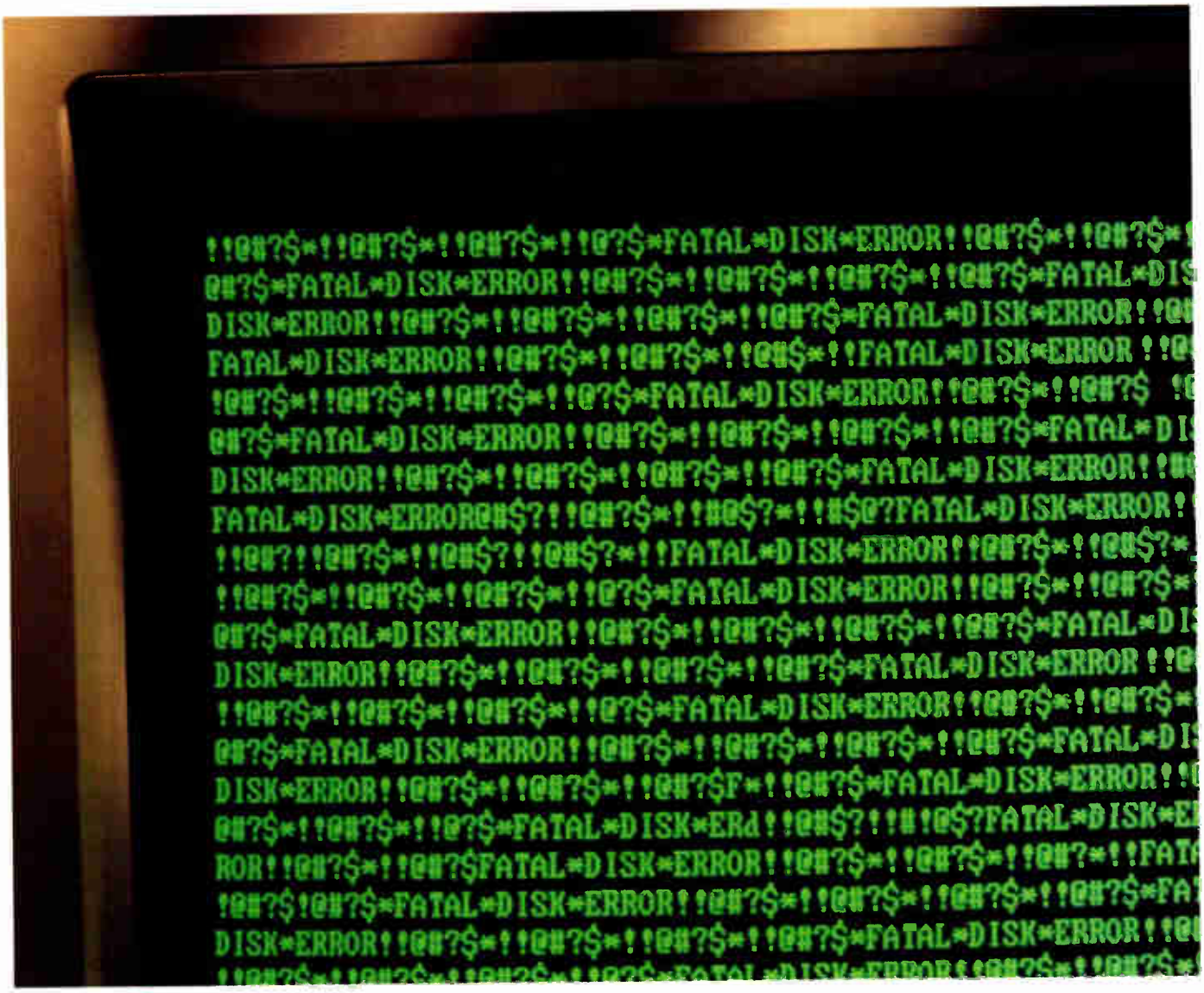

Computers are smart. Use a bad disk, and they'll tell you. With a pointed message like the one you see on the screen above. Now, you can do one of two things. Swear right back at your computer. Or start using BASF disks. Made by the people who invented magnetic recording.

BE SAFE. BASF.

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NEWS

MICROBYTES

Intel to Blend CISC/RISC in Future P5 Chip

Intel's upcoming P5 CPU will be a "mix of RISC and CISC" technology, or what Intel calls CRISC, general manager David House said at the recent SCO Forum for Unix users. The P5, which some observers say will surface in mid-1992 as the 586 chip, will contain a pair of RISC integer execution units running in parallel and performing all instructions in hardware—no microcode. Both instruction and data caches will exist on-chip, and floating-point functions will be an integral element as well, House said. A corner of the chip's die will be given over to the "complex instruction unit," a separate microcode-driven execution unit that will provide 386 (and previous x86) compatibility.

With a separate 386 execution unit, it's possible that the chip will be able to run protected-mode programs, even operating systems. Beneath that, if the full 386 architecture has been implemented, the P5 could support virtual 8086s. Presumably, the 386 execution unit could run independently of the RISC units.

John Mashey of Mips Computer Systems says that CRISC "is basically nonsense." "If it looks like a duck, walks like a duck, and quacks like a duck, it's a duck," Mashey said. Mips's R4000 RISC chip will be seen as competing with Intel's P5. Two key points of the R4000, according to Mips, are its 16-KB cache with specialized coherency control (for multiprocessing) and a 64-bit architecture.

—Tom Yager

Superscalar Chip Will Be the Brains of Faster SPARC Systems

Sun Microsystems and Texas Instruments (TI) have started fabricating early samples of the Supersparc processor that will be the brains of future SPARC systems. In addition to running at 50 MHz, the new implementation of Sun's SPARC architecture features superscalar design to execute as many as three instructions per clock cycle.

Superscalar architectures get their speed by having multiple execution units that can work on instructions in parallel. The Supersparc has separate execution units for floating-point numbers and integers. The integer execution unit has two ALUs with interconnections to combat the kind of "stalls" (instruction or data dependencies) that can bog down execution.

Phil Campbell, TI's SPARC marketing manager, says the Supersparc is designed for single-processor or multiprocessor configurations. For higher performance, system designers can add an external cache controller with a megabyte of cache memory. "Once you've gone through the learning cycle of implementing superscalar, it's easier in the next design to add more execution units or increase the performance of the existing units even more," Campbell says.

The fastest SPARC processor to date is an implementation from Cypress Technology that runs at 40 MHz and is rated at about 25 million instructions per second. By contrast, Hewlett-Packard's new RISC processor, code-named "Snakes," is rated as high as 76 MIPS at 66 MHz. Hitachi is supposedly readying a 100-MIPS version of the HP architecture for release before the end of the year.

—Rick Cook

Apple Solves 32-bit-Unclean Problem with Connectix Software

Apple Computer has remedied the "32-bit-unclean" problem of certain Macintosh models by acquiring the rights to distribute the MODE32 software utility from Connectix. The software, which Apple can distribute at no charge, provides users of Mac II, IIx, IIcx, and SE/30 systems access to the virtual memory–addressing features of System 7.0. The utility is necessary because the ROM chips in these Macs are not able to execute 32-bit addressing; these ROM chips are not "32-bit clean."

The MODE32 memory management utility lets 32-bit-unclean Mac users access up to 128 MB of physical RAM using System 7.0, and Mac II users up to 72 MB, which was previously not possible on these four systems. ■

—Larry Loeb

NANOBYTES

IBM's plant in Rochester, Minnesota, has started manufacturing a 3½-inch hard disk that holds **up to a gigabyte**. One of the keys to

the size of the device is its **magneto-resistive recording head**, which is much smaller than read heads in other drives; IBM says it's about half the size of a grain of rice (in the photo, it's the tiniest item next to the edge of the dime). The slider that the head moves on is also tiny—about one-sixth the size of other sliders. □

Want to **trade up to a 486?** **Lightning Computers** (San Francisco) will take your 286 or 386 PC toward the cost of a Lightning 33-MHz 486-based system. The Lightning machine comes with a 130-MB hard drive, a floppy drive, 1 MB of RAM, a VGA card, and the usual accoutrements (monitor separate). If you trade in a 386 system, the Lightning 486 costs $1499; with a 286 system, it's $1689, and with an old XT, it's $1899. The used PCs must have at least a 20-MB hard drive and be working. □

Now through January 5, **Apple is giving rebates** on Mac/printer combinations. The rebates range from $125 for a Mac Classic with StyleWriter or Personal LaserWriter to $800 for a Mac IIsi with Personal LaserWriter. □

Responding to **AMD**'s latest allegations that **Intel** has monopolized the CPU market, part of a $2 billion federal antitrust suit, Intel CEO **Andrew Grove** said that the suit is "ridiculous" and called AMD "the **Milli Vanilli** of semiconductors." According to Grove, AMD's "last original idea was to copy Intel." No word on which group AMD CEO Jerry Sanders compared Intel to. ■

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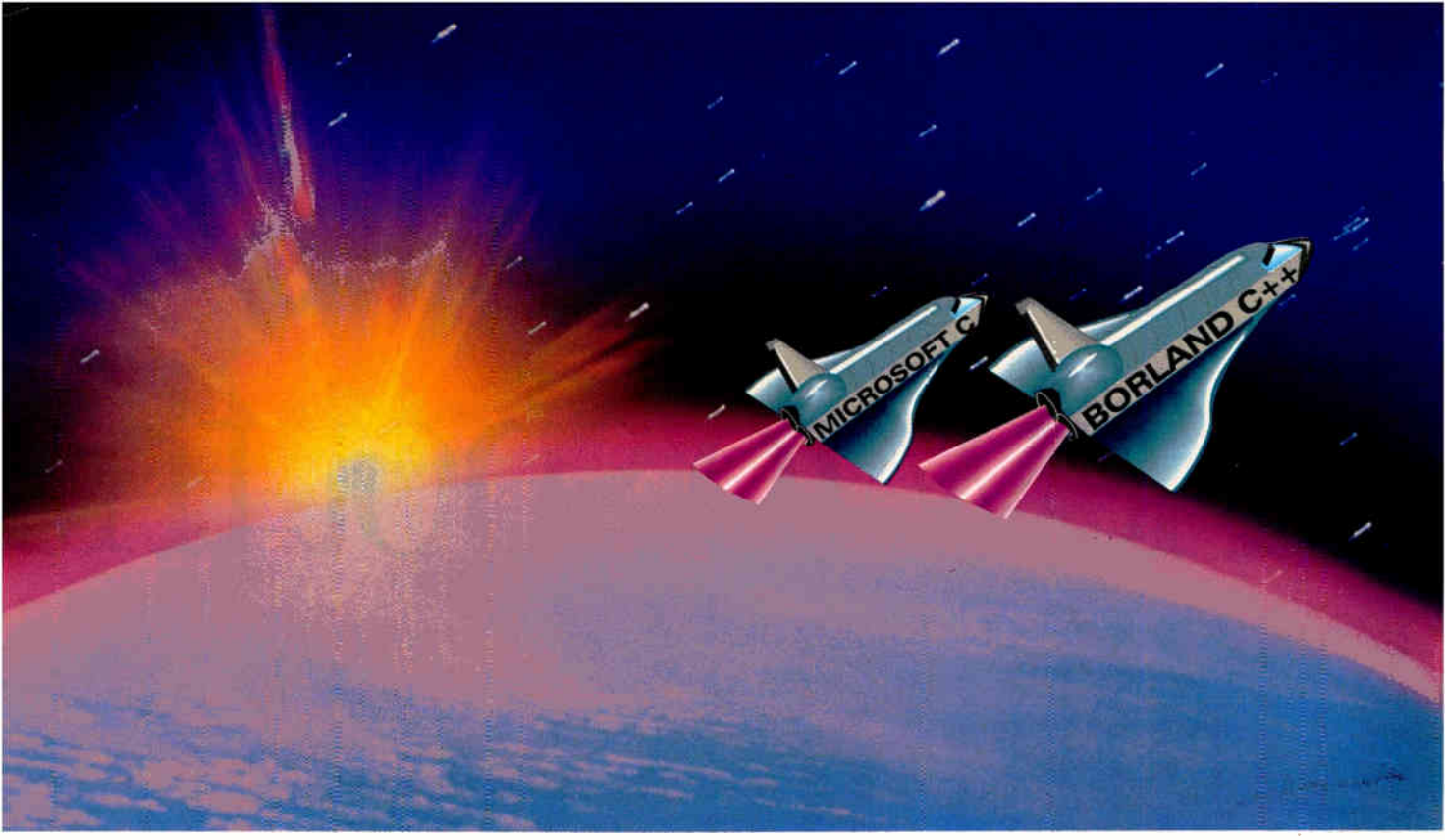

C BEYOND 640K DOS

Borland C++ or Microsoft C?
Either way, your choice for building multi-megabyte applications is simple — Phar Lap's 286|DOS-Extender™.

It's never been so easy.

You've been hearing a lot lately about DOS extenders and their ability to let you create programs that can access memory beyond the 640K DOS limit. Now Phar Lap makes it easier than ever! With our 286|DOS-Extender and your Borland C++, Microsoft C or Microsoft FORTRAN compiler, you've got all the tools you'll need to quickly and easily build multi-megabyte protected-mode applications – often by simply relinking without making source code changes. 286|DOS-Extender enables you to build programs that have room for more features and capabilities, without having to suffer with overlays or EMS. And you can finally access all the memory available in your machine – up to 16 megabytes!

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That's right... now you can develop multi-megabyte protected mode applications with the standard Borland and Microsoft tools you're used to! 286|DOS-Extender is compatible with both the C and C++ compilers included in Borland C++, Borland's Turbo Debugger, the Microsoft C and Microsoft FORTRAN compilers, and Microsoft's linker and CodeView debugger. You can even use Turbo Debugger to debug a Microsoft C program! 286|DOS-Extender is designed to work seamlessly with these three widely-used compilers in order to make protected mode development easier for you.

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From the leader in protected mode development tools.

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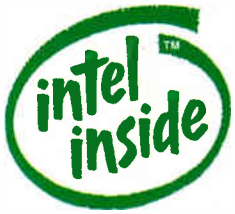

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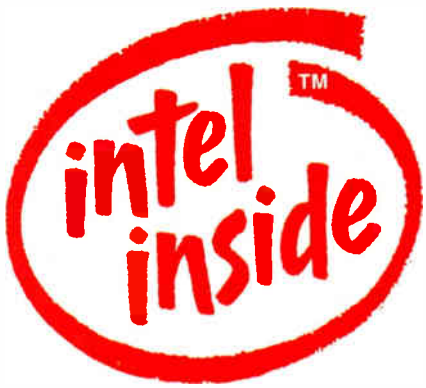

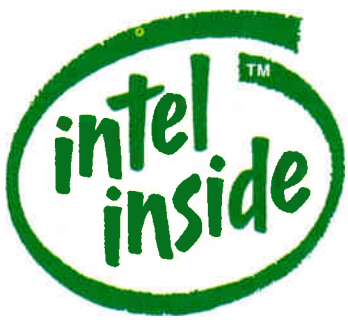

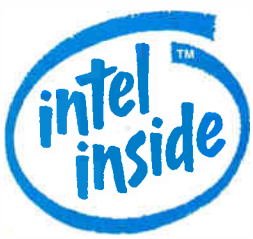

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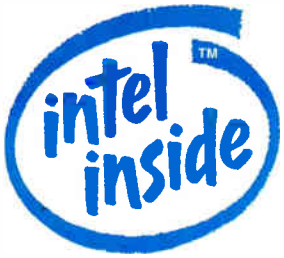

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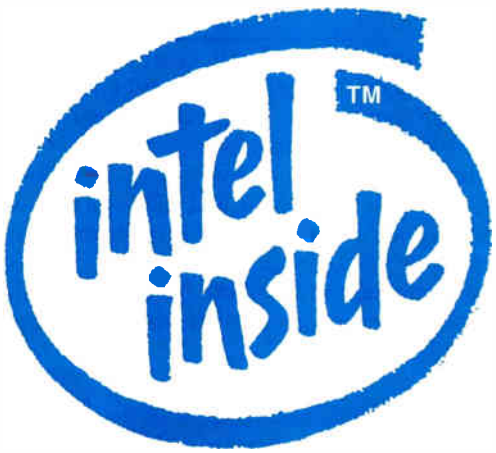

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Momenta Points to the Future

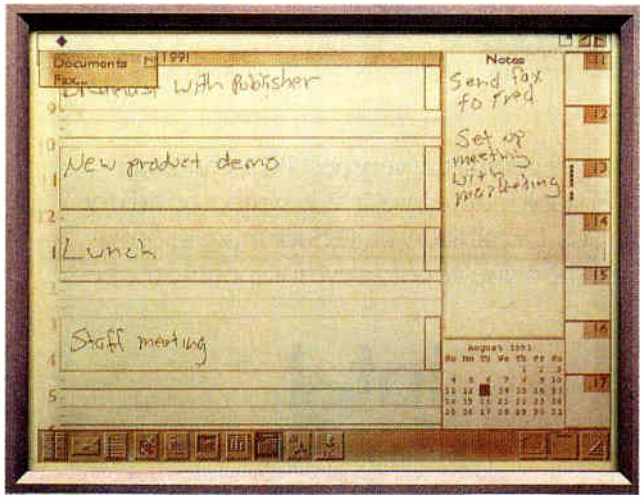
ANDY REINHARDT

A new notebook merges the pen, the keyboard, and a slick —but risky—new GUI

Many players in the nascent pen-based computing market see the transition from conventional notebooks to pen systems as a chance to bypass the DOS standard and start afresh with more modern technology. Although the era of pen-based systems has barely begun, there are already three competing operating environments. This mad scramble to set new software norms for pen computers may be a rude shock to users comfortable with the uniformity of DOS.

In the midst of all this uncertainty, a fourth environment has arrived from start-up Momenta. One of the most widely anticipated entrants to the market, Momenta's pen-based laptop sports a new GUI that represents yet another effort to define the look and feel of pen computing.

The Momenta computer is different in other ways, too. The company is aiming it at mobile executives, not at the blue-collar and field workers who have until now been the target audience for pen-based PCs. Perhaps most surprising, Momenta is playing down the role of handwriting recognition in the system, saying that the technology is too immature to substitute for a keyboard in many cases. Instead, Momenta sees the pen, in conjunction with its new GUI, as a more intuitive substitute for a mouse.



Momenta's pen-oriented calendar program lets you make your schedule much as you would with a Day-Timer.

Momenta is headed by an impressive team of industry veterans, and it has raised $30 million in venture capital. With its strong credentials and innovative technology, the company could grab a chunk of the mobile computing market. But it may have a hard time selling a new GUI against three tough competitors: Microsoft, Go Corp., and Grid Systems.

The Wedge

The Momenta is different from any other notebook even before you turn it on. Measuring 10 inches deep by 12 inches wide, it tapers from a thickness of 2½ inches at the back down to 1½ inches at the front. Momenta says that a sloped surface is easier to write on than a flat tablet, such as the NCR System 3125 (see "NCR Knows Notepads," August BYTE). The computer weighs 7 pounds.

The keyboard is an important point: Momenta calls its machine a *pen-top*, to indicate that it is a merging of a pen computer and a desktop. The system is meant to be used in the office as well as in the field, so it will ship with both a small "full-size" keyboard and a stylus that attaches with a short cord.

The brain of the Momenta computer is a 20-MHz 386SX chip. It's backed up with 4 MB of RAM, 1 MB of ROM, 256 KB of flash memory, and a 40-MB hard drive. A 2400-/9600-bps send/receive fax modem and a small microphone and speaker are built in, along with standard serial and parallel ports on the back. The system is powered by 10 AA batteries, which can be alkaline or rechargeable nickel-cadmium or nickel-hydride. Momenta says that the system works for 6 to 8 hours on a charge. Options include an external 3½-inch floppy drive and Xircom LAN adapters.

Like other pen systems, the Momenta is dominated by its display, which is hinged at the front, so it can lie flat or be opened up for desktop use. The LCD panel, with 640- by 480-pixel VGA resolution, is reflective, not backlit, which saves power and improves legibility outdoors but makes it harder to read inside. A backlit screen will be available early next year.

Although the screen shows 80 dots per inch, the digitizer recognizes 400 dpi and the system retains that amount of detail, which means that "ink" written on the screen will be faithfully reproduced on a laser printer or when sent through the fax modem. There is no external CRT port, since a normal monitor could not be used for pen input, but Momenta may offer one in the future.

The Momenta computer offers typical power-conservation features (e.g., powering down the hard drive and display), and it also supports advanced capabilities such as suspend/resume.

New GUI

Momenta is treading a middle path between the DOS-incompatible PenPoint and Microsoft Windows for Pen Computing. The system is built on DOS and will

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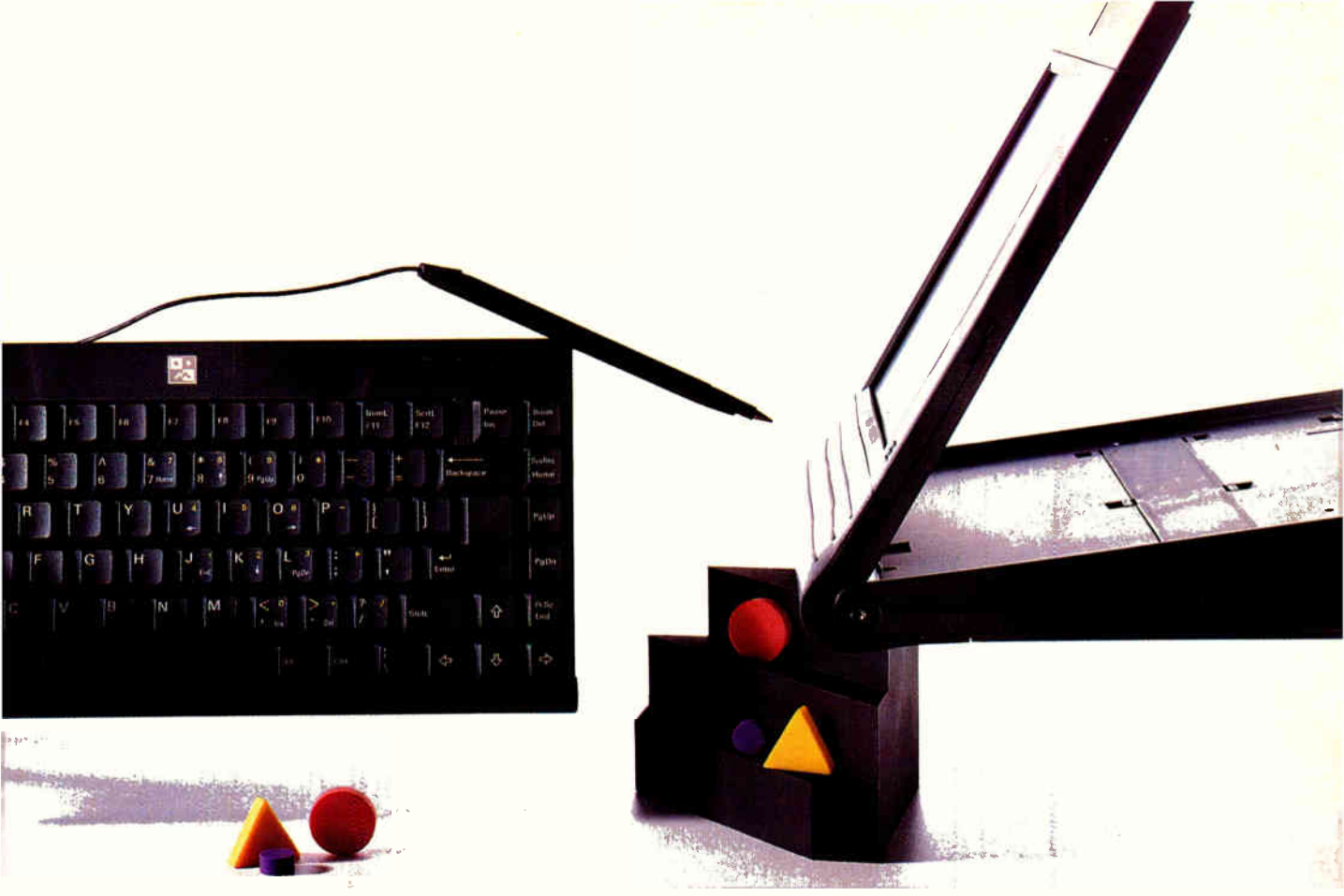

run DOS and Windows applications unchanged, although at this time Momenta doesn't support the pen in DOS programs. But the intended interface is the Momenta software environment, an object-oriented GUI that is built in Smalltalk.

The computer normally boots up in the Momenta environment, an elegant graphical desktop with a suite of built-in productivity programs. Icons for the seven programs (i.e., an address list, a memo writer, a calendar, a to-do list, a presentation maker, a fax, and a "mark-up" program to annotate documents with handwritten comments) are located on the bottom left. All these modules share data, so an address selected from the address list and a "marked-up" document will flow automatically to the fax. In the bottom right corner of the screen are the clipboard icon and the suitcase, a trove of goodies like clip art, training programs, and a calibrator for the digitizer.

A guiding principle of Momenta's interface design was to display only the information needed at any time. The pull-down menus at the top of the screen are very spare, and they alter based on what you're doing. Most of the time, you won't need to use menus because of a feature called the *command compass*, a pentagonal object that pops up on the screen when you tap the pen. The command compass lets you move, copy, delete, and edit objects, or bring up a menu tailored to your situation. You can also teach the system to recognize your particular way of making gestures.

In addition to its built-in programs, the machine will be bundled with four third-party applications developed to run in the Momenta environment: a spreadsheet called PenCell that was developed by PenWare, a word processor and a file transfer program from Rupp Software, and a Structured Query Language database from a new company whose identity was not disclosed at press time.

Third-party developers who have used the Momenta environment praise its powerful object orientation and interface-building tools, which have been compared to NextStep. Momenta plans to ship a full 486-based developer's kit, including class libraries and methods, to help third parties create "pen-centric" programs.

Training Required

The Momenta looks to be a solid product, although the prototypes I played with were slow. Momenta says the performance will be two to three times faster when the system ships. When it was running Microsoft Windows for Pen Computing, the performance was perky, but I found the screen a bit difficult to read in both Momenta and Windows for Pen Computing environments.

My more serious concern has to do with the GUI. I don't know if I've gotten slow in my old age, but I found it difficult to navigate and, at times, quite frustrating to use. Maybe more training would solve my problem. But if the Momenta interface isn't immediately and substantially better than its competitors, I find myself wondering why customers and developers should bother with it.

It's too early in the evolution of these kinds of systems for any machine to be considered the final word in pen-based computing. And Momenta's immediate challenge will be to attract sufficient third-party support to justify its unique GUI. But Momenta's hardware and the software reveal much about state-of-the-art pen-based system design, and they deserve a serious look. ■

Andy Reinhardt is a BYTE news editor in New York. He can be reached on BIX as "areinhardt."

THE FACTS

Momenta Computer
with 4 MB of RAM, a 40-MB hard drive, and a built-in fax/data modem, $4995

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World Radio History

A Peck of New Apple Macintoshes

TOM THOMPSON

Apple broadens its Mac product line with light notebooks, powerful 68040-based computers, and a low-cost system

Two years ago, Apple introduced its first traveling Macintosh, the Mac Portable, and its high-performance computer, the 68030-based 25-MHz Mac IIci. Time has shown us that the largely unsuccessful Portable was too large and too heavy to serve its intended on-the-go audience, while the Mac IIci now represents midrange computing power since the introduction of the 40-MHz 68030-based Mac IIfx.

At fall Comdex, Apple is introducing not two, but *six* new Macs: three notebook computers, two high-performance 68040-based machines, and a new member of the Classic line (see the text box "The Classic Gets a New Family Member" on page 52). The new computers come with the System 7.0.1 Mac OS, which is modified to support the new computers and offers some enhancements. Time will tell if Apple has accurately perceived the needs of the market, but my initial impressions are that the company has hit the mark squarely.

Not Your Father's Portable

Wayne Westly, CPU product marketing manager for Apple's new notebook computers, stated: "I have good news and bad news. The bad news is that the notebook product line weighs about the same as the Mac Portable [18 pounds]. The good news is that the product line consists of three computers." So saying, he introduced Apple's notebook family—termed PowerBooks—by opening a briefcase and taking one out.

These new Macs easily earn the term *notebook*. They're slightly larger than an 8½- by 11-inch sheet of paper and are 1¾ to 2¼ inches thick. The PowerBook 100, including the battery, weighs 5.1 pounds; the PowerBook 140 and 170, with batteries, tip the scales at 6.8 pounds each.

Despite their small size, there's been no compromise on these computers' capabilities: They are fully functional Macs. Furthermore, you have a choice in processing power and cost. The PowerBook 100 uses a 15.667-MHz 68000 processor and is essentially a Mac Portable placed on a crash weight-reduction program by Sony. The PowerBook 140 and 170 are built by Apple itself and represent full-blown desktop Macs, using 15.667- and 25-MHz 68030 processors, respectively. The PowerBook 100 uses a sealed lead-acid battery; the others use nickel-cadmium batteries. Battery life is expected to be 2 to 4 hours for the PowerBook 100 and 2 to 3 hours for the 140 and 170.

All three PowerBooks use a clamshell layout, where the display covers the keyboard and trackball when it's stowed for travel. The trackball is located in the lower center, in front of the keyboard, in a design that favors neither hand. Two wide buttons, which act as a single mouse button, flank the trackball at the top and bottom. The full-size keyboard is set back from the front of the PowerBook for ergonomic reasons. You can rest your palms on the flat area around the trackball, rather than bend your wrists to type on a keyboard placed at the front edge. A keypad option is not available from Apple, but you can obtain one from a third-party vendor.

The PowerBook 100 and 140 both use 640- by 400-pixel backlit supertwist LCD screens; the 170 uses a 640- by 400-pixel active-matrix LCD screen, the same as the Mac Portable's.

The back of the PowerBooks has the usual serial, sound, SCSI, and Apple Desktop bus (ADB) ports. To cram this many ports in this smaller form factor, Apple replaced the standard DB-25 SCSI connector with a smaller HDI-30 connector. To save space internally, there's no Processor Direct Slot (PDS) or ROM expansion slot, as found in the Mac Portable. There are expansion slots for a memory board and a 9600-bps fax/2400-bps data modem board. None of the PowerBooks has an external video port. However, third-party adapters from Radius and Envisio provide a way to connect the PowerBooks to an external monitor.

The PowerBooks come bundled with AppleTalk Remote Access, software that lets you dial into a remote Mac so that your machine will appear as a node on the AppleTalk network to which it is connected. This allows you to print documents on a remote office's printers, copy files to and from its servers, and run networked products.

PowerBook 100

The PowerBook 100 is the low-cost member of the family. It has a 9-inch diagonal supertwist LCD screen. The 100 uses the same Apple Sound Chip for sound reproduction that is found in the Portable, and virtually the same 256-KB Mac Portable ROM chips. Memory can be expanded to 8 MB using a RAM expansion board in the memory slot, and there's a slot for an optional fax/modem board. Because the computer stands only 1¾ inches tall, there's no room to include a 1.44-MB SuperDrive floppy drive. An external SuperDrive, with a smaller HDI-20 floppy port connector, is available separately or bundled with one of the PowerBook 100 configurations.

You can use a SCSI disk adapter cable to "dock" the PowerBook 100 to a desktop Mac via its SCSI port. This adapter lets the desktop Mac treat the 100's internal drive as an external hard drive.

Prices were tentative at press time, but the basic configuration should cost approximately $2299. This includes 2 MB of 100-nanosecond pseudostatic RAM and a 20-MB hard drive. An extra $200 gets you an external SuperDrive floppy unit (see the table).

PowerBook 140

The PowerBook 140 uses a 15.667-MHz 68030 processor, which places its processing power in the same league as that of a Mac IIcx. Spreadsheet jockeys, take

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THE NEW MACINTOSHES BY FAMILY

	Model	Processor	Standard RAM	Maximum RAM	Slots	Ports	Dim. (inches); weight (lb.)	Configuration and price*
	PowerBook 100	16-MHz 68000	2 MB	8 MB	Memory, fax/modem	1 ADB, 1 RS-422 serial, HDI-30 SCSI, HDI-20 floppy, sound output	1¾ x 11 x 8½; 5.1	2 MB RAM/20-MB hard drive: $2299 With external SuperDrive: $2499
	PowerBook 140	16-MHz 68030	2 MB	8 MB	Memory, fax/modem	1 ADB, 2 RS-422 serial, HDI-30 SCSI, sound input, sound output	2¼ x 11¼ x 9¼; 6.8	2 MB RAM/20-MB hard drive: $2899 2 MB RAM/40-MB hard drive: $3199 4 MB RAM/40-MB hard drive: $3499
	PowerBook 170	25-MHz 68030, 68882 FPU	4 MB	8 MB	Memory, fax/modem	1 ADB, 2 RS-422 serial, HDI-30 SCSI, sound input, sound output	2¼ x 11¼ x 9¼; 6.8	4 MB RAM/40-MB hard drive: $4599 (includes fax/modem board)
	Quadra 700	25-MHz 68040	4 MB	20 MB	2 NuBus 90, 1 68040 PDS	2 ADB, 2 RS-422 serial, DB-25 SCSI, sound input, sound output, AUI-15 Ethernet, 24-bit video	5½ x 12 x 14½; 13.7	4 MB RAM: $5699 4 MB RAM/80-MB hard drive: $6399 4 MB RAM/160-MB hard drive: $6999 Upgrade from IIci: $3499
	Quadra 900	25-MHz 68040	4 MB	64 MB	5 NuBus 90, 1 68040 PDS	2 ADB, 2 RS-422 serial, DB-25 SCSI, 3 sound input, sound output, AUI-15 Ethernet, 24-bit video	18½ x 9 x 20½; 36.7	4 MB RAM: $7199 4 MB RAM/160-MB hard drive: $8499
	Classic II	16-MHz 68030	2 MB	10 MB	ROM slot	1 ADB, 2 RS-422 serial, DB-25 SCSI, sound input, sound output, floppy	13¼ x 9¾ x 11¼; 16	2 MB RAM/40-MB hard drive: $1899 4 MB RAM/80-MB hard drive: $2399 Upgrade from Classic: $699

* These prices were tentative at press time.

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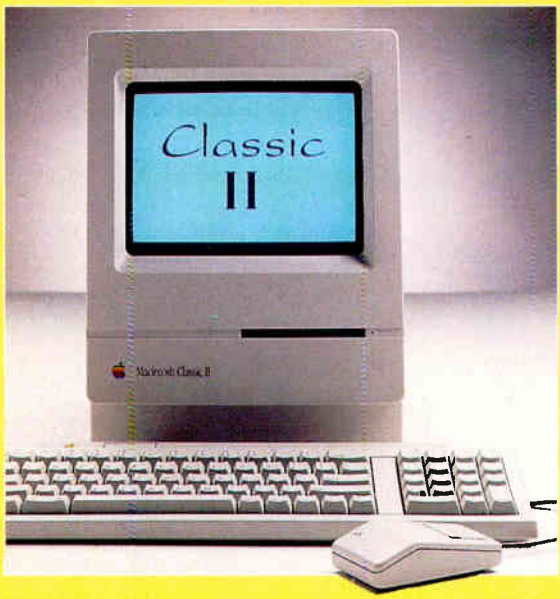
The Classic Gets a New Family Member



Amid all the hoopla of the PowerBooks and Quadras, it was easy to overlook the fact that the Classic, the linchpin of Apple's low-cost market strategy, became a product line. This occurred with the arrival of a new family member, the Classic II.

The Classic II serves the needs of Classic users whose work has run into the performance wall of its 8-MHz 68000 or its 4-MB RAM limit. It solves the performance issue with a 68030 CPU running at 15.667 MHz. The Classic II starts with 2 MB of RAM on the main logic board. Two SIMM sockets let you expand the RAM to 10 MB, which should satisfy the memory needs of most users. The Classic II also sports sound input, another feature missing from the Classic.

The Classic II's logic board is a derivative of the Mac LC design. It uses the same custom IC to handle sound input, and it has the Combo chip that is used by the PowerBooks and the Mac IIsi. The Classic II also uses the LC's same 512-KB ROM chips, but with patches to support the smaller 512- by 342-pixel screen. A 50-pin internal connector (not a Processor Direct Slot) lets you expand the Classic II's ROM to 4 MB, or you can add an FPU. And the Classic II serves up a claimed Mac LC performance, or twice that of the original Classic.

A Classic II with 2 MB of RAM and a 40-MB hard drive costs $1899. Available for $2399 is a version with 4 MB of RAM and an 80-MB hard drive. Classic users can upgrade to the Classic II for $699, which involves swapping the main logic board and the back of the case.

note: There's no 68882 FPU, nor a socket for one. The 140 uses a 10-inch diagonal supertwist LCD screen, and its 2¼-inch height accommodates an integral SuperDrive that reads 1.44-MB Mac, DOS, and OS/2 floppy disks. For this reason, there is no external floppy drive port. Instead, this space contains a sound input port and an additional serial port.

The 140 uses 100-ns RAM, expandable to 8 MB via the memory slot. An optional fax/modem board goes in another slot. The 140 borrows components from previous Macs. Both a Combo chip that combines serial and SCSI functions and a sound input chip come from the Mac LC. The clock chip and interface logic used to maintain the real-time clock and parameter RAM come from the Classic.

But there are differences between the PowerBook 140 and previous Macs. The PowerBook 140 uses 1-MB ROM chips. The lower 512 KB of ROM contains 32-bit clean universal code that's common to the Mac IIci, IIfx, IIsi, and LC; the upper 512 KB contains PowerBook-specific code. The universal-code portion provides support for Color QuickDraw and virtual memory in the PowerBook 140 and 170. There's also the new Enhanced Apple Digital Sound Chip (EADSC), which supplies superior sound capabilities (e.g., an output range of 11 kHz, up from 7.5 kHz on other Macs).

PowerBook 170

The PowerBook 170 is practically a twin of the 140. However, its 68030 CPU and 68882 FPU run at 25 MHz, which means that it packs the processing punch of a Mac IIci. The 170 also uses a 10-inch diagonal active-matrix LCD screen.

The Mac Portable and PowerBook 100 implement a rest mode, where the processor's speed is effectively reduced by adding more wait states to a bus cycle. (For additional information, see "The Portable and the Powerful," October 1989 BYTE.) On the PowerBook 140 and 170, the rest-mode mechanism was modified to reduce the power-hungry 68030's energy consumption by 90 percent.

The Quadras: Real Speed Demons

For those MacFolk whose needs demand screaming performance, Apple has got something for them: the Quadra 700 and 900. The Quadras are the most powerful Macs to date, deriving most of their speed from a 25-MHz 68040. The Quadra 700 is a small Mac IIci–size desktop computer, while the Quadra 900 is a PC-style floor-standing tower. Both use common 80-ns Mac IIci RAM and have a 24-bit video and Ethernet port built in. For sound manipulation, the Quadras use the EADSC

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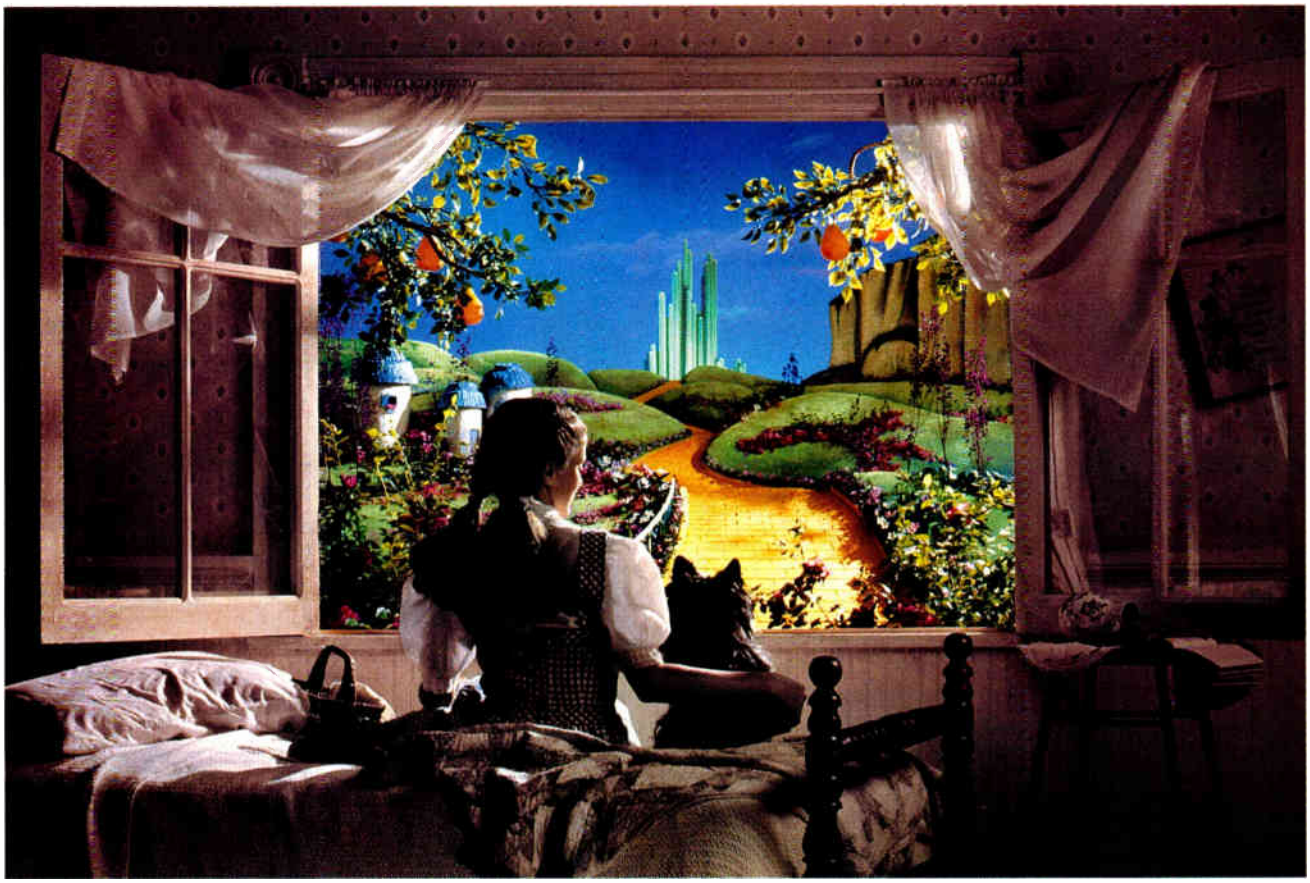

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and offer a 16-kHz-range sound output.

The 68040 has an on-chip memory management unit (MMU), an FPU, and 4-KB code and data caches that greatly simplified the Quadra's design. There's no separate FPU or 32-KB static RAM cache, as are found on the Mac IIfx. But there's more to the performance equation than just plugging a hot processor into a computer. A variety of support processors off-load various tasks from the 68040, while other subsystems have been redesigned for better throughput. For example, the same I/O processors in the Mac IIfx manage the Quadra's serial ports, ADB, and SuperDrive.

A National Semiconductor DP83932 Ethernet controller handles the Ethernet subsystem, and its driver supports real DMA transfers. Since the controller is connected directly to the I/O bus, Ethernet transfers don't incur the overhead of NuBus transaction, as happens with NuBus Ethernet boards. This adds up to fast Ethernet transfers. Between two Quadras, the transfer rate is 10 times that of a LocalTalk transfer. The Quadra's built-in Ethernet port uses Apple's Attachment Unit Interface connector. This allows you to have connections for thin, thick, or 10Base-T Ethernet cabling by plugging the appropriate transceiver into the Quadra's AUI.

The Quadra's hard disk subsystem uses NCR's 53C96 SCSI controller. This chip has a maximum transfer rate of 5 MBps, versus the old Mac mainstay, the 53C80, which tops out at 1.5 MBps. The 53C96 also has a 16-byte first-in/first-out buffer and faster hardware handshaking. Also, it handles more of the SCSI transaction in hardware. The Mac IIfx's SCSI DMA mechanism, which never really worked with the Mac OS, has been eliminated.

Access to NuBus has been boosted in several ways. First, the NuBus controller uses faster bus clocks to speed the synchronization of logical read/write transfers between main memory and NuBus. Second, the controller has a write buffer that lets the 68040 continue processing while it completes the write operation. Third, NuBus-style block transfers to and from main memory are supported. All this doubles the NuBus transfer rate.

dles Apple monitors from 12 to 21 inches in size, and NTSC, PAL, and VGA monitors are supported using the appropriate cable. The Quadras come equipped with either 512 KB (on the 700) or 1 MB (on the 900) of video RAM soldered to the main logic board; the latter supports 8-bit-deep screens on all displays. To increase the screen depth to 24 bits, you add more VRAM to six SIMM sockets. The maximum of 2 MB of VRAM supports 24-bit pixels on monitors up to and including 16 inches.

Since the video controller and buffer are connected directly to the 68040 bus, writes to the screen are blazingly fast. The claimed display speed is 80 percent of that of Apple's accelerated 8•24 GC display board, which uses an Advanced Micro Devices 29000 RISC processor. Even better, since the frame buffer isn't located in main memory, there's no performance hit when using the built-in video, as is the case with the Mac IIci and IIsi.

Both Quadras use 1-MB ROM chips. As with the PowerBook 140 and 170, the lower 512 KB contains the universal code, and the upper 512 KB contains patch code and new resources to support the 68040. For example, support for the 68040's MMU instruction set, integral FPU, and copyback cache was added. Many changes were made to the ROM code to support the 68040's copyback cache mode, which involves keeping the main memory's contents up to date with the cache's contents. Although it took some effort and can cause some compatibility problems, the gain is a 50 percent boost in processing speed.

Quadra 700

The Quadra 700 has the size and shape of a Mac IIci, but the units I saw had footpads that stood them on their side. It has two NuBus slots and one 68040 PDS inline with one of the NuBus slots, a setup similar to that on the IIfx. The 68020 and 68030 PDS boards aren't compatible with this slot. A 90-watt Mac IIci power supply provides an ample power budget, so the Quadra 700 can handle one 25-W NuBus board and one 15-W NuBus board. The built-in video has 512 KB of VRAM, which supports 8-bit-deep 12- and 13-

not cheap, but remember that you can keep your RAM with this upgrade. There is no upgrade path to a Quadra system available for Mac IIfx owners.

Quadra 900

The Quadra 900's floor-standing housing has room for four 3½- or 5¼-inch half-height drives, and one bay can hold a 5¼-inch full-height drive. Two bays are located at the tower's front, and the upper bay normally has a SuperDrive. The lower bay can accommodate removable media devices (e.g., a tape drive, a magneto-optical drive, or a CD-ROM drive).

The Quadra 900 has five NuBus 90 slots, with a power budget that can handle two 25-W boards and three 15-W boards. Also, you can remove plastic carriers from the housing to accommodate NuBus boards that are 2 inches taller. The combination of a large power budget and extra board size supports complex expansion boards. A beefy 300-W power supply handles the demands of a fully configured system with expansion boards.

There are three sound input ports on the back of the 900: the standard Apple microphone jack and two RCA sound jacks. The latter two are for stereo input, but for now, both channels are mixed before going into the sound circuits. There's also a sound input connector on the main logic board, so sound can be piped directly off a CD-ROM drive and into the sound circuitry.

The basic Quadra 900 includes 4 MB of RAM and a SuperDrive. The built-in video has 1 MB of VRAM, which supports 8-bit-deep displays of any size. Twelve SIMM sockets let you expand RAM to 64 MB.

Macs for Everyone

Although my hands-on experience was brief, it left no doubt that the PowerBooks are small, light, and powerful Macs. I'll swap the Mac Portable for any PowerBook without a second thought, and DOS users should give them a serious look as well. While some might view the lack of a video output port as a serious problem, in all my travels with a Mac Portable, I've never had to use its video port. Nevertheless, if your work requires a video port,

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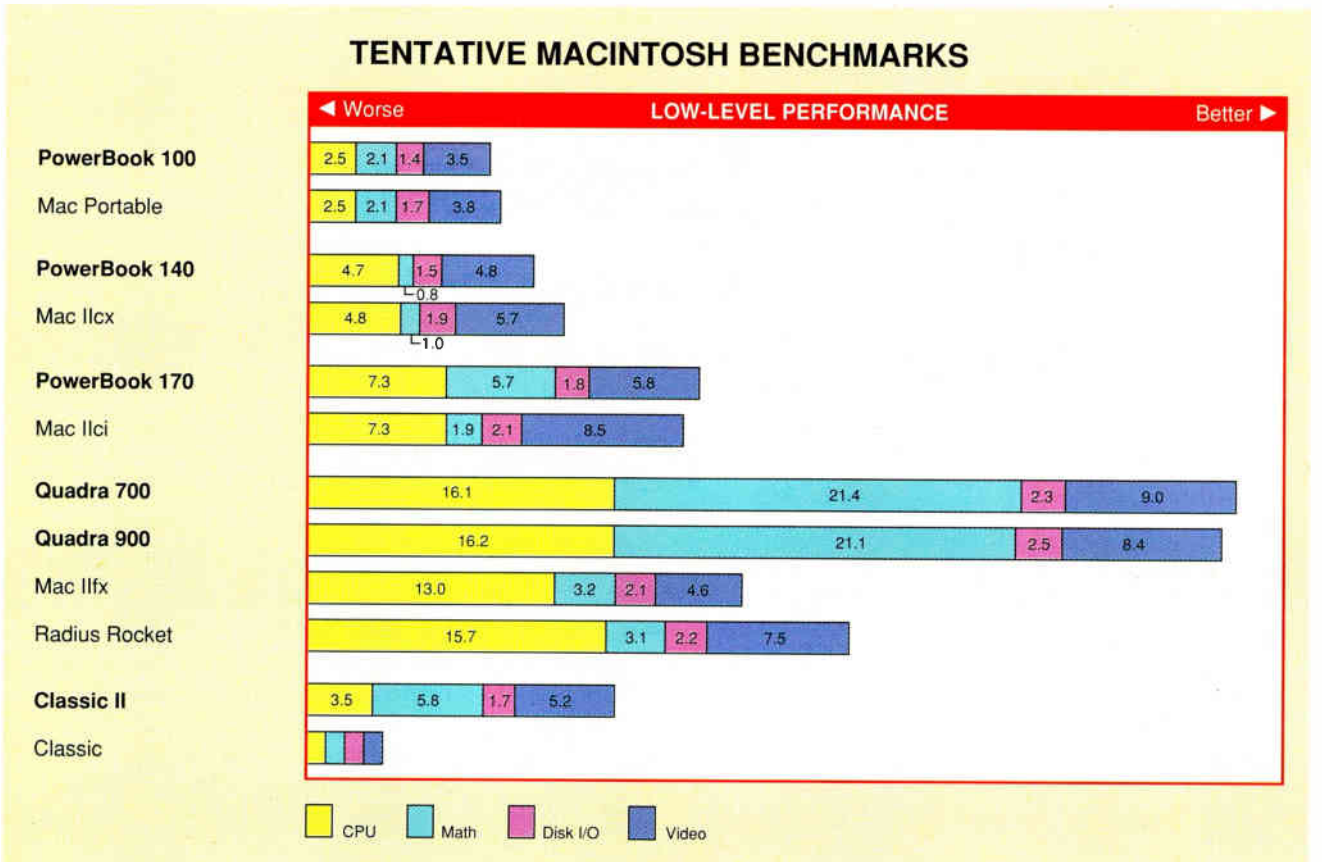

The new systems ran a beta System 7.0.1. All old systems ran System 7.0 except for the Radius Rocket, which ran System 6.0.7.

The Radius Rocket ran on a Mac II with a 130-MB hard drive and a Radius 19-inch display. Display depth for 68040-based systems and the Mac IIfx was 8 bits.

FPU values are relative to the Mac IIcx except for the PowerBook 100, Mac Portable, and Classic II, which are made relative to the Classic.

Tentative subsystem performance results of the new Macs compared to those of existing models. In System 7.0.1, the Standard Apple Numeric Environment math calls have been improved. Notice how the PowerBook 170's floating-point performance easily outpaces the Mac IIfx's. All results are indexed to show relative performance; for all tests, a Classic = 1.

that of a Mac Portable, while the PowerBook 170's approximates that of a Mac IIci (see the figure). The PowerBook 140 closely matches the Mac IIcx except in floating-point performance, where the lack of an FPU lowers processing power.

The Quadras raise the ante on Mac computer power to easily rival all those 486 computers you keep seeing in BYTE. The Quadras run roughly 30 percent to 50 percent faster than a Mac IIfx, but remember that we're measuring subsystems here. The floating-point performance is amazing: The Quadras are easily five times faster than the IIfx.

The combination of the 68040's high performance and built-in 24-bit video makes it a killer image engine and CAD workstation. If you need massive storage or have special multimedia needs, you should consider a Quadra 900, but the Quadras will also find use as process or database servers. The only fault I can find is that the Quadra 700's main memory tops out at 20 MB. With users regularly running the Mac IIfx with 32 MB of RAM, this seems low. The Classic II's performance hovers around that of the 68020-based Mac LC and Mac II.

All in all, Apple has done its homework, admitted its mistakes, and fixed things with this new breed of Macs. As I've pointed out in the machine descriptions, you can see where Apple reuses proven technologies like the Combo chip while still pushing the envelope with an enhanced sound chip. This saves development costs and helps shorten the design cycle, while keeping the competitive edge in its computers. If these Macs are any indication of what's in store for us, the future will be interesting indeed. ■

THE FACTS

PowerBook 100
PowerBook 140
PowerBook 170
Quadra 700
Quadra 900
Classic II

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Tom Thompson is a BYTE senior technical editor at large. He has a BSEE degree from Memphis State University. He can be reached on BIX as "tom_thompson."

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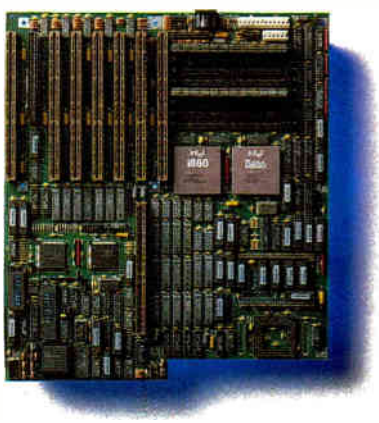

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Sweet Memory

FRED LANGA

New versions of QEMM, 386Max, and three other DOS memory managers give your applications more room than ever

By the time you read this, there will be at least five new DOS memory managers: four are upgrades (QEMM 6.0 from Quarterdeck, 386Max 6.0 from Qualitas, Memory Commander 2.11 from V Communications, and Netroom 2.01 from Helix Software), and one is brand new (QMaps from Quadtel). I've had a ball using these products, some in beta form, to see just how much memory I can make available on my work and home-office machines. The best case so far: over 792,000 bytes free at the basic DOS command line.

These new memory managers achieve their high numbers using a variety of sophisticated techniques, such as temporarily "borrowing" the EMS page frame to initialize large device drivers that otherwise would not load high; sniffing out unused addresses within your system ROM chips and using this memory as high RAM; remapping ROM addresses to provide large contiguous blocks of high RAM; and even completely "hiding" ROM code so DOS can use essentially the entire high-RAM space. It would take an entire separate article to cover the innovations in these products.

Guinea Pigs

To see how these new managers stack up, I used several machines, including a networked Swan 386/25 and a stand-alone Gateway 486/33 as guinea pigs (see the table). The Swan used an AMI BIOS, a clone VGA card, and a Micom-Interlan Ethernet adapter. Each memory manager had to work around the Swan's ROM chips and try to fit NetWare's corpulent resident software—IPX and NET5—into high memory.

The Gateway system used a Phoenix BIOS and had an unusual video card that required a device driver to run even in standard VGA mode. Because most memory managers are quite aggressive in remapping video addresses, a slightly unusual video setup would help smoke out potential problems there.

Both machines ran DOS 5.0 loaded high (via HIMEM and EMM386). As a baseline, my initial setup used DOS 5.0's LOADHIGH and DEVICEHIGH to try to move drivers and TSR programs into upper memory. Then, starting each time with a clean configuration, I installed and ran each of the five memory managers as they came out of the box, generally accepting whatever defaults were built into each product and following whatever on-screen advice the installation programs suggested.

All the tested memory managers were able to beat DOS 5.0's performance in at least one area. But QEMM and 386Max, even in beta form, remain the clear champions. Both products have been around a long time, and it shows in the polished interfaces and ease with which the products handled even complex configurations and difficult AUTOEXEC files. Both are superlative products that I recommend without qualification.

QEMM and 386Max include powerful system information utilities. They are the only products I've seen that include new BIOS exercisers that test (rather than just view) your system's ROM chips to be certain of what code can be remapped or converted to high RAM.

Both of these products ran without a hitch on all the test systems. At the plain DOS prompt, 386Max moved ahead of QEMM by delivering 3 KB more of available memory. But QEMM could deliver up to 49 and 138 KB more of available memory under Windows and Desqview, respectively, than could 386Max. If the final releases turn in similar numbers, QEMM will be the clear winner—but it's too soon to say, and Qualitas is too good to count out.

continued

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CHKDSK MEMORY AVAILABLE

Even with exactly the same hardware, software, and CONFIG.SYS and AUTOEXEC.BAT files, different memory managers turn in surprisingly different performances. All numbers are in kilobytes.

	DOS 5.0[1]	QEMM 6.0 (beta)	386Max 6.0 (beta)	Memory Commander 2.11	QMaps (beta)	Netroom 2.01
Gateway 486/33						
@ DOS prompt	615	636	639	792[2]	631	638
Windows 3.0 DOS box	607	628	579	619	564	579
Desqview DOS window	479	606	468	467	461	469
Swan 386/25						
@ DOS prompt	574	636	638	N/A	619	626
Windows 3.0 DOS box	508	582	573	N/A	552	559
Desqview DOS window	438	540[3]	453[4]	N/A	452	459

Notes: Gateway 486/33: SETVER, VMODE, MOUSE, and files eligible for high loading; a total of 74 KB to initialize, 17 KB to run. Swan 386/25: SETVER, IPX, NET5, MOUSE, and files eligible for high loading; a total of 150 KB to initialize, 85 KB to run. DOS 5.0 was loaded high (DOS=HIGH in CONFIG.SYS) for all tests.
N/A = Would not work with Micom-Interlan Ethernet adapter.

[1] DOS 5.0 with EMM386.EXE and HIMEM.SYS.
[2] 792 KB is available for one-page text-mode programs. Conventional VGA graphics have 637 KB.
[3] Loading DOS low yields 567 KB of memory in Desqview windows.
[4] Could be expanded at the cost of excluding some areas of high memory.

Netroom

Netroom is a suite of products designed to manage memory on 386-based networked systems. Like QEMM and 386Max, Netroom provides a system-analysis utility and installed painlessly.

Netroom matched 386Max's performance almost byte for byte on the lightly loaded Gateway, but it fell somewhat behind on the more heavily loaded Swan. Part of the Swan's large load was a network card and drivers—the very thing that Netroom is designed to handle. Netroom also took an excruciating hour to auto-configure itself on a SCSI-drive-equipped machine, while the beta versions of QEMM and 386Max took only a few minutes.

QMaps

Quadtel is a longtime maker of clone BIOSes. Quadtel's QMaps exploits that insider's knowledge to deliver true high-performance memory management.

I ran several EMS-function timing tests on a beta version of QMaps and found that this is indeed the fastest memory manager of the lot, fully 70 percent faster than DOS 5.0's EMM386. What this means in terms of human productivity is unclear: I was unable to perceive any speed difference in running and loading applications. A final answer will have to wait until the BYTE Lab runs the applications benchmarks on a finished version of the product.

In delivering memory, the beta version of QMaps offered a mixed bag. On the heavily loaded Swan, it came in fourth out of five; on the Gateway, it offered good numbers only at the basic DOS prompt and was beaten by everything else—including DOS 5.0's EMM386 and HIMEM—in Windows and Desqview performance.

Like all betas, QMaps is a work still in progress. If the rest of QMaps can be honed as finely as its speed, the final product will definitely be worth a look.

Memory Commander

Memory Commander is a different animal. Rather than maximizing high RAM, Memory Commander tries to maximize low RAM—the DOS program area. V Communications explains it this way: "Memory Commander allows devices in high memory to 'float.' By 'pushing' devices such as video display memory, BIOS ROMs, and hard disk cards upwards as far as possible, Memory Commander makes more DOS main memory available."

And it works—up to a point. On the Gateway, Memory Commander delivered 792 KB at the DOS prompt; miles ahead of the competition. But that was for running CHKDSK, a simple utility that displays only one text page of information occupying about 4000 bytes. Other applications require different screen modes that consume more space. Memory Commander keeps a database of your software and automatically chooses (on the fly) which of five separate mapping arrangements to use when running each program. But don't expect miracles. VGA graphics programs get only about as much space as that provided by the other memory managers.

Alas, an unresolvable conflict with an Ethernet adapter caused Memory Commander to lock up the Swan. Even after a spectacular effort by V Communication's technical support—they did everything but crawl through the telephone lines to help—Memory Commander still choked. None of the other memory managers had networking problems.

Help for the RAM-Crammed

These early tests and the proven track records of both Quarterdeck and Qualitas indicate that the new QEMM and 386Max are great products in the making. They'll be well worth your attention. If their final performance remains about the same as that of the beta software, then 386Max may be slightly better for folks who live at the DOS prompt, with QEMM better for Windows and Desqview environments. QMaps may also be a serious contender, especially in speed-critical applications, once the rough edges are polished off.

Netroom and Memory Commander are not in beta form: I tested shipping copies of new releases of the software. Netroom's efficient memory use makes it an acceptable alternative to 386Max, despite a sometimes agonizingly long auto-configuration process. Memory Commander, when it works, works very well, and it offers the easiest route to lots of RAM for plain-text applications. However, you will want to check with your dealer first to make sure that Memory Commander has been tested and is known to work with your specific hardware. ■

Fred Langa is BYTE's editor in chief. You can reach him on BIX as "flanga."

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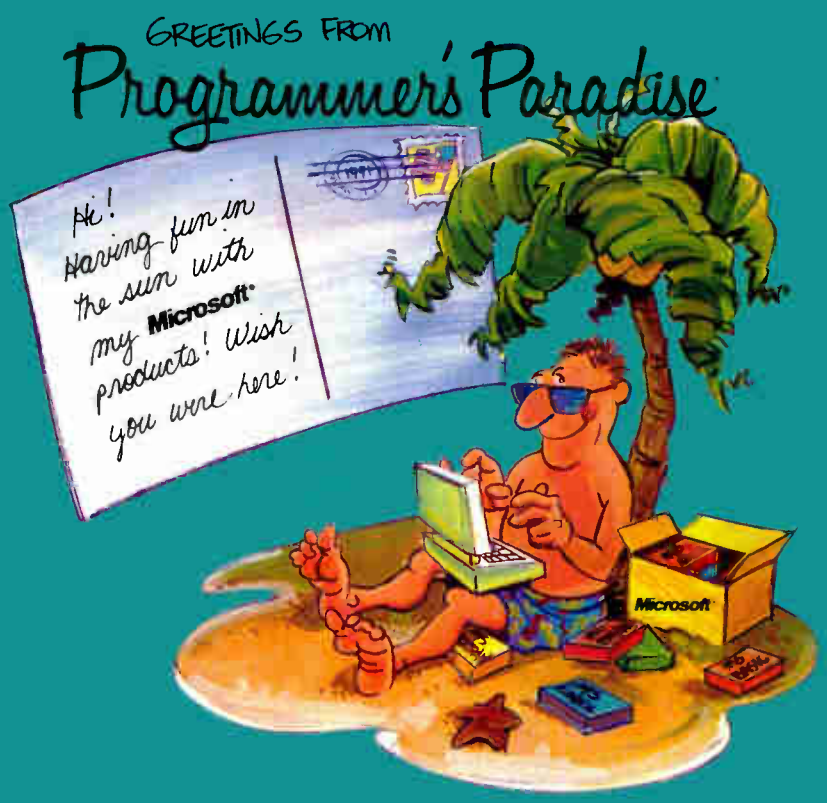

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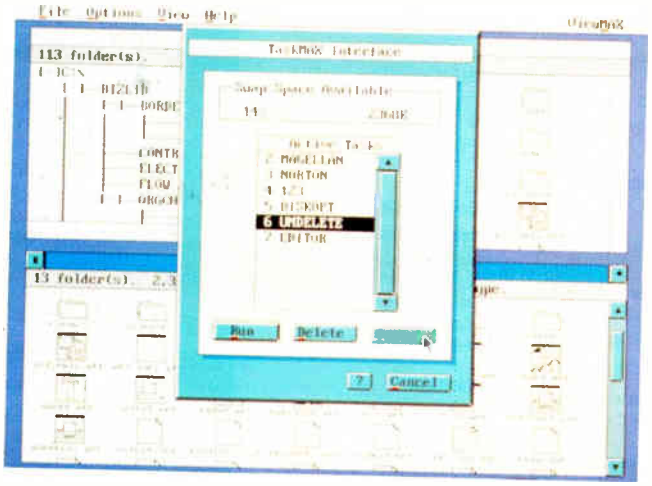
Digital Research Creates a Better DOS

When Microsoft came out with MS-DOS 5.0, it basically caught up with the features that had been in DR DOS 5.0 for over a year. Thus, Digital Research forged ahead. **DR DOS 6.0**, however, is not as sophisticated as some rumors have claimed. For example, there's no new high-performance filing system. But I did not find that surprising. Like MS-DOS, DR DOS had to keep compatibility foremost, and it has succeeded in spades.



What's new in DR DOS 6.0? The list is long. Most noticeable is an advanced version of MemoryMax that puts even more usable memory into the high-DOS area (between 640 KB and 1 MB) and into the upper memory blocks. Even with a pile of device drivers and TSR programs, I was easily able to keep 628 KB of main memory free (with a 386-based system). If you use MS-DOS 5.0, you need an add-on memory manager to get that much application space.

Compared to MS-DOS 5.0, DR DOS 6.0 is an absolute pleasure to install. Unlike MS-DOS, it's not just an upgrade to whatever operating system you have on your hard disk. DR DOS 6.0 is bootable, so you can install it on any system. The installation process gives you a wealth of choices (e.g., a quick default installation) and lets you fine-tune your choices.

Also new is DiskMax, a sophisticated disk-caching utility. (Actually, Digital Research has licensed Multisoft's well-respected Super PC-Kwik cache.) It is more than a small step forward from MS-DOS's SMARTDRV cache.

Another part of DiskMax is a file-compression utility. For this, the company licensed AddStor's SuperStor technology. Compression averages about 2-to-1. DR DOS 6.0's setup utility gives you the option of setting up special partitions for compressed files. I went all the way, changing my 105-MB hard drive into a 210-MB unit; DR DOS left a small non-compressed partition with the boot files. Of course, this on-the-fly, software-only compression does give a performance penalty, but the delay was far from objectionable on my 16-MHz 386SX-based system.

For me, TaskMax is the most notable new feature. Its task switcher goes far beyond MS-DOS 5.0's rudimentary round-robin switcher. Based on the multitasking technology that was perfected in DR Multiuser DOS, TaskMax lets you load up to 20 applications at once. You can run it from the command line or by using hot keys (MS-DOS's task switcher requires you to run the DOS shell). Even more prominent is TaskMax's ability to use extended or expanded memory, using *no* memory below 640 KB.

DR DOS 6.0 has many more features. Its sophisticated security system goes from requiring a password at boot-up to protecting files, subdirectories, and full partitions, and it can't be circumvented by booting from a floppy disk. Not new, but improved, is ViewMax. The latest incarnation of this venerable GEM GUI sports more Windows-like functionality and a three-dimensional look and feel. Finally, there's a full hypertext help system and FileLink, a LapLink-like file transfer utility.

Not new in DR DOS 6.0, but nonetheless one of its handiest features, is the ability to put a question mark at the beginning of lines in CONFIG.SYS and AUTOEXEC.BAT. At boot time, you're asked if you want to load that line, and you press *Y* or *N*. As I experiment with wide varieties of device drivers and TSRs, that feature has been a lifesaver on numerous occasions.

What about compatibility? I encountered no problems whatsoever. DR DOS 6.0 ran a wide variety of applications and utilities without choking.

DR DOS 6.0 is so feature-packed because of the very fact that Digital Research isn't Microsoft. It can pack features and utilities into its package without risking the accusation that it's driving other companies out of business. At $99, it's exactly the same price as Microsoft's MS-DOS 5.0 upgrade. But with MS-DOS, you'd have to spend hundreds of dollars more to get advanced memory management, sophisticated caching, file compression, and a file transfer utility.

In addition, DR DOS 6.0 comes with free lifetime support. (After 90 days, support for MS-DOS 5.0 costs $2 per minute.)

Overall, DR DOS 6.0 lets even beginners install and use sophisticated features without slogging through hundreds of pages of obtuse documentation. And since Digital Research was recently acquired by Novell, it's not surprising that connectivity features are built in. DR DOS 6.0 includes a NETX.COM NetWare requester and other connectivity files.

DR DOS 6.0 shows once again that if you are number two, you try harder. Under Novell's corporate wing, Digital Research has developed a large following in overseas markets and is now aggressively courting large corporate users. It's not difficult to see that DR DOS will become an integral part of Novell's network strategy. And that can only mean an even larger presence for what's obviously a superior DOS.

—Stan Miastkowski

THE FACTS

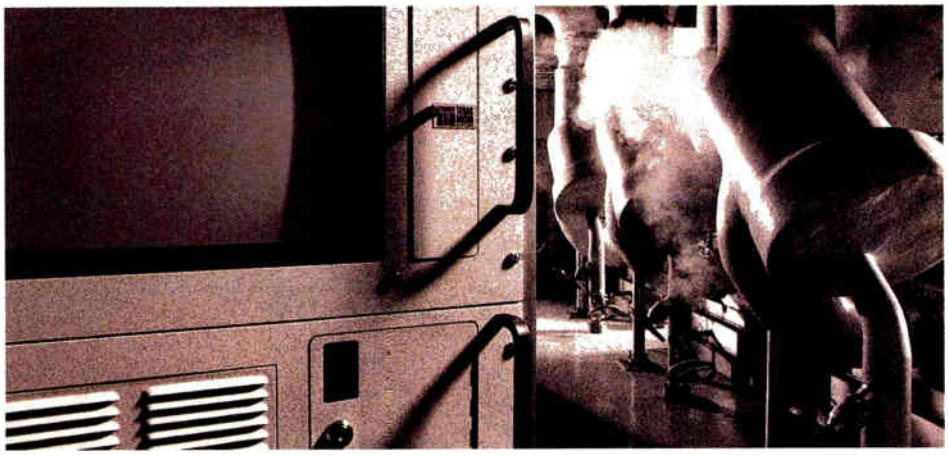
DR DOS 6.0
$99

System requirements:
Any IBM PC, AT, PS/2, or compatible.

Digital Research, Inc.
Box DRI, 70 Garden Court
Monterey, CA 93942
(800) 443-4200
(408) 649-3896
fax: (408) 646-6248
Circle 1166 on Inquiry Card.

World Radio History

If You Need A PC That Will Go Through Hell, Get One That's Been There.



IN A HARSH ENVIRONMENT, AN ORDINARY PC IS A DEAD PC. A lot of PCs do well to survive a desktop. But on the production floor or in the field, the dust, heat, vibration and traffic can finish an ordinary PC–and your operation–in a hurry. Even if your PC has to withstand hell, your business doesn't have to. As long as you're using ruggedized PCs from Texas Micro.

OUR PCS TAKE A BEATING FROM THE FORTUNE 100. In fact, 70 of them put Texas Micro PCs through the wringer every day, in everything from industrial applications to severe office environments.

And we don't spare our PCs, either. During factory tests, we shake, bake and beat them like there's no tomorrow. Because with an ordinary PC, there may be none.

OUR PCS ARE THE BEST BECAUSE THEY'RE BUILT FOR THE WORST. We design our Intel-based 286, 386™ and 486™ systems using rugged design techniques that give them up to three times the life expectancy of other PCs.

Our passive backplane, for example, gives you instant access to plug-in CPU cards and components, reducing Mean Time To Repair to under 10 minutes.

We shock-mount the drives within our nickel-plated, all-steel chassis to withstand vibration. We implement VLSI and PAL technology to increase component reliability. And we use positive airflow filtration to reduce contamination and system heat.

STRONG SUPPORT IS OUR STRONG SUIT. We provide toll-free technical assistance and a regional network of field application engineers. We also customize PCs to meet your particular specifications.

FIND OUT WHAT OUR PCS ARE REALLY MADE OF. Call us for complete product information and specifications. Or send in the attached card.

But don't delay. The pathway to hell is paved with good intentions.

TEXAS MICRO

intel inside

Ruggedized Rackmount
- 10 option slots, 3 drive bays
- Nickel-plated, steel chassis
- 100,000 hr. MTBF* power supply
- Complete front panel accessibility
- 14" VGA Multisync monitor

Ruggedized Workstation
- 9 option slots, 2 drive bays
- NEMA-4 compliant
- 100,000 hr. MTBF* power supply
- CRT/CPU in one unit
- VGA monitor

Ruggedized Benchtop
- 10 option slots, 2 drive bays
- Nickel-plated, steel chassis
- 100,000 hr. MTBF* power supply
- Extra small footprint

Ask A Few Tough Questions: 1-800-627-8700.

All trade names referenced are the service mark, trademark or registered trademark of the respective manufacturer. *Mean Time Between Failure.

Circle 268 on Inquiry Card.

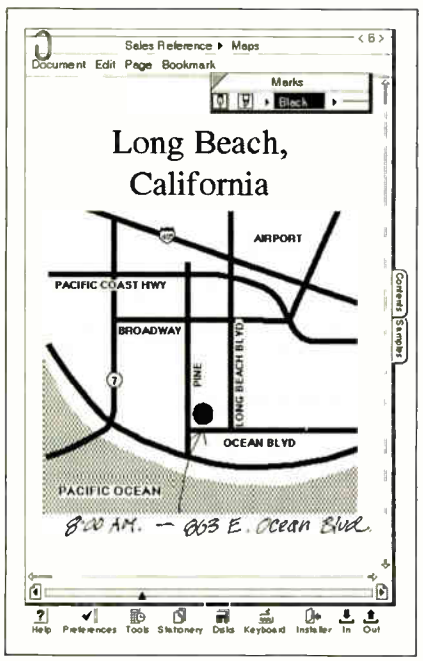
World Radio History

Publishing Electronic Documents

PenBook is an electronic document reading, publishing, and disseminating system that Slate hopes is as easy and convenient to use as paper. PenBook is split into two programs: PenAuthor and PenReader.

PenAuthor runs on IBM PC compatibles and the Mac. It takes any form of PostScript document, runs it through an Adobe PostScript interpreter, and reformats the output for display under either PenPoint or Windows for Pen Computing. During this process, it also dramatically compresses the file to the point where Slate claims that on average a file becomes 60 percent smaller than the original file before it was turned into PostScript.

For example, a Word file of about 40 KB might become about 120 KB when output to a PostScript file. PenAuthor would turn this into a PenBook file of about 16 KB. The resulting files look exactly as they would if they had been printed on a PostScript printer with the resolution of the computer screen. Once PenBook files are created, they can be transferred by disk, over a network, or by a direct cabled connection to a pen-based computer running Windows for Pen Computing or PenPoint, to be read using PenReader. PenAuthor also indexes the file to allow fast searching by PenReader.



PenReader is designed to let you read a PenBook file as easily on the computer as if it had been printed on paper. Besides being able to read the document as if you were reading a book, you can rapidly search for the occurrence of any word or word part, add labeled bookmarks, and annotate the book.

The interface to PenReader detracts as little as possible from the document. It has a menu bar that you can hide or turn off, a page-turning bar at the bottom of the screen to rapidly scroll through different pages of the document, and an optional set of scroll bars that you use for pages too big to fit on the screen. You can completely control the program by gesturing with the pen. For instance, to turn the page forward, draw a rapid horizontal line from right to left, as if grabbing the right edge of the page and turning it. To go back a page, reverse the direction.

Documents can be divided into sections, and to go forward or backward a whole section, flick twice, in the same way. To go to the start or end of the document, flick three times.

Overall, the interface is remarkably easy to use and does have the feel of a paper book. However, paper has a significant advantage: clarity. The resolution of even the best LCD is only about 72 dots per inch, making small text hard to read. PenBook, with its internal 300-dpi display, is ready for better screens, but it's held back by hardware limitations.

PenBook is a worthy attempt to bring true electronic documents to users of pen-based computers. Most of the benefits of the natural interface mean that this technique is limited to the users of such systems. As a result, Slate may be limited in the initial success of this product until pen-based computers significantly penetrate the market. Within that market, PenBook should be successful because it gives you serious reason to consider putting all your paper documents on your computer.

—Owen Linderholm

THE FACTS

PenAuthor
$695

System requirements:
An IBM compatible or a Mac with a hard drive.

PenReader
$95

System requirements:
A pen-based computer running PenPoint or Windows for Pen Computing.

Slate Corp.
15035 North 73rd St.
Scottsdale, AZ 85260
(602) 443-7322
fax: (602) 443-7325
Circle 1167 on Inquiry Card.

Ensemble 1.2 Goes Windows One Better

It's often been observed that Ensemble is what Windows 3.0 should have been. I have to agree. Unlike Windows, Ensemble doesn't just wrap itself around DOS as a sophisticated shell. It hooks itself deep into DOS, replacing much of that tired old operating system's antiquated abilities with cutting-edge technology, such as a true preemptive multitasking kernel.

With **Ensemble 1.2**, GeoWorks has brought the package even further into the future with a raft of new features. Admittedly, most of these features are much-needed omissions from version 1.0.

Even though Ensemble was never intended as a tool for workgroups, it's being used that way. So GeoWorks has added network support to version 1.2. It's all automatic. When I installed Ensemble 1.2 on my system, it automatically recognized all network drives on our in-house Novell network and added network drive icons. It's as simple as that, and much appreciated. Besides NetWare, Ensemble now supports PC-NFS, LAN Manager, and LANtastic.

Other changes aren't as earthshaking, but such additions as a spelling checker in the GeoWrite word processor and a PostScript printer driver (along with 300 more

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Stars cool. Volcanos fizzle. Even suns burn out. But the IBM RISC System/6000™ family of POWERstations and POWERservers only gets hotter. Today's performance ranges from 9 to 25 MFLOPS and from 33 to 72 SPECmarks. At prices that won't fry your budget.

	Hardware Price	MFLOPS	SPECmarks™
POWERserver 550	$62,000	25.2	72.2
SPARCserver™ 470	$77,800	3.8	19.4
DECsystem™ 5500	$74,700	4	21.5

An operating system that sizzles. The RISC System/6000 family operates on AIX,® IBM's enhanced open standards version of the UNIX® operating system. AIX runs across the broadest range of platforms in the industry, and supports all major industry standards and programming languages.

The RISC System/6000 family already runs over 3,500 applications in mechanical design, visualization, software engineering, accounting, retail store management and many more.

IBM support: an eternal flame. There's never been anything lukewarm about IBM's commitment to its customers. With the RISC System/6000, you get service 24 hours a day, 365 days a year, worldwide.

To find out more, contact your IBM marketing representative or Business Partner. For literature call 1 800 IBM-6676, ext. 845. Sorry, marshmallows not included.

For the Power Seeker.

MFLOPS are LINPACK double-precision where n=100. AIX XL FORTRAN Version 2.1 and AIX XL C Version 1.1 compilers were used for these tests. SPECmark is a geometric mean of the ten SPECmark tests. All prices current at publication.

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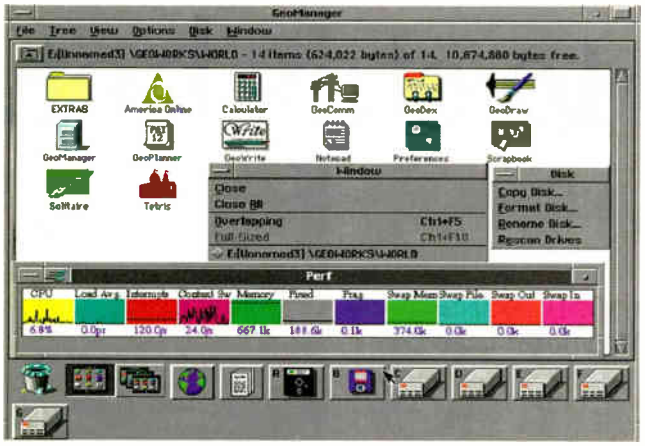

a screen-capture utility, and Perf—a set of performance gauges that dynamically display what's happening in the system. Also included are a couple of demonstrations that eat up CPU time. Nevertheless, the system just keeps zooming along. It's a heck of a display of Ensemble's multitasking capabilities.

Ensemble still suffers from a lack of third-party applications, and (at this writing) software development tools for the environment are still lacking. Taken as it stands, though, Ensemble 1.2 is a reasonably complete software system that will let you do 90 percent of your work. If you've been looking for a Windows alternative, look no further than Ensemble 1.2.

—Stan Miastkowski

THE FACTS

Ensemble 1.2
$199.99

System requirements:
Any IBM PC, AT, PS/2, or compatible.

GeoWorks, Inc.
2150 Shattuck Ave.
Berkeley, CA 94704
(415) 644-0883
fax: (415) 644-0928
Circle 1169 on Inquiry Card.

Tandy Notebook Packs Desktop Power

The mad scramble for PC makers to differentiate their products in what is essentially a commodity market is particularly crazy with regard to portables. Hundreds of machines are on the market, most with a bevy of analogous features. I'm confused. But one thing's for sure: The competition is driving down prices fast.

A case in point: the **Tandy 3810 HD**. This is a *loaded* system at a too-good-to-pass-up price. This $3299 package has more power than most desktop PCs and will not quickly become obsolete. The 3810 HD is based on a 20-MHz 386SX processor. It has the standard complement of ports, a 3½-inch 1.44-MB floppy drive, and 1 MB of RAM (expandable to 5 MB). But what really sets the 3810 HD apart is the standard 60-MB fast (19-millisecond) hard drive. With this size drive, I could take all my large graphics applications and data with me on a trip and have plenty of room to spare.

As you would expect, a high-end machine like the 3810 HD also comes with high-end graphics. A full-size fluorescent backlit VGA display is standard, and the rear panel has a VGA-out port. I had no difficulty reading the display under a variety of conditions, including the bright lighting of a fully illuminated TV studio. There's one minor annoyance with the screen: The antiglare coating isn't quite matte enough for my taste. If there are lights behind you, you must do some adjusting to be comfortable.

The 3810 HD has the usual power management features that we've come to expect in notebooks, with standby and resume modes and screen and hard drive power-down options. It runs for the usual 3 hours on a charge and recharges in about 2 hours.

There's internal space for a modem, and Tandy offers two: a 2400-bps model ($199.95) and a 2400-/9600-bps modem/fax combination ($249.95). Add-in memory, however, is pricey ($249.95 per megabyte). And you must use Tandy's proprietary low-profile SIMMs.

You can't ignore Tandy. At this writing, the 3810 HD was the lowest-priced notebook in its class. And best of all, support is as close as the nearest Radio Shack store. In Peterborough, that's walking distance from BYTE headquarters. ■

—Stan Miastkowski

THE FACTS

Tandy 3810 HD
$3299

Radio Shack
700 One Tandy Center
Fort Worth, TX 76102
(817) 390-3921
Circle 1168 on Inquiry Card.

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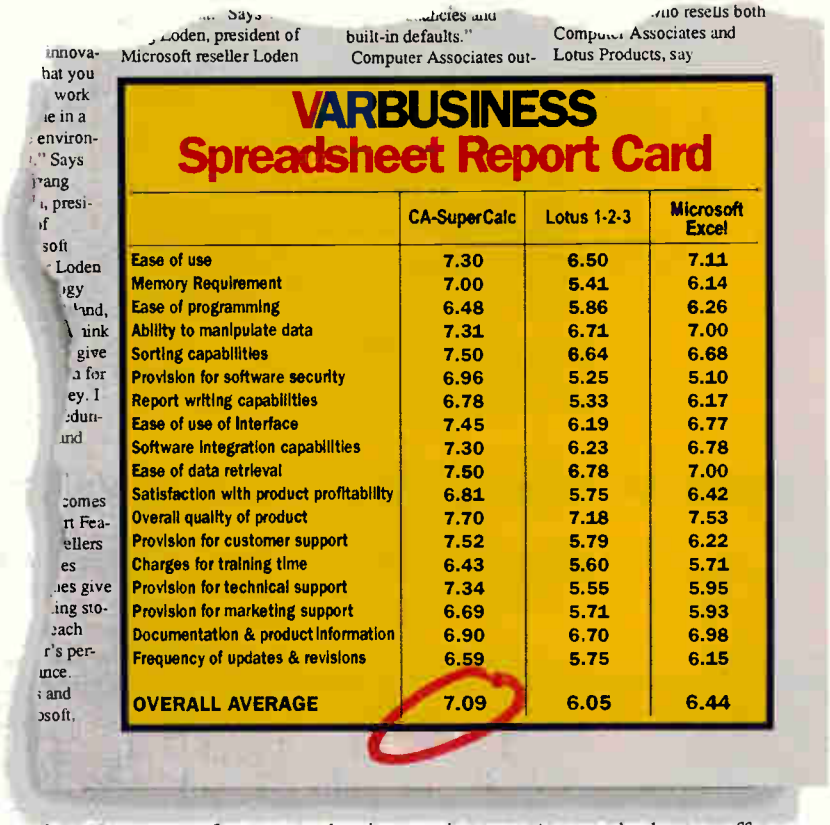
The Pros Rate CA-SuperCalc Higher Than Lotus 1-2-3 And Microsoft Excel.



VARBUSINESS Spreadsheet Report Card

	CA-SuperCalc	Lotus 1-2-3	Microsoft Excel
Ease of use	7.30	6.50	7.11
Memory Requirement	7.00	5.41	6.14
Ease of programming	6.48	5.86	6.26
Ability to manipulate data	7.31	6.71	7.00
Sorting capabilities	7.50	6.64	6.68
Provision for software security	6.96	5.25	5.10
Report writing capabilities	6.78	5.33	6.17
Ease of use of interface	7.45	6.19	6.77
Software integration capabilities	7.30	6.23	6.78
Ease of data retrieval	7.50	6.78	7.00
Satisfaction with product profitability	6.81	5.75	6.42
Overall quality of product	7.70	7.18	7.53
Provision for customer support	7.52	5.79	6.22
Charges for training time	6.43	5.60	5.71
Provision for technical support	7.34	5.55	5.95
Provision for marketing support	6.69	5.71	5.93
Documentation & product information	6.90	6.70	6.98
Frequency of updates & revisions	6.59	5.75	6.15
OVERALL AVERAGE	7.09	6.05	6.44

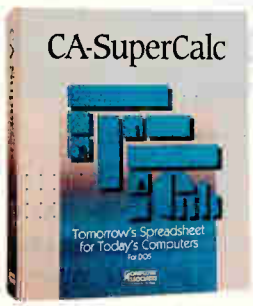
Recently, *VARBUSINESS* conducted a survey of some people who know more about spreadsheets than anyone.

The people who sell, install, and support them for a living. The survey asked hundreds of spreadsheet dealers and resellers all kinds of questions to find out what the pros rate as the best spreadsheet. And the pros told them.

CA-SuperCalc.®

In virtually every category from ease-of-use to technical support, CA-SuperCalc was rated higher than Lotus® 1-2-3® and Microsoft® Excel.

We're not surprised. While Lotus and Microsoft have been fussing over their many different spreadsheet versions, we've been stuffing one spreadsheet, CA-SuperCalc, with everything you would ever want. From spreadsheet linking to 3-D graphics and beautiful, presentation-quality output, CA-SuperCalc has it all.



And it runs on just about any PC.

But the best part is the price. At $149.00, CA-SuperCalc costs less than half the price of Lotus 1-2-3 and Excel. Heard enough? Call 1-800-645-3003 today for the name of the nearest dealer where you can buy the best spreadsheet there is.

If you're willing to spend a couple hundred dollars less.

CA90s
CA's Computing Architecture For The 90s.

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Software superior by design.

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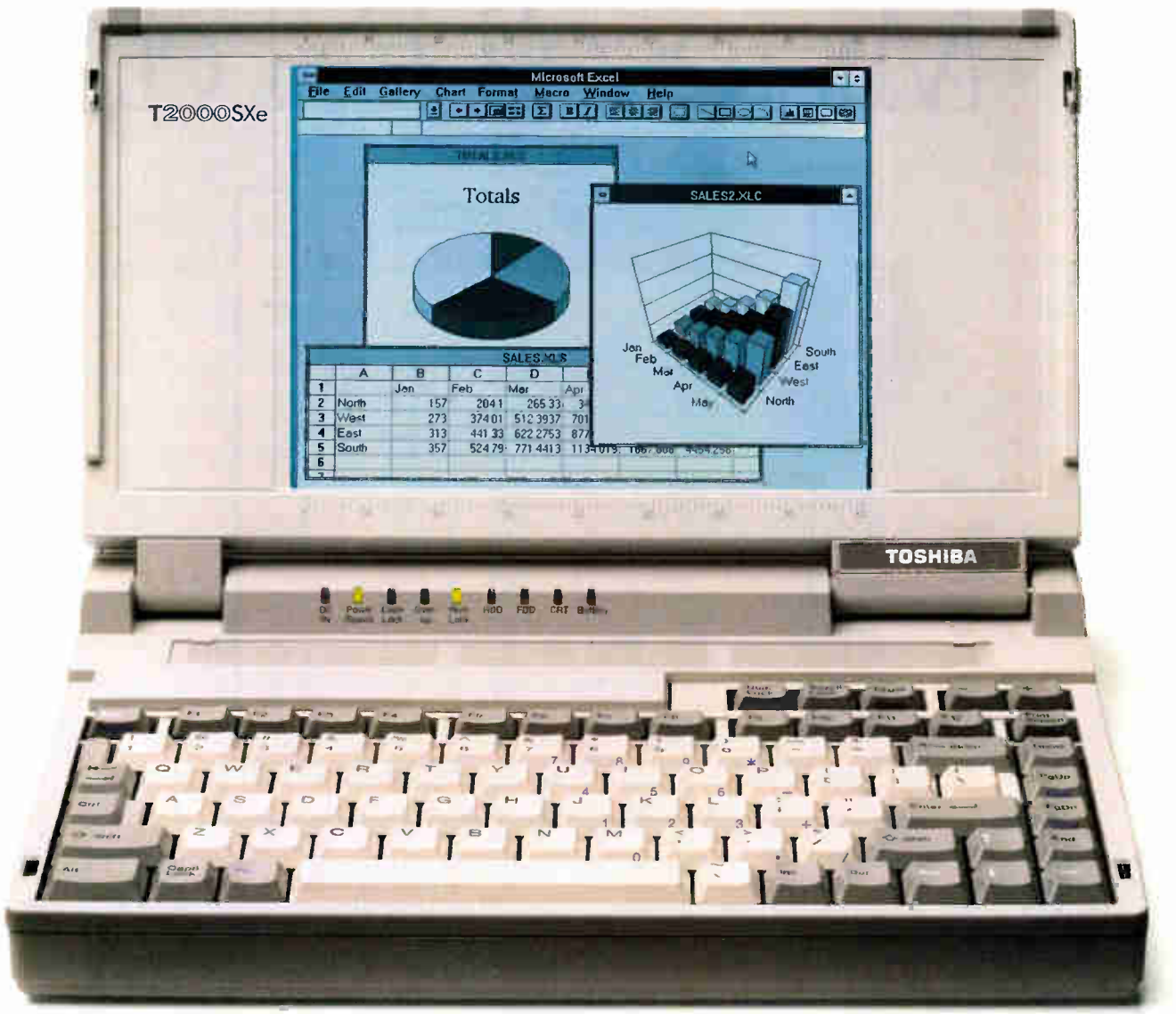
THE MOST USE
TO COME ALONG



A few months ago we brought you the world's most useful computer—the Toshiba T2000SX.

That computer symbolized what we call "the next generation in personal computing." A computer that not only allows you the freedom to work where, when, and how you want to. But is so precisely engineered—from its superior keyboard to its easy-to-read VGA screen—that you'll actually enjoy using it.

Well, thanks to the incredible speed of modern technology, here we are once again.

This time to present the new Toshiba T2000SXe.

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FUL COMPUTER SINCE FEBRUARY.

THE E STANDS FOR EXTRA POWER.

Like the T2000SX, the T2000SXe weighs a minuscule 6.9 pounds, it boasts a 386SX processor, and it supplies up to 60 MB of hard disk storage space. But, and here's the news, the T2000SXe gives you a bigger dose of speed (20MHz) and more memory (2-10 MB RAM).

Of course, the T2000SXe also offers Hypertext, a VGA screen, full modem capabilities (including available cellular and fax accessories), full-size sculpted keys on its keyboard and a host of additional benefits that make other notebooks look more like memo pads.

After testing eight of the top notebook computers on the market, Byte Magazine said, "Buy the Toshiba T2000SX." Wait'll they try the T2000SXe.

A LONGER LASTING BATTERY.

The most useful computer isn't of much use if its battery doesn't last long.

That's why the T2000SXe, like the T2000SX, is armed with a Nickel Hydride battery. Nickel Hydride is proven to deliver 22% more power per ounce than the NiCad batteries found in other portable computers. In fact, according to Byte magazine, the battery on Toshiba's T2000SX lasted well over three hours on a 90-minute charge. Outlasting every other notebook they tested and lasting twice as long as some.

To get even greater battery life, the T2000SXe offers Toshiba's highly acclaimed AutoResume. A special feature that allows you to shut your computer down and start up precisely where you left off. Without the hassle of rebooting, restarting applications and reloading files.

NOW THERE ARE EVEN MORE CHOICES.

At Toshiba, we've always believed that no one computer is right for everyone. That's why we've also added a more affordable notebook to our line called the T2000. Featuring a 12MHz, 286 processor, it's designed for people who don't need all the power of the T2000SX or the T2000SXe.

If you'd like to learn more about the world's most useful notebook and portable computers, please call us at **1-800-457-7777.**

Well, that's the latest. Three incredible notebooks that fit your needs, your briefcase and now your budget.

Isn't technology wonderful?

In Touch with Tomorrow

TOSHIBA

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Multiple Reasons for a 486 EISA

The first of AvTech's Series 350 486 EISA tower systems, the 25-/33-MHz Model 353 is designed for the multitasking and multiuser environments of Unix and LANs. The machine has seven 32-bit EISA slots—six available—and two dedicated proprietary memory/CPU expansion slots.

The Model 353 has a 213-MB hard drive and easy CPU expandability via its modular plug-in board. System memory can be increased from 4 MB to 128 MB in 4-MB increments.
Price: $5499.
Contact: AvTech Development, Inc., 1001 South Placentia Ave., Fullerton, CA 92631, (714) 773-5880; fax (714) 773-5881.
Circle 1287 on Inquiry Card.

The Model 353 is the first in AvTech's series of 486 computers.

A 486SX EISA for Business

The BusinessStation 486ASX features an integrated DMA-Intelligent Drive Electronics controller, integrated video with up to 1024- by 768-pixel resolution, 256 colors, and 512 KB of video RAM. You can upgrade the 20-MHz machine by adding a 25-MHz CPU to the system board. Options include a hard drive and support for networks.
Price: $1995.
Contact: Advanced Logic Research, Inc., 9401 Jeronimo, Irvine, CA 92718, (714) 581-6770; fax (714) 581-9240.
Circle 1290 on Inquiry Card.

Work in a Windows Box

The WorkBox SX/40, a plug-and-play 386SX system with a 40-MB hard drive, has a Super VGA graphics adapter with 800- by 600-pixel resolution. With DOS 4.01 and Windows 3.0 preconfigured on the hard drive, the WorkBox opens in Windows.

Additional features are support for a 387SX math coprocessor, 1 MB of RAM (expandable to 16 MB on the motherboard), and a dual-button mouse. The WorkBox has two serial ports, a parallel port, six available expansion slots, and a 150-W power supply.
Price: $999.
Contact: Cumulus Corp., 23500 Mercantile Rd., Cleveland, OH 44122, (216) 464-2211; fax (216) 464-2483.
Circle 1288 on Inquiry Card.

The WorkBox SX/40 goes directly to Windows 3.0.

The Keyboard's Key to This Computer

Computers in keyboards, the KeyComp 386SX models run at 16, 20, or 25 MHz and have 1 MB of DRAM on a SIMM (expandable to 8 MB). Onboard interfaces include one parallel and two serial ports, a floppy drive control port that supports two floppy drives, and a hard drive control port. Included is an internal 3½-inch floppy drive as well as room for a 120-MB hard drive.
Price: Without a video card or hard drive, $615.
Contact: Texas Microcomputers, Inc., 850 East Arapaho Rd., Suite 220, Richardson, TX 75081, (214) 437-0400; fax (214) 437-3546.
Circle 1289 on Inquiry Card.

Two 486 ISA Computers

The motherboard in the 486/33 ISA WinStation supports 128 KB of external and 8 KB of internal cache memory and has 4 MB of RAM, expandable to 32 MB. The unit has a 125-MB hard drive and a VGA monitor.
Price: $2995.
Contact: Austin Computer Systems, 10300 Metric Blvd., Austin, TX 78758, (800) 752-1577 or (512) 339-7932; fax (512) 454-1357.
Circle 1291 on Inquiry Card.

Strobe Computer's 33-MHz 486 ISA computer has 256 KB of cache, 4 MB of RAM, expandable to 32 MB, and a 142-MB hard drive. It has a 1-MB Super VGA card and a monitor.
Price: $2475.
Contact: Strobe Computer, 15480 Arrow Hwy., Suite 201, Baldwin Park, CA 91706, (800) 888-5095 or (818) 962-0060; fax (818) 813-1483.
Circle 1292 on Inquiry Card.

World Radio History

The Mac Gets a LaserJet IIISi

Able to print at 300 dpi and 17 pages per minute, Hewlett-Packard's LaserJet IIISi printer for the Macintosh includes PostScript and HP's Resolution Enhancement technology. The printer comes with an AppleTalk interface, 5 MB of printer memory, 35 internal Adobe typefaces, and Adobe Type Manager.

The HP LaserJet IIISi for the Macintosh has two 500-sheet letter-size paper trays you can access through software. A RISC-based formatter scales type and produces mixed text and graphics. The printer's memory accepts data for one page while it processes another page and is expandable up to 17 MB via three SIMM slots.

Price: $6995.
Contact: Hewlett-Packard Company Inquiries, 19310 Pruneridge Ave., Cupertino, CA 95014, (800) 752-0900.
Circle 1293 on Inquiry Card.

DrawingBoard II Goes Serial to the Mac

The Macintosh Edition of DrawingBoard II has a Macintosh serial port connection in addition to the original Apple Desktop Bus port, letting you choose your connection. Another new feature is a pressure-sensitive pen, which lets you control the thickness and density of your lines simply by the amount of pressure you exert when using it. The pen comes cordless or with a cord. The board has a resolution of 1000 lines per inch and an accuracy of ± 0.010 inch.

Price: $495 to $3145.
Contact: CalComp, Inc., Digitizer Products Group, 14555 North 82nd St., Scottsdale, AZ 85260, (800) 458-5888 or (602) 948-6540; fax (602) 948-5508.
Circle 1294 on Inquiry Card.

Hewlett-Packard's LaserJet IIISi for the Macintosh.

A Fast CD-ROM for the Mac

The Access CD/Allegro CD-ROM drive for the Macintosh features a 310-ms access time and an average data transfer rate of 153 KBps. The formatted capacity of the drive is 599 MB in Mode 1 and 683 MB in Mode 2.

In addition to supporting AppleShare, System 7.0, and TOPS, the Allegro has dual 50-pin SCSI connectors, a push-button SCSI ID switch, and a SCSI-2 connection. Its headphone and RCA jacks provide audio output.

Price: $799.
Contact: Optical Access International, 800 West Cummings Park, Suite 2050, Woburn, MA 01801, (800) 433-5133 or (617) 937-3910; fax (617) 937-3950.
Circle 1295 on Inquiry Card.

Expresso Scans Slides for One

Expresso, a personal, stand-alone slide scanner that works with PCs and Macs, outputs images as standard NTSC video and can be hooked directly to a TV monitor or VCR. You can capture images on your computer using frame grabber boards such as RasterOps Colorboards or the Truevision board.

Expresso has an invert switch that outputs color negatives as positive images. The unit's ×3 zoom lens enlarges details of a slide or negative.

Price: $999.
Contact: RasterOps Corp., 2500 Walsh Ave., Santa Clara, CA 95051, (408) 562-4200; fax (408) 562-4065.
Circle 1296 on Inquiry Card.

Expresso scans slides neatly right on your desk.

Room on a Fast Drive

With 2.4 gigabytes of unformatted capacity, the Model 1924 5¼-inch hard drive has a spindle motor speed of 5400 rpm. The SCSI-2 controller supports 10-MBps data transfer rates.

Price: $7995.
Contact: Micropolis Corp., 21211 Nordhoff St., Chatsworth, CA 91311, (818) 709-3300; fax (818) 709-3497.
Circle 1297 on Inquiry Card.

Simplicity Is a Portable Drive

The 2-pound Simplicity Portable Drive has 40-, 80-, or 120-MB capacity. The drive attaches to your PC's parallel port without requiring a card.

Price: $499 to $899.
Contact: Simplicity Computing, Inc., 415 Madison Ave., New York, NY 10017, (800) 275-6525; fax (212) 678-6143.
Circle 1298 on Inquiry Card.

World Radio History

Multimedia on Your Desktop

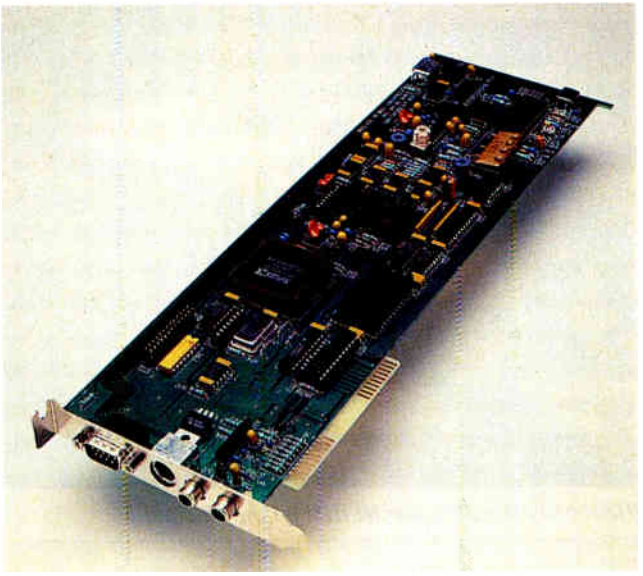
The VGA Broadcaster board adds multimedia to your computer by letting you record on a VCR, display on a TV, or project with a video projector what you see on your screen. You attach the VGA Broadcaster to your present VGA card's feature connector.

Configured as a complete system, the board comes with software for digital sizing and positioning of video output. You underscan the computer screen image, letting the full image be viewed on a standard video monitor. Features include NTSC/RS-170 video and S-video output, RGB/Sync RS-170 with key signal, and Sync input for genlock.

Price: $695; optional Video Mixer, $695.

Contact: IEV Corp., 3030 South Main St., Salt Lake City, UT 84115, (800) 438-6161 or (801) 466-9093; fax (801) 466-5921.

Circle 1299 on Inquiry Card.



The VGA Broadcaster adds multimedia to your VGA board.

Add Ports to Your PC

Four parallel ports for printer and scanner applications are yours with the Quad LPT card. Compatible with ISA, EISA, and AT computers, the Quad LPT eliminates the need for external expansion boxes. You can configure the ports as standard AT ports or general-purpose I/O ports.

Price: $295.

Contact: Computer Modules, Inc., 2348C Walsh Ave., Santa Clara, CA 95051, (408) 496-1881; fax (408) 496-1886.

Circle 1300 on Inquiry Card.

Smart and Modular CPU Cards

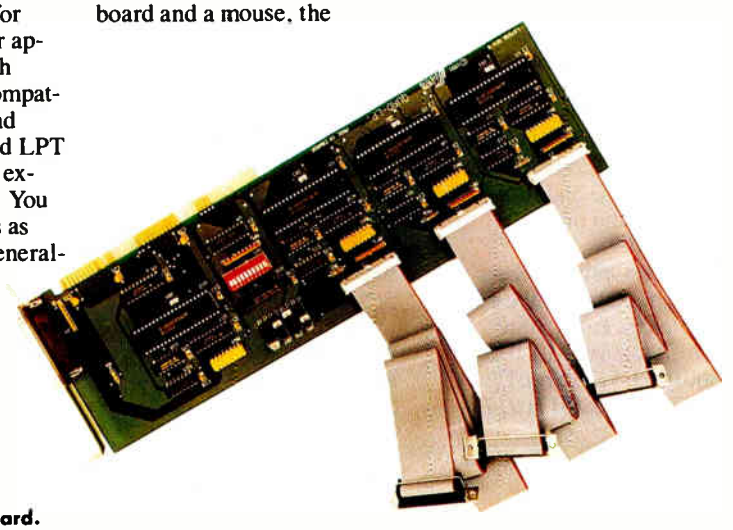
Modular Smart Sim CPU cards fit into a custom eight-slot passive backplane. The boards include a 386SX processor, AT I/O, 2 to 16 MB of RAM, and a power supply.

With controllers for a floppy drive and an Intelligent Drive Electronics hard drive, as well as for a keyboard and a mouse, the miniature cards support an external monitor or LCD via an 800- by 600-pixel VGA chip and provide one serial and two parallel ports. Five slots are open on the backplane. The full configuration is 5 9/10 by 1 7/10 by 2 inches.

Price: $1096.

Contact: Dover Electronics, 1108 Boston Ave., Longmont, CO 80501, (800) 848-1198 or (303) 772-5933; fax (303) 776-1883.

Circle 1301 on Inquiry Card.



The Quad LPT card gives you four additional parallel ports.

Upgrade Your 286 to a 386SX

The Cumulus 386SX Card with Windows 3.0 upgrades your 286 machine with its 16-MHz Intel 386SX processor. The 1½- by 1½-inch card also supports a 387SX math coprocessor. The card plugs into the 286 processor socket.

Price: $299.

Contact: Cumulus Corp., 23500 Mercantile Rd., Cleveland, OH 44122, (216) 464-2211; fax (216) 464-2483.

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Ultra Features on an Ultra Controller

The Ultra 22F EISA-compatible ESDI controller provides 32-bit bus-master support and has 64 KB of intelligent read-ahead buffer memory. The board's menu-driven BIOS lets you boot from DOS without external drivers.

Under DOS 5.0, the BIOS supports four drives without additional software. Drivers that support EISA 32-bit bus-master transfers to other operating systems ship with the board.

Able to co-reside with other hard drive controllers, the Ultra 22F is compatible with 16-bit ISA and 32-bit EISA operations and supports drives as large as 2 gigabytes.

Price: $595.

Contact: UltraStor Corp., 15 Hammond St., Suite 310, Irvine, CA 92718, (714) 581-4100; fax (714) 581-0826.

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World Radio History

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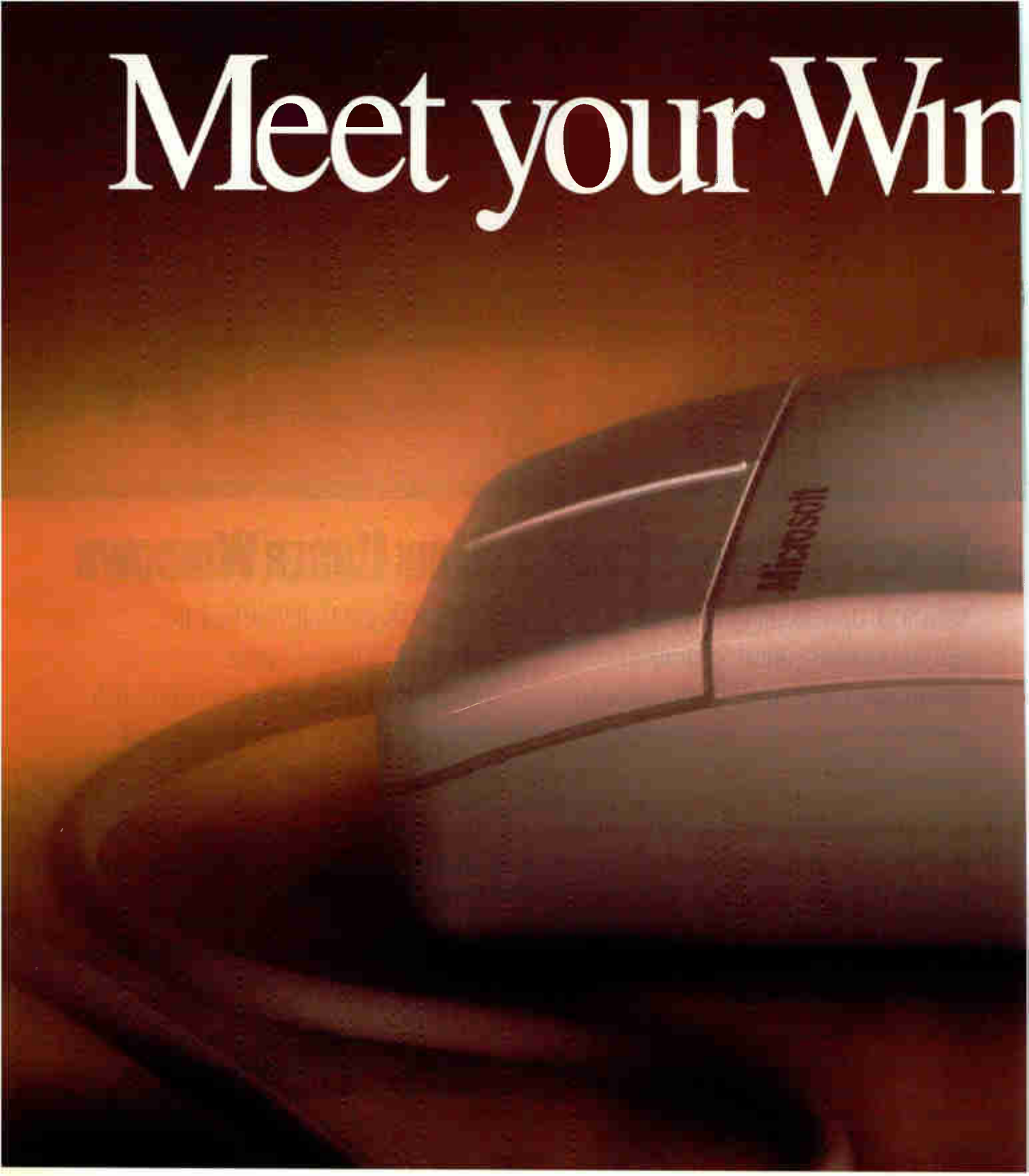

As you've probably heard by now, there are quite a lot of things to see and do in the Windows™ environment. And the Microsoft® Mouse is the perfect way for you to take in all the sights.

Its sleek, award-winning shape was designed to fit your hand perfectly. So you'll find it's easy to maneuver and incredibly comfortable to use.

Maybe that's why over 3 million

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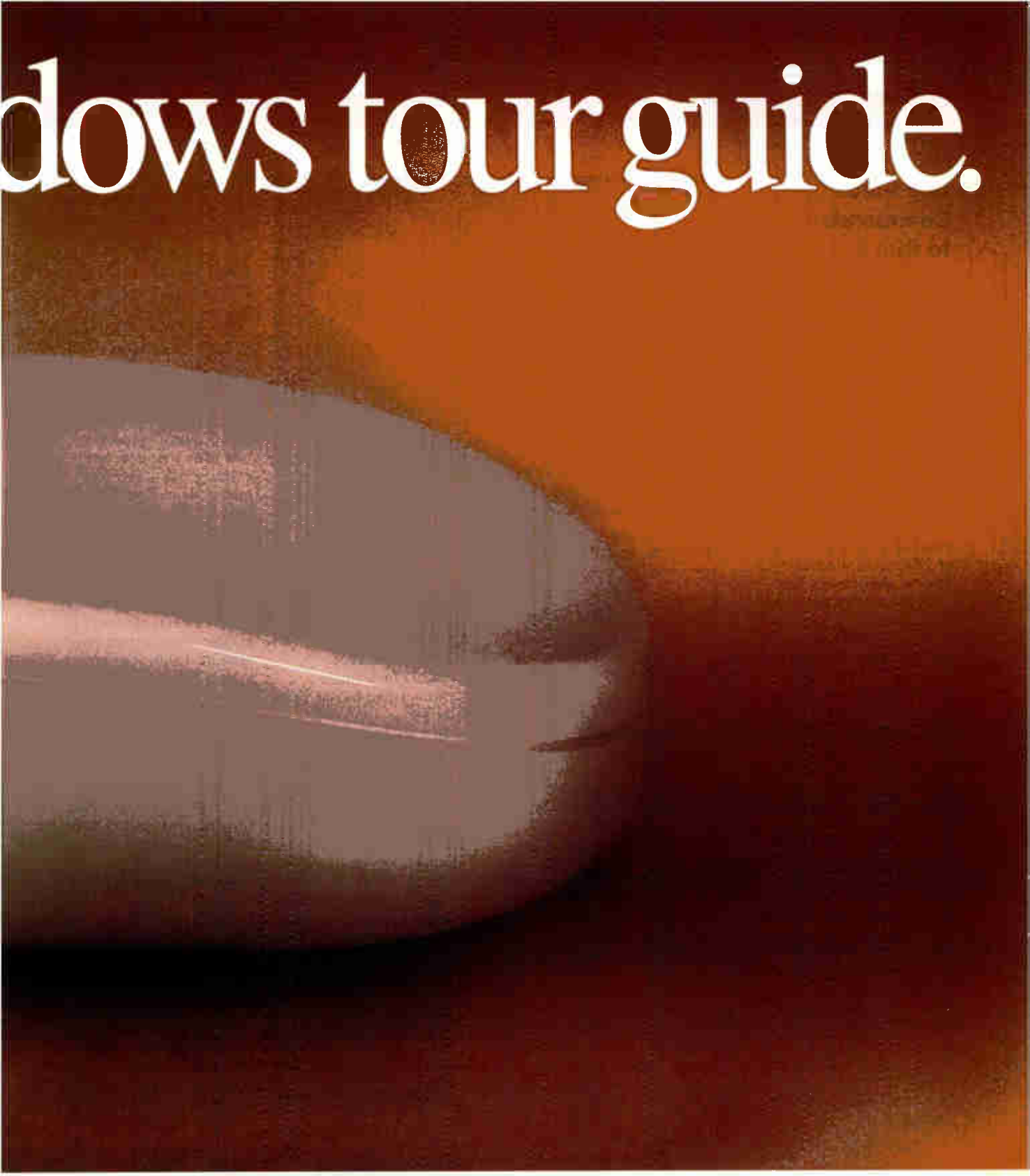


people have chosen the Microsoft Mouse as their personal Windows computing guide.

So if you'd like more information on the industry-leading Microsoft Mouse, just call (800) 541-1261, Department V52.

Or head on over to your nearest dealer. They'd be more than happy to arrange a tour just for you.

Microsoft

Canada, call (416) 568-3503. Microsoft and the Microsoft logo are registered trademarks and Windows is a trademark of Microsoft Corporation. The Microsoft Mouse is patented (No. 302,426).

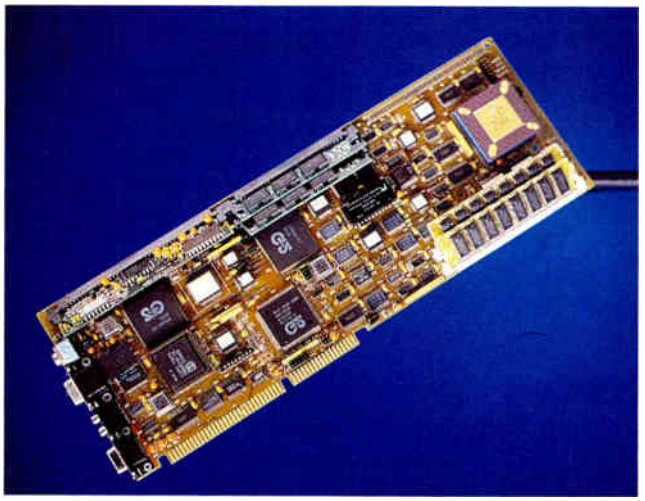
World Radio History

Use Voice Commands to Run Your PC

Speech Secretary, jointly produced by Verbex Voice Systems and Applications Express, is a hardware/software combination that lets you use vocal input to operate data-processing applications. You can use the product on your PC to run applications varying in sophistication from letter dictation to mathematical equation development.

Speech Secretary is available with a 300-, 830-, or 2200-word vocabulary. The vocabularies include common words and a phonetic library. You choose words by spelling them out or using abbreviations or macros. The software includes HandiWord, a memory-resident program that uses statistically weighted predictions to choose words for you. HandiWord understands regional accents and comes in foreign language versions.

The Verbex speech-recognition hardware is available as an add-in card or standalone unit. Both configurations include noise-reduction microphones.
Price: $4835 to $7000, depending on vocabulary and configuration.
Contact: Applications Express, 179 Avenue at the Common, Shrewsbury, NJ 07702, (908) 389-3366; fax (908) 542-6762.
Circle 1305 on Inquiry Card.



Speech Secretary lets you use normal speech to run desktop publishing, graphics, word processing, and other applications.

Security Options for Multiple Platforms

Three vendors offer different solutions to your data security problems.

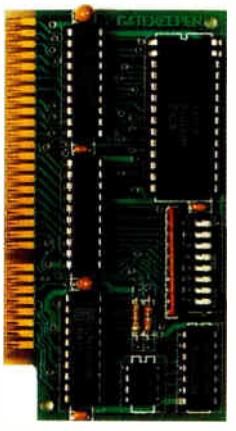
SunSoft lets network managers create their own security systems for Unix networks. Account Resource Manager (ARM) and Automated Security Enhancement Tool (ASET) run on Unix software platforms that comply with SPARC Compliance Definition 1.0.

ARM lets you specify parameters for functions such as length of password and number of log-in attempts. You can further individualize your security system by using ARM to enforce limits on certain areas or systems within the network. Other features include password aging, user account expiration, and access hour restriction.

ASET lets you adjust the level of security on the network. The software maintains the network at your indicated level of security and reports unresolvable problems, such as a user account that lacks a password.

ARM and ASET are available as a package.
Price: $295 for a single-machine version; $4500 for a site license.
Contact: SunSoft, 2550 Garcia Ave., Mountain View, CA 94043, (415) 336-0678.
Circle 1306 on Inquiry Card.

The GateKeeper is a simple, low-cost security option for PC users. The card installs in one slot and activates at power-up to prevent unauthorized boot-up. The GateKeeper activates before the operating system loads and becomes invisible when you enter one of 15 passwords. The 2- by 3¾-inch 8-bit card works with IBM PC systems and compatibles.



Price: $49.95.
Contact: JDR Microdevices, 2233 Branham Lane, San Jose, CA 95124, (408) 559-1200; fax (408) 559-0250.
Circle 1307 on Inquiry Card.

The DataCryptor protects your data by encrypting it as it is transmitted via modem. The product uses the U.S. Government's DES encryption algorithm and a numeric key, which you select to scramble information. Once you transmit your data, it can be decrypted only by another DataCryptor programmed with your numeric key. The encryption process is transparent to the user. You can use the DataCryptor between any two serial devices.
Price: $695.
Contact: Triton Systems, Inc., 109 Scenic Dr., Pass Christian, MS 39571, (800) 367-7191 or (601) 452-3925; fax (601) 452-2007.
Circle 1308 on Inquiry Card.

Stop Shocking Your System

Now you can dissipate harmful static buildup with the touch of a finger. The Touch It static mat sits under your keyboard or system and directs static through a grounding cord rather than into your CPU. The mats are putty-colored and come in four sizes.
Price: $16.95 to $29.95, depending on size.
Contact: Computer Cover-up, Inc., 2230 South Calumet, Chicago, IL 60616, (800) 282-2541 or (312) 326-3000; fax (312) 326-3032.
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Carry-1 booksize desktop PCs can be at hand wherever you work, whenever you work. Small, yet powerful, they are completely compatible with all DOS and Windows applications. Now our 5000 series adds more versatility with two 16-bit expansion slots. But the essence of the Carry is **to be handy.** It's still small enough to tote to the corner of the desk where the work is waiting.

Get the whole story. For the name of your nearest dealer, call 408-727-7373.

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ow your Carry can have a 386 processor, a modem-and-fax card, and still have one extra 16-bit slot for expansion. Ready? Give us a call.

World Radio History

World Radio History

Used to be, when your hard disk got full you had to empty your wallet and buy a bigger one.

Or, you could buy yourself some time by deleting a bunch of your files.

At Stac,® we didn't think this was much of a choice. So we invented Stacker.™

In the process, we created an instant bestseller. Which isn't surprising, considering that Stacker instantly gives you twice the disk capacity you had before.

Now, aren't you glad you didn't rush out and buy a new hard disk?

How?

By compressing all the files on your disk–applications, utilities, documents, spreadsheets, data, everything–using our patented Stacker LZS data compression technology.

Don't know a thing about data compression?

Don't worry. You don't have to.

In fact, you don't have to think about Stacker at all.

Stacker works behind the scenes, expanding your data when you need it and compressing it again as it goes back to disk.

Automatically.

It doesn't even matter what kind of software you use. Because Stacker is 100% compatible with everything from business and graphics programs to undelete utilities and low-level formatters.

Not to mention the latest versions of DOS® and Windows.®

If you think doubling your disk capacity will slow you down, think again.

As data is stored on your disk, Stacker instantly compresses it. Then, when your PC reads the data, Stacker instantly expands it. You don't have to do a thing.

You see, Stacker is fast. So fast, in fact, that it actually improves the performance of many of your applications.

Stacker is also 100% safe–something no other data compression product on the market can say.

Which explains why every leading utility software publisher and tape drive manufacturer uses our technology in their own products.

Speaking of software publishing and hardware manufacturing, we do both.

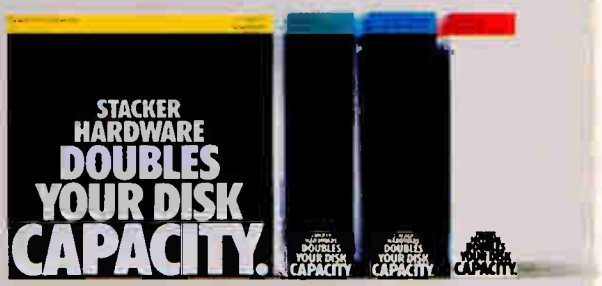
Which means we give you a choice.

If your PC can't spare a slot, or if your PC is a portable, a laptop or a notebook, the software on the opposite page is just what you need.

But if you're one of those who insist on smaller driver size and the highest possible speed and compression ratio, you'll want to install one of our three hardware versions.

Installation, by the way, is a snap. Just plug the board into any slot–no jumpers or switches to set.

The software practically installs itself. It even optimizes your disk for you.



In addition to the software-only version, Stacker is now available in three co-processor-with-software versions: Stacker XT/8, Stacker AT/16 and Stacker MC/16, each featuring the unique Stacker LZS chip.

To find just how much Stacker can do for your disk, your data and your wallet, call 1-800-225-1128 Ext. 298. Or ask your dealer for a demonstration.

And see how well we Stac up.

STAC

The Data Compression Company

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World Radio History

Smart Faxing for the Mac

Fully System 7.0 compatible, the Smart One MacFax gives you Class II faxing on the Mac. The 9600-bps fax/2400-bps data modem has an on-board 16-bit microcontroller for full background operation. It automatically detects and routes incoming fax and data calls and lets you send a fax from within any Mac application. Additional features include unlimited-capacity multiple phone books, time-scheduled transmissions, and file merge.
Price: $299.
Contact: Best Data Products, Inc., 9304 Deering Ave., Chatsworth, CA 91311, (818) 773-9600; fax (818) 773-9619.
Circle 1310 on Inquiry Card.

Terminal Emulation and Remote Access

Blast Professional lets you emulate minicomputer or mainframe terminals, remotely control another computer, and access E-mail or a printer from a remote PC. LAN systems it works with include NetWare, EtherTerm, TokenTerm, StarLAN, NetBIOS, and Net/One. The software gives you full screen and keyboard remote control and automatically translates MDA, CGA, EGA, VGA, MCGA, and Hercules text and graphics. Video scaling gives fast and accurate terminal emulation.
Price: $295.
Contact: Communications Research Group, USRobotics, Inc., 8100 North McCormick Blvd., Skokie, IL 60076, (800) 242-5278.
Circle 1311 on Inquiry Card.

The Smart One MacFax is System 7.0 compatible.

Mac Multimedia

Voice Impact Pro, a sound recording and editing product, provides all Macintosh owners with the advanced sound capabilities included in the Mac LC and IIsi, according to Articulate Systems. An externally clocked, asynchronous serial device, Voice Impact Pro has a built-in digital signal processor, a unidirectional microphone, and on-board digital compression.

Interrupt-driven with a RAM buffer, Voice Impact Pro lets you record while your Mac continues to operate in other programs. Shipping with the product is Voice Record software, which lets you cut and paste, copy, and adjust the volume of a sound without rerecording the entire sound. You can import and export sound files from one document or application to another from within any Mac application that supports sound input. You can also record sound from an external audio source.
Price: $299.
Contact: Articulate Systems, 600 West Cummings Park, Suite 4500, Woburn, MA 01801, (617) 935-5656; fax (617) 935-0490.
Circle 1312 on Inquiry Card.

Three-in-One Cards for the Mac

Each of the three cards in Asanté's family of three-in-one networking cards for the Mac gives you connectivity to thick, thin, and 10Base-T Ethernet. Each card is designed to support the upcoming fiber-optic and wireless standards.

The cards are the MacCon3 for NuBus, which works with Mac II computers, except for the IIsi; the MacCon3 for SE; and the MacCon3 for IIsi, which works with the Mac IIsi and SE/30.

The MacCon3 cards automatically sense the type of cable to which they are connected and configure themselves accordingly without your having to reconfigure the software or use jumpers or switches. Network operating systems supported include TOPS, AppleShare, NetWare, 3+Open, TCP/IP, and DECnet.
Price: $379.
Contact: Asanté Technologies, Inc., 404 Tasman Dr., Sunnyvale, CA 94089, (408) 752-8388; fax (408) 734-4864.
Circle 1313 on Inquiry Card.

OS/2 Gets Network Navigator

Network Navigator OS/2 consists of two integrated components for software and data distribution. Dispatcher for OS/2, an LU 6.2–based store-and-forward platform, uses a queued file transfer approach. Autopilot for OS/2 completes the distribution and collection by automating the remote installation of software and data updates.

The Dispatcher has Presentation Manager (PM) and command-line interfaces. It is CUA/SAA compliant and allows multiple concurrent interactions and sessions.

The Autopilot automates remote installation of software and data updates by extending OS/2 and Rexx command files with utilities. It operates in the background to find and execute the newly received Autopilot instruction files. Its point-and-select PM interface to PKZip compresses and consolidates files into a single package.
Price: $375 per PC.
Contact: Annatek Systems, Inc., 1655 Walnut St., Suite 200, Boulder, CO 80302, (303) 444-6675.
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World Radio History

Manage Your Network with Insight

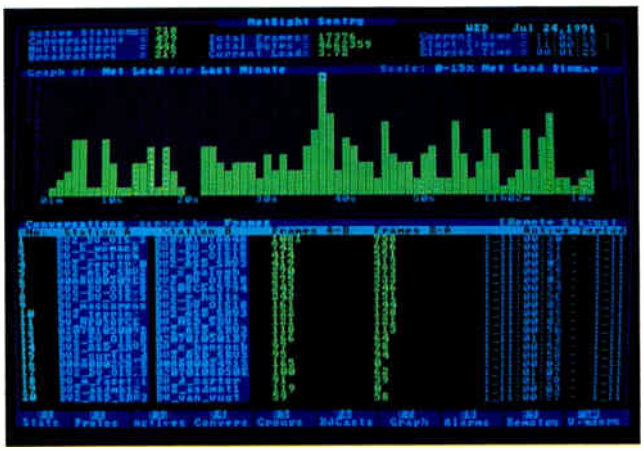
Four new network management tools help isolate and solve LAN problems quickly, Intel says. The products are NetSight Sentry, an Ethernet and Token Ring network monitor; NetSight Analyst, a portable protocol analyzer; NetSight Professional, a network monitor and protocol analyzer with real-time data collection and diagnostics; and LANSight Support, an enhanced version of LANSight 2.0, a Windows-compatible utility for managing your network.
Price: NetSight Sentry, $1995 and $2995; NetSight Analyst, $995; NetSight Professional, $7995 and $8995; LANSight Support, $395.
Contact: Intel Corp., 3065 Bowers Ave., Santa Clara, CA 95052, (800) 538-3373 or (503) 629-7354.
Circle 1315 on Inquiry Card.

SuperStations for Neural Networks

The SuperStation/PC and the SuperStation/SPARC neural network workstations are designed to make applications development faster and generate high-precision networks. The SuperStations include NeuralWare's NeuralWorks Professional II/Plus network development software.

Based on a 33-MHz 486 chip, the SuperStation/PC includes a 40-MHz Alacron 860 board with integrated software that lets you compile on the fly, 16 MB of RAM, and an AT channel interface. The system has 8 MB of RAM, 256 KB of cache memory, a SCSI controller, six EISA slots (three available), two serial ports, and one parallel port. The SuperStation/PC comes with a 16-inch NEC MultiSync 4-D video monitor, a 256-color Super VGA video board, a 3½-inch floppy drive, and a 200-MB SCSI drive with 512 KB of cache memory.

The SuperStation/SPARC combines a Sparcstation with a 40-MHz Sky Station; like the SuperStation/PC, it lets you compile on the fly. The SuperStation/SPARC features 32 MB of RAM, SCSI and Ethernet connections, two serial ports, and an S-bus. Also included are a 16-inch Trinitron monitor, a 256-color Super VGA video board, a 3½-inch floppy drive, and a 414-MB internal hard drive.
Price: SuperStation/PC, $29,995; SuperStation/SPARC, $55,995.
Contact: NeuralWare, Inc., Penn Center West, Building IV, Suite 227, Pittsburgh, PA 15276, (412) 787-8222; fax (412) 787-8220.
Circle 1316 on Inquiry Card.



The NetSight Sentry, an Intel network management tool.

Large-Screen Video and Ethernet

The Ethernet Display System combines Ethernet and large-screen video on a single card that has two built-in transceivers. For the Mac LC and SE/30, the system supports twisted-pair and thin Ethernet. Ready to use right from the box, the system gives network users instant access to shared information. The card supports Mobius's one- and two-page displays and Apple and compatible full-page monitors.
Price: One-page display, $1095; two-page display, $1295; video/Ethernet card alone, $595.
Contact: Mobius Technologies, Inc., 5835 Doyle St., Suite 111, Emeryville, CA 94608, (800) 669-0556 or (415) 654-0556; fax (415) 654-2834.
Circle 1317 on Inquiry Card.

Ethernet Transceiver Gives You 10Base-T

A 10Base-T twisted-pair Ethernet transceiver, the Model 177 lets you upgrade your LAN coaxial Ethernet adapters and wiring networks to 10Base-T. You attach the Model 177 directly to Ethernet equipment such as a PC adapter, bridge, or repeater that supports an AUI interface. You can also attach it via an Ethernet transceiver cable.

Four LEDs indicate link, collision, receive, and transmit status. The transceiver gets its power from the AUI port and uses an RJ-45 connector for the 10Base-T port.
Price: $119.
Contact: Telebyte Technology, Inc., 270 East Pulaski Rd., Greenlawn, NY 11740, (800) 835-3298 or (516) 423-3232; fax (516) 385-8184.
Circle 1318 on Inquiry Card.

Entrust Your Memory to a Bank

A 2.7-gigabyte disk storage/5-gigabyte tape backup subsystem, Memorybank II for Mac networks is compact enough to fit on your desk. The System 7.0–compatible unit features two hard drives, a 13.5-ms seek time, and a SCSI connection with transfer rates of up to 10 MBps. The tape backup system has a maximum transfer rate of 500 KBps.
Price: $9900 and up.
Contact: Memorybank, Inc., 2223 Packard Rd., Suite 12, Ann Arbor, MI 48104, (800) 562-7593 or (313) 761-2782; fax (313) 761-3263.
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Ventura announces the most colorful news in PC publishing history.

PANTONE® 3015 C

PANTONE 123 C PANTONE® 151 C

New Ventura color extensions: process color from the desktop to film.

Now get the impact and excitement of color with a single-vendor solution. Ventura brings you the complete spectrum of color prepress software. To scan, retouch, color correct, and color separate—all using the easy and intuitive Windows interface.

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Ventura Scan.™ Scan black and white, grayscale or full-color images directly into Ventura Publisher® 4.0 for Windows. Color correct before you scan. Get professional quality using a range of popular reflective, slide or transparency scanners.

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Full-page desktop separations.

Ventura Separator.™ Create professional color separations of Ventura Publisher documents with text, graphics, and continuous tone color images in place, ready to print. For quality color without the complexity or cost of traditional separation processes.

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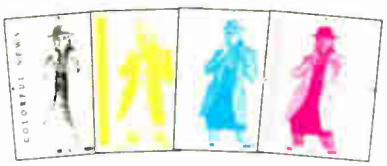
Ventura PhotoTouch.™ Professional retouching for grayscale or color. With real-time color correction, image-editing, and masking for images of any size or resolution. Plus special effects and creative tools to alter and enhance your image until it's picture perfect.



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Ventura Software Inc.
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World Radio History

Wrong.

"you need look no further than *FoxPro*, Version 1.02.
This $795 database from Fox Software has succeeded *dBASE* as the industry leader in innovation, power, and speed—a winning combination."

–PC Magazine 5/28/91

Write.

Don't get us wrong –we love the quote. And FoxPro 1.02 really was that good.

But we've just released FoxPro 2.0. And it's more innovative, more powerful, and far, far faster.

You'll have to write (or call) for details, but here are some of the highlights:

In tests against IBM's DB2 on a mainframe, FoxPro on a PC was 4 times faster querying a million-record, 200 megabyte database.

PC MAGAZINE EDITORS' CHOICE

And against other PC database management systems like dBASE and Paradox, it's devastating, thanks to our patent-pending Rushmore™ query optimization techniques.

The DBMS that acts like a Mac and runs like a mainframe. In DOS.

On top of its state-of-the-database-art performance, FoxPro 2.0 with its CUA-like interface gives you the ease-of-use of a Graphic User Interface (GUI) on your character-based DOS PCs.

You use pulldown menus to open multiple windows you scroll through, reposition and resize using keyboard shortcuts or a mouse.

Our Fourth Generation Language (4GL) tools make screens, menus, reports and labels a snap. Create your own custom data entry and viewing screens just by picking-and-clicking to position data, buttons, check boxes and scrolling lists

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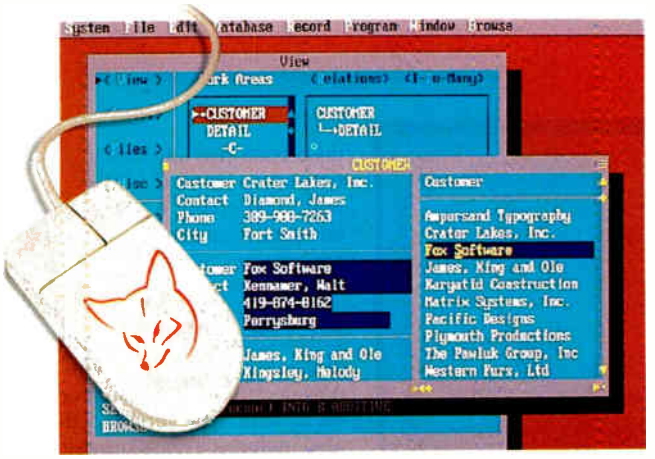


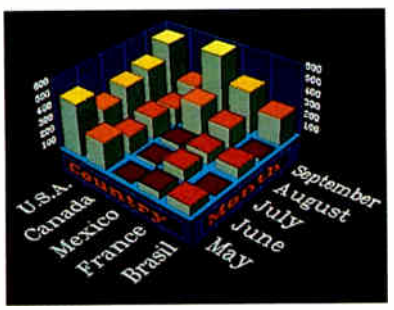
anywhere you want them. Then assemble everything into your own custom applications without writing a single line of programming code.

But that's only the tip of the iceberg.

Our new demand paging memory management works with the memory you have now while speeding up your single-user and networked applications.

Our new compound indexes are as small as a quarter the size of those in competitive products and far, far faster.

Our new Relational Query-By-Example (RQBE) is a simple, interactive interface to the information you need. Unlike other query systems, RQBE lets you browse the answer table, or create an instant database, report, labels or a business graph (with our optional FoxGraph or other graphic program).



Behind its friendly exterior, RQBE creates an efficient SQL SELECT statement you can add seamlessly to any of your applications. And do the same with our new SQL INSERT and CREATE TABLE commands, too.

We've added over a hundred new and enhanced commands and functions, including one-to-many-to-many relations, new array handling, and a BROWSE FOR command that could be the basis for an entire application itself.

We've added a new project manager that keeps track of all the needed files and any changes then automatically builds your applications (and EXE files with our optional Distribution Kit). And an API (Application Program Interface) that lets you dynamically link to libraries written in C or assembler (Library Construction Kit optional) using a single FoxPro command.

LAN TIMES NETWORKING EXCELLENCE 1990

And we've made FoxPro networking even better than when NSTL said:"...multiuser databases fall into two general performance categories: FoxPro/LAN and all the others." *

The new strategic standard for all your database management needs.

FoxPro 2.0 is language-compatible with — and improves the performance of — dBASE III+/IV and earlier Fox applications, so you don't have to relearn, retrain and rewrite. And you don't have to change the way you manage your business.

It's ideal for single-user and networked applications. For order entry, accounting, and sales management. For decision-support and mission-critical systems. And for managing all the other information you deal with every day.

And for your needs tomorrow, our high-performance, highly-compatible Mac, Windows and Unix versions are in development now, so you can get a headstart on your cross-platform applications with FoxPro 2.0 for DOS. And you'll be ready for the Fox client/server solution, planned for 1992.

Call for our free demo disk.

FoxPro 2.0 runs on a 512K XT yet in extended mode (included) uses every bit of power in a 386 or 486. For a free copy of our fully-featured demo, write (or call) Fox Software, 134 W. South Boundary, Perrysburg, OH 43551.

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(Ask for Offer BYT-1001)

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The complete power trip.™

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NEWS

Mission-Critical GUIs for Windows, OS/2

Choreographer 2.0, the GUI development environment for creating mission-critical applications in OS/2, now supports Windows 3.0, letting you move applications between the platforms by recompiling. The GUI development tool provides connectivity to new or existing C or COBOL programs.

With Choreographer 2.0, end users and analysts can develop an application's look while programmers develop its behavior. For cooperative processing, the program's 3270/EHLLAPI (Extended High-Level Language Application Programming Interface) capability lets you replace the mainframe interface without changing the underlying application.

Price: $7500.

Contact: Guidance Technologies, Inc., 800 Vinial St., Pittsburgh, PA 15212, (412) 231-1300; fax (412) 231-2076.

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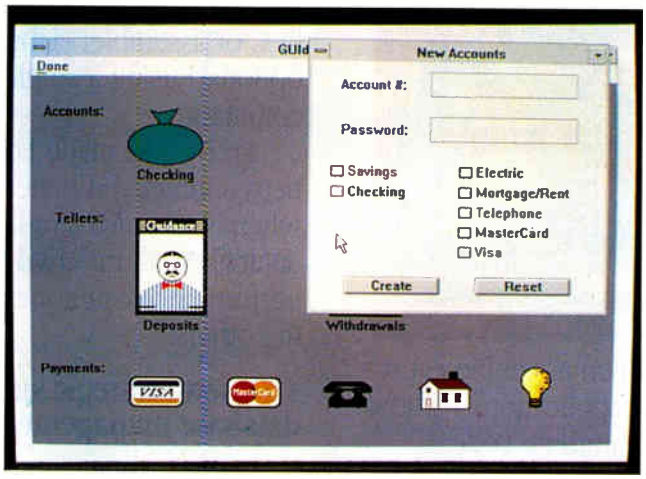

Developers have used Choreographer to create cooperative processing systems for factory-floor management, travel reservation, and bank teller systems on OS/2. Choreographer 2.0 supports Windows 3.0; a version is planned for Motif.

Saber-C for Unix: The Sequel

Saber-C 3.1 now supports embedded Structured Query Language preprocessors by Oracle and Informix, and other standard SQL databases. The programming environment for Unix can load FORTRAN code and supports Hewlett-Packard's SoftBench platform on the HP 9000 Series 300 and 400.

If you're developing a database application, preprocessor support lets you take advantage of Saber-C and work directly with your original C source code even if it contains embedded, non-C statements, the company reports. Once you run applications through a preprocessor, Saber-C gives you source-level debugging and graphical browsers.

Other new features include support for dynamic shared libraries on the Sun platform.

Price: $2995.

Contact: Saber Software, Inc., 10 Fawcett St., Cambridge, MA 02138, (617) 498-3000; fax (617) 868-6655.

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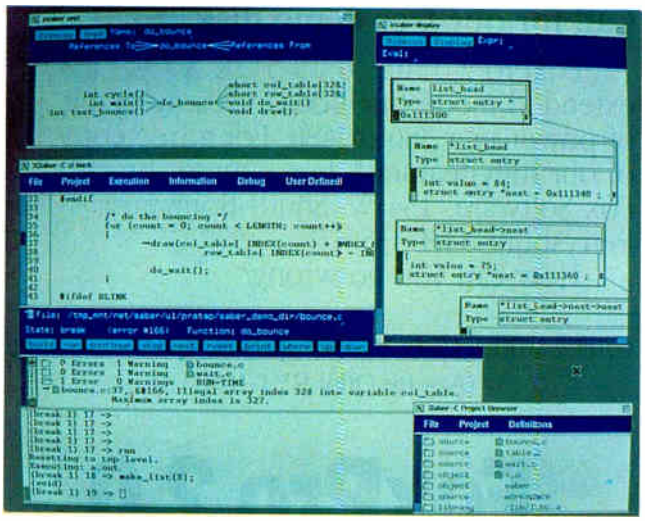

The large screen at lower left is Saber-C's main window, which contains a source panel, message panel, and interactive workspace. Other browsers are also shown.

A New Way of Thinking in C and Pascal

Think C 5.0, a major upgrade to Symantec's development environment for the Mac, has a rewritten compiler and code generator for generating compact, efficient code. A global optimizer lets you further reduce code size and execution time. Think C is also now 100 percent ANSI compatible, letting you port applications to other platforms, Symantec says.

Enhancements to the Think Class Library include dialog boxes, multiple-window documents, and support for System 7.0. Version 5.0 also includes a class browser. The integrated source-level C debugger saves breakpoints and data displays across sessions.

Symantec says that Think Pascal 4.0's new Instant Project lets you create a project with a single command.

Both environments run under System 7.0 in 24- and 32-bit modes.

Price: Think C, $299; Think Pascal, $249.

Contact: Symantec Corp., 10201 Torre Ave., Cupertino, CA 95014, (800) 441-7234 or (408) 253-9600; fax (408) 253-4092.

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32-bit Power for DOS and Windows

The C 8.5/386 Optimizing Compiler and Tools lets you develop and debug 32-bit applications for DOS and Windows. Along with the C compiler, Watcom has also released the 32-bit FORTRAN 77/386 Optimizing Compiler and Tools.

The C 8.5/386 compiler includes DOS/4GW, a 32-bit DOS extender developed by Rational Systems and based on its DOS/16M product.

Price: $795 each.

Contact: Watcom, 415 Phillip St., Waterloo, Ontario, Canada N2L 3X2, (800) 265-4555 or (519) 886-3700; fax (519) 747-4971.

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DOS, Windows & UNIX!

Diving Into C++ Without Raima Object Manager Can Be Pretty Ugly

Raima Object Manager is designed to enhance the elegance of your C++ development. The functionality required to store objects is built into the base classes. Development time is decreased. Quality is increased. Plus, your applications gain the performance edge Raima products are known for.

Raima Object Manager is based on the latest object-oriented technology and db_VISTA III's proven database engine. You can add persistence to objects and maintain complex inter-relationships using direct reference, relational, and network database models.

Inheritance is incorporated into Raima Object Manager, yielding greater code re-use and object extensibility. Now you have the tool to more closely model *real world* objects.

All Raima database products are designed for C and C++ programmers, providing a smooth transition from C to C++. Available on MS-DOS, Windows, UNIX, OS/2 and others.

Raima Object Manager prices start at just $395.00. For more information on turning the ugly into elegant, call

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(1-800-327-2462) Outside U.S.: 206-747-5570

Raima products offer unique advantages for C and C++ development:

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- **Portability** - runs on all the most popular environments.
- **Royalty-Free** - increases profits, decreases overhead.
- **Source Code Availability** - provides total programming flexibility and control.

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Discover Your Database with IDIS

An information discovery system for PC applications and Structured Query Language databases combines automated data analysis, graphics, statistics, induction, and hypermedia to analyze your data without requiring you to formulate and test hypotheses. IDIS, the Information Discovery System, automatically formulates questions, executes them, and collects the data.

IDIS can uncover interesting, and unexpected, rules and graphs that characterize the database. You can focus IDIS's analysis on a specific task or let the program analyze data on its own, according to IntelligenceWare.

On the PC, IDIS can read files in dBase DBF, Lotus DIF and WKS, and ASCII formats. IDIS supports databases such as Sybase, Oracle, Gupta SQLBase, DB2, and the Teradata Database Machine. A version is planned for Sun/Unix platforms.

Price: $995; for SQL systems, $10,000 and up.
Contact: IntelligenceWare, Inc., 5933 West Century Blvd., Los Angeles, CA 90045, (213) 216-6177; fax (213) 417-8897.
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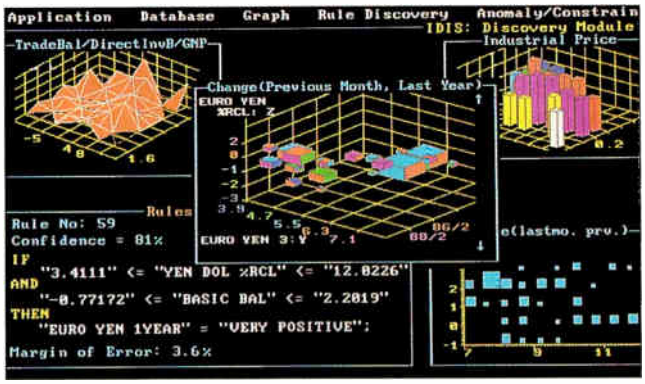

IDIS, the Information Discovery System, analyzes your database and lets you graph discovered patterns and rules in a number of 2-D and 3-D charts and graphs.

New Minitab More True to the Mac

Like several other statistical programs for the Mac originally developed for DOS or mainframe platforms, early versions of the Minitab Statistical Software package didn't have a true Mac interface. But with the release of Minitab 8.0 for the Mac, you no longer have to remember Minitab commands and their syntax.

Minitab 8.0's true Mac interface lets you use menus and dialog boxes to find the statistical method you need and properly execute it.

Price: $695.
Contact: Minitab, Inc., 3081 Enterprise Dr., State College, PA 16801, (814) 238-3280; fax (814) 238-4383.
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PowerLeads lets you access vital client information from a single screen.

A Relational Contact Manager for Windows

PowerLeads, a contact-management and sales-lead tracking system for Windows 3.0, brings relational database power to the task of prioritizing your day and tracking clients.

PowerLeads supports mail-merge and uses the Windows interface to make it easy to schedule call-backs, plan daily activities, track expenses, and generate labels.

Price: $295.
Contact: Pyramid Data, Inc., 1000 East William St., Suite 100, Carson City, NV 89701, (800) 972-7972 or (415) 726-1722; fax (415) 726-0467.
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Activate Your Business Presentations

A complement to programs that produce static slide and overhead presentations, MacroMind Action lets you combine sound and motion with text and graphics in your presentations. The package comes with dozens of presentation templates to which you can add your own text, sound, or graphics.

A Clip Media Library includes a variety of special sounds, still graphics, and animations for you to use in the presentation. Action can import text, charts, and graphics in various formats for adding motion to presentation elements.

The program lets you manipulate the timing and flow of the presentation with an intuitive Timeline feature and a VCR-like control panel.

Price: $495.
Contact: MacroMind, Inc., 410 Townsend St., Suite 408, San Francisco, CA 94107, (415) 442-0200; fax (415) 442-0190.
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Peachtree Links Accounting to Billing

The Insight Expert Accounting Series now supports Timeslips III Accounting Link (TAL) for the Mac, letting you seamlessly link any of the accounting modules to the Timeslips III time- and expense-tracking system.

Price: $395 per module.
Contact: Peachtree Software, 1505 Pavilion Place, Norcross, GA 30093, (800) 247-3224 or (404) 564-5700; fax (404) 564-5888.
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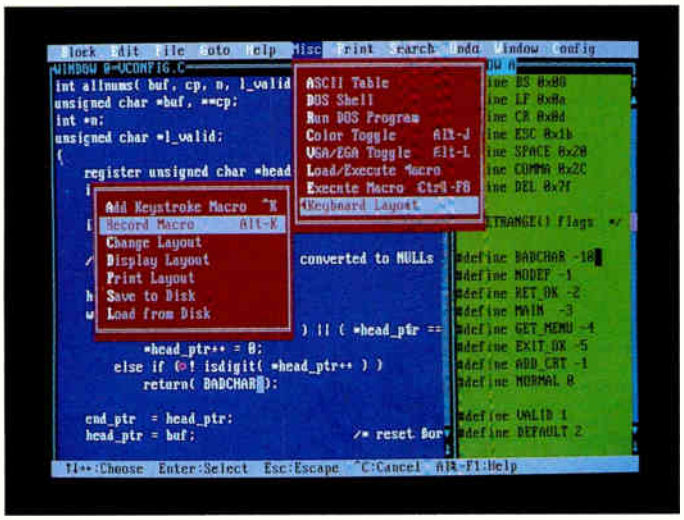
New VEDIT PLUS 3.50

The fastest text editor for programming and editing huge files.



VEDIT PLUS

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- **Mouse Support**
- **Drop-down menus**
- **Columnar blocks**
- **1000 Level Undo**
- **Regular expressions**
- **Small 80K size, fast**
- **Also VEDIT for $69**
- **Emulate Wordstar, Word Perfect, Brief, vi, others**
- **Edit text and binary files of any size and line length**
- **Powerful macro programming language for instant "off-the-cuff" macros**
- **Also VEDIT Jr. for $29**

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As a computer professional, you need the best text editor available. The new VEDIT PLUS 3.50 excels as the finest programmer's editor and also for editing huge text and binary files that are becoming commonplace.

Written entirely in assembly language, VEDIT is small and lightning fast. It's the first programmer's editor that can edit *any* file - 600 megabyte CD ROM files, files downloaded from mainframes, huge postscript and plotter output files, any binary file.

Incredibly, VEDIT is 30 to 100 times faster than other editors on just a 3 megabyte file, and even faster on larger files. You may not need to edit huge files today, but with files getting larger every day, you will soon. And VEDIT is the only editor that can do it.

BENCHMARKS IN 3 MEG FILE

	VEDIT	Brief	Sage
Save and continue	52 sec	3:52 min	1:47 min
Load, modify, save, exit	21 sec	49 sec	1:38 min
Block-column copy (40x200)	2 sec	30 sec	2 sec
Delete one column in file	9:58 min	1:50 hour	1:03 hour
60,000 search & replace	3:18 min	1:44 hour	1:32 hour

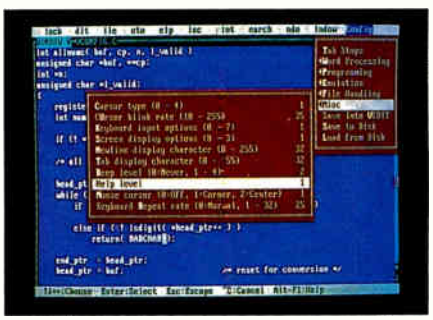
VEDIT's breakthrough compiler support runs not only popular compilers, but also your favorite linkers, debuggers and Make programs from within the editor. When shelling to DOS, VEDIT swaps itself and any desired TSRs out of memory, giving you as much as 600K of available memory for compiling the biggest programs with the biggest compilers.

Only VEDIT gives you the advantages of a powerful editor with the convenience of an integrated environment.

An intuitive user interface with drop down menus, hot keys, mouse support, optional scroll bars, context sensitive help, point and shoot file selection, 1000 level undo and a completely configurable keyboard layout with unlimited keystroke macros make VEDIT easy to use, easy to learn.

Just about everything in VEDIT is configurable. The keyboard layout, the screen colors, the way control characters, long lines and window borders are displayed, and much more, is all configured with easy to use menus.

VEDIT PLUS has every advanced feature you might expect. Simultaneously edit numerous files, split the screen into windows, search/replace with regular expressions. Automatic indent, block indent, parentheses matching and block operations by character, line, file or column speed program development. Word wrap, paragraph formatting, justification, centering and many printing options are ideal for text processing.



VEDIT PLUS has the most powerful macro programming language of any editor. It eliminates repetitive editing tasks and lets you create your own editing functions. The macro language includes testing, branching, looping, user prompts, keyboard input, string and numeric variables, complete control over windows plus access to hardware interrupts, memory and I/O ports. Source level macro debugging with breakpoints and tracing.

You can confidently order your copy of VEDIT PLUS today, because it comes with a 30 day money-back guarantee. You will immediately see why VEDIT has been the choice of 100,000 programmers, writers and engineers since 1980.

VEDIT PLUS - DOS single user license: $185; DOS network 5 user license: $295; UNIX/XENIX, QNX, FlexOS/IBM 4680 single CPU license: $285. Multiple user discount pricing is available.

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Z-486SX/20E

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Microprocessor	i386™SX – 20/10 MHz	i486™SX – 20 MHz	i486DX – 33 MHz	i486DX – 33 MHz	i386SX – 16 MHz
Co-Processor	Optional 80387SX	Weitek 4167 socket i486DX upgrade	Weitek 4167 socket	Weitek 4167 socket	Optional 80387SX
Memory (Std./Board Max.)	2MB/16MB	4MB/32MB	4MB/64MB	8MB/64MB	1MB/8MB
Expansion Slots	4 open 16-bit ISA	3 open 32-bit EISA	3 open 32-bit EISA	8 open 32-bit EISA	2 open 16-bit ISA
Hard Disk Drive	40MB or 80MB IDE	80MB or 200MB IDE	200MB or 400MB IDE	340MB half-height SCSI; 6 open half-height bays	Diskless; 40MB IDE optional
Ports	2 serial, 1 parallel	2 serial, 1 parallel	2 serial, 1 parallel	2 serial, 2 parallel, 1 mouse	2 serial, 1 parallel
Disk Drive Controller	Combined IDE connector/ floppy controller	Combined IDE connector/ floppy controller	Combined IDE connector/SCSI/ floppy controller	EISA bus master SCSI mass host adapter	IDE connector/ floppy controller
Video	16-bit VGA card	16-bit VGA card	TIGA/VGA	16-bit VGA card	16-bit VGA on board
LAN Features				Optional RAID 5 disk array software	Dual level ROM-based password protection

Z-486/33E

Z-486/33ET and Z-LS

Novell tabs tested & Approved

* The Z-486/33ET has been tested for compatibility with Novell NetWare® and Microsoft LAN Manager.™
The Z-486/33ET has been submitted for testing and compatibility with Banyan® VINES™ and SCO™ and ISC™ UNIX.®

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DSP Goes 3-D

DADiSP, the data analysis and display program that combines data analysis with the ability to interpret large data sets visually and interactively, now supports 3-D and 4-D plotting capabilities, expanding on the graphing functions. DADiSP 3.0 is available for the X Window System on Sun, IBM, DEC, Hewlett-Packard, and Concurrent workstations, as well as the PC.

DADiSP 3.0 includes hundreds of data reduction, mathematical, statistical, Fourier transform, peak analysis, and graphical tools. You can define new functions and automate DADiSP sessions. Version 3.0 adds more extensive matrix math and statistics.
Price: $895 and up.
Contact: DSP Development Corp., 1 Kendall Sq., Cambridge, MA 02139, (617) 577-1133; fax (617) 577-8211.
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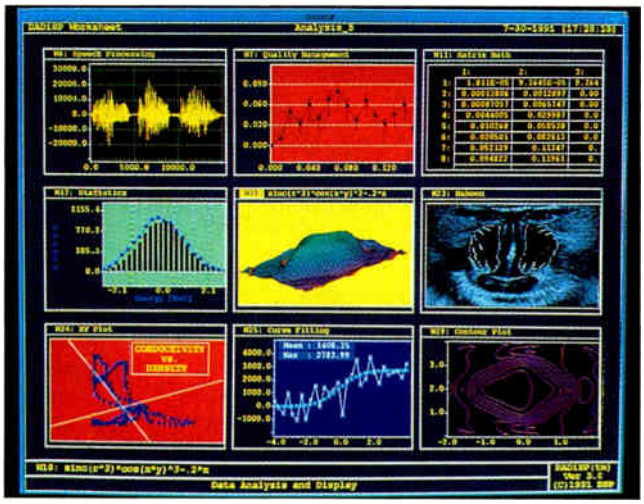

The DADiSP worksheet lets you convert data from windows into numbers. Any change in data, a function, or an argument causes all dependent windows to update.

TK Solver for Motif

The latest version of TK Solver, the math equation solver and graphing program, takes advantage of the Motif interface to work in a multiple-window environment while multitasking. You can run two or more models simultaneously and compare their results side by side. The Motif version also lets you transfer information between windows in a single application or between different models. The Motif version runs on the IBM RISC System/6000, DECstation 3000 and 5000 series, HP/Apollo 300 and 400 series, and Sun Sparcstations and compatibles.
Price: $995 and up.
Contact: Universal Technical Systems, Inc., 1220 Rock St., Rockford, IL 61101, (800) 435-7887 or (815) 963-2220; fax (815) 963-8884.
Circle 1280 on Inquiry Card.

TK Solver for Motif running a gear analysis, showing functions, plots, and charts simultaneously.

Maple for Mac Adds More Functions

A new version of the Maple V algebra system for the Mac delivers 3-D graphics and a worksheet interface that lets you work in your own defined styles for mathematical expressions and documentation. Maple V now has more than 2000 functions.

The program offers specialized functions for engineers and a facility for defining and using mathematical operators. The worksheets let you combine mathematical input, output, text, and graphics in one document. You can control the formatting of input, output, and text separately. The program lets you step through a previously created worksheet, recalculating one input at a time.

Versions of Maple are also available for the PC, Amiga, Silicon Graphics Iris, Sun-3, Sparcstation, and many other workstations.
Price: $450 for the Mac version.
Contact: Waterloo Maple Software, 160 Columbia St. W, Waterloo, Ontario, Canada N2L 3L3, (519) 747-2373; fax (519) 747-5284.
Circle 1281 on Inquiry Card.

Timing and Signal Analysis for the Indigo

Silicon Graphics' Iris Indigo RISC-based computer now has a family of system-level timing and signal analysis tools for electronic design automation. Quad Design says that its ports to the new Indigo system include Motive (Modular Timing Verifier), the system timing verifier; XTK (Crosstalk Tool Kit); TLC (Transmission Line Calculator); and PDQ (Pre-Route Delay Quantifier).

XTK automates the board-level analysis of cross talk and other signal distortions that can foul up complex digital designs. TLC provides accurate simulations of transmission line effects in printed circuit board traces and other conductors. PDQ evaluates and specifies component and cell placement strategies to minimize signal delays in digital circuits and boards.
Price: $15,000 to $50,000 per module.
Contact: Quad Design Technology, Inc., 1385 Del Norte Rd., Camarillo, CA 93010, (805) 988-8250; fax (805) 988-8259.
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Prototyping in 3-D on the Mac

Sketch, a program that offers free-form 3-D illustration and design on the Mac, lets you create 3-D free-form models, render them using a choice of shaders, and place them into scanned 2-D photos you've imported into the program. With Sketch, you can prototype complex 3-D wireframe models using tools one normally associates with 2-D drawing programs.

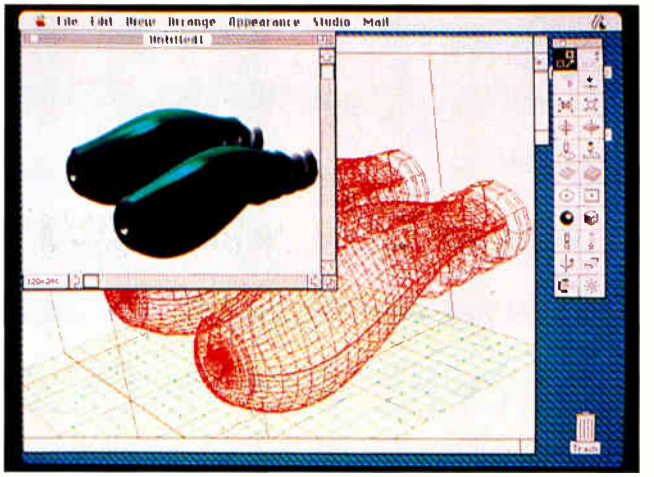
You can use Sketch's free-form drawing tool to lay the base for an object, such as an airplane fuselage, and then use several other tools to extrude and further modify the object in 3-D. The program lets you assign surfaces to the 3-D model and render it using a range of renderers and texture maps.

Once you place a model into an imported 2-D bit-map or scanned image, by clicking on three vertices in the 2-D plane (e.g., three corners on a 2-D image of a table), your model automatically gains perspective in the flat environment. The mathematics underlying Sketch's 3-D models will let you export models to high-end CAD packages for detailed designing and material tracking in a materials database, Alias says. You can expect a Windows version in about six months.

Price: $1995.

Contact: Alias Research, Inc., Style Division, 110 Richmond St. E, Toronto, Ontario, Canada M5C 1P1, (800) 267-8697 or (416) 362-9181; fax (416) 362-0630.

Circle 1283 on Inquiry Card.



Alias says it took 20 minutes to develop this concept of a pair of binoculars using Sketch. The shape was created using Sketch's 3-D pencil, pencil extrusion, and Curve-o-Matic tools. The body shape was developed using surface manipulation tools, while the image at top left was shaded with a built-in renderer set at low.

CAD Programs for Precise Home Design

Four new programs composing Generic Software's Home Series for the PC let you design floor and landscape plans accurate enough for construction use. The Home Series calculates distances, clearances, wall heights and widths, and square footage as you design your deck, wall, or room. Included predrawn symbols for representing fixtures, walkways, outlets, jacks, and cabinets add realism to your drawings.

The Home program lets you transform home design plans into working floor plans. The Kitchen program is a source of remodeling ideas for your L-shaped, single-wall, or U-shaped kitchen. The Bathroom program offers a detailed floor plan and an automatically rendered elevation view, for experimenting with different layouts and decor. The Landscape program lets you generate side and overhead sketches of your land.

Price: $59.95 each.

Contact: Generic Software, Inc., 11911 North Creek Pkwy. S, Bothell, WA 98011, (206) 487-2233; fax (206) 485-0021.

Circle 1284 on Inquiry Card.

New PCB System Rounds the Corners

An enhancement to the Pads-2000 32-bit electronic engineering system for PC and SPARC workstations lets you automatically insert an arched or beveled miter at each route corner if you prefer to interactively route a board, CAD Software says. (Miters form the edge of a piece where joints are made by cutting two pieces at an angle and fitting them together.) This new feature of version 3.0 lets you define up to seven different mitering radii to meet varying design requirements.

Price: $6995; SPARC version, $14,950.

Contact: CAD Software, Inc., 119 Russell St., Littleton, MA 01460, (800) 255-7814 or (508) 489-8929; fax (508) 486-8217.

Circle 1285 on Inquiry Card.

SilverScreen Supports RenderMan

SilverScreen, the 3-D CAD and solid-modeling package for DOS workstations, now comes in a professional version that supports the RenderMan language for turning models into real-life images. The program can export in DXF, HPGL, IGES, PCX, and PostScript formats. Version 3.0 uses Phar Lap's 386|DOS-Extender and virtual memory manager to let you access up to 4 gigabytes of available memory.

SilverScreen supports hidden line removal, filled surface, shading, and shadowing. Versions are also available for standard DOS and Silicon Graphics Personal Iris workstations.

Price: Standard DOS version, $495; professional version, $2995; Renderman edition, $4995; Iris version, $5000.

Contact: Schroff Development Corp., 4732 Reinhardt Dr., Roeland Park, KS 66205, (913) 262-2664; fax (913) 722-4936.

Circle 1286 on Inquiry Card.

SPREAD THE WORD

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1-2-3® for Windows

Now included in every

For a limited time only, ZEOS Windows systems buyers will also receive Lotus 1-2-3 for Windows plus Ami Pro 2.0, the Lotus Word Processing package for Windows. Complete and fully documented!

Your new ZEOS Windows system includes Microsoft Windows Version 3.0 plus a genuine Microsoft Mouse.

Unbelievable? Believe it! Because now, when you buy any new ZEOS Windows® system, you will also receive Lotus *1-2-3 for Windows* plus Lotus' new word processor for *Windows, Ami Pro™ 2.0* at no additional charge!

It's the ultimate bundle! First, you're going to be receiving the incredible new ZEOS modular system complete with the upgradable CPU of your choice. These new ZEOS systems are the hottest computers money can buy. And that's just for starters.

Because you're also receiving the hottest software money can buy. Yet you don't have to buy it. Because we're including it at *no additional charge.* Go ahead and pinch yourself, it's really true!

And not only are you receiving the *amazing* new Lotus *1-2-3® for Windows* and *Ami Pro 2.0,* you're also getting Microsoft® *Windows* itself, plus a genuine Microsoft Mouse plus Microsoft *DOS 5.0.* All included at one low package price.

These are not some scaled down versions or trial disks either. They are the *complete* and *fully documented* editions of Lotus *1-2-3 for Windows* and Lotus *Ami Pro 2.0* for *Windows* provided to you by special arrangement between ZEOS and Lotus. This is one incredible value that no one else can offer. You're going to love it, too.

Because nothing else brings out the power of the most powerful software like your blazing new ZEOS system. And when you strap your-

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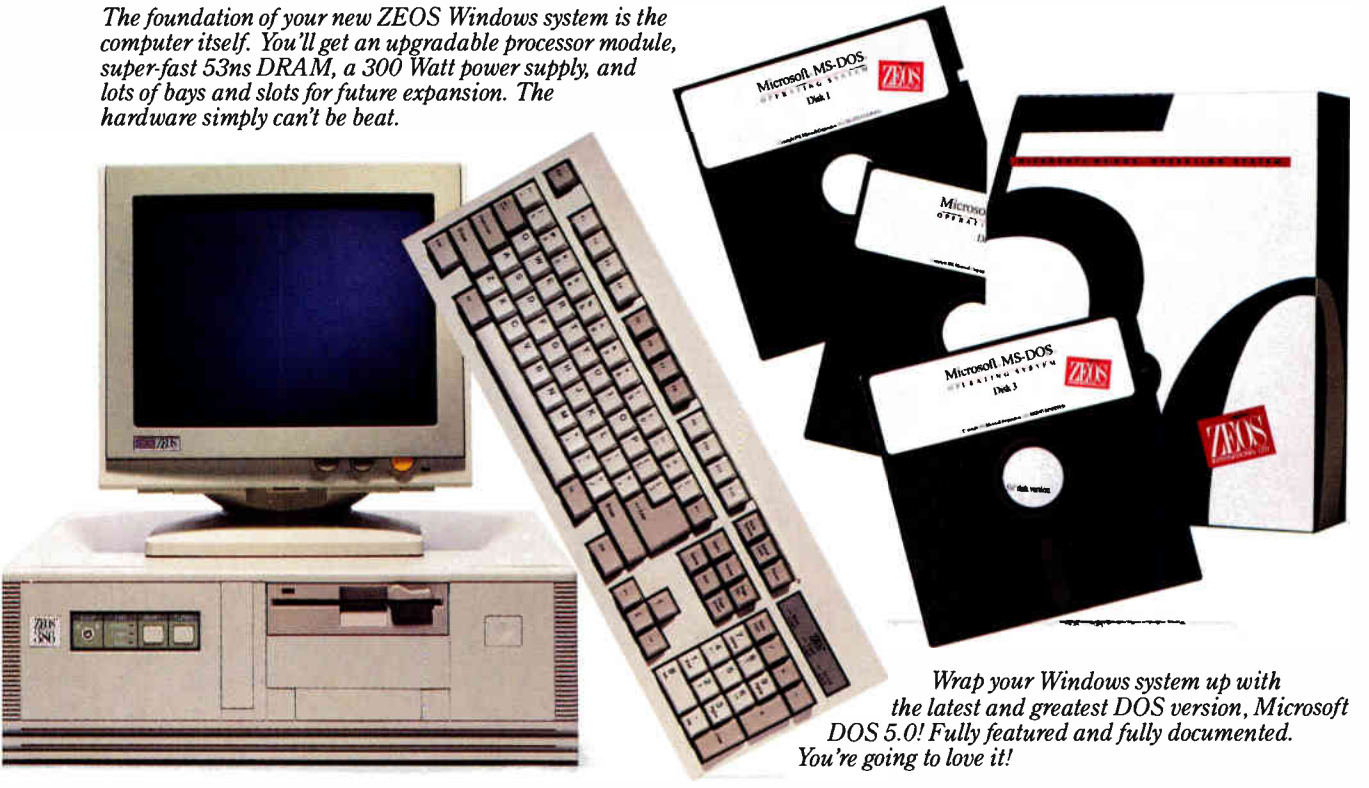
plus Ami Pro® 2.0!

ZEOS Windows System.

The foundation of your new ZEOS Windows system is the computer itself. You'll get an upgradable processor module, super-fast 53ns DRAM, a 300 Watt power supply, and lots of bays and slots for future expansion. The hardware simply can't be beat.



Wrap your Windows system up with the latest and greatest DOS version, Microsoft DOS 5.0! Fully featured and fully documented. You're going to love it!

self in and fire up *Windows* with Lotus *1-2-3* and *Ami Pro,* you're in for the ride of your life!

After all, nobody knows spreadsheets better than Lotus. And when they sat down to write *1-2-3 for Windows* they created a masterpiece. It starts out as a full-fledged *Windows* application. Offering that perfect balance of power and simplicity, it remains fully compatible with all the earlier versions of *1-2-3*. And it's absolutely loaded with new features.

Power, Simplicity, complete Compatibility *plus* loads of new features. It's Lotus *1-2-3 for Windows* and it comes with every ZEOS Windows system. And so does *Ami Pro 2.0!*

After all, *Ami Pro 2.0* is the Lotus word processing program that was designed for Windows from the ground up. Linking with a full suite of Windows applications *including* your new Lotus *1-2-3 for Windows, Ami Pro 2.0* is perhaps the finest word processor on the market today.

Buying your new ZEOS Windows system is possibly the best purchase decision you'll ever make. Then add to it Lotus *1-2-3 for Windows, Ami Pro 2.0* plus *Windows 3.0, DOS 5.0* and a genuine Microsoft mouse. It's an offer that can't be beat and one we simply can't offer for long. So pick your new ZEOS Windows package now and we'll include a bundle! *Call now 800-423-5891!*

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Upgradable. High Performance. Low Cost. And every ZEOS Windows system comes with Lotus *1-2-3 for Windows* and *Ami Pro 2.0* at no additional charge. Absolutely incredible!

With ZEOS 386-25s starting at only $1395 right thru '486-33MHz systems starting at $1795, computing will never be the same again! And it's not just the prices that make these new systems hot. It's Performance and Upgradability as well.

UPGRADABLE CPU

When we first sat down to design these new systems, we wanted computers that would *blow the doors off* anything else out there. Plus, we wanted you to be able to upgrade from one CPU to another as your computing requirements changed, *without having to buy an entirely new system.* The results?

Incredibly low cost, high performance systems so very advanced you can move freely from the '386 family of processors to the latest '486s all without a moment's hesitation.

Now, you can pick your power! Today *and* tomorrow. Choose from high speed '386-25 and 33MHz systems, either cached or non-cached, plus the '486SX and '486-33MHz with or without a secondary cache. Whichever you decide upon you know that as your computing requirements change, your processing power can change as

Upgradable.

Hot New ZEOS '386

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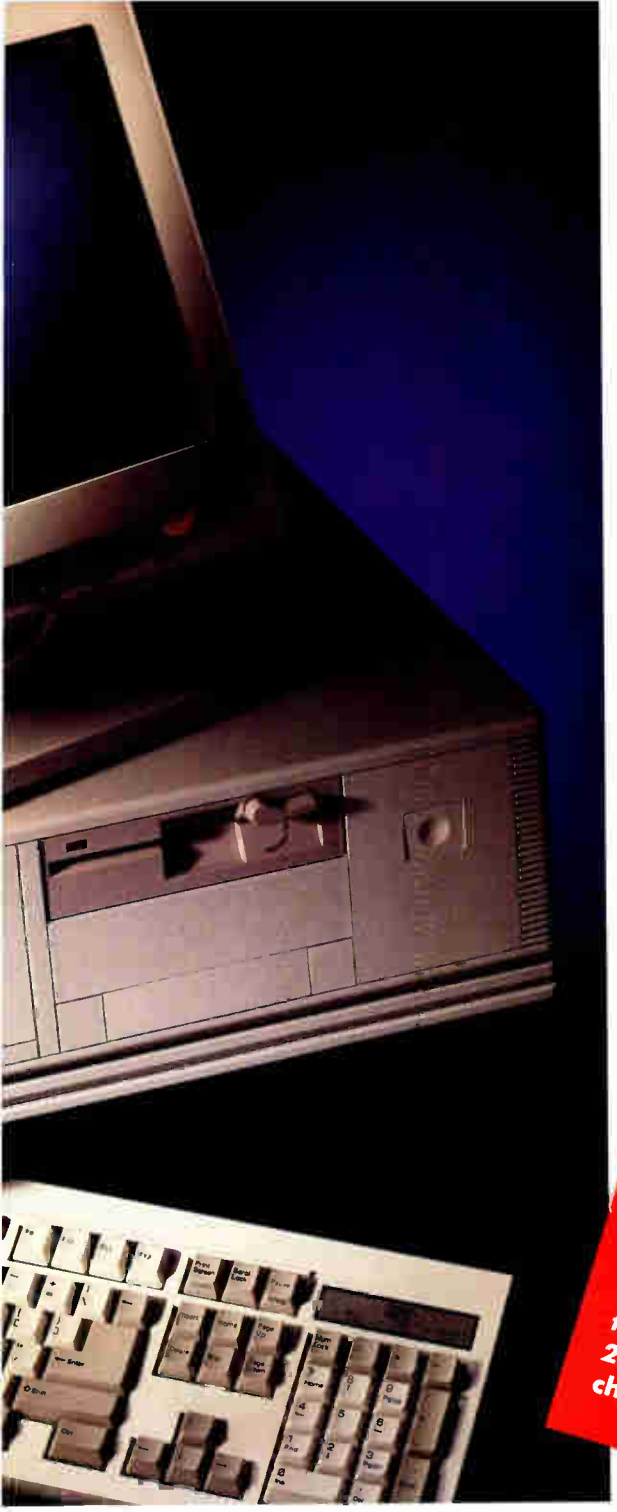
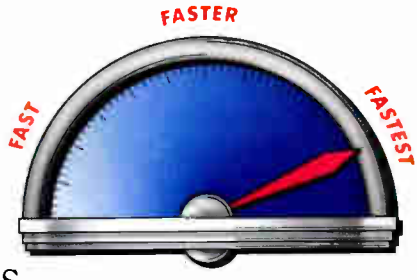


well. But are the prices really that good?

Yes. *Absolutely Yes!* The prices really *are* that good, and the quality too. Because when you buy from ZEOS you're buying directly from the manufacturer. Starting with the main system board, your new computer is designed and built by us right here in Minnesota. That saves money for you. And your ZEOS factory direct advantages are evident not only in the price, but in the performance and quality of your system too.



Z•SPEED METER

To help you select the processor option that's right for you, we have developed the Z-Meter. *The* Z-Meter *shows you the relative performance gains achieved by moving from one processor module to another—fast, faster, fastest! No matter which system you select you can be sure of one thing*—these babies are Hot!

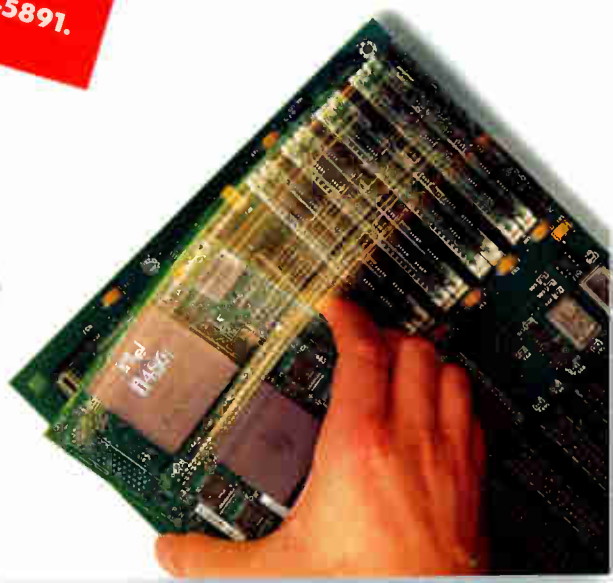
Not only that, but your new ZEOS system is supported around the clock by our 24 Hour a Day Toll Free technical support hotline. Should you have any questions, we're here to help, 24 hours a day, 365 days a year!

So if you're looking for a high speed, upgradable, rock solid system supported like none other *and* you want incredibly low prices, you've found your company. And your computer. Read on!

This ZEOS ad reviews each of four money saving upgradable system packages based on processor type. For a limited time only, every ZEOS Windows system includes Lotus 1-2-3 for Windows and Ami Pro 2.0 at no additional charge! Call 800-423-5891.

Low Cost.

and '486 systems!



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ZEOS. Your

ZEOS COMPLETE SYSTEM PACKAGE #1

- The Processor and Speed of your choice plus future upgradability!
- 1MB of High Speed 53ns DRAM, expandable to a system total of 32MB right on the motherboard.
- 42MB High Speed IDE hard drive with its own cache.
- 1.2MB or 1.44MB Teac® floppy drive.
- ZEOS 14" flat screen Hi-Res amber monitor with Tilt/Swivel base.
- Shadow RAM and EMS support for enhanced performance.
- ZEOS/RS 101 key SpaceSaver keyboard.
- Two Serial, one Parallel & one Game Port built right onto the motherboard.
- 7-16, 1-8 bit expansion slots. 80387 math co-processor support for '386 systems.
- Rugged ZEOS SpaceSaver case with twin cooling fans for added reliability and product life.
- Seven drive bays and our custom 300 Watt power supply for your future expansion!
- Includes ZEOS 24 Hour a Day Toll Free Technical Support and Customer Satisfaction package.

PACKAGE #1
486-33 $1795
486SX-20 $1595
386-33 $1495
386-25 $1395

INCREDIBLE ZEOS PACKAGE #2

We take Package #1 and upgrade your ZEOS Modular System to include:

- 2 full Megabytes of Rip-roaring 53ns DRAM.
- Our incredible 85MB IDE hard drive with its own built in cache.
- Both the Teac® 1.2MB *and* 1.44MB floppy drives.
- The awesome Diamond SpeedStar Plus VGA graphics card Complete with 1MB DRAM.
- ZEOS 14" High Res VGA Mono Monitor with Tilt & Swivel base.
- Lotus 1-2-3 for Windows, *plus* Ami Pro 2.0, *plus* Microsoft Windows and DOS 5.0, *plus* a genuine Microsoft mouse!

PACKAGE #2
486-33 $2395
486SX-20 $2195
386-33 $2095
386-25 $1995

For Vertical Systems add only $150.

Harnessing the ZEOS power and value you want is easy. Pick your processor then your package. Package #1 gets you up and running for a very reasonable price. To add even more options *and* savings select from Packages 2, 3 or 4.

Because when you select from Packages 2, 3 or 4 you receive VGA, additional memory, larger drives and more. You also receive *Windows 3.0* plus Lotus *1-2-3 for Windows* plus Lotus' great new *Windows* word processor *Ami Pro 2.0,* plus Microsoft *DOS 5.0* plus a genuine Microsoft Mouse. Nobody gives you this combination of hardware *and* software power. And it's yours, all for one low package price!

And that's just for starters. Because *inside* your new ZEOS system rests the very latest advancements in surface mount, high integration technology. As an example, we have freed two normally occupied expansion slots by placing our high speed IDE hard drive and floppy drive interfaces right on the main board. Then, we put the high speed serial, parallel and game ports on the motherboard too. The result?

Eight expansion slots, *seven* of which are available for your future use! After all, expansion and non-obsolescence are what these great new ZEOS systems are all about. We've built in some other very important expansion features for you as well.

Like our *300 watt* power supply. Providing you with all the pure clean power you'll need right now, your ZEOS 300 watt supply also provides you with plenty of power for the future as well. Plenty of slots, plenty of power. How about space? This is where ZEOS has performed something akin to magic.

It's your new ZEOS SpaceSaver case! Complete with *seven drive bays,* this incredible case is actually *smaller* than many cases offering only five bays. We've also added *a second whisper quiet cooling fan.* Why? Because whether you expand your system or not, the cooler it

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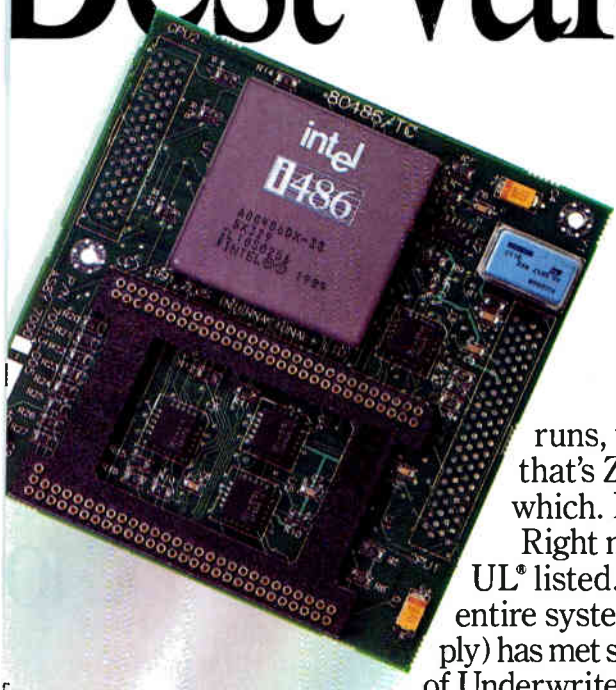
Best Value!



486-33 $2895
486SX-20 $2695
386-33 $2595
386-25 $2495

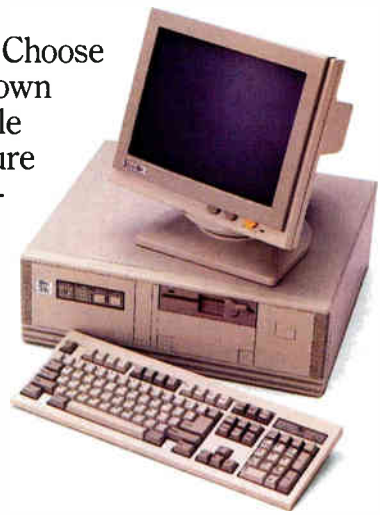
runs, the longer it will last. Now that's ZEOS *value*. Speaking of which. How about UL® listings?

Right now every ZEOS system is UL® listed. This listing means your entire system (not just the power supply) has met stringent safety requirements of Underwriters Laboratories. We believe UL® listings also say a lot about quality. And UL® safety listings are something many of our competitors simply don't (or can't) provide. At ZEOS quality and safety are important to us. *You* are important to us.

Price. Performance. Quality and Support. There are ***many*** reasons to buy your new ZEOS upgradable system. Plus, your ZEOS advantages include *24 Hour a Day Toll Free* Support and our 30 Day Money Back Guarantee and ironclad warranty (for more ZEOS advantages see the section entitled *"Why ZEOS is Your #1 Choice"*).

486-33 $3395
486SX-20 $3195
386-33 $3095
386-25 $2995

Selecting your new ZEOS system is easy. Choose from any of the money saving packages shown here. Or let your friendly and knowledgeable ZEOS Systems Consultant help you configure exactly what you want from our huge selection of upgrades and options. Whatever you select, one thing is for certain.



Buying your new ZEOS system is perhaps the best purchase decision you'll ever make! Simply pick up the phone and give us a call now. Incredible ZEOS power awaits you! *Call now Toll Free, 800-423-5891.*

For Complete Processor and Package Pricing, simply turn the page!

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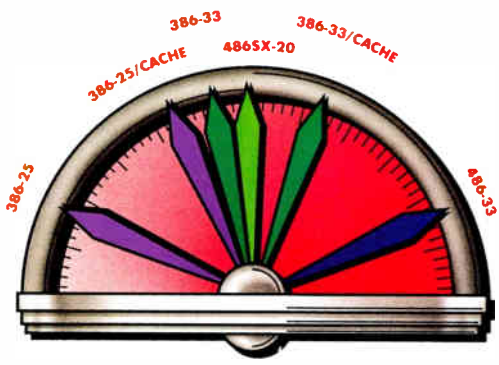
Pick You Package

Or Let Us Custom Build to

Now, ZEOS lets you pick the power you want for the price you want to pay! Not only that, every ZEOS Windows System (Packages 2, 3 and 4) includes not only Microsoft *Windows*, *DOS* and a mouse—we're also including Lotus *1-2-3 for Windows plus* Lotus' new Windows word processor *Ami Pro 2.0!*

And with your new ZEOS modular system, the computer that's right for you today is also the computer that's right for you tomorrow. In the future, you can upgrade to even more performance with a new '386 or '486 processor module.

And that's only the start of your many ZEOS system advantages. But what more could there be than dazzling performance, incredible prices and upgradability? From ZEOS there's lots more.



Z•SPEED METER

Let the "Z-Meter" help you pick the processing power that's right for you. The comparisons are easy to make. Fast, Faster or Fastest!

Because your new ZEOS system is not only fast, it's absolutely *loaded with features.* Like our *300 watt* power supply, eight expansion slots, twin cooling fans (for even more reliability) and our unique seven bay SpaceSaver case. And, *every ZEOS system is UL®* listed.

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r Power, & Price!

Your Exact Specifications.

PACKAGES 2, 3 AND 4 INCLUDE LOTUS BUNDLE!

	Pkg. #1	Pkg. #2	Pkg. #3	Pkg. #4
386-25	$1395	$1995	$2495	$2995
386-33	$1495	$2095	$2595	$3095
486SX-20	$1595	$2195	$2695	$3195
486-33	$1795	$2395	$2895	$3395

Add $200 to any price for a 128K cache.

In addition to all of these standard ZEOS advantages, you're also receiving our legendary ZEOS Technical Support, *24 Hours a Day, 365 Days a Year.* Plus, our 30 day Absolute Satisfaction Money Back Guarantee and more!

So pick your Power, and your Price *then give us a call!* Your expert ZEOS Systems Consultant is ready to answer any questions you may have. Why not give us a call right now, Toll Free at 800-423-5891.

Call to confirm current pricing, product specifications and configurations, all are subject to change without notice. Purchase orders subject to approval. Lotus, 1-2-3, Ami Pro, Classic and SmartIcons are trademarks of Lotus Development Corporation; Windows and Microsoft of Microsoft Corporation; Z-Card, SpaceSaver, and ZEOS of ZEOS International, Ltd., 530 5th Avenue NW, St. Paul, MN 55112 USA © 1991.

INCREDIBLE ZEOS PACKAGE #3

Add even more memory, a larger drive. And more Savings! You now receive:

- **4 full Megabytes of Ultra High Speed 53ns DRAM.**
- **Our fast 130MB IDE hard drive with built in cache.**
- **Both Teac® floppies, the 1.2MB *and* 1.44!**
- **Your Diamond VGA Plus card with 1MB DRAM.**
- **ZEOS 14" 1024x768 VGA Color Monitor w/Tilt & Swivel.**
- **Lotus 1-2-3 for Windows, Ami Pro 2.0, Microsoft Windows, DOS 5.0 *plus* a Microsoft mouse!**

PACKAGE #3

THE ULTIMATE ZEOS PACKAGE #4

Now, Memory goes to 8MB and the drive to 210MB. The ultimate Power User's Dream Machine!

- **8 full Megabytes of High Speed 53ns DRAM.**
- **Your screaming 210MB IDE hard drive with its own built-in cache.**
- **Both Teac® floppies, the 1.2MB *and* 1.44!**
- **The Diamond VGA Plus card with 1MB DRAM.**
- **ZEOS 14" 1024x768 VGA Color Monitor w/Tilt & Swivel.**
- **Lotus 1-2-3 for Windows, Ami Pro 2.0, Microsoft Windows, DOS 5.0 *plus* a Microsoft mouse!**

PACKAGE #4

ORDER NOW TOLL FREE

800-423-5891

FAX Orders: 612-633-1325
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Govt. & Educ.: 800-245-2449
Outside US and Canada Call: 612-633-6131
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ZEOS INTERNATIONAL, LTD.

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Why ZEOS is

CHECK YOUR EXCLUSIVE

If you're deciding which new computer to buy, there are many important considerations.

Here, we've gathered together a number of these considerations for your review. Some are of obvious importance,

☑ Now, your ZEOS modular system allows you to upgrade from one CPU to another as your computing requirements change. Obsolescence is virtually obsolete!

☑ You may choose between a variety of '386 and '486 processor options, both cached and non-cached.

☑ Made in USA! Your new ZEOS system boards are designed and manufactured by ZEOS, right here in the USA.

☑ ZEOS has utilized the very latest in highly integrated surface mount technology. Faster, cooler, more reliable systems for you!

☑ Every ZEOS modular system comes standard with incredibly fast *53 nanosecond DRAM.*

☑ Plus, you may expand your system with up to 32 megabytes of memory right on the motherboard.

☑ Your new system features the *exclusive* ZEOS seven bay desktop case, smaller than most five bay cases yet plenty of room for future expansion.

☑ Two whisper quiet cooling fans move more cool air thru your system increasing reliability and component life.

☑ Your *entire* system is UL® listed (not just the power supply). Few others offer this security; we wonder why.

☑ Eight slots, one for the video, seven more open providing plenty of room as your system requirements grow.

☑ Two high speed serial ports, one parallel port and one game port.

☑ Our top quality 300 watt power supply provides you with plenty of power for your present *and* future needs.

☑ ZEOS uses *only* genuine Teac® floppy drives. Accept nothing less.

☑ Monochrome TTL systems feature Genuine Hercules® brand graphics controllers. Only the best for you.

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Your #1 Choice!

ZEOS ADVANTAGES:

while others are subtle yet critical to your ultimate satisfaction. We'll go over them here with you one by one.

Please feel free to use these as a basis for comparison with other system vendors. We believe you will come away with the conclusion that *ZEOS is indeed Your #1 Choice.*

☑ VGA color systems feature the high-res ZEOS 1024x768 monitor with the incomparable SpeedStar Plus card complete with One Full Megabyte of memory!

☑ Special package savings are available incorporating our most popular upgrades. Many packages include Microsoft® DOS plus Windows and a Mouse!

☑ For a limited time every ZEOS Windows system also comes with Lotus *1-2-3 for Windows* plus Lotus' incredible new Windows word processor *Ami Pro 2.0!*

☑ *PC Magazine* said ZEOS offers "more options than even the most configuration hungry hound could possibly need." Let us build whatever you require.

☑ Everybody loves ZEOS' 24 Hour a Day Toll Free Technical Support. You can call for advice any time of the day or night, 365 days a year!

☑ ZEOS systems have been selected by *PC Magazine* as *Editor's Choice, Eight Times!* These, along with many other consumer and industry awards attest to ZEOS' consistent and outstanding value.

☑ Your new system is backed by our 30 Day Absolute Satisfaction Money Back Guarantee, One Full Year Limited Warranty and our Express Replacement Policy.

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Yes, we can ship your new ZEOS '386 or '486 today! We've built up an extra supply of the hottest selling computers in America in their most popular configurations.

Here's how it works. We have these incredible ZEOS '386 and '486 color VGA systems pre-built and ready to ship. While supplies last, we will ship any of these systems to you *the day you order* subject to these conditions:

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If we accept your order for immediate shipment and fail to ship your system under the conditions outlined, we will ship it at *our expense* as soon as it is ready.

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These are not just any computer systems. They're the high performance, high quality ZEOS *upgradable* systems. Packing all the ZEOS value that has won PC Magazine Editor's Choice—*eight times!*

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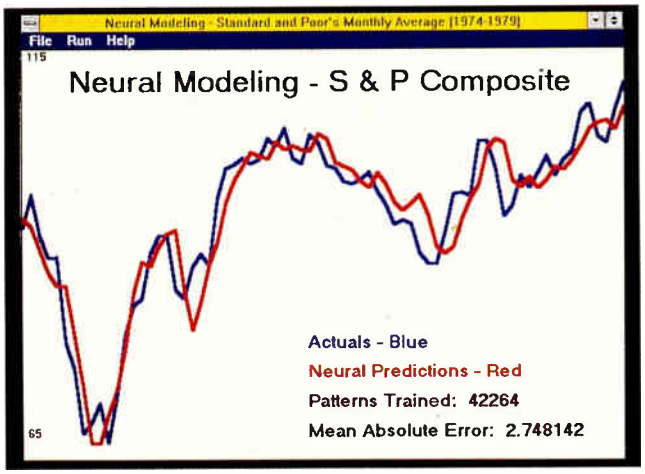
NEWS

Neural Networks and Visual Basic

With NeuroWindows and Visual Basic, you can build neural-network business applications for making correct price and market forecasts. NeuroWindows also lets you create applications for scientific waveform recognition and the optimization of experiments.
Price: $295.
Contact: Ward Systems Group, Inc., 245 West Patrick St., Frederick, MD 21701, (301) 662-7950; fax (301) 662-5666.
Circle 1175 on Inquiry Card.



The NeuroWindows programming tool for Microsoft's Visual Basic lets you create price- and market-forecasting applications, such as this Standard & Poor's modeling application.

Visual Basic Library for SQL Server

A new Visual Basic Library lets you develop Windows-based client-server applications for Microsoft SQL Server, Microsoft's database server for Microsoft LAN Manager, Novell NetWare, Banyan Vines, and IBM LAN Server networks. Microsoft Visual Basic Library offers almost 100 functions and routines for building front-end Windows applications for SQL Server. The Visual Basic Library is built on top of the Sybase DB-Library, SQL Server's client interface.

Using the library, you can develop systems that integrate with other Windows applications through Dynamic Data Exchange. The library supports SQL Server 1.11, which adds support for Banyan Vines 4.10, improved support for Novell networks, and client interoperability with Sybase SQL Servers on Unix and VAX servers.
Price: $495; 10-user SQL Server license, $2995; unlimited user version, $7995.
Contact: Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052, (206) 882-8080; fax (206) 883-8101.
Circle 1177 on Inquiry Card.

A Simplified Vermont View

Vermont Views, the user-interface development system for C, is now available in a simplified Quick Version that provides 123 functions. Within the Designer, Vermont Creative Software's menu-driven screen manager, Vermont Views QV provides mouse support, exploding windows, shadow borders, radio buttons, and push buttons. Vermont Views QV runs on PCs.
Price: $199.
Contact: Vermont Creative Software, Pinnacle Meadows, Richford, VT 05476, (800) 848-1248 or (802) 848-7731; fax (802) 848-3502.
Circle 1179 on Inquiry Card.

SQLWindows Now More Visual

SQLWindows 3.0, the latest version of Gupta's graphical application-development system for Structured Query Language databases, now lets you do most of your interface programming visually. As you draw objects in the design window, the code for the objects appears in the outliner. You can modify code in the outliner.

To help with programming workgroups, SQLWindows 3.0 lets you separately define application objects and include them in various applications. SQLWindows 3.0 adds over 150 SQLWindows Application Language functions. Systems for Oracle or Microsoft SQL Server are under development.
Price: $1295; SQLWindows Client-Server Starter Kit, which includes a five-user DOS SQLBase Server, SQLWindows 3.0, and one copy of Quest, $1995.
Contact: Gupta Technologies, Inc., 1040 Marsh Rd., Menlo Park, CA 94025, (415) 321-9500; fax (415) 321-5471.
Circle 1176 on Inquiry Card.

Better Graphics for Text-Mode Library

Version 3.3 of the Mewel Window Library, which lets you create text-mode applications that have the look and feel of a Windows 3.0 program, offers the improved ability to run applications in graphics mode under EGA or VGA systems. Support for graphics lets you toggle your program between the DOS text and the graphics modes and use third-party graphics libraries to display graphics in your Mewel application, Magma Software Systems reports.

Mewel supports DOS, OS/2, Unix, and VAX/VMS platforms. It is application programming interface–compatible with Windows, letting you port your existing Windows application to text mode for use on low-end machines. Mewel lets you support DOS, extended DOS, OS/2 Protected Mode, Unix, and VAX/VMS with one set of C source code.

Version 3.3's new graphical-device interface wrapper provides a subset of the Windows Graphical Device Interface. The wrapper supports graphics libraries from Microsoft, Borland, and Genus. It contains functions for reading and displaying a PCX file, a Windows BMP file, and a Windows ICO file from within a Mewel program.
Price: $295; with source code, $595.
Contact: Magma Software Systems, 15 Bodwell Ter., Millburn, NJ 07041, (201) 912-0192; fax (201) 912-0103.
Circle 1178 on Inquiry Card.

World Radio History

Prograph Adds Database, SQL Support

Version 2.5 of Prograph, the visual programming environment for the Mac, adds a database engine and support for System 7.0 Inter-Application Communications. Prograph will also connect to Structured Query Language databases through interfaces for Apple's Data Access Language (DAL) and Oracle.

The new database engine lets you create databases that accommodate text, numeric, Mac (e.g., picture and icon), and Prograph object data types. It supports multiple tables per database, indexed key access, and multiuser access. Databases can be flat file, relational, or object-based.

Price: $495; DAL application programming interface, $199; Oracle API, $199; FORTRAN interface, $149; Pascal interface, $75.

Contact: TGS Systems, 2745 Dutch Village Rd., Suite 200, Halifax, Nova Scotia, Canada B3L 4G7, (800) 565-1978 or (902) 455-4446; fax (902) 455-2246.

Circle 1180 on Inquiry Card.

Evergreen Comes In Low with CASE Tool

Seeking to do for the CASE market what companies such as Borland and Generic did with their respective low-cost programming and CAD offerings, Evergreen has developed EasyCASE Plus 3.0. For under $500, the program offers front-end CASE technology for the PC with a Systems Application Architecture/Common User Access–compliant interface, click-and-drag selection and manipulation of chart objects, PostScript support, and a dBase III Plus–compatible data dictionary.

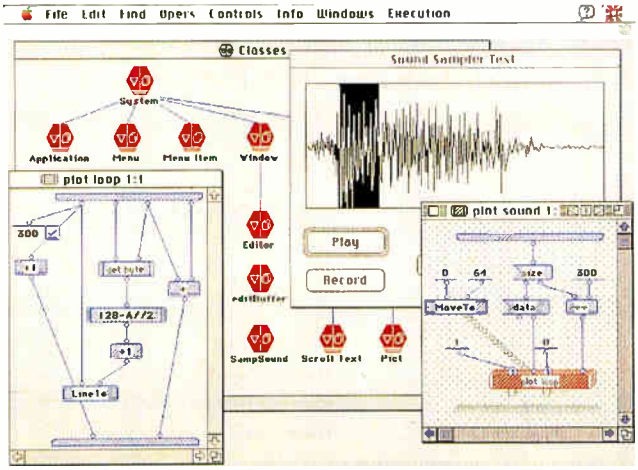
Version 3.0 of the program supports Martin entity-relationship diagrams and adds record and element definition for enhanced data modeling. EasyCASE Plus 3.0 supports data-flow diagrams, transformation schemata (real-time extensions to DFDs), state-transition diagrams, entity-relationship diagrams, data-model diagrams, and structure charts.

An optional program called EasyCASE Professional 3.0 performs chart and data-dictionary consistency checking and verification against specific layout and methodology rules.

Price: $495; EasyCASE Professional 3.0, $649.

Contact: Evergreen CASE Tools, Inc., 16650 Northeast 79th St., Suite 200, Redmond, WA 98052, (206) 881-5149; fax (206) 883-7676.

Circle 1181 on Inquiry Card.



Prograph is object-oriented and visual. It lets you see where data originates and where it goes. Operation icons and data links create data-flow diagrams that are the code of a program.

Kubota Opens Its 3-D Graphics Library

DORE (Dynamic Object Rendering Environment), the 3-D graphics application development environment, has been opened up, letting you plug in the renderers, devices, and primitives that best suit your needs and the processing power of various target platforms.

Version 5.0 comes with complete source code and specifications for the applications and internal interfaces. DORE works on several platforms, including Silicon Graphics (which is the reference port), Sun CXP, and Stardent, as well as hardware platforms based on Unix and X Window System 11. DORE is also portable to Hewlett-Packard and IBM RISC System/6000 workstations.

Price: $5000.

Contact: Kubota Pacific Computer, Inc., 2630 Walsh Ave., Santa Clara, CA 95051, (408) 727-8100; fax (408) 727-9301.

Circle 1182 on Inquiry Card.

Windowing Added to dBase Generator

Genifer 3.0 adds a new user interface to the template-driven application generator for dBase, with windowing, pull-down menus, and a built-in screen editor. Other new features include browse lists, dialog boxes, pop-up windows for data screens, and the ability to change screen colors while Genifer is running.

Version 3.0 adds direct database indexing in the data dictionary, automatic or manual index expression, improved error checking and error messages, and window-only or full-screen data entry.

Price: $395.

Contact: Bytel Corp., 1029 Solano Ave., Berkeley, CA 94706, (800) 777-0126 or (415) 527-1157; fax (415) 527-6957.

Circle 1183 on Inquiry Card.

Widgets for X

Xtra XWidgets, a new toolkit for building widgets for Motif and Open Look applications, provides a library of reusable application-level components (e.g., pie charts and bar graphs). The widgets, basic building blocks for creating the GUI of an application, enhance and complement those already provided by Motif and Open Look. Xtra XWidgets supports Interactive 386, IBM, Hewlett-Packard, and Sun platforms.

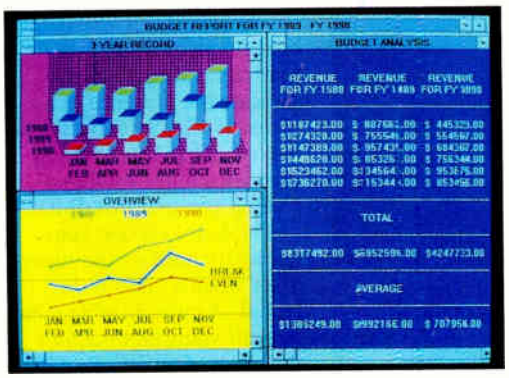
Price: $795.

Contact: Graphical Software Technology, 1559 East Pacific Coast Hwy., Suite 300, Hermosa Beach, CA 90254, (213) 328-9338; fax (213) 374-0134.

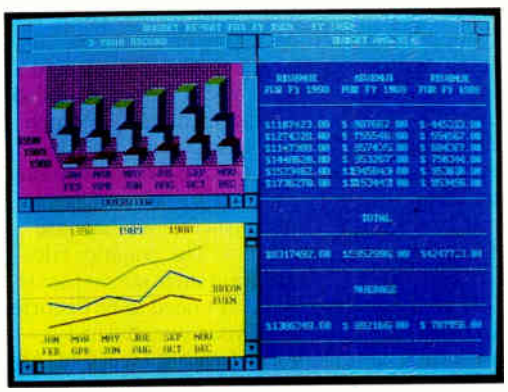
Circle 1184 on Inquiry Card.

World Radio History

Only one programming language lets you cross develop for Windows 3.0 and MS-DOS without rewriting code. Introducing GFA-BASIC.



GFA-BASIC for Windows



GFA-BASIC for MS-DOS

```
main
PROCEDURE main
  set_database
  bar_graph
  line_graph
  budget_a
  stop_program
RETURN
> PROCEDURE set_database
> PROCEDURE bar_graph
```

With GFA-BASIC you use the same commands and functions whether you are developing for Windows 3.0 or MS-DOS.

GFA-BASIC gives you a simple, but powerful, language for developing sophisticated, state-of-the-art Windows 3.0™ and MS-DOS™ applications. Write a program with either the DOS or Windows version of GFA-BASIC and port it to the other platform, maintaining a common look and feel.

One set of source code

Both versions of GFA-BASIC include 500 system and mathematical commands and functions to facilitate software development. At the same time, common commands and functions enable you to develop and maintain a single set of source code for each program.

Simplifies GUI development

Another 400 commands and functions in the Windows version simplify the development of a complete GUI interface, including clipboard, DDE, DLL's, and dialog boxes. And, you don't need any additional libraries or the SDK.

In the DOS version, a subset of the same commands and functions lets you bring Windows-like programs to AT- and XT-class PCs without using any additional tools.

Bind in existing routines

What's more, routines you've already developed in C or Assembler can be bound into a compiled GFA-BASIC program. And, GFA-BASIC supports arrays larger than 64K as well as the use of EMS in DOS.

Half Price Introductory Offer

	list	intro
GFA-BASIC for Windows 3.0	$ 495.00	$ 295.00
GFA-BASIC for MS-DOS	$ 295.00	$ 235.00
Both Windows and DOS version	$ 790.00	**$ 395.00**

offer expires November 14, 1991

Add it all up and you have a very low-cost, easy-to-use structured language for developing Windows and MS-DOS applications[1]. To see for yourself how powerful GFA-BASIC is, just ask for our free demo disk. Call 1-800-766-6GFA, or write GFA Software Technologies, Inc.; 27 Congress St.; Salem, MA 01970; Fax (508) 744-8041.

GFA
SOFTWARE TECHNOLOGIES INC.

Call: 1-800-766-6GFA

[1]UNIX and OS/2 versions of GFA-BASIC available in 1992.
Windows 3.0 and MS-DOS are trademarks of Microsoft Corporation.

Circle 603 on Inquiry Card.

World Radio History

NEWS

Sounds for Hollywood

PC-Sound enhances IBM's Windows-based Hollywood graphics program by letting you add music and sound effects to presentations. You can import sounds from the four disks of PC-Soundclips or create your own audio effects using PC-Recorder.

PC-Sound for IBM Hollywood ships with SoundPort, an adapter that plugs into the PC's printer port, and an amplified minispeaker. The system is also available for Harvard Graphics and Freelance Graphics.

Price: $98; PC-Recorder, $198.

Contact: Arkay Technologies, Inc., 5 Tsienneto Rd., Suite 2, Derry, NH 03038, (603) 425-2149; fax (603) 434-5674.

Circle 1185 on Inquiry Card.

Your Hollywood presentations will have all the pizzazz of Tinsel Town when you use PC-Sound to add audio punch.

OmniPage 3.0 Integrates Tools in an OCR

OmniPage 3.0, page-recognition software for Mac-compatible scanners, integrates spelling-checking and draft dot-matrix recognition modules that were previously available as separate packages.

OmniSpell features error-recognition and -correction capabilities. OmniDraft recognizes text printed in draft mode on nine-pin dot-matrix printers. Version 3.0 supports Publish/Subscribe under System 7.0, Caere says.

Price: $695.

Contact: Caere Corp., 100 Cooper Court, Los Gatos, CA 95030, (408) 395-7000; fax (408) 354-2743.

Circle 1186 on Inquiry Card.

Utilities Galore for System 7.0

Go Technology and Advanced Software offer programs to enhance the Mac System 7.0 environment.

Hot Keys for System 7.0 Finder lets you invoke predefined macros through function keys on the extended keyboard. You can use the 18 global macros included with the program on most Mac applications or use the included version of MacroMaker to make your own macros. The program also includes Super 7, an on-line tutorial and help facility that contains 23 explanatory screens.

Price: $59.95.

Contact: Go Technology, Inc., P.O. Box 7667, Incline Village, NV 89450, (800) 468-5391 or (702) 831-3100.

Circle 1187 on Inquiry Card.

QuickTools is Advanced Software's collection of eight System 7.0 utilities that can be integrated into your system.

PowerStrip is an application launcher. Snipper is a 24-bit color screen capture program. Sunset is a screen saver with 30 modules. Work Saver issues a save command at specified intervals. Instant Menus brings the menu to your cursor and allows program and window switching. Barricade provides security. Dialog Power assigns unique command-key equivalents to each option in a dialog box. Functionality enables the F1 through F4 keys on an extended keyboard to undo, cut, copy, and paste.

Price: $79.95.

Contact: Advanced Software, Inc., 1095 East Duane Ave., Suite 103, Sunnyvale, CA 94086, (800) 346-5392 or (408) 733-0745.

Circle 1188 on Inquiry Card.

XTree Branches Out

ViruSafe, ViruSafe/LAN, and AllSafe are three new programs from XTree that add file protection and security to your PC.

ViruSafe monitors, detects, and removes known and unknown viruses in memory, file allocation tables, boot sectors, partition tables, root directories, and executable files. The program can isolate the signatures of unknown viruses and use that information to strengthen its defenses, XTree reports. It also detects changes in memory size or interrupt values that may indicate the presence of a virus. If ViruSafe itself is attacked, it can dynamically reconstruct itself without forcing you to reinstall it.

The LAN version automatically notifies the supervisor when a virus is detected. A customizable menu can tell you who to call in the event of an attack. AllSafe provides system password security and file encryption.

XTree has also released XTreeGold 2.5, its hard disk management utility, which now has 13 graphics-file viewers to go along with the program's word processing, spreadsheet, and database viewers. The graphics files maintain their normal scale and don't need to be distorted to fit your screen when viewed with XTreeGold. You can navigate images that are larger than the screen using the keyboard.

Version 2.5 features an improved AutoView feature and support for many popular graphics file formats, including BMP, DXF, IFF, and PIC.

Price: ViruSafe, $99; ViruSafe/LAN, $595; AllSafe, $129, XTreeGold 2.5, $149.

Contact: XTree Co., 4330 Santa Fe Rd., San Luis Obispo, CA 93401, (805) 541-0604; fax (805) 541-8053.

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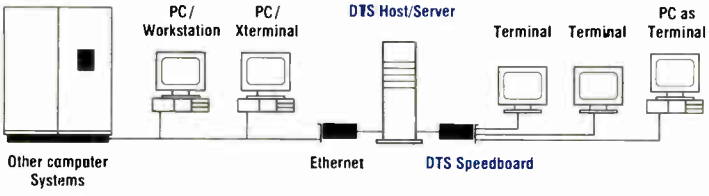
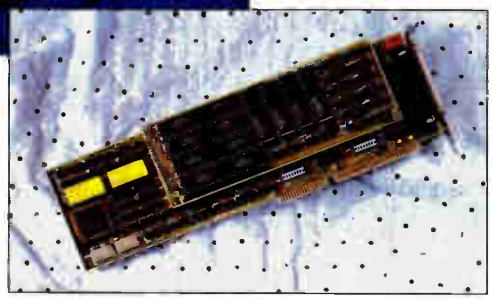
Designed for today's growing multiuser environment, our **433e Host/Server** and **433i Host** are equipped with the powerful Intel 80486 CPU and Datatrans Speedboard. Both systems come with SCO UNIX operating system pre-installed and fully tested, so you can get it up and running quickly and easily. Our 433i Host is a truly affordable solution for small-to-medium sized businesses. Our 433e Host/Server is Ethernet ready, thus acts simultaneously as a UNIX multiuser host and a UNIX network server.





Datatrans Speedboard™ is a proprietary serial I/O controller, developed by Datatrans to handle heavy data transfer in a multiuser computing environment. With its on-board 16 MHz 80186 processor, up to 512 KB of memory buffer, and statistical supporting software, Speedboard relieves main CPU overhead and effectively accelerates I/O speed.

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- 1.2 GB SCSI drive arrays
- 1.3 GB DAT tape backup
- Monochrome VGA display
- 32-user subsystem ready (max. 64-user)
- SCO UNIX V/386 OS installed
- 3COM Ethernet ready

$14,995

DTS 433i Host

- 80486-33 MHz ISA
- 8 MB RAM (max. 64 MB)
- 1.2 MB 5.25" floppy drive
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- 210 MB hard drive
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- 8-user subsystem ready (max. 64-user)
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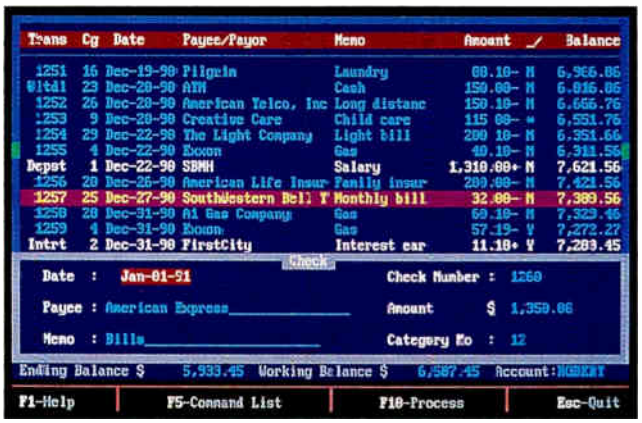
Circle 623 on Inquiry Card (RESELLERS: 624).

World Radio History

Small-Business Management from 786

CheckStar IV, a personal and small-business financial management program for the PC, offers tools for budgeting, account reconciliation, cash-flow analysis, and check writing. The program lets you print checks in many formats, and you can modify, relocate, copy, erase, and sort transactions by date or check number, according to 786 Systems.

Built-in utilities include a text editor and note pad, three calculators, text-file viewing, a reminder, and a calendar. A cash-reservation system with automatic updating helps you maintain a cash-flow balance.
Price: $59.95.
Contact: 786 Systems, Inc., P.O. Box 55135, Houston, TX 77255, (713) 464-3713.
Circle 1190 on Inquiry Card.



CheckStar IV, a financial management program for small businesses, lets you print checks in many formats on the PC.

QED's Worldly Business

QED Office, a program for business workgroups running PCs on a network, offers office automation and the ability to communicate with other E-mail systems through its X.25 and X.400 mail gateways. The program's support for international gateways complements its support for LAN, fax, and telex communications.

QED Office has E-mail, calendar management with automatic scheduling, document and form creation, a filing system, contact database management, and a reminder system. The filing system provides document management capabilities, letting you store key information in folders for fast retrieval. Each electronic message can have up to five attached documents.

QED Office runs on NetBIOS-based networks and requires a dedicated PC for its office message controller.
Price: Five-node version, $595.
Contact: Strategy Marketing Associates, 2785 Pacific Coast Hwy., Suite 251, Torrance, CA 90505, (213) 378-7632; fax (213) 378-8285.
Circle 1193 on Inquiry Card.

Contact Plus Turns Pro

Following a successful life as a shareware product, Contact Plus is now also available in commercial and network versions. Contact Plus Professional lets you record and display appointments, meetings, correspondence, and conversations with each client.

The program has native-file interfaces for WordPerfect, WordStar, and XyWrite, and it offers its own word processor. Contact Plus Professional supports mail merge, auto-dialing with time and date stamping, prebuilt reports, ticklers, and expense tracking, and it has a calendar that can display all your upcoming events. Optional interfaces to dBase, Paradox, and Power Up's Calendar Creator Plus are available.
Price: Contact Plus Professional, $250; Contact Plus shareware version, $79.
Contact: Contact Plus Corp., P.O. Box 372577, Satellite Beach, FL 32937, (800) 366-9876 or (407) 779-4900; fax (407) 779-3311.
Circle 1194 on Inquiry Card.

Entry-Level Planning for the Mac

A new addition to Micro Planning International's line of project management programs for the Mac and the PC offers entry-level planning on the Mac. Micro Planner Manager can pass information to MPI's high-capacity products, such as X-Pert for the Mac ($1995), and export and import files directly from Micro Planner for Windows, MacProject II, and Insta-Plan for the PC.

Micro Planner Manager's inner desktop lets you build and modify projects using PERT, Gantt, outline, or spreadsheet models and charts. The program can handle up to 1500 activities and five subprojects per project. Micro Planner Manager supports cash-flow forecasting, job costing, and budget control.
Price: $595.
Contact: Micro Planning International, Inc., 655 Redwood Hwy., Suite 311, Mill Valley, CA 94941, (415) 389-1414; fax (415) 389-8046.
Circle 1192 on Inquiry Card.

Intuit Adds More Reporting, Cash Management

Quicken 3.0 for the Mac, a major upgrade of the financial management program, adds credit card and cash management, electronic bill paying, asset and liability management, and more report templates.

New preset business reports include income statement, balance sheet, payroll, and several others.

If you have more than one bank account or credit card, Quicken 3.0's instant reports can consolidate information from all accounts or from selected accounts. Electronic payment is achieved through CheckFree ($9.95 minimum monthly fee).
Price: $69.95.
Contact: Intuit, Inc., 155 Linfield Ave., P.O. Box 3014, Menlo Park, CA 94026, (800) 624-8742 or (415) 322-0573.
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World Radio History

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		ESDI/EISA 32-bit Controller	add $795

SHOPPER'S ADVISORY--The 25MHz 486 is a thing of the past. It offers no performance advantage over a 386/33MHz System (with coprocessor). While other distributors are more than willing to liquidate their outdated components on the public, we continue our commitment to providing the highest quality components at the best price. **All LSI Professional Systems Are FCC Certified.**

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Circle 608 on Inquiry Card (RESELLERS: 609).

World Radio History

NEWS

WHAT'S NEW • WORD PROCESSING / DOCUMENT MANAGEMENT

QuickPix Nixes Plain Text Applications

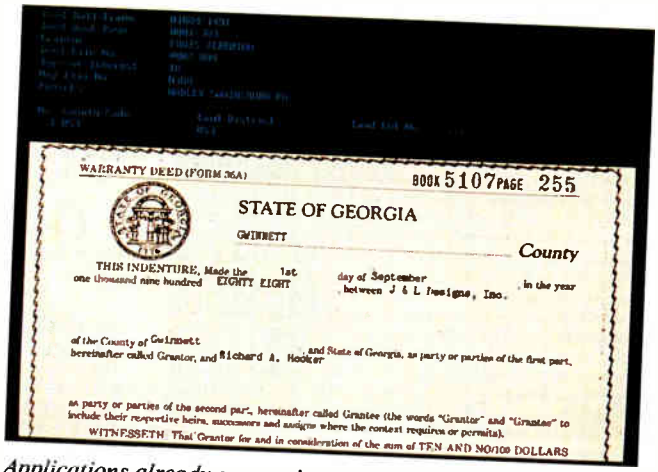
QuickPix 1.1, a program that lets you add image management capabilities to your existing DOS applications, now supports the incorporation of TIFF graphics into a program. QuickPix enables you to add images to what would otherwise be plain text-only applications, and it lets you see images as you browse through records and fields in your real-estate, parts-inventory, or accounting application.

QuickPix 1.1 lets you work with text as you view the displayed PCX or TIFF image. The new program automatically scales images to fit an allocated space, or you can pan around the image. The program can also print color graphics in halftone format on black-and-white printers.

Price: $495; LAN version, $895 per server.

Contact: PowerSoft, Inc., P.O. Box 956338, Duluth, GA 30136, (800) 437-4128 or (404) 418-0821; fax (404) 928-9294.

Circle 1195 on Inquiry Card.



Applications already supporting record locking and indexing gain the added benefit of imaging with QuickPix. The program lets you integrate PCX or TIFF images with your text-based applications. In this application, you can see an image of a check as you access its associated record.

SoftSolution Adds Imaging

A new image-processing add-on for the SoftSolution document management system lets you manage and control images as components of a compound document system. With SoftSolution Image Manager, you can store images or convert them to TIF, PCX, or CCITT Group 3 or Group 4 formats. Once in the system, you can attach documents to the images so that you can access the document by its profile or through a full-text search.

SoftSolution Image Manager works with the SoftSolution Advanced and Global systems. Global, for NetWare 2.x and 3.x and Unix, offers wide-area networking capabilities.

All products use the same search technology, called SpeedSearch, which SoftSolutions says it has patented. You can search for documents by concept or topic. The image manager integrates with LaserMaster's printing and scanning cards, and it is sold as an add-on for the DOS versions of Advanced and Global.

Price: SoftSolution Image Manager: $125 per server; $120 per workstation. Advanced: $1495 per server; $195 per workstation. Global for NetWare: $2495 per server; $295 per workstation.

Contact: SoftSolutions Technology Corp., Park-View Plaza, 625 South State St., Orem, UT 84058, (801) 226-6000; fax (801) 224-0920.

Circle 1196 on Inquiry Card.

Imara for Windows

Imara, the document management program first developed for OS/2, is now available in a Windows-client version. The Windows client runs on Imara's new version 2.0 for OS/2, which lets you annotate pages of information with voice tabs or written tabs. The voice annotation can be a simple message or a response to correspondence.

Imara (see "Document Management on Networked PCs," November 1990 BYTE) includes a mail system for sharing documents on the network and the ability to directly send and receive faxes. The company has added, through the Windows client optical character recognition, functionality from within Imara.

Price: Windows client, $1995; Imara 2.0 for OS/2: stand-alone version, $2495; workstation license, $1995 each.

Contact: Imara Research Corp., 111 Peter St., Suite 804, Toronto, Ontario, Canada M5V 2H1, (416) 581-1740; fax (416) 581-1605.

Circle 1197 on Inquiry Card.

Document Tracking for the Legal Profession

For managing documents in a paper-intensive legal environment, CAT-Links developed the Case-Links Document Manager. To use the program, you need to input data into abstracts that contain fields for date, author, recipient, and other information regarding each document. Once you've done that, you can search up to 1 million documents per case, the company reports.

Price: $1250.

Contact: Cat-Links, Inc., 2100 North Broadway, Suite 320, Santa Ana, CA 92706, (800) 825-4657 or (714) 834-0563.

Circle 1198 on Inquiry Card.

Yes, Virginia, There Is Sonar for Sparcstations

Virginia Systems now offers a version of its Sonar Professional Text Retrieval System for Sun Sparcstations running under Open Look. According to the company, when you use advanced keyword searching techniques, search speeds can exceed 15,000 pages per second. The program was originally developed for the Mac.

Price: Single-user license, $1499.

Contact: Virginia Systems Software Services, Inc., 5509 West Bay Court, Midlothian, VA 23112, (804) 739-3200; fax (804) 739-8376.

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World Radio History

Two Multimedia Encyclopedias for CD-ROM

Not only can you read up on some of your favorite subjects in Britannica's two latest CD-ROM discs for the PC, but you can listen up, too. Both Compton's Family Encyclopedia with World Atlas and Compton's MultiMedia Encyclopedia for Windows 3.0 let you view text and images while listening to sound excerpts in selected entries.

The new family edition of Compton's Encyclopedia offers more than 8 million words in over 30,000 articles; 15,000 maps, images, and graphs; 30 minutes of sound; and an interactive, multiple-windowed World Atlas. The program's search-and-retrieval system lets you type in questions and find the answers almost immediately. A notebook feature lets you cut, paste, and write your own notes.

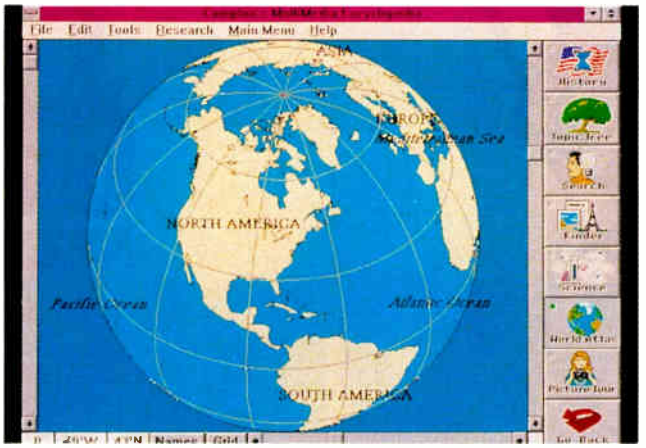
The MultiMedia Encyclopedia offers more than 15,000 illustrations, over 9 million words, 45 animated sequences, 60 minutes of music and sound, and a search-and-retrieval system. Both discs have on-line dictionaries.

The Family Encyclopedia requires an IBM XT, DOS 3.3, a CD-ROM drive with audio output, and 512 KB of memory. The MultiMedia Encyclopedia requires an IBM AT or better, Windows 3.0, 2 MB of RAM, and a CD-ROM drive with a controller card.

Price: Family edition, $695; MultiMedia version, $795.

Contact: Britannica Software, Inc., 345 Fourth St., San Francisco, CA 94107, (800) 533-0130 or (415) 597-5555; fax (415) 546-1887.

Circle 1201 on Inquiry Card.



Compton's MultiMedia Encyclopedia for Windows 3.0 lets you explore the world through text, images, sound, and animation.

An Entire Stand of Monarch Notes on CD-ROM

Remember the good old days of Literature 101 and how the *Monarch Notes* helped you keep all those Russian names straight in Dostoyevski's *Crime and Punishment*? Even if you didn't use that particular version of *Monarch Notes*, chances are you've turned to the series at one time or another to supplement classroom lectures and otherwise help in a pinch. Now more than 200 different titles of *Monarch Notes* are available on CD-ROM discs for the Mac and the PC.

The CD-ROM version of the Monarch Notes has every word of every Monarch Note published. Also included are pictures and drawings of the authors, characters, and settings, many in full color.

Complete word and title indexing lets you search and correlate concepts.

Price: $99.

Contact: Bureau of Electronic Publishing, Inc., 141 New Rd., Parsippany, NJ 07054, (800) 828-4766 or (201) 808-2700; fax (201) 808-2676.

Circle 1202 on Inquiry Card.

Eleven Years of Facts on CD-ROM

The past 11 years' articles and cumulative indexes from the *Facts on File World News Digest* are now on the updated edition of Facts on File News Digest CD-ROM. Covering the years 1980 through 1990, the CD-ROM disc provides the full text—not just the summaries—that appeared in the printed version of *News Digest*, according to Facts on File.

The CD-ROM disc is compatible with the PC and the Mac. Features include more than 500 maps, keyword search capabilities, index browsing, and a mark function.

Price: In the U.S.: subscribers, $695; nonsubscribers, $795; annual update, $195. In Canada: subscribers, $870; nonsubscribers, $1000; annual update, $253.

Contact: Facts on File, Inc., 460 Park Ave. S, New York, NY 10016, (212) 683-2244.

Circle 1204 on Inquiry Card.

PhoneDisc Finds the Number for You

Although it's hard to imagine Chuck Berry crooning to a CD-ROM drive for long-distance information from Memphis, Tennessee, that's just what he can now do with a new line of CD-ROM discs from PhoneDisc USA. The two latest additions to the line of telephone-directory CD-ROM discs, which run on the PC, are PhoneDisc California + and QuickRef +.

PhoneDisc California + includes nearly 14 million white-page listings in California. You can search the directory by name, address, telephone number, or ZIP code. The company updates the CD-ROM disc semiannually, and, for $200 more, you can get quarterly updates.

QuickRef + contains the most frequently called telephone numbers in the U.S. The first edition covers businesses, government contacts, schools, libraries, and toll-free numbers. The CD-ROM disc is updated annually.

Other PhoneDisc titles cover different regions, including New York and New England, Western U.S., Eastern U.S., Canada, and Germany. All these titles are compatible with each other, and you can access them in seamless fashion over networks or multiple-drive environments, the company says.

Price: PhoneDisc California + annual subscription, $995; QuickRef +, $299.

Contact: PhoneDisc USA Corp., 8 Doaks Lane, Little Harbor, Marblehead, MA 01945, (800) 284-8353 or (617) 639-2900; fax (800) 284-8355.

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World Radio History

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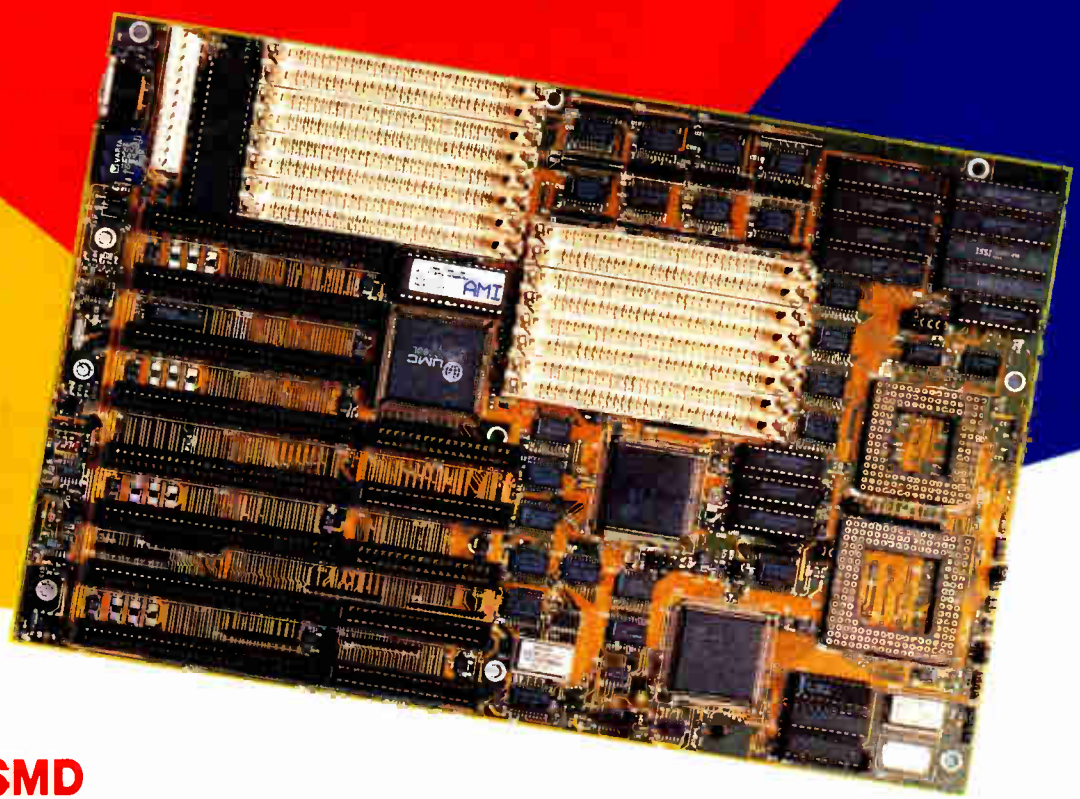

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World Radio History

Harvard Draw Complements Business

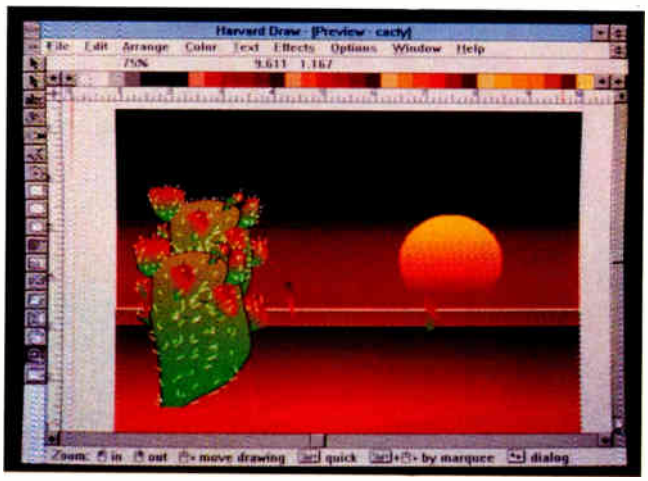
A new program from Software Publishing called Harvard Draw lets you produce illustrations to complement your presentations, reports, and internal documents. The program is the first Windows-based illustration program that lets you draw and edit effectively in the preview mode, the company says. When creating an image in the preview mode, you can see color applications and line widths immediately, bypassing the tedious process of working in the limited outline mode and viewing changes in the preview mode.

Color thumbnails appear when you highlight a filename in a directory. You can create drawings entirely in the color preview mode.

Price: $595.

Contact: Software Publishing Corp., 1901 Landings Dr., P.O. Box 7210, Mountain View, CA 94039, (415) 962-8910.

Circle 1206 on Inquiry Card.



An information bar at the bottom of Harvard Draw's screen provides a quick reference regarding the capabilities of icons and menu commands.

Jaggies Are Gone

JAG (jaggies are gone) for the Mac can antialias (smooth) 8- and 24-bit still images and animations and deliver improved images in PICT and antialiasing animation (PICS) output file formats. Not only does JAG remove the dreaded stair-step effect caused during the sampling process, but in PICS files, JAG can output 24-bit animations to videotape, Ray Dream reports. JAG can save images in NTSC-compliant format, and it's System 7.0–compatible.

Price: $99.95.

Contact: Ray Dream, Inc., 1804 North Shoreline Blvd., Mountain View, CA 94043, (415) 960-0766; fax (415) 960-1198.

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Illustration by Audrey Fleisher, Computer Specialist, Saatchi & Saatchi Advertising

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World Radio History

Civil War CD-ROM

The Civil War on CD-ROM includes information and images compiled from public and private sources. The major areas include biographies, statistics, chronology, equipment, campaigns, battles, foreign involvement, bibliography, political figures, and photographs. Quanta Press compiled the CD-ROM disc and distributes the PC version. Wayzata distributes the Mac version.

The disc also has music of the Civil War period, played with period instruments by Bobby Horton.
Price: $129.
Contact: Wayzata Technology, Inc., 406 Pokegama Ave. N, P.O. Box 807, Grand Rapids, MN 55744, (800) 735-7321 or (218) 326-0597; fax (218) 326-0598. Quanta Press, Inc., 2550 University Ave. W, Suite 245N, St. Paul, MN 55114, (612) 641-0714; fax (612) 644-8811.
Circle 1208 on Inquiry Card.

CD-ROMs for Multiple Platforms

A new version of the Makedisc CD-ROM formatting utility lets you place binaries for multiple computer platforms on the same CD-ROM disc. The Rock Ridge version of Makedisc, a formatting utility for preparing data before it's mastered at a CD-ROM production house, creates discs that support the ISO-9660 and X/Open XCDR standards. Discs formatted using the Rock Ridge extensions let end users run their Unix software binaries directly off a CD-ROM. The program creates POSIX-compliant disc images that are ready for in-house testing and mastering.

The Rock Ridge specifications support long (255-plus character) filenames, upper- and lowercase characters, and symbolic links. An included utility supports Unix-style names for platforms that don't have Rock Ridge drivers.
Price: $6995; software support, $950.
Contact: Young Minds, Inc., 308 West State St., Suite 2B, Redlands, CA 92373, (714) 335-2895; fax (714) 798-0488.
Circle 1209 on Inquiry Card.

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Price: $179.
Contact: CMC Research, Inc., 7150 Southwest Hampton, Suite C-120, Portland, OR 97223, (503) 639-3395; fax (503) 639-1796.
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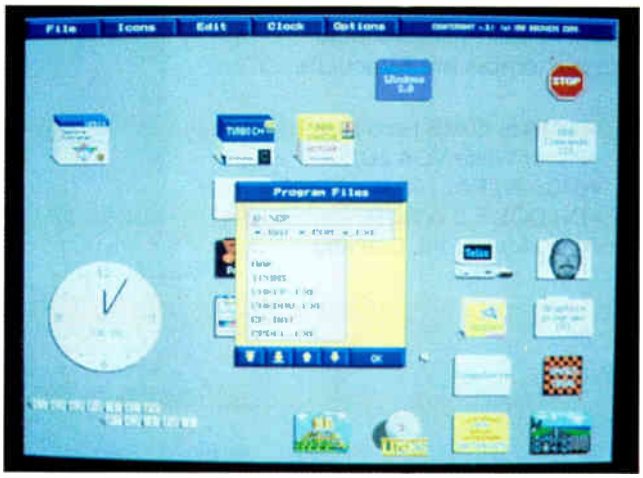

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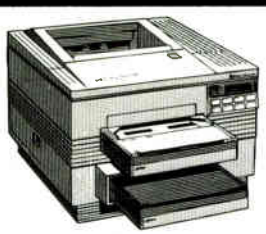

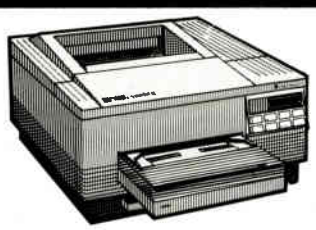

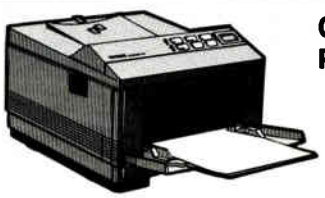

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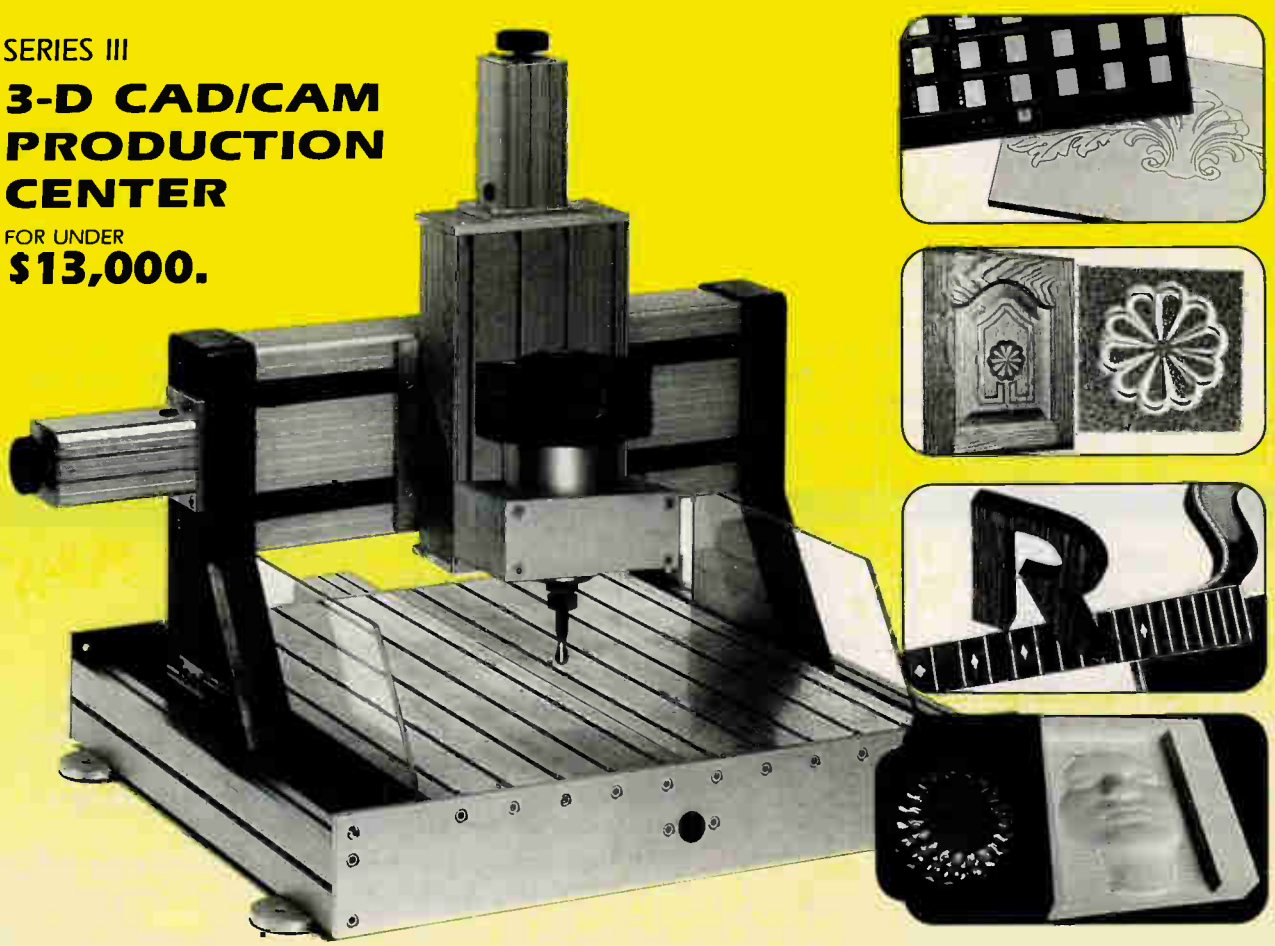

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NEWS

@Risk for Mac Excel 3.0

The Macintosh Excel add-in that lets you perform risk analyses, @Risk, is now available for Excel for the Mac 3.0 and is System 7.0–compatible. As with @Risk for 1-2-3, the program uses the Monte Carlo simulation technique to let you view model results from hundreds or thousands of what-if scenarios without requiring you to leave your worksheet or do tedious manual changes.

The new version lets you run a simulation in the background. You can also restart a completed simulation to increase the number of what-if scenarios. @Risk presents results using standard Excel charts and worksheets.

Price: $395.
Contact: Palisade Corp., 31 Decker Rd., Newfield, NY 14867, (800) 432-7475 or (607) 277-8000; fax (607) 277-8001.
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Add-ins for Lotus 1-2-3 Release 2.3

Two companies have released add-ins for the WYSIWYG Lotus 1-2-3 release 2.3.

Convergics' @Project/Graph performs critical-path analysis, calculates project costs for each project and task, and plots Gantt or PERT diagrams. @Project/Resources adds to the functionality of @Project/Graph with support for automatic resource leveling, and up-to-the-minute resource reports.
Price: @Project/Graph, $149; @Project/Resources, $249.
Contact: Convergics Corp., 7910 Ivanhoe Ave., Suite 405, La Jolla, CA 92037, (619) 689-2433.
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Intex Solutions' graphical version of Forecast provides time-series and multiple-regression analysis, seasonal adjustments, and other advanced forecasting techniques. The company says 24 other add-ins support Lotus 1-2-3 release 2.3.
Price: $165.
Contact: Intex Solutions, Inc., 161 Highland Ave., Needham, MA 02194, (617) 449-6222; fax (617) 444-2318.
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Make Your Worksheets Lean and Mean

The Worksheet Optimizer, a spreadsheet utility that reads in a worksheet file and writes out a smaller and faster optimized worksheet, now supports Quattro Pro. The utility makes its optimizations in two ways: It cleans the worksheet by doing things like removing cells that contain only a space character and optimizes worksheet formulas through algebraic simplification.
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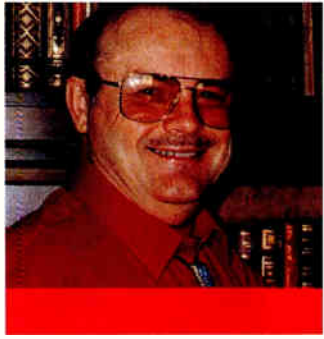


JERRY POURNELLE

STELLAR ATTRACTIONS

Well, we went to Baja for the eclipse: a long drive. The weather was variable along the eclipse's center line of totality, and it was clouded over at the coast. The Mexican authorities had set up a press camp at the point of maximum totality in the interior along the highway from La Paz to Todos Santos, but Baja California is a desert, the eclipse was at noon on July 11, and it was *hot* at that press camp; we wanted to be on the beach. We finally compromised by staying where we had camped, on the beach in Todos Santos. This was about 30 miles south of the path of maximum totality, but well within the zone of totality.

Indeed, thanks to the Magellan GPS NAV 1000 Pro navigation satellite receiver, I can tell you that we were at 23°21'55" N by 110°11'55" W. The Magellan thought we were at 46 feet altitude, but I'd put that at closer to 25 feet above sea level. It's hard to tell, of course, because the eclipse, aligning sun and moon, caused a superhigh tide, and altitude is measured conventionally from mean low water.

The eclipse was wonderful. My logbook records the location, begins to talk about shadow bands, and breaks off with "WOW!" I can see how people become eclipse freaks, traveling great distances for a good one. We went down 1000 miles of bad road, and I don't regret a moment of it.

I carried The Monster, my Zenith 386SX Supersport, as well as the Zenith Minisport and a Texas Instruments/Sharp laptop. Like the Magellan, they all worked fine despite the tropical sun and temperatures that ran upward of 110°F. The machines have since been used enough that I can conclude they weren't damaged by bouncing around in the back of the Bronco at far too high a temperature.

I'd intended to use one of the laptops to integrate data from the Magellan, but I didn't get around to it. I've since done that: if you connect the Magellan to a PC (it has a connector and comes with the proper software), you can integrate the satellite data to get any degree of accuracy you like. I am told that out at the Jet Propulsion Laboratory they use a Magellan to locate some instruments with an accuracy of *centimeters* by letting it run long enough and using appropriate statistical techniques.

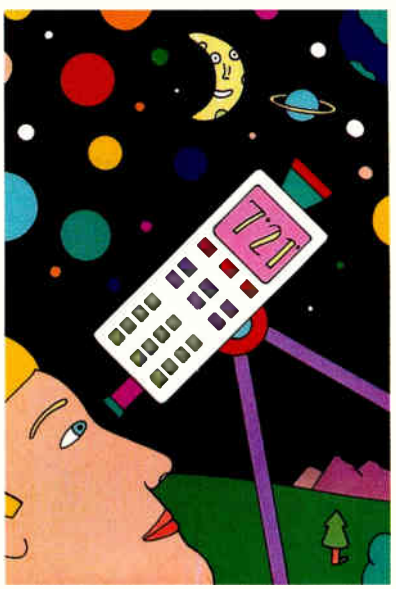
The best eclipse story is my wife Roberta's: imagine the only paved road in that part of Baja, quite lonely, for, despite all the dire warnings of overcrowding, there weren't many people down there. Now imagine a dirt road leading off into fields of giant sentinel cactus, thorny scrub bush, and sand. We went down that road 10 or 12 miles toward the beach. I was driving my son Phillip's pickup truck; Roberta had the Bronco. We came to a lonely switchback up a high hill; at the top of the hill was a magnificent view and a single camper truck. As we got to the top of the hill, Roberta rolled down the window, held out a roll, and said to the only human being we had seen for miles, "Pardon me, but would you have any Grey Poupon?...."

Jerry travels down 1000 miles of bad road to see an eclipse, sets up Roberta's new system, and looks at CD-ROMs

EZ Cosmos

Someone recently gave me a copy of this program, which does a good job of plotting what's in the sky at any particular time and place—such as here and now, or in lower Baja on July 11, 1991, at 11:40 a.m. local time. (The program shows the moon directly over the sun, as it was, and what stars and planets were visible then.)

I'd give you more details, but I've mislaid the manual, and the publishers have foolishly decided not to print their address and phone number on the box it came in.



You don't need the manuals to use EZ Cosmos. The program is intuitive: you just set in times, dates, and locations, and let it go to work. It will also draw in constellation lines and label them, and clicking the mouse on a star or planet will get you the object's name. You can zoom fields. There's a data file of photographs of objects like M31 (the Andromeda galaxy), all of which look simply wonderful in VGA; you can access those photographs either by clicking on the display or by looking them up in the photo list.

EZ Cosmos is a DOS application that installs and runs fine under Windows as well as under DOS. All told, this is a really nifty program, and one that I do recommend, but I'd be happier if Future Trends had been clever

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Setting Up

Roberta has for some years been using the Kaypro 386i as her main system. She'd been running it with a Logitech EGA and Bus Mouse Board (mouse and video port combined) and a Logitech monitor; she does mostly text work. She was rather fond of the machine, and it was plenty good enough, and indeed still is.

Roberta wanted a CD-ROM drive and a 3½-inch floppy drive, and since people are always sending us music programs, she wanted a sound board. I had all that stuff here, but it didn't get installed because it didn't make sense to put so much additional equipment in a very old and comparatively slow system.

Eventually, I got a burst of energy and set up a new system for her. By coincidence, my sometime collaborator Roland Green (we are just now finishing up *Hour of Treason*, the fourth book in the Janissaries series) has decided to update from a Kaypro 10 (a CP/M machine) to something a bit more modern, and he wanted advice on what he needed. All this got me thinking about what's nice to have, what we really need, and what we can't live without.

Gateway 2000

We've had a Gateway 2000 386/33 around for months. It has 6 MB of memory, a 200-MB hard drive, VGA, a game port, two serial ports, a parallel port, and both 5¼- and 3½-inch floppy drives. We've used it as a test-bed for new video boards, fax boards, and that sort of thing, and never had any problems: a well-burned-in, reliable 386 machine I could set up with few problems. Just the thing for Roberta's new system.

The first order of business was to back up Roberta's system. That was simple enough: I initialized a Pioneer read/write optical drive and strung a new blue "designer" LapLink serial cable from her Kaypro to the Arche Legacy 486 that houses the Pioneer drive. That worked fine at 115 KBps and in turbo mode. Transferring 50 MB that way takes time, but you don't have to watch while it does it.

We created an RJP directory on the glass disk and under that two subdirectories, C:\C1\ and C:\D1\. Everything from her C drive went into C:\C1\. LapLink creates subdirectories on the fly, so one command got it all. Then I logged onto the C:\D1\ subdirectory and blasted everything from her D partition into that.

While data was transferring from her machine to the Arche Legacy, I worked on the Gateway. First I dropped in a Hitachi CD-ROM board. As near as I can tell, those boards haven't changed for years. Hitachi has, however, updated the ROM chips in their CD-ROM drives and the driver software. The result is that their "pizza-box" CDR-1750 CD-ROM drive is very fast.

We had a shrink-wrapped Microsoft "Dove Soap Bar" Bus Mouse, so I put the bus card for that in. By now the Gateway was filling up. Roberta will be using the—*very* reliable even with line noise—US-Robotics Courier HST Dual 9600-bps external modem and a Sound Blaster sound board. There's now only one empty slot in Roberta's machine.

DOS 5.0 and Desqview

The Gateway had an older beta version of DOS 5.0, so the next order of business was to update that. DOS 5.0 demands that when you update you have ready a floppy disk in the A drive. The first one I put in was only a 360-KB disk, and the DOS 5.0 Setup demanded another, which was to teach me to use a high-density floppy disk in the first place. What I really wanted was to skip the needless backup procedure altogether, but Setup, unfortunately, won't let you do that.

Once we had DOS 5.0 updated, I installed the latest version of Quarterdeck's QEMM and Desqview. Roberta hasn't always been a Desqview user, but she's got accustomed to it in the past year. And although I am beginning to like Windows (on the Cheetah 486/33 with the very fast Perceptive Solutions hard drive controller and really snappy video accelerators), I still run Desqview on my main machine, the Cheetah 386/25.

I'm also running DOS 3.3, which means that I couldn't just copy my CONFIG.SYS and AUTOEXEC.BAT files over for Roberta's Gateway with its DOS 5.0. The only DOS 5.0 experience I have had is with Windows. There was nothing for it; I was going to have to learn to deal with DOS 5.0 and Desqview.

First things first: DOS 5.0 has its own memory managers: HIMEM.SYS and EMM386.SYS. It also has the ability to stuff most of DOS itself up into high memory, giving you much more memory to work with. On the other hand, the DOS 5.0 memory managers are larger than QEMM, which has been tailored to work with Desqview. It didn't take any effort to decide that I'd be using QEMM rather than the DOS 5.0 memory managers.

Next: the only major driver I'd have to stuff into high memory was HITACHIA.SYS, the CD-ROM driver. The rest (e.g., the mouse driver) were pretty

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small. Thus, everything seemed simple enough. I loaded QEMM, tried that out, and found that we had Desqview windows smaller than 500 KB, which wasn't acceptable, but then I hadn't done any fiddling with it.

The next thing was to try Quarterdeck's Optimize program, which is supposed to load your devices and programs to maximize memory availability, and thus provide maximum-size Desqview windows. Optimize trundled for a while and proudly announced that I now had 12 KB *less* memory than before. Clearly, this wasn't the way to go....

Time to consult the experts. I logged onto BIX.

BIX Comes Through

Quarterdeck has their own BIX conference, and "listings" has a white paper on DOS 5.0. The important information is that you do not want to let DOS 5.0 load itself high if you're going to use Desqview. DOS 5.0 and Desqview want the same area, and Desqview will use it to better advantage. There are a few other tricks, but the most important is to get DEVICE=QEMM.SYS with the RAM switch in as about the first statement in CONFIG.SYS. Then notice that you can't load buffers high anymore, and that the /X switch for BUFFERS that worked in DOS 4.0 won't work in DOS 5.0. After that, you can let Optimize do its thing, and you'll probably be fine.

That isn't what I did. After my first disappointment with Optimize, I thought I'd do it by hand. I put in DEVICE=C:\QEMM\LOADHI.SYS C:\DEV\HITACHIA.SYS in CONFIG.SYS, and in the AUTOEXEC.BAT file I put in MSCDEX (the Microsoft CD-ROM extensions) with the /E switch, meaning that it should load itself into expanded memory. This time I got Desqview windows of greater than 575 KB, which is all I needed, and indeed is larger than I get on my regular machine.

All was well. I connected the Gateway to the Arche Legacy, where Roberta's files were waiting on the Pioneer optical drive, and since the machines were only a few feet apart, I used LapLink running in parallel mode. This speeded up the file transfer something wonderful. When it was done, I used Tree86 to kill off old directories that had been on the Gateway. While I was at it, I went through C:\C1\ and C:\D1\ and slaughtered a bunch of gubbage that had been wasting space for years. Finally, I used Golden Bow's Vopt disk optimizer to repack the disk. Roberta now had one big 200-MB drive, with nearly 100 MB free.

Next: update her Desqview setups. This meant going through and using Tree86 to move some subdirectories now part of C:\C1\ out to C, or telling Desqview that files that used to be found on D were now C:\D1\. That didn't take long. Now to test the CD-ROM drive.

MSCDEX Mysteries

One of the most useful CD-ROMs we have is the Grolier Encyclopedia Americana. Having that on-line can make you an instant trivia expert; it also has more serious purposes, particularly for Roberta's on-line education conferences. Unlike most new CD-ROMs, Grolier comes with its installation software on a separate floppy disk rather than on the CD-ROM itself. I installed the 1990 Grolier software and ran that inside a Desqview window. No problem. I did a few other tests and announced that the new machine was ready.

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World Radio History

It took about an hour to disconnect her old Kaypro and install the Gateway. My first test was to log onto BIX and thank everyone for their help in setting things up. That worked, and so did everything else. It was time to demonstrate the new CD-ROM drive. We opened Grolier in a Desqview window and let it tell us about husky dogs; one feature of Grolier is a picture, and it looks just like our husky.

OK so far; now to look at some other CD-ROMs. I got out the new Quanta one on the Middle East, put it into the CD-ROM drive, and logged onto drive D—and got "Invalid Drive Specification." I dropped out of Desqview and tried again with a different CD-ROM. Same result. Try E—then all the way through the alphabet. No joy. Grolier could find that CD-ROM drive, but DOS couldn't.

Reboot, and notice that after AUTOEXEC.BAT tells the system to execute MSCDEX, I get "Incorrect DOS Version." I thought about that a bit and did three things: I logged onto BIX and sent a loud wail about the situation; I used MCI Mail (under Norton Commander) to fire off a fax query to the stalwarts at the Bureau of Electronic Publishing; and I got down a collection of DOS 5.0 books for some heavy research.

Fascinating: did you know that there are over two dozen books purporting to tell you everything about DOS 5.0—and that not one of them has anything about MSCDEX? One, *The Secrets of the DOS Masters*, has a single index reference that will tell you that MSCDEX is a Microsoft program that uses undocumented DOS features to access a CD-ROM. That's it. Wonderful.

Then two things happened: a fax came from the Bureau, and I began to get replies on BIX, both saying the same thing: MSCDEX checks for DOS versions and won't work with DOS 5.0. However, you can fool it. You put DEVICE=SETVER .EXE into your CONFIG.SYS file and execute the command SETVER MSCDEX 4.01 at the DOS command line, and lo!, DOS 5.0 will dutifully tell MSCDEX that it's really DOS 4.01; and after that, MSCDEX loads properly, and DOS 5.0 can find the CD-ROM as drive D. It turns out, incidentally, that the Grolier software knows the actual device name for the CD-ROM drive and looks for it that way, so it doesn't need MSCDEX.

Final Problem Solved

Just for the heck of it, I ran Optimize again; this time, it trundled a while and reported that it had found about 1 KB of additional memory; so Roberta now has Desqview windows of 578 KB, with the CD-ROM available in all of them. Now I wanted to show her how easy it was to transfer text from the CD-ROM to BIX, or into a Q&A Write file.

I put up the entry on Siberian husky dogs, used Desqview to mark a paragraph, and tried to transfer it into a Q&A Write window. No joy. I thought about that awhile and realized that we'd upgraded her system, but I hadn't changed anything in her Desqview profile files. I went into Desqview and called up Procomm Plus, Q&A Write, and any other programs that she might be transferring text into, and I changed the "Keyboard Conflict Level" from the default of 0 to 1.

That did it. At last count, Roberta's Gateway 2000 has much larger windows than her Kaypro 386i had (or, indeed, than my Cheetah 386/25 under DOS 3.3 has now); it's a great deal faster; the CD-ROM works splendidly; communications through the USRobotics modem are excellent; and

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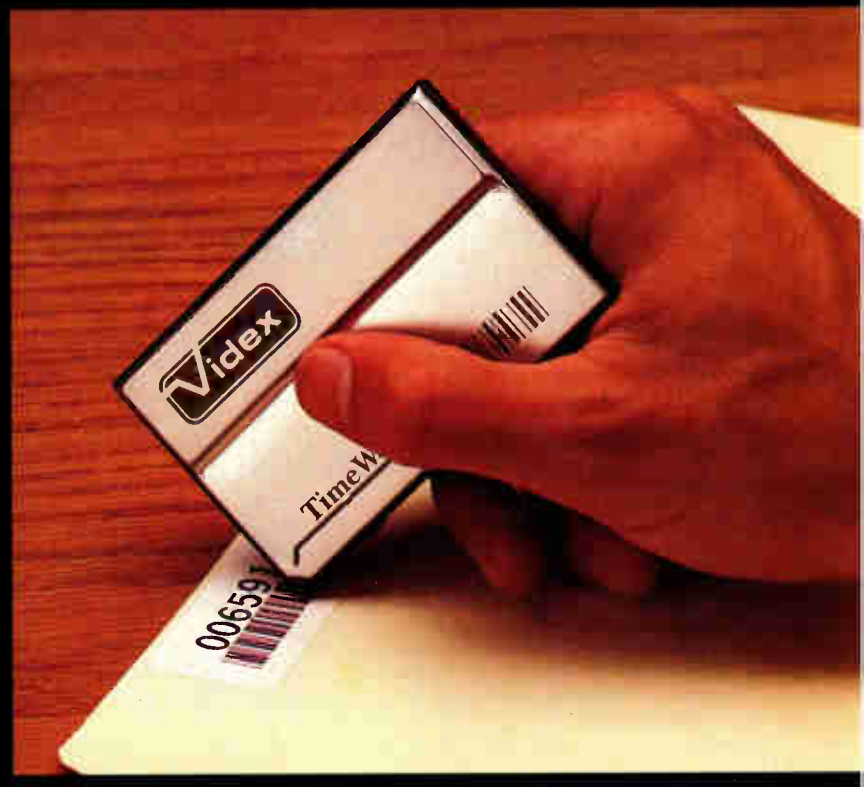

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LOOK WHO'S TALKING

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HP has developed a network trouble-shooting tool called the Network Advisor. The Network Advisor offers a comprehensive set of tools including an expert system, statistics, and protocol decodes to speed problem isolation. The NA user interface is built on a windowing system which allows multiple applications to be executed simultaneously.

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NCR has an integrated test program development environment for digital, analog and mixed mode printed circuit board testing.

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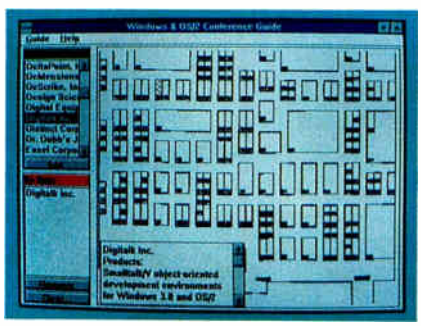
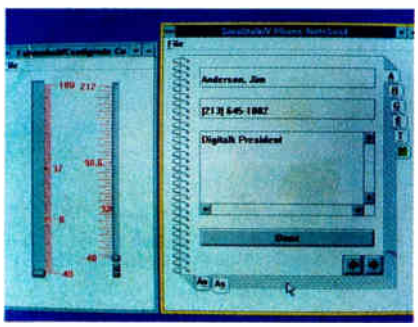


This Smalltalk/V Windows application captured the PC Week Shootout award—and it was completed in 6 hours.



Smalltalk/V PM applications are used to develop state-of-the-art CUA-compliant applications—and they're portable to Smalltalk/V Windows.

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Railroad Tycoon puts out great train sounds through the Sound Blaster and the little stereo speakers.

More as things develop, but I think you'll be hearing about her Gateway for a while.

DocuComp and DocuComp II

DocuComp is a document-comparison program: if you feed it new and older versions, it will tell you, quickly and painlessly, where and how they're different. I found that Larry and I had confused some versions of a chapter of *The Moat Around Murcheson's Eye*, and it wasn't at all clear which was the latest one.

I set DocuComp up on the Ergo Brick I take to the beach with me; the whole process took under 5 minutes, and seconds later we knew all about the differences between the two versions of Chapter Five, Part Three.

DocuComp II has a bit smoother interface and a few new features; what it won't do is work with Q&A Write files. The original DocuComp, which is still for sale, works just fine with Q&A Write files, so it's the one I use.

This is the kind of software I like: it works, and you don't need to read the manuals. It has saved me several hours of time in the few weeks I have had it. There's a Mac version, too. Highly recommended.

CD-ROMs

It's wonderful: everyone is working like mad to put out anthologies, libraries even, of classic works on CD-ROM. Pretty soon everyone who wants it will have access to the literary treasures of the world.

And the Bureau of Electronic Publishing tells me they now have a CD-ROM of the Monarch Notes. *All* of them. More, in fact, than the publisher knew: they thought there were only about 100, but then they found another 112 long out of print and buried in the publisher's warehouse, so there are 229. The Bureau had them all keyed in and indexed, and now they are all on one CD-ROM. Details next month, but this will be out by the time you read this.

The Bureau also distributes Voyage to the Planets, Volume 1, which contains images sent back by the *Voyager* spacecraft. The retrieval software was written on government contract and is horrible. Such is life. The images are wonderful.

Then there's the Bureau's Countries of the World, which has maps and data about, you guessed it, the countries of the world; it's a geography lesson in its own right, and the retrieval software is, if not elegant, at least quite good enough to do the job. It will let you browse, which you should. The interesting thing about this one is that it can run on either a PC or a Mac, and the software for both is right there on the CD-ROM. One of the Bureau founders performs on it: some of the national anthems are played by Larry Shiller on violin.

The CD-ROM of the month is the 1991 Grolier Encyclopedia Americana. Expanded and revised. Easy to browse. Phil Farmer's definition of a dullard is someone who looks up an item in the encyclopedia, turns to the item, reads it, and closes the book without being distracted by something else. One thing I had against the CD-ROM was that it made fortuitous discovery more difficult. But I find with Grolier that when we do word searches, we find a number of items worth looking at in addition to what we wanted. Good stuff.

Virus News International

The virus threat is getting serious. We've always been careful here, because I'm an obvious target and I get so much stuff on hand-labeled disks; so far I've found a few attempts—most clumsy, but there were

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two clever ones—to infect my machines. Now I have horror stories from colleagues; also, a virus got into one building at NASA. Nothing to do with flight control, but it did make life miserable for some mission planners.

A few years ago, after the Lehigh virus mess, there was a predictable spate of expensive "protection" programs accompanied by much hype. A number of users got bit despite warnings from people like me.

This time, though, it's no joke and no hype. The virus threat is very real in Europe. In the U.S., we're a few months to a year behind. Maybe. And maybe not, because these things can spread like wildfire once they get going.

There is no absolute protection from virus infections. Moreover, many of the "protection" programs are worse than useless. Useless, because they watch for "virus-like behavior," and a really clever virus writer can tunnel under the protection by hooking the proper interrupts; worse than useless because they (almost of necessity) give false alarms. One brokerage house shut down its whole operation because of a false virus alarm. It's pretty hard to measure the cost of that.

There's no absolute protection, but if you understand what a virus is and is not, and what virus protection can and cannot do, you'll be a lot better off. The best way to start off, in my judgment, is to get Dr. Solomon's Anti-Virus Toolkit.

That gets you started. After that, subscribe to *Virus News International*. It's published in England and is also available from Ontrack Computer Systems. Every issue has a readable, understandable discussion of what's new in the virus scene; they also send an update of the antivirus program that's at the heart of Dr. Solomon's system. (Dr. Alan Solomon is one of the editors of the newsletter.) I won't say that reading this soberly written and thoughtful newsletter will give you peace of mind, because sometimes it's going to scare the hell out of you; but I will say that you'll be a lot better informed about the threat. Highly recommended.

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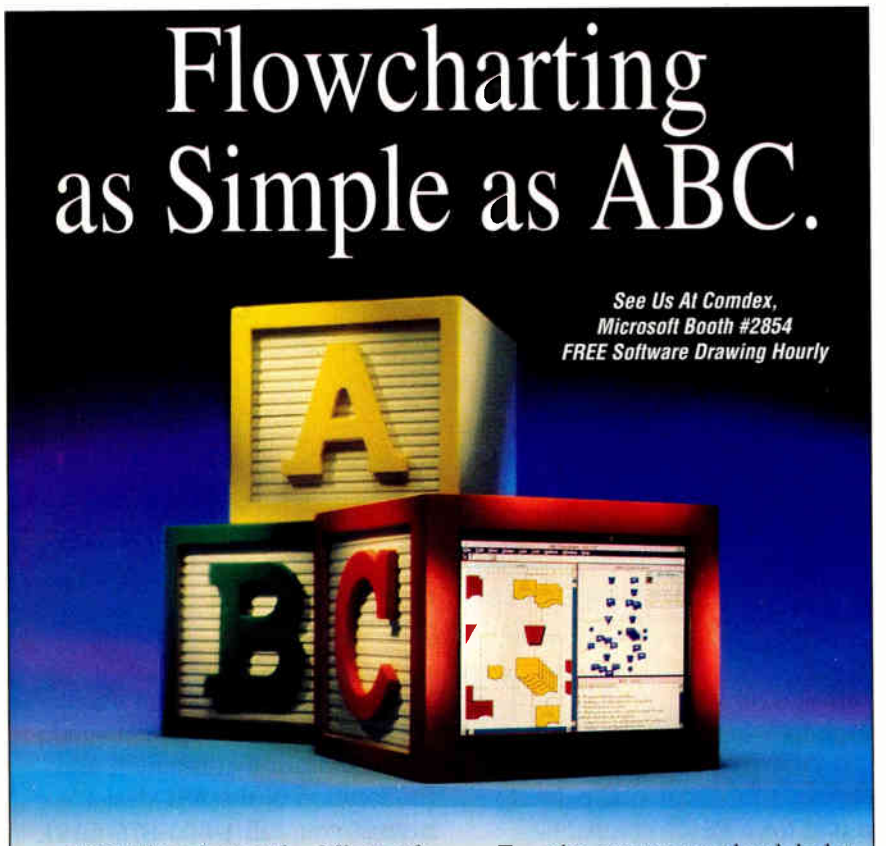

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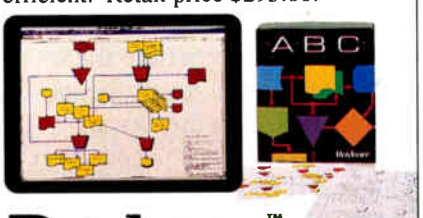

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MacroAde

WordPerfect has become enormously popular, in part because the WordPerfect people are just plain nice: they're easy to deal with, and they have the world's best telephone-support team. I don't happen to care for the WordPerfect philosophy, but I have to say that those who do like the program like it a lot.

One of WordPerfect's features is macro capabilities. They're extremely powerful. However, they are not stored in an ASCII format, so it's nontrivial to *edit* WordPerfect macros.

MacroAde, a shareware package that converts WordPerfect macros into ASCII, lets you edit them and converts the edited result back into WordPerfect's format. It also gives some neat ways to remember what macros you have defined, and how they work, and what they do. If you're a WordPerfect user, you probably want this. Recommended.

BOOTCON Again

One of the neat features of Digital Research's DR DOS 5.0 is that you can put conditional statements in CONFIG.SYS; that is, precede it with a question mark, and on boot-up DR DOS will ask if you want it to execute that or ignore it. It makes changing CONFIG.SYS much easier. Alas, there's no similar provision for modifying AUTOEXEC.BAT in DR DOS, and none for either AUTOEXEC.BAT or CONFIG.SYS in DOS 5.0. However, BOOTCON.SYS, which lets you have as

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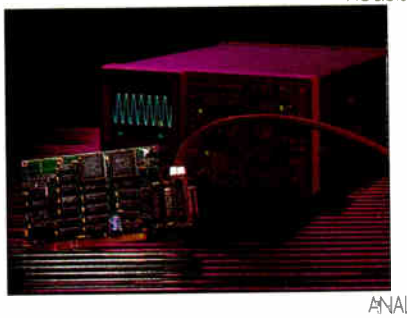

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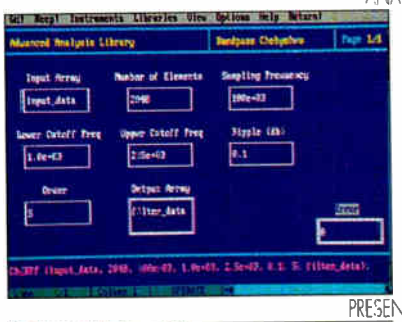

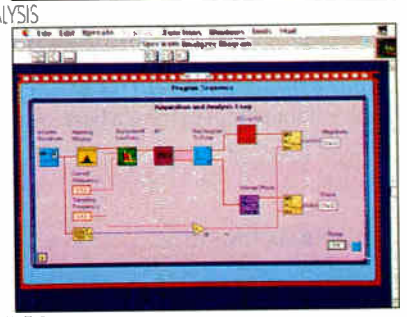

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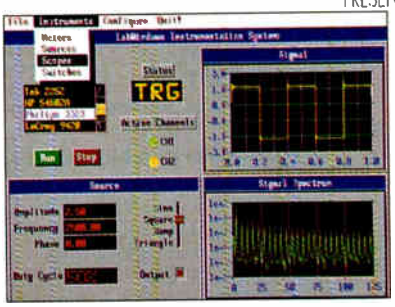

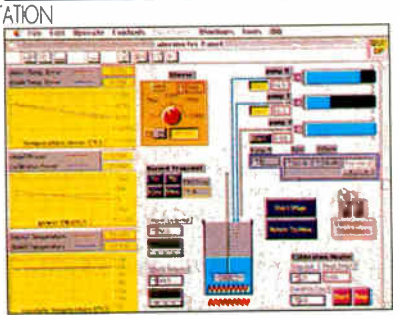

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World Radio History

many as 26 different CONFIG.SYS and AUTOEXEC.BAT combinations, now works with DOS 5.0 as well as all the earlier DOS versions.

I've been using BOOTCON on Big Cheetah with DOS 3.3 for a year now, with no problems. BOOTCON lets me boot up with WORM (write once, read many times) and CD-ROM device drivers, or without them to have a bare system. Its most popular use is switching between memory managers and allocations (e.g., use QEMM with Desqview and HIMEM.SYS with Windows).

It's really neat for experimenting with new installations, or trying to rearrange things to get that last few bytes of memory free, because you can give BOOTCON a vanilla default and put all the fancy stuff that might hang up the machine in one of the other choices. Using BOOTCON, I can tell the Arche Legacy 486 to come up in Windows (with QEMM-386 or EMM386, say) or in Desqview (QEMM, of course). And so forth. As before, highly recommended.

Results from the Precincts

The National Commission on Education was appointed 10 years ago: it reported

ITEMS DISCUSSED

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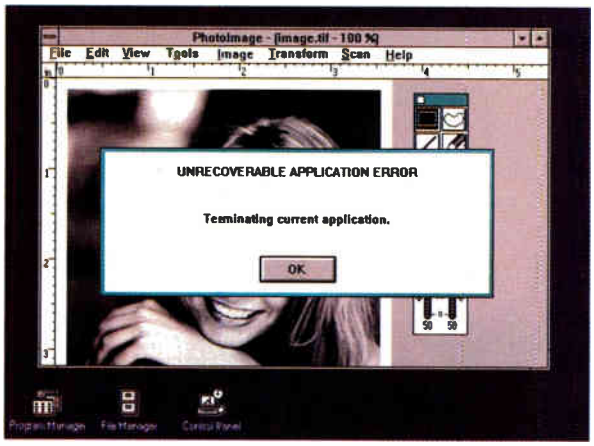

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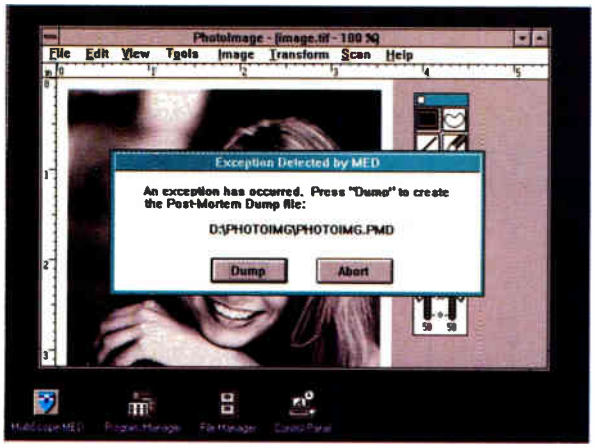

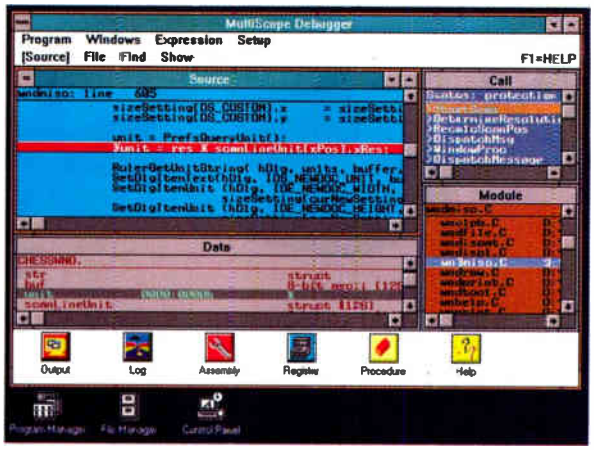

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that, "If a foreign government had imposed this system of education on the U.S., we would rightly consider that an act of war."

Mrs. Pournelle's Reading Program has been out for a few years now; the latest result is from a local elementary school, where the teacher reports using the program for one semester (under five months). *Every* student tutored with the program gained more than the school's normal gains in reading ability; most grew at twice normal; and one gained six times normal growth.

The "reading instructor" in this class was another student plus the software.

PC and Atari ST only; a Mac version is in the works.

Winding Down

The book of the month is *Boojums All the Way Through: Communicating Science in a Prosaic Age* by N. David Mermin (Cambridge University Press, 1990). This isn't always easy slogging, but it has a lot of good material about making science comprehensible. Mermin also introduced Lewis Carroll's boojum into scientific literature and tells the story in his first essay.

Last month, I mentioned a book on Railroad Tycoon. It turns out there are not one, but *two* books on that game. The first computer book of the month is Russell Sipe's *The Official Guide to Railroad Tycoon* (Compute Books, 1991). It's even better than the one I recommended last month, *Railroad Tycoon: Master Strategies for Empire Builders* by Shay Addams (Osborne/McGraw-Hill, 1991). If you love Railroad Tycoon—and how can you not?—get Russell Sipe's book.

The other computer book of the month is a CD-ROM: Microsoft Programmer's Library. If you're serious about programming, how can you be without this? The game of the month is still Martian Dreams, which infuriated me in places, but I'm not sorry I finished it.

Next month, Desqview versus Windows, and why I like both. Norton Desktop, Visual Basic, and other Windows stuff. Stay tuned. ■

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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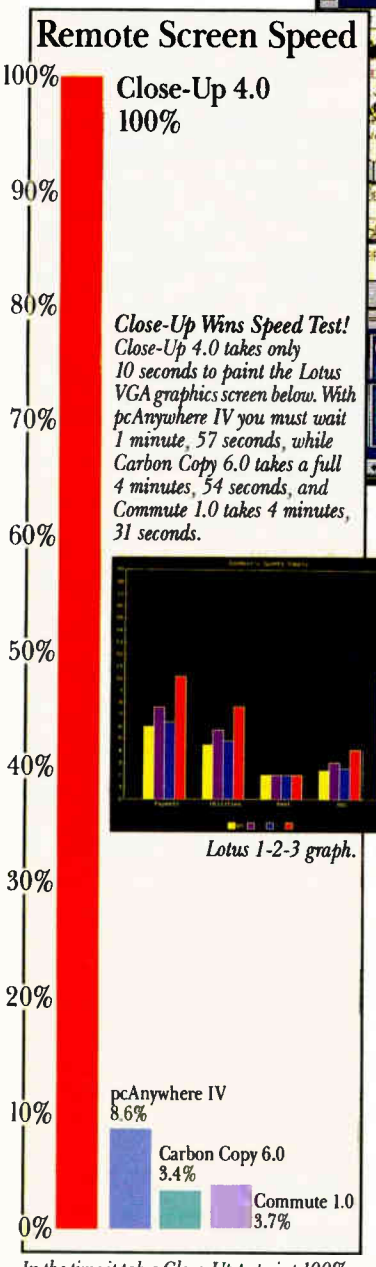
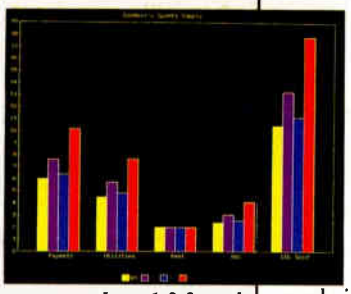


Close-Up Wins Speed Test! *Close-Up 4.0 takes only 10 seconds to paint the Lotus VGA graphics screen below. With pcAnywhere IV you must wait 1 minute, 57 seconds, while Carbon Copy 6.0 takes a full 4 minutes, 54 seconds, and Commute 1.0 takes 4 minutes, 31 seconds.*



Lotus 1-2-3 graph.

In the time it takes Close-Up to paint 100% of the above Lotus VGA graph, pcAnywhere IV has painted just 8.6%, Carbon Copy 6.0 has painted just 3.4% and Commute 1.0 has painted just 3.7% of the graph.

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We took a standard VGA color graph from Lotus 1-2-3 and compared the top 3 remote programs—Close-Up, Carbon Copy, and pcAnywhere—to see how long each would take to paint a graphic screen. The results were *very* convincing. Read on!

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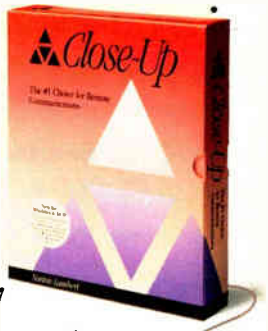

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†We invite you to reproduce our Remote Screen test. The graph used was a color VGA graph found in Lotus 1-2-3 Release 2.2, on the "Sample Files Disk." The file is TUTOR9X.WK1. The PCs were Everex 16 MHz 386/SXs and the modems Hayes 2400 baud Smartmodems. The baud rate was 2400.

‡Only Close-Up passes the Windows test. 1. Total remote keyboard and mouse support in all Windows modes: 386 Enhanced, Standard and Real. 2. Remotely run multiple Windows applications and multiple (full screen or windowed) DOS applications simultaneously. 3. Use a mouse to remotely cut & paste between windowed DOS applications and Windows applications.

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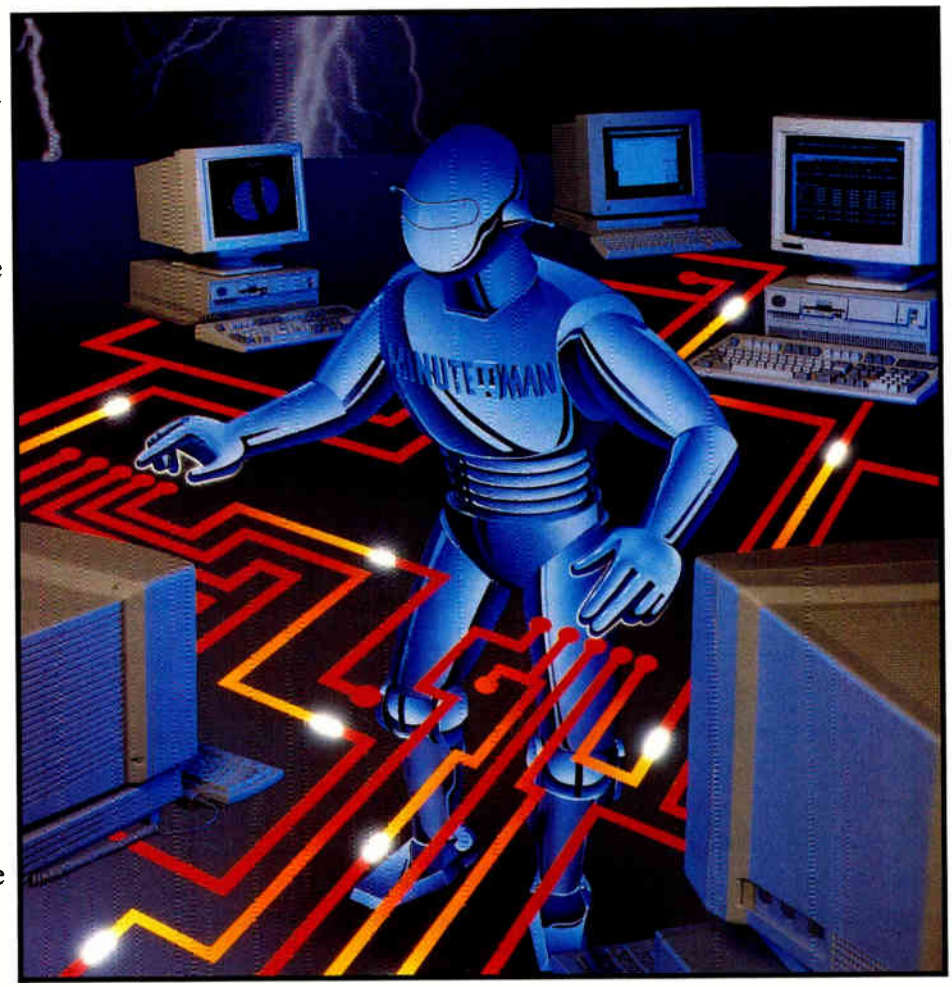

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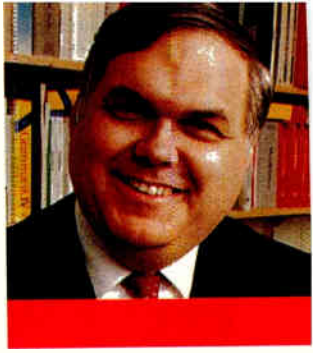

WAYNE
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THAT PESKY 640-KB BARRIER

You could see the relief on Frank's face when I told him about the new memory management capabilities of DOS 5.0. Frank Mara—a guy that I work with—had been dealing with a thorny problem involving a Windows front end for a database server. Frank's programmers were running out of memory when they tried to cram Windows, DOS, a couple of TSR programs, and network driver software into the standard 640-KB MS-DOS address space. No matter what they did, they just didn't seem to find a satisfactory solution. DOS just didn't provide enough memory.

Frank's problems are a little unusual in that he has to worry about making newly developed software fit into DOS, but he's not at all unusual in that he has had problems meeting today's needs with yesterday's operating system. Despite the fact that DOS has been king of the hill for nearly a decade, it has clearly fallen further and further behind in meeting the real-world needs of business users. Finally, in May of this year, Microsoft said that at least some of the most-needed requirements would be met with DOS 5.0, chief among them the ability to make better use of memory, especially on 286 and 386 computers.

Unlike its ancestors, DOS 5.0 recognizes the fact that many computers have more memory than the 640 KB originally provided with the IBM PC. Finally, you get the ability to load DOS itself into high memory, along with a few drivers and TSRs. This means that you can make use of nearly all the original 640 KB for running programs. If you have complex setups, this means you suddenly have an extra 75 KB to 100 KB available, which can make the difference between using and not using the software you need.

Allocation Headaches

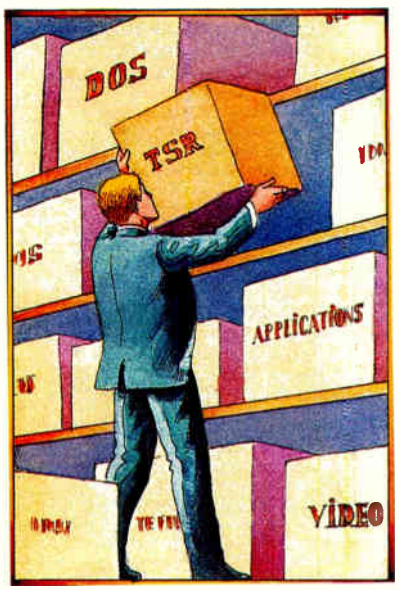
As it turns out, DOS 5.0 is a compromise. This is no surprise, since software that tries to be all things to all people usually turns out to be neither. Microsoft undoubtedly realized this and seems to have kept the DOS requirements achievable. DOS will indeed let you shift DOS itself into high memory, and it will also shift other TSRs if it can find room. The problem is that it can't always find room by itself, and it can't move your programs around until it finds a way for everything to fit.

What's missing from DOS 5.0 is a method for the software to figure out automatically what the best way would be to move things into high memory. When you install DOS, it simply takes the items in your CONFIG.SYS file and your AUTOEXEC.BAT file in sequence. Since this might not make best use of the available chunks of free memory in your machine, you have to experiment to see what loads best in which sequence. This requires a lot of time and patience. In this area, DOS comes up short.

Memory Managers

Fortunately, there is help. The two leading makers of third-party memory managers have found ways to take advantage of the new capabilities of DOS 5.0, while still retaining their ability to make the best possible use of existing memory. Qualitas and Quarterdeck Office Systems both support DOS 5.0 with their latest releases of 386Max and QEMM, respectively. Both can move software into high memory that DOS couldn't move by itself, and both have special programs that let you optimize the use of your high memory without spending your time experimenting. In addition, both work with Windows, and the extra space they free up is available to programs running with Windows.

Memory managers take over where DOS 5.0 leaves off



Qualitas's 386Max has an updated version of the installation software that knows what to expect when encountering a system running DOS 5.0. It automatically changes the instructions in the CONFIG.SYS file to work to best advantage with 386Max, and it will find ways to shoehorn programs and drivers into almost any nook and cranny in memory.

QEMM is a lot like 386Max in the way it operates, although you'll have to make a few of the changes to your CONFIG.SYS file that 386Max would make for you. On the other hand, QEMM comes with Manifest, which is one of the best system reporting utilities I've ever used. QEMM has its own optimizing utility that works much like the one 386Max has, and it produces similar results.

The most important result shows up when you look to see how much memory you have available to programs. With DOS 4.01, you would often find that you had some-

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thing like 540 KB by the time you'd loaded DOS, a mouse driver, a network access package, and similar items. A lot of software won't run in a memory space that small. With DOS 5.0, that number is suddenly up to something like 600 KB. That's a lot better, but with QEMM and 386Max, you might find that you've scavenged enough available memory from one place or another to have all 640 KB available for programs. Some systems work out even better. I use a Northgate Elegance 386/25 at the office, and the combination of 386Max and DOS 5.0 generates 655 KB of space available for program use.

What about Windows?

For the last year, you've probably been hearing about memory management and Microsoft Windows. After all, isn't Windows supposed to manage memory in its 386 enhanced mode? Well, there's memory management, and then there's memory management. What Windows supports is the kind of memory management that allows applications to run in a multitasking environment. You can start a communications program, for example, and start a long download; then you can fire off your word processor and get some work done while the download runs in the background. What Windows does *not* do is figure out where to place system-related software in memory.

Actually, DOS 5.0, Windows, and memory managers work very nicely together, each complementing the other. Using DOS 5.0 and the memory managers lets Windows provide more memory for each DOS session, meaning that you can run bigger programs. In some circumstances, the memory managers may make more expanded memory available to Windows as well, increasing the total system resources available to Windows and the programs designed to take advantage of Windows and its capabilities.

The combination of Windows, DOS 5.0, and either 386Max or QEMM makes an effective foundation for serious use of a 386- or 486-based workstation in business. It supports a vast array of software while providing access to most of the computer's resources. You no longer have to feel like you're wasting memory when you run a word processor on an 8-MB machine, and you can still run the large programs you need to use while retaining access to the network drivers and similar software you have to use to do your job.

This is one area in which the 386 architecture shows its value. While most application software looks at the 486 as simply a very fast 8088, DOS 5.0 and Windows both have the capability to look behind the facade and see the real machinery. QEMM and 386Max go even further and make the whole machine readily available.

Microsoft's Other Product

DOS 5.0 isn't the only new product from Microsoft this summer. A little before DOS 5.0 came out, Microsoft introduced a new pointing device called the Ball Point Mouse. This is a trackball designed to work with a notebook computer.

Until recently, there really wasn't much need for pointing devices for laptop and notebook computers. They had neither the computing power nor the storage capacity to deal with a GUI such as Windows, and without a GUI, mice weren't all that necessary. When notebook computers got powerful enough to support Windows, buyers resisted because they didn't have mice designed to work properly with computers that small.

ITEMS DISCUSSED

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Windows 3.0 ..... $149
Ball Point Mouse $175
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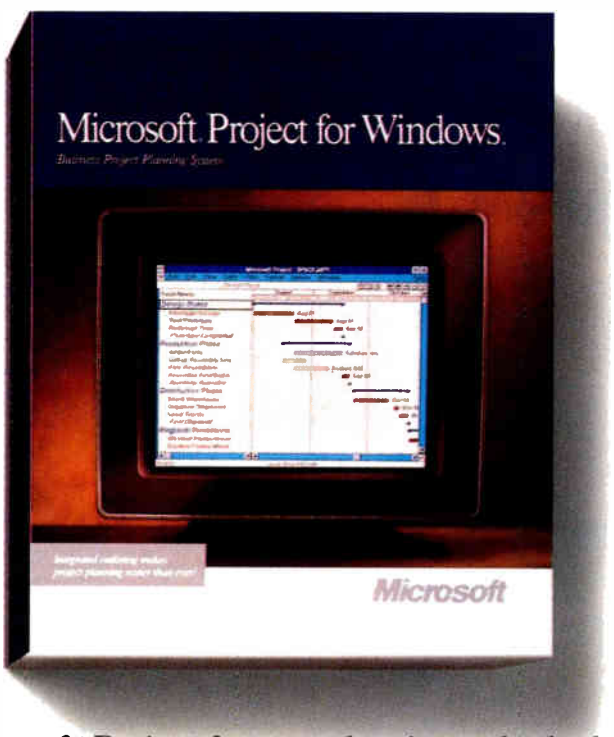

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Microsoft apparently decided to break this stalemate with a miniature trackball designed to clamp onto the edge of a notebook computer's keyboard. This is a handy place, since you can still use the mouse when you're not using the computer at a desk. You might, for example, use the Ball Point Mouse attached to the computer when you're using the computer on an airliner.

This new device proved useful to me when I began looking at two notebook computers that would be perfectly suited for running Windows if only they had a mouse. The computers are the AST Premium Exec 386SX/20 and the Librex 386SX/20. Both machines weigh about 6 pounds, both have excellent screens with VGA resolution, and both have enough memory to support the 386 enhanced mode with Windows. When you add the Ball Point Mouse, you've got a very pleasant portable Windows workstation. I can use the Librex anywhere I want to, and run the software I need to run, regardless of whether it requires Windows or DOS. I also took the opportunity to upgrade the Librex to DOS 5.0, which works fine and adds some extra access to memory for programs.

The Ball Point Mouse is clearly designed to handle the flexibility of working in a wide variety of positions on a large number of computers. It is shipped with clamping jaws of several sizes so that differences in keyboards won't easily defeat attempts to attach the mouse. These jaws are inserted into a mounting bracket that in turn supports mounting the mouse at an angle to the keyboard. One way or the other, you shouldn't have any problem setting up the Ball Point Mouse so that it's comfortable to use.

Of course, mounting the mouse isn't the last step. Once you've done that, you also need to tell the mouse software where the mouse is so that it will know which way you're moving the trackball when you intend to move it in the direction you see as "up." To make this work, Microsoft provides a program called Compass that lets you show the software where "up" is. You also get the mouse Control Panel for both DOS and Windows so you can set other characteristics such as acceleration and click speed.

The Ball Point Mouse will also work just fine on any other computer and is a very nice trackball in its own right. It comes with rubber feet so that you can use it on a desk instead of clamped in place, and you can order an extension cord to make attachment to a desktop computer easier. Of course, Microsoft isn't the only company now making trackballs for notebook computers. Logitech makes a similar product that I haven't had the chance to see, and other companies have announced similar items.

The Ball Point Mouse is a clear example of a product that grew from a clear understanding of users' needs. It's exactly the right solution that came at just the right time. ■

Wayne Rash Jr. is a contributing editor for BYTE and a principal and technical director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He is coauthor of two books for business network users: The Executive Guide to Local Area Networks *and* The Novell Connection. *You can contact him on BIX as "waynerash," or in the to.wayne conference.*

Your questions and comments are welconme. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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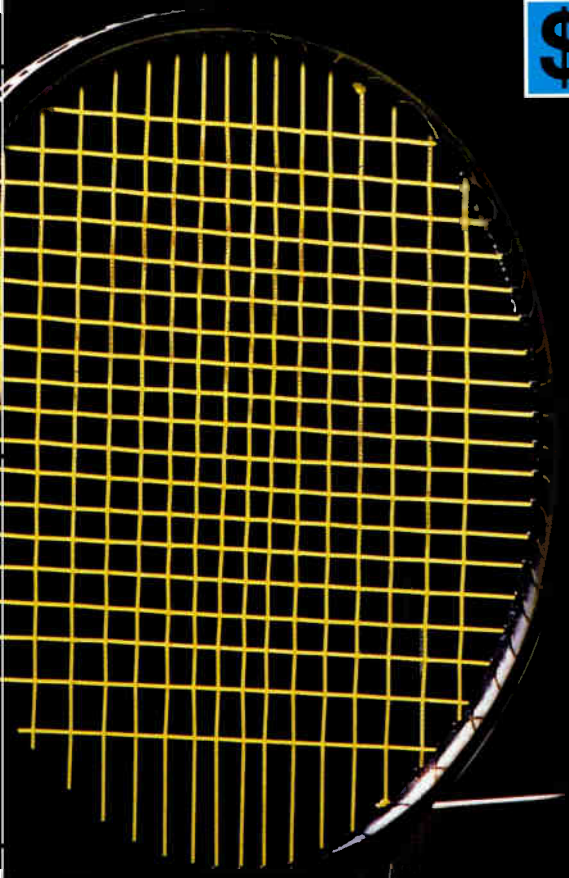

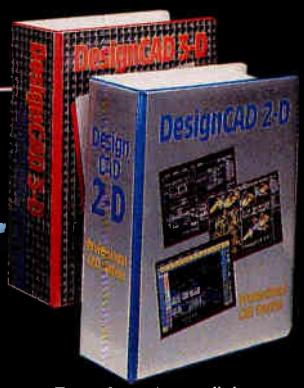

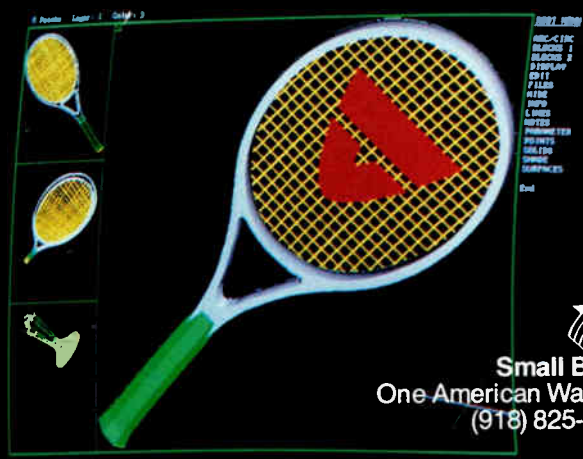

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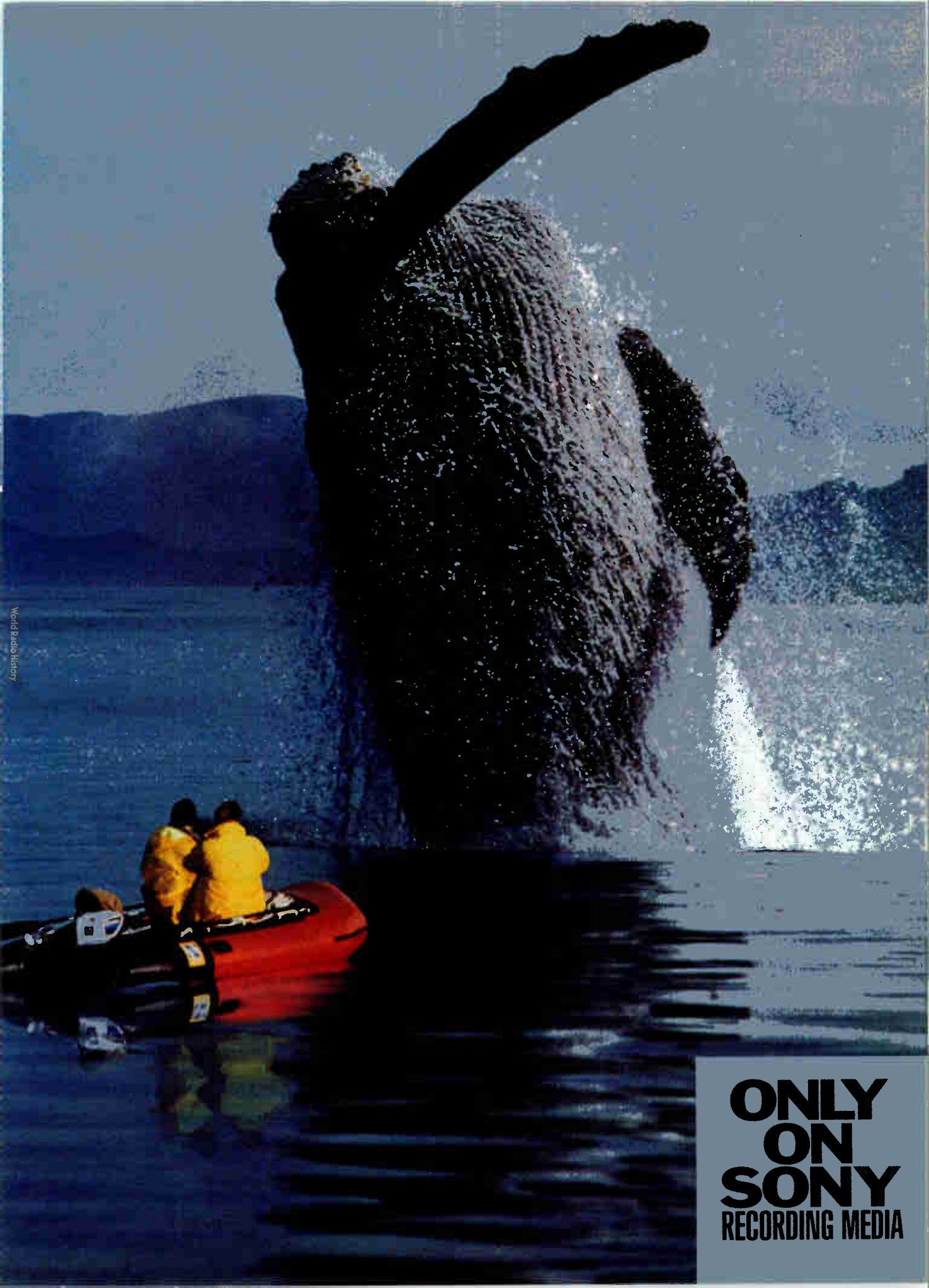

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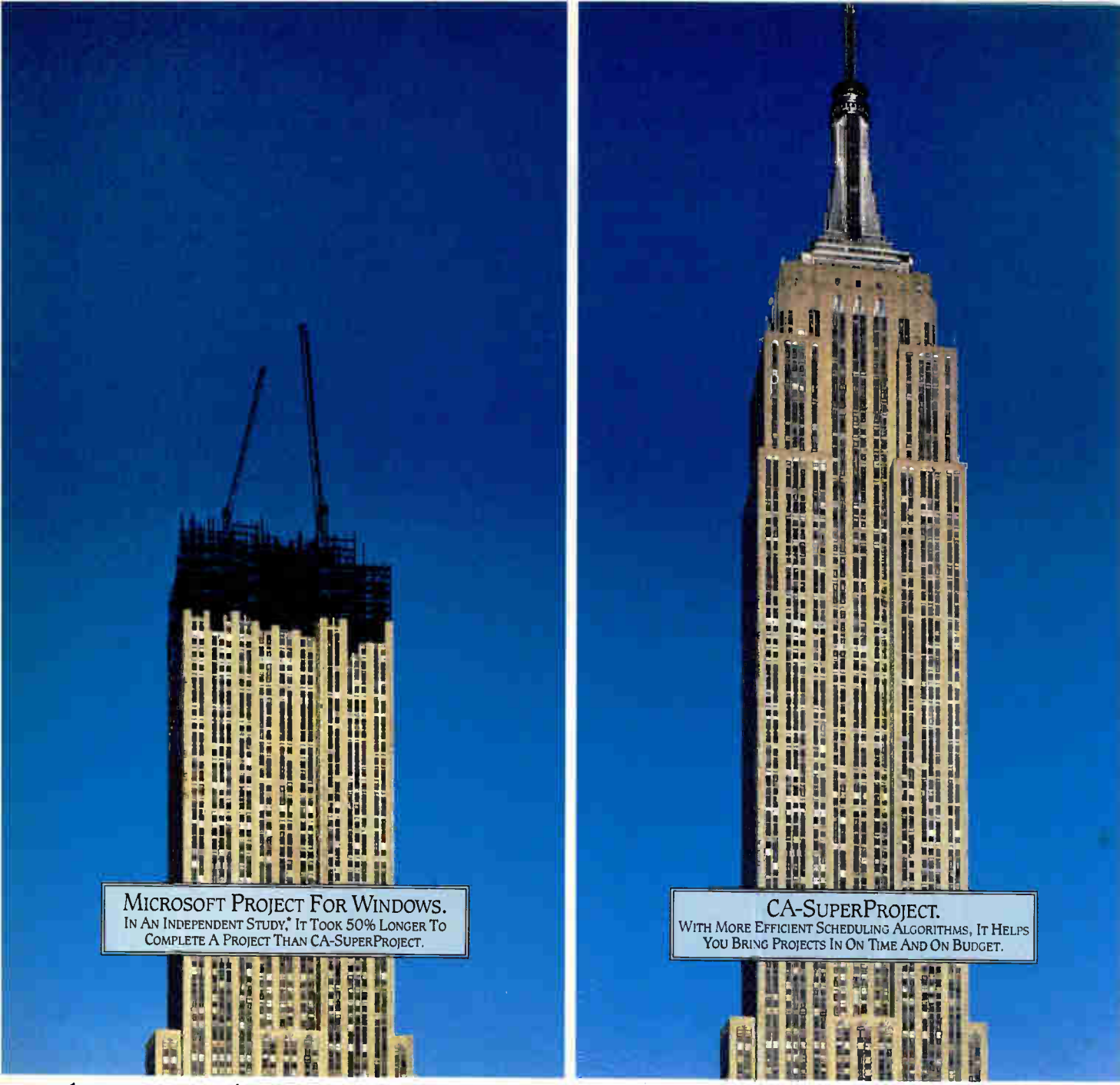

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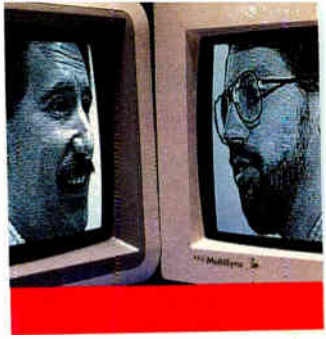

BYTE columnists, staff, and contributors debate the issues

THE PUBLIC SPEAKS ON OS/2 VS. WINDOWS

Roundtable is a forum in which BYTE editors, columnists, and contributors debate key issues that affect how you purchase and use hardware and software. The "conversations" take place on BIX, where you can participate in the round.table conference.

Editor's note: *This month, Roundtable turns the tables and presents the views of developers and end users on the dispute between Microsoft and IBM over Windows and OS/2. We found this dialogue on BIX in the ibm.dos conference, in the "os2" topic, starting with message 389. We think you will find it interesting and insightful.*

roedy [Roedy Green]: I just saw a rather distressing post about Microsoft disowning OS/2 and going its own way with NT (New Technology), which will be yet another application programming interface, basically Windows Plus. Sounds like it will be DOS gussied up with yet another layer of junk.

This stupid tiff between Microsoft and IBM is forcing us to stay with DOS-like addressing far, far too long! Finally OS/2 begins to look like a winner, and Microsoft spoils it for all of us.

How will IBM be able to tempt developers? It could publish a series of reasonably low-cost books on developing. It will get OS/2 talked about and treated as real. IBM could sell the development tools and OS/2 itself through ordinary distribution channels so that it is on display at every Mom & Pop computer store. And it could start broadcasting what is already available and what niches are still open.

Microsoft is faltering—stumbling about changing its mind. It has money but no sense of direction. IBM could emphasize its stability and momentum to finish the job. It could talk about the early days of DOS when CP/M was king. Those who went with the new, powerful DOS reaped buckets of gold. Those who stayed with the old technology quickly faded.

hamilton [Doug Hamilton]: The writing's been on the wall for some time. I think Microsoft has reached its zenith. It has created way, way too many enemies and has made it impossible for anyone in the industry to view Microsoft as a reliable partner for anything. Gone are the days when any sane person would make his or her company's future dependent on Microsoft's carrying out its promises.

OS/2 2.0 is going to be a success with or without Microsoft. If you have any doubts, you need only take a look at IBM's OS/2 videotape or get your hands on the new 6.149 beta. This is a dynamite system, the pricing is right, and it's beginning to look like IBM may get the marketing going after all.

And one thing you do have to give IBM credit for: Probably more than any other company around, it keeps its promises.

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karenk [Karen Kenworthy]: Steve Ballmer, Microsoft senior vice president for system software, in a recent interview published in *Computer Reseller News*, said, among other things, that Microsoft will provide Windows NT for the ACE machine, instead of OS/2 3.0. Windows NT will support DOS applications, 16- and 32-bit Windows applications, C2 data security, fault tolerance, and Posix applications. At a later, unspecified date, Windows NT will support OS/2 and Presentation Manager applications, via an "OS/2 and PM subsystem." Windows NT is scheduled for 1992.

"I can't tell you what IBM's strategy is, but I'm pretty sure it's not working with us," Ballmer said. Will Windows NT with an "OS/2 and PM subsystem" be "a better DOS than DOS, a better OS/2 than OS/2"?

roedy: Look on BIX. All the excitement and activity are in the Windows conference. Users are moving prematurely to Windows. They are losing productivity, but they don't care. Windows is more fun than character-mode interfaces, and you can play games more easily when the boss is not watching.

Some large corporations that should know better are moving to Windows. If people are willing to put up with

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the dreadful performance of DOS/ Windows now, surely they will in future when various things can be bandaged on to fix the problems. Only purists like me feel nauseated at how disgustingly filthy it is inside.

Graphics coprocessors are now cheaper than VGA cards were a short time ago. They claim to be 24 times faster than Super VGA. Very smart hard drive controllers and lots of RAM help solve some of DOS's reentrancy and file allocation table problems.

Eventually, DOS/Windows may be retrofitted with something like High Performance File System. Eventually, DOS/Windows will be so integrated that you will get the overhead of Windows whether you like it or not, but by then processors will be fast enough that you won't care.

hamilton: You should take another look at the ibm.os2 conference and the various os2 topics here and elsewhere. Once moribund, the traffic has been way up in the last couple months. Look for an explosion of interest once OS/2 2.0 achieves general availability.

rpreuninger [Roy Preuninger]: OS/2 burying Windows will only happen when it includes all the functionality and extras of Windows. If it weren't for the formidable competition of the Windows environment and the products developed for it, OS/2 would still be a text-oriented, single-user, multitasking operating system. Windows is a part of the evolution of computing, as will be the operating system (or environment) that buries it. All in due time.

Of course, who really knows what the consumer will buy, in spite of everything all the technical experts know.

hamilton: What makes you say that? From the day it was announced, OS/2 has always been planned and viewed as a graphical windowed system.

rpreuninger: OS/2 was available early on in a configuration that didn't include the PM component. If you know of any other reason than the competition of the Mac environment that may have led to the development and inclusion of PM in OS/2, I would like to hear about it.

As for functionality available in Windows that is missing in OS/2, compare the Control Panel functions in Windows with those of OS/2. Windows lets you change the profile of the mouse. OS/2 doesn't. Consider all the ways that Windows allows the user to customize the environment to suit specific needs. In OS/2, where it's possible, making changes is complicated. The extras that come with Windows are almost completely within the Accessories Group. While they may be slim, a lot of basic work can be done with those tools.

When you consider the price of Windows as compared to that of OS/2 (at least to get started) and the level of expertise that is required to get something to look good (even if it isn't much), it is no wonder that many casual computer users like Windows.

hamilton: Wait a minute! You told us that the reason OS/2 wasn't strictly a text-mode system was competition from Windows. Now you claim that competition from the Mac was the sole reason? Which is it?

Either way, I'm going to disagree. PM wasn't tacked onto OS/2 in response to any particular system. PM was an integral part of the OS/2 story from the beginning

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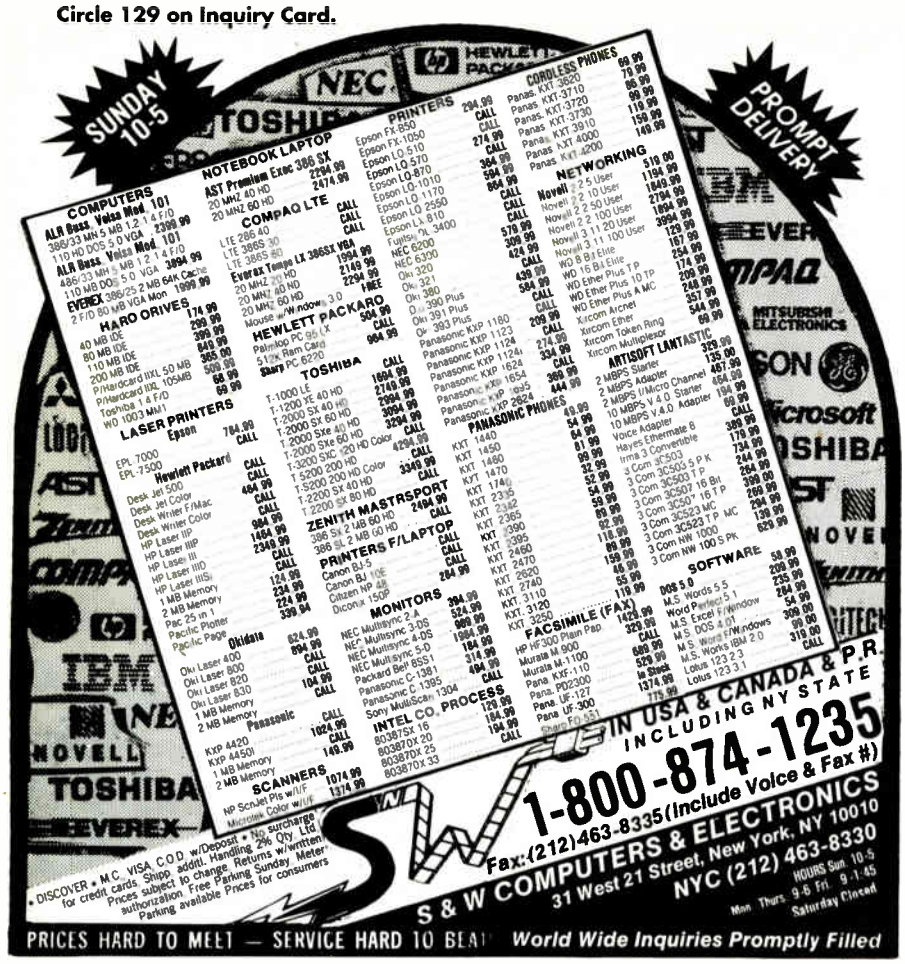

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ROUNDTABLE

because the whole industry's been moving to windowing systems for 10 years and it was obvious that that was "jacks or better" for any new system.

OS/2 1.0 did ship without PM. But that's only because PM wasn't finished. My understanding is that there's more code in PM than in the OS/2 kernel. But even before I had a copy of 1.0, I had specs that came with the software developer's kit for PM.

OS/2 1.0 was never claimed to be complete. It was claimed only to be a first widely distributed code drop for early developers (like me) and other early adopters to begin working with. OS/2 1.1 with PM shipped less than a year later.

I argued your last point myself in my Beyond DOS column earlier this year [April BYTE] commenting on the OS/2 1.3 announcement. Windows is prettier and does come with more games and toys and a much better control panel for setting colors and so on. Also, when OS/2's price was $340, that was way too high. But things are changing.

OS/2 2.0 will be much prettier. It will have a nice control panel similar to the one in Windows. It'll have a graphical installation program that's very nice. It'll come with a full suite of games and sample applications. A new, optional "Mac-like" interface, called the Workplace shell, will sit on top of PM. This stuff is not vaporware. A lot of this is already in the new 6.149 beta, and it works.

Costs are also much more in line. For $150 (or about $120 through Egghead), you get the whole OS/2 system, which is less than you would pay for DOS/Windows and Adobe Type Manager (which is built into OS/2). Hardware requirements for OS/2 are about the same as for Windows.

hgessau [Henry Gessau]: Is the following true? If you are running DOS, you can run DOS programs. If you are running Windows, you can run Windows and DOS programs. If you are running OS/2 2.0 or higher, you can run OS/2, Windows, and DOS programs. If this is true, why would people settle for less?

aweiner [Alan Weiner]: According to all the press, and Lee Reiswig (IBM's Blue Ninja), yes! In an August 15 demo in Boston, IBM showed lots of stuff running; it looks real pretty (and faster than Windows 3.0). At one point there were 11 or 12 windows, running several OS/2 programs, DOS boxes, DOS 4.00, DOS 5.0, DR DOS, and Desqview—which was itself running three programs! I'm still skeptical, but it looks like it's real. ■

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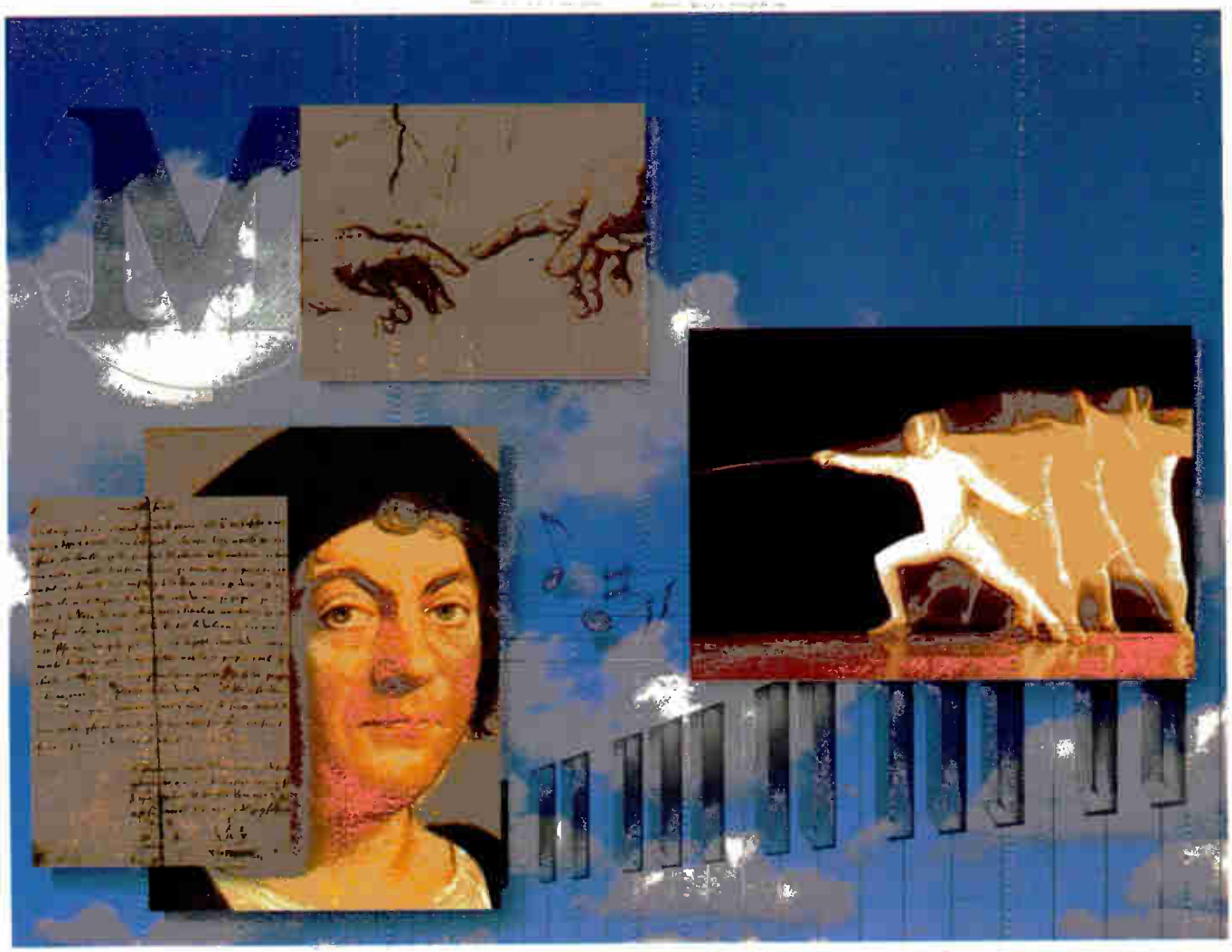

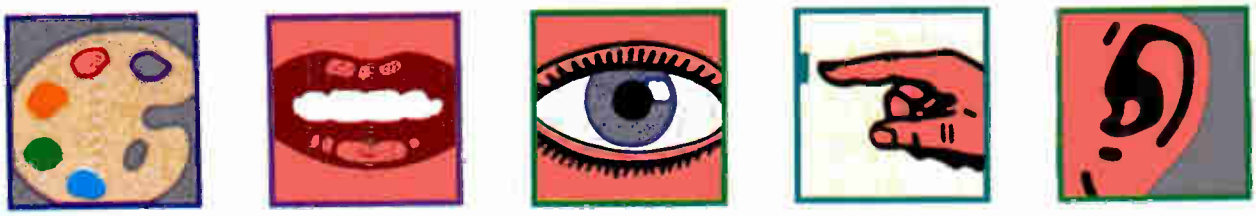

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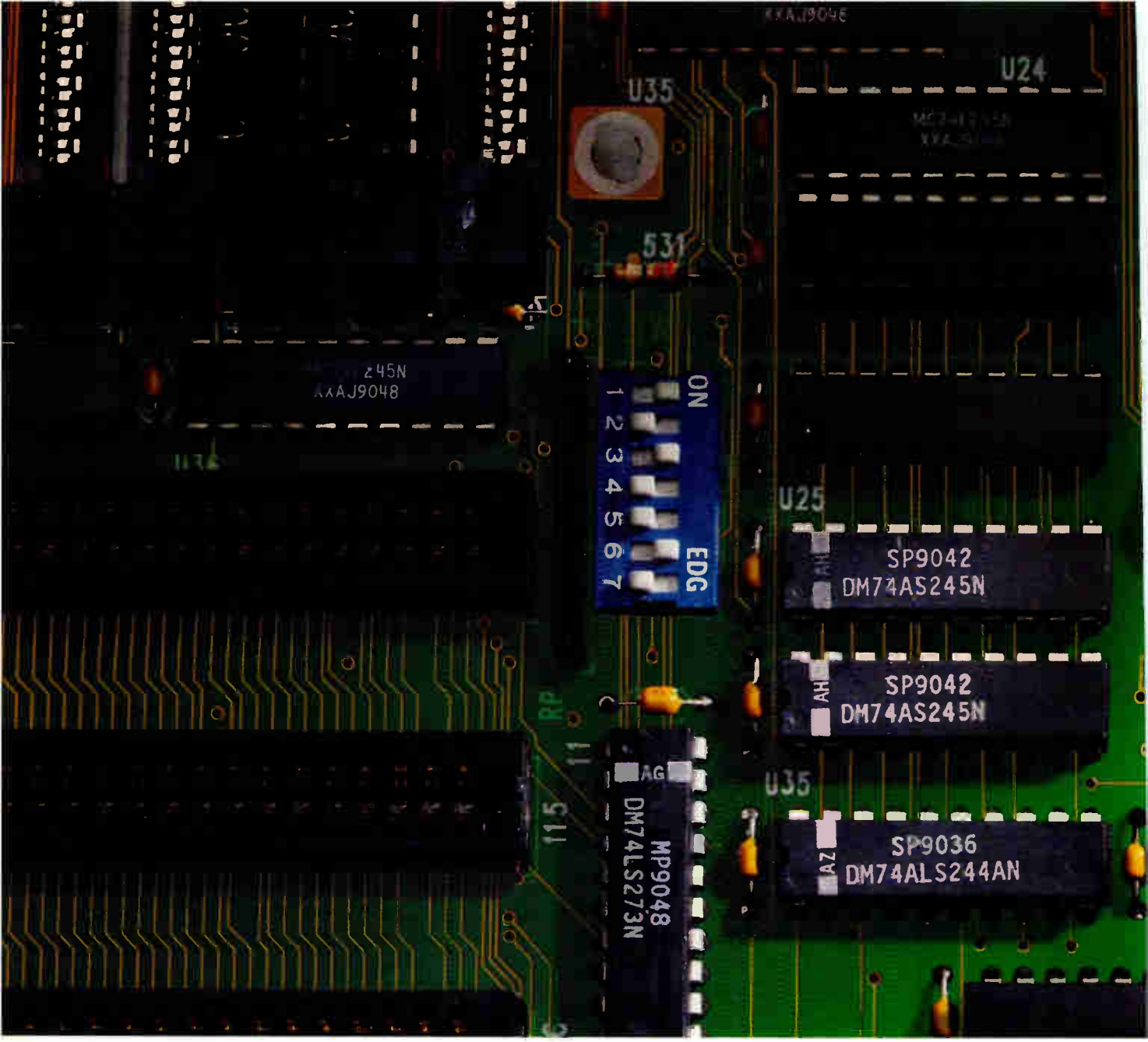

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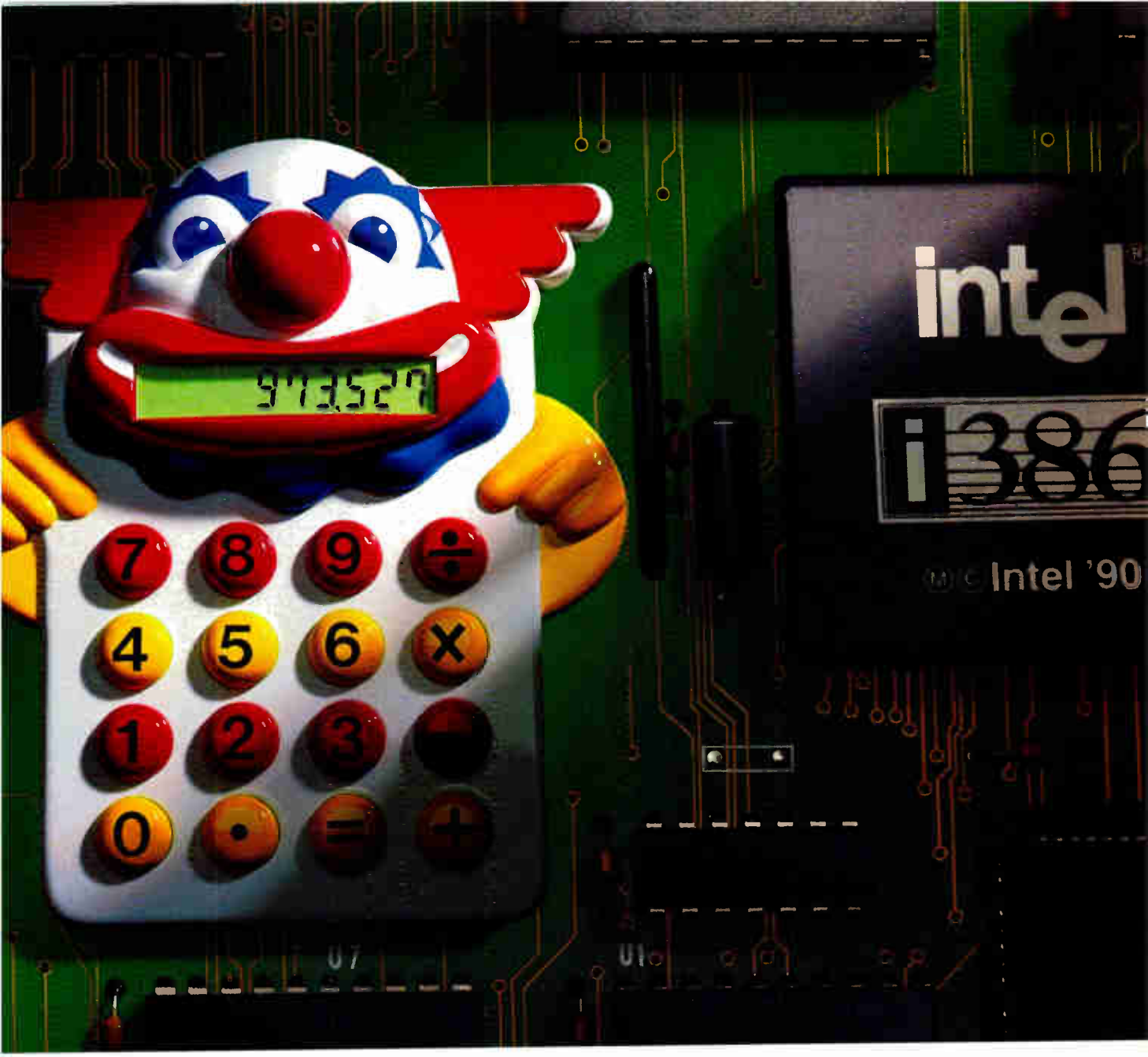

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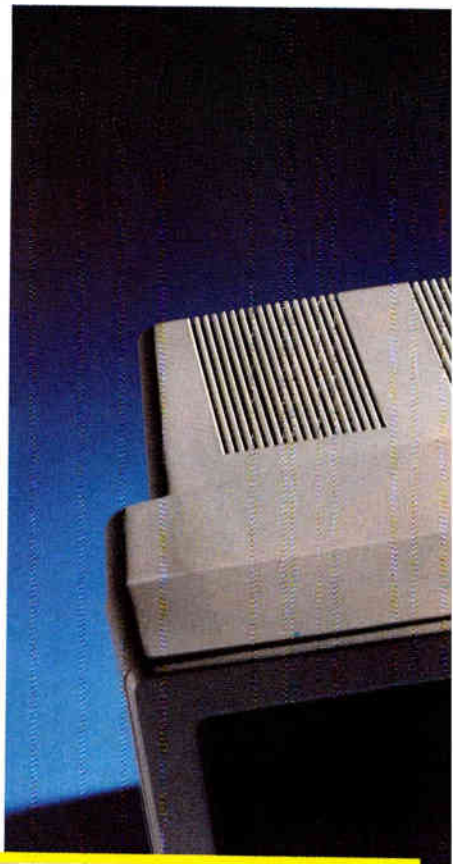

To most people, the microprocessor *is* the computer. It performs the main computational functions and defines the potential speed and power of any personal computer. It is so often discussed as the main feature of a personal computer—"I just bought a 486 machine"—that it's easy to mistake the microprocessor for a single-chip PC. But complete PC systems include many functions that are not delivered by their CPUs.

Functions such as graphics, disk storage, memory, and communications are performed by subsystems. These functions provide many of the choices you have in configuring a system. They also define the actual performance of a system. Most of these functions require their own controllers and other support chips to allow them to work with a microprocessor. As a result, there is a lot of complex circuitry associated with them in any computer system. Advances in chip integration, however, could render support chips obsolete.

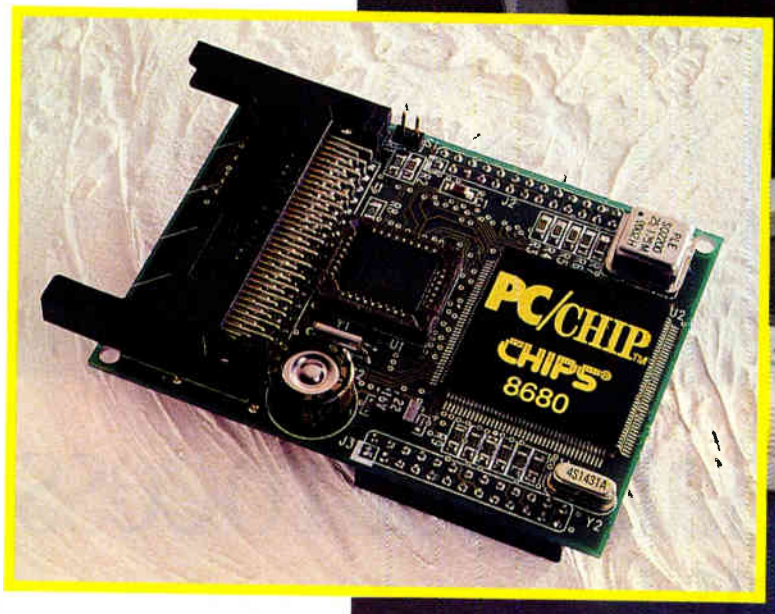

Photo 1: *The Chips & Technologies philosophy is "add memory and go." The F8680 single-chip PC reduces the area needed to implement a complete PC-compatible computer to a few square inches.*

The PC Ensemble

The original IBM PC housed most of its support circuitry in collections of standard logic chips, which made its motherboard a crowded place indeed. With the advent of PC-compatible systems from manufacturers other than IBM, systems designers looked for alternatives to clunky TTL chips to implement the functions of the PC support circuitry. This led directly to the creation of standard chip sets that implemented these functions. The use of chip sets dramatically reduced the number of chips needed to build a system and, as a result, reduced the costs and the design complexity inherent in building a PC clone. Chip sets became the standard building blocks for PCs and "made" the PC clone business. Today's PC-compatible systems typically consist of a microprocessor, a chip set of around eight ICs, some DRAM, and a scattering of miscellaneous components to make

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sure everything works together.

If you combine a microprocessor and a chip set on a single chip, you further reduce the cost of building a PC and more easily achieve higher levels of system performance, because the chip will provide all the base functions of a system in an integrated, pretested package. Recognizing these considerable benefits, a number of semiconductor manufacturers have been working to develop a single-chip PC. The first to achieve the goal, Chips & Technologies, recently announced its F8680 PC/Chip (see photo 1). As Gary Baum, C&T's marketing director for new product development, says, "Our definition of the single-chip PC is 'add memory and you have a PC.' "

It's important to note that the definition of a single-chip PC seeks to include only the common functions required to build a basic XT- or AT-compatible system. These typically include a microprocessor, a display controller, a memory controller, a drive controller, an I/O controller for ports, and a keyboard. Adding anything beyond this (e.g., a full VGA display) requires additional chips.

Other functions that might be added to a next-generation single-chip PC include a cache, a floating-point processor, accelerators for specific functions such as graphics in Microsoft Windows, advanced I/O controllers, and alternative device controllers such as a SCSI. Future single-chip PCs might include multimedia functions and compression or even stylus input or voice recognition.

Why a Single-Chip PC?

There are numerous reasons why manufacturers are trying to come up with a single-chip PC. The main reason is integration. Dealing with one chip instead of 10 or so when designing a system makes a designer's job much simpler. It also directly affects the cost of a system, its power consumption, its size, and the ease with which it can be manufactured.

In volume, it can be expected that the cost of a single-chip PC part will be less than the combined cost of the parts that go into it. This cost saving grows even further, because it allows a manufacturer to design a smaller system board and make a smaller overall system.

Size is important. It's clear that the market for notebook computers is very large, but users don't want designers to sacrifice functions just to achieve a smaller package. A single-chip PC dramatically reduces the size of a system board and allows manufacturers either to produce smaller systems or to cram more functions into the same size box.

Smaller size also raises the issue of power consumption. People want to carry around portable systems and use them while traveling, requiring battery power. Lower power consumption can radically improve battery life.

Another advantage is manufacturing convenience. Once manufacturers don't need to design all the ancillary features on a single-chip PC, they can design systems faster. Fewer parts result in simpler system boards and manufacturing that is easier and more likely to be fault free.

continued

BYTE ACTION SUMMARY

Single-chip PCs, which integrate multiple support chips such as graphics and RAM controllers with a microprocessor, are now a reality. Chips & Technologies' new F8680 PC/Chip is a complete computer system—just add RAM. This and similar chips from other companies will bring PC power to bear in places it's never been before.

BACKGROUND PHOTO PAUL AVIS © 1991

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SuperState in Focus

John W. Donovan

The PC industry is built on standards. But adherence to standards extracts a price by limiting flexibility for systems designers. The standard PC hardware architecture assumes that a machine is a desktop configuration equipped with peripheral devices such as a keyboard, a CRT, and one drive or more. It also assumes that those peripherals communicate with the processor in rigidly (and sometimes archaically) defined ways. This limited standard architecture creates difficulties in designing newer forms of PCs such as notebooks.

The standard PC software approach assumes that an application owns the system. This assumption complicates the development of functions such as power management in laptop systems or the addition of real-time devices to a system.

While adhering to the standard practices of the PC industry limits designers, they've learned that flexibility achieved through noncompliance has heavy costs. As a result, many designers are still searching for practical ways to tailor their products to the needs of specific groups of users or applications.

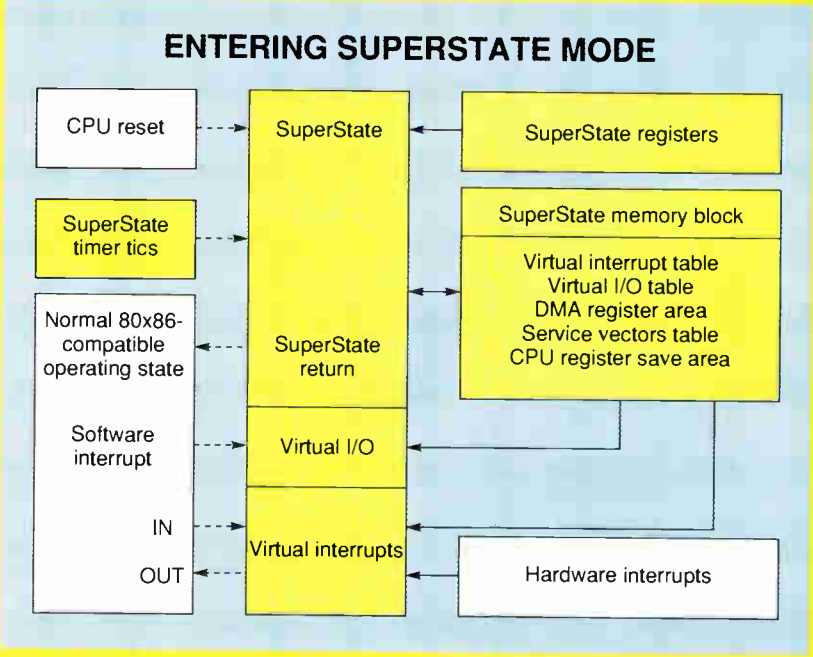
Chips & Technologies has addressed these problems by extending the Intel 80x86 processor family architecture with SuperState, a new operating mode that is being implemented in the company's PC/Chip and Super386 microprocessors. SuperState provides a new execution state, usable as a reserved space in the system to run designer-developed software. It also provides controls for changing system functions. It does not use application memory or registers and is invisible to the application, operating system, and BIOS.

Figure A shows how you can access SuperState capabilities as they are implemented on the PC/Chip. Because the chip is a real-mode processor, this suite of capabilities is called SuperState R.

For systems designers, SuperState is a vehicle for innovation. System functions may be changed on a custom basis, yet the system will be compatible with any operating system. SuperState code can intercept and modify I/O to and from the hardware and observe system conditions. It can also adjust performance and power. Since the code functions in a new and protected address space, the new functions are secure and can't be damaged by application crashes or viruses.

A real-world example of the use of SuperState R functions is in the design of a palmtop system. The system's designer eliminated the need for a separate keyboard microcontroller by using SuperState to scan the keyboard and send keystrokes to a standard XT-compatible BIOS using virtual interrupts and virtual I/O. The keyboard emulation is transparent to the BIOS and applications. The PC/Chip supports SuperState operations with 57 registers (out of a total of 100 on-chip) and eight instructions. This operation requires 5632 bytes of memory that is pro-

Figure A: *To ensure compatibility, SuperState is invisible to software applications. Any one of a number of hardware-based events can trigger SuperState execution.*



Single-Chip Approaches

All the companies working on single-chip PCs take different approaches. Perhaps the most significant approach is Intel's. Intel already has a "tightly coupled" chip set solution in the form of the 386SL. This chip and its companion, the 360SL, implement the basics for a 386SX-based computer that is designed with power management in mind.

The 386SL uses a modified form of the 386SX architecture to allow intelligent power management. One way it does this is to include a new interrupt, invisible to existing software, at the highest priority level of the system. This interrupt lets the processor switch into an alternative memory-address space where power management code and functions can be executed, while the rest of the processor is completely frozen and unaware of the external activity. This approach allows the 386SL to remain fully compatible while adding new functionality. The disad-

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tected and can't be modified by an application. In addition, this memory is usually shadowed.

Software Transparency

The PC/Chip can be programmed to go into the SuperState mode through a hardware interrupt request or a software interrupt, when an IN or OUT instruction has been executed and a device on the I/O bus must be emulated or monitored (virtual I/O), when a specified amount of time has elapsed, when a DMA channel must be set up or auto-initialized, or when an external request on one or more of the four programmable pins must be serviced. For example, in a palmtop system, SuperState could be used to emulate a drive, simplifying operations with a solid-state memory card. In this case, when the request for access indicates the proper disk track and sector, SuperState intercepts the request and translates it to the appropriate location on the memory card. Bank switching is then used to access the memory space.

The PC/Chip contains the SuperState R logic, while the Super386 works with a separate chip set. SuperState V on the 386-compatible processor creates a separate 4-gigabyte address space. Two gigabytes is used for system instrumentation—such as built-in performance or power indicators—and for in-circuit emulation. The other 2 gigabytes is reserved for real-mode operations such as power management. A very high priority interrupt, ANMI, sends the processor into SuperState mode. An address line and address strobe access memory.

Systems and SuperState

SuperState can be used to execute real-time embedded control functions, overcoming the limitations in DOS. Critical control functions execute in SuperState, and the remaining code executes as a normal PC application. Long calculations and application crashes can't affect the control code running in SuperState. The two types of code work together through emulated I/O devices.

SuperState lets PC designers adapt their systems to new uses without sacrificing PC compatibility. It lets designers benefit from the range and economics of industry-standard hardware and software while transcending their inherent limitations on design innovation.

John W. Donovan is BYTE's senior editor for State of the Art/Features. You can reach him on BIX as "jwd."

vantage of this approach is that it requires systems manufacturers to redesign their systems to use the new features.

Intel has announced that it intends to come out with more integration in future products—specifically, a single-chip AT. The company has not indicated what features the AT chip will include. It is likely to have a basic feature set, and it may reflect Intel's interest in the high-end system market by including a cache, VGA graphics, and perhaps even a math coprocessor.

continued

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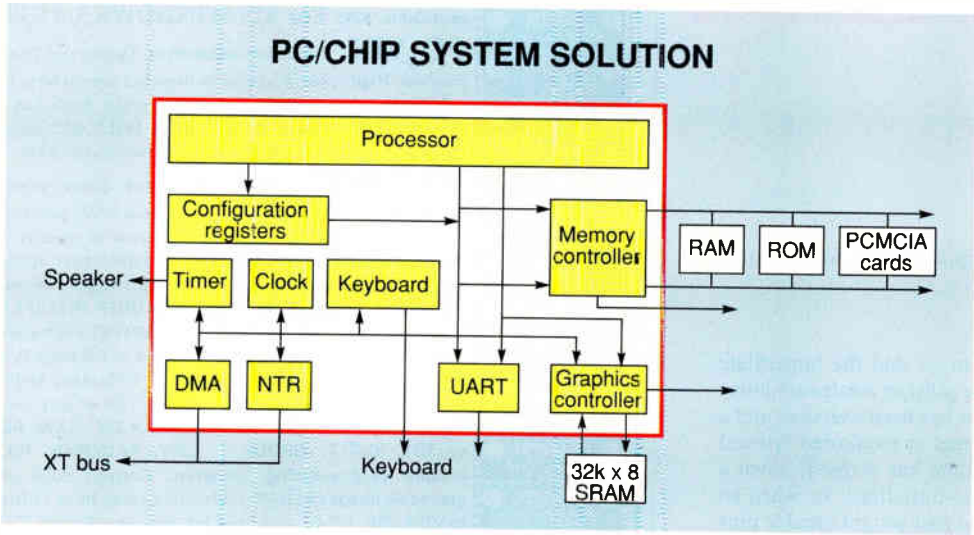

Figure 1: *The only thing you have to add to the F8680 to make a complete PC system is memory. Main memory takes conventional DRAM, while the graphics controller requires static RAM.*

Advanced Micro Devices and IIT are rumored to be working on single-chip PC designs. AMD, which is now allowed to sell its own 386, is undoubtedly looking for other markets and could be working on a single-chip PC based on the 286 or the 386. IIT is best known for its math coprocessors and may come out with a single-chip PC that includes one.

The First Single-Chip PC

That C&T was the first company to announce a single-chip PC is not surprising, considering its experience in the chip-set market. It knew what functions PC designers wanted. What is surprising are the architectural innovations the chip includes.

The F8680 PC/Chip consists of an 8086-compatible CPU, an 8524-compatible timer, an 8259-compatible interrupt controller, a flexible memory controller, a DMA emulation mechanism, an XT keyboard controller, a CGA-compatible graphics controller, and a 16C450-compatible universal asynchronous receiver/transmitter for serial communication. The chip also supports the standard 8-bit XT bus. See figure 1 for an example of how the F8680 fits into a simple design.

In addition, the chip has a new operating mode called SuperState R. SuperState R is similar to the alternate mode used in the 386SL, except that it's more flexible. When in the SuperState mode, the PC/Chip can execute alternate sequences of instructions and uses an alternate memory space without affecting the basic operation of the 8086-compatible CPU. This mode is entered automatically on power-up and system reset. SuperState can also be started by any hardware or software interrupt, an I/O instruction, a timer, or any of four external programmable signals. The result is a flexible architecture that permits the F8680 to do much more than power management. The architecture also lets the chip provide virtual devices, manage new external hardware, and emulate other processors. One of C&T's first customers for the F8680 is planning a system that emulates an IBM AT by using SuperState to trap 286 instructions and emulate them in the SuperState mode. See the text box "SuperState in Focus" on page 150 for more details on SuperState.

The graphics controller part of the chip supports CRT and LCD screens and is fully CGA compatible, supporting 640- by 200- or 400-pixel resolution in monochrome or 320- by 200- or 400-pixel resolution in four colors. In addition, C&T has included Visual Map, a technology to allow the controller to drive an LCD with up to 16 gray-scale levels and accurately map colors to gray shades.

Power management is an important part of the F8680 design. Some of it is implemented using SuperState R, and some is designed into the chip. The F8680 is a fully static design. Its CPU core can operate using any voltage from 2.7 V to the standard 5 V, while the surrounding on-chip logic operates at 5 V. As transistor geometries shrink, the semiconductor industry is migrating toward a new 3.3-V standard. As more low-voltage parts become available for the rest of a system, the whole chip may be made available as a low-voltage part. A 3.3-V chip uses approximately 40 percent of the power used by a comparable 5-V chip. The fully static design of the F8680 allows C&T to completely stop the system clock, suspending operation. In addition, the clock signal can be divided to run the system in slow states that use less power. Finally, C&T has implemented some sophisticated power management in the SuperState code.

One important advantage of the F8680 over a standard 8086 or even a 286 is that it uses 26-bit memory addresses, allowing accesses of up to 64 MB of RAM. It uses bank switching and can accommodate all forms of memory from full static through dynamic, including PCMCIA memory cards. The PC/Chip operates at from 0 to 14 MHz, although low-voltage operation limits the maximum clock rate. The chip also uses a four-stage pipeline, which C&T claims makes it comparable in performance to a 286 processor operating at the same clock speed.

Differentiating the Single-Chip Computer

One important challenge in designing a single-chip PC is to give system integrators the ability to differentiate their products. Since all the major functions of a PC are included on the chip, the only way to differentiate one from another is to add functions, which in part negates the purpose of the single-chip PC. C&T's answer to this problem uses the SuperState R mode to allow systems designers to differentiate their products. They can implement unique functions in software or by easily adding new hardware functions. See the text box "The PC/Chip Bears Fruit" on page 154 to see how one designer is using the F8680.

Other single-chip PC manufacturers are likely to take the same route as C&T, because it allows a single hardware part to be used very flexibly for a wide variety of options. The F8680 is likely to be used for embedded applications. Besides using SuperState to emulate other processors, wider possibilities include using an array of F8680s as a parallel computer with the SuperState function providing interprocessor communication or allowing the F8680 to operate in alternative architecture

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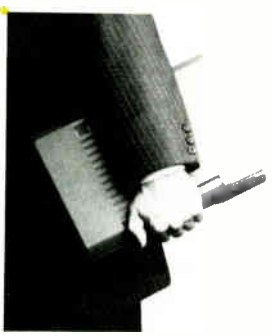

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The PC/Chip Bears Fruit

Ellen Ullman

Given a PC on a chip, like the F8680 PC/Chip from Chips & Technologies, what sort of computer can you build? What are the new possibilities—and the new design problems? Alex Hwang of Abstract R&D faced some of these questions in developing a forthcoming palmtop that is based on the F8680 chip—a machine that Hwang calls a "hand-held PC."

According to Hwang, the new hand-held computer will be small (7 by 4 by 1 inches), low powered (providing between 50 and 100 hours of use on two AA batteries), and inexpensive ($500 to $600 retail), and it will run off-the-shelf PC software. So far, Abstract's hand-held PC sounds like a less expensive version of the HP 95LX palmtop. But Abstract lists some specifications—a 25-row by 80-column CGA screen, 640 KB of memory with EMS, a bus connector, and perhaps even a hard drive—that make this small machine sound more and more like a full-fledged, general-purpose computer.

Photo A: *With a 25-row by 80-column screen and full PC internals, the Abstract R&D hand-held PC packs a lot of power into a tiny volume.*

Controlling the Juice

The main design problem that must be addressed in building a full-featured hand-held computer, according to Hwang, is power management. "A hand-

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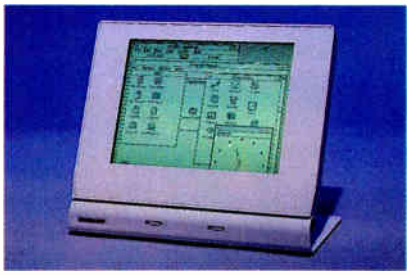

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The PC/Chip Bears Fruit *(continued)*

held PC is not hard to build at all—except for power management," he says.

Hwang says that the power management features C&T has built into the F8680 PC/Chip make the Abstract hand-held PC a practical reality. Said Hwang, "We came to the conclusion that the ultimate solution is a CPU designed with power management in mind."

With the PC/Chip's power management in both hardware and SuperState software, Abstract was able to consider adding a 20-MB hard drive to a palmtop machine. A 1.8-inch hard drive will add about 1 inch to the thickness of the case and will require the use of three AA batteries rather than two. To save power, Abstract plans to operate the hard drive as if it were a floppy drive, turning it off when it's not in use. To extend battery life even further, the company is studying the possibility of providing 30 percent to 40 percent of power requirements by using solar panels, like those used in portable calculators.

In spite of the power management features offered by the PC/Chip, don't expect to see a backlight on palmtop screens any time soon. "We can't deal with it," said Hwang of the backlight. "It consumes more power than the hard disk."

In addition to power management, the PC/Chip offers manufacturers the benefits of integration. For example, the CGA screen in Abstract's hand-held device owes its existence to the F8680's built-in LCD controller. Hwang commented of the LCD controller, "That's not something I would want to develop on my own."

Keyboard Concerns

Besides the problem of power, the keyboard is the single biggest stumbling block in the design of a hand-held computer. "The keyboard is a very painful thing to deal with," said Hwang.

To design a small but functional keyboard, Abstract first tried a mechanical analog of the desktop computer. That turned out to be too tight to use and too expensive to build. The company next tried a foldable design, but that made the system too thick. Finally, Abstract settled on a keyboard with hard plastic keys. The design solution for the keyboard is more like that of an electronic organizer (e.g., the Sharp Wizard) than a desktop system, but it preserves the normal PC key layout. Still, Hwang bemoans the fact that on small systems, "people will never be happy with the keyboard."

Abstract is showing working samples (see photo A) at Comdex, with production systems becoming available by the end of the year. It expects to sell two models: one with a hard drive and one without. The diskless model will have a PCMCIA memory card. Both models will have a serial port, a parallel port, and a bus connector, as well as 640 KB to 2 MB of memory with EMS.

Whatever designs Abstract sells, the company expects to stay light on its feet. The market is new, and the components keep changing in features and pricing. Abstract expects the length of a product generation to be just six months. Weighing the possibilities and problems presented by the hand-held PC, Hwang summed it up by saying, "Small—that's its strong point and its weak point."

Ellen Ullman is a BYTE news editor based in San Francisco. You can reach her on BIX as "ullman."

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Attack of the 386-Chip Clones

Kenneth M. Sheldon

If imitation is the sincerest form of flattery, Intel should be feeling honored these days. Intel's 386 microprocessor, which first appeared in PCs in 1986, is now the chip of choice for the average PC user—and the target of attempts by competing semiconductor companies that would like to capture a share of the 386 market. These include Advanced Micro Devices, currently embroiled in a legal battle with Intel over an earlier agreement that gave it the right to clone Intel's 286 and—according to AMD—subsequent chips. AMD announced the AM386—its reverse-engineered clone of the 386—in January of this year (see "AMD's Replicant 386: It's Alive, It's Compatible," Microbytes, January BYTE).

Other companies making (or rumored to be making) 386-compatible chips include Meridian Semiconductor of Irvine, California; NexGen Microsystems of Woodbridge, Ontario, Canada; Integrated Information Technology of Santa Clara, California; Cyrix of Richardson, Texas; and V. M. Technology of Tsukuba, Japan. Most are attempting to develop 386-compatible chips without copying its microcode. They hope to avoid the kind of legal disputes with Intel that have dogged AMD.

But the first company out of the gate with a 386-compatible chip built from scratch is Chips & Technologies of San Jose, California. This long-time manufacturer of support chips and devices for Intel's 80x86 microprocessors has announced a family of 386-compatible microprocessors called the Super386 ChipSystem Architecture.

The Super386 family consists of four new chips: the 38600 SX and DX, which are pin-compatible with Intel's 386SX and 386DX chips, and two high-performance versions called the 38605 SX and DX. The DX chips (full 32-bit chips) will be offered at speeds of 25, 33, and 40 MHz; the SX chips (which have a 16-bit data bus) will be offered at speeds of 16, 20, and 25 MHz.

Improved Performance, Lower Power

According to C&T, its engineers worked under clean-room constraints, using only publicly available information to develop their 38600 chip. To a 386 "core"—object code–compatible with the Intel 386—they added a five-stage pipeline, which allows some instructions (e.g., FETCH and POP) to be executed in only half the number of clock cycles as on the 386.

All of C&T's new chips are fully static CMOS designs, which allows them to be used in lower-power applications. They support ×1 or ×2 clock input for greater design flexibility. (Previous 32-bit chips actually require two clock cycles for many operations, effectively cutting the rated speed in half. Support for ×1 clock input means that the Super386 chips will,

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Attack of the 386-Chip Clones *(continued)*

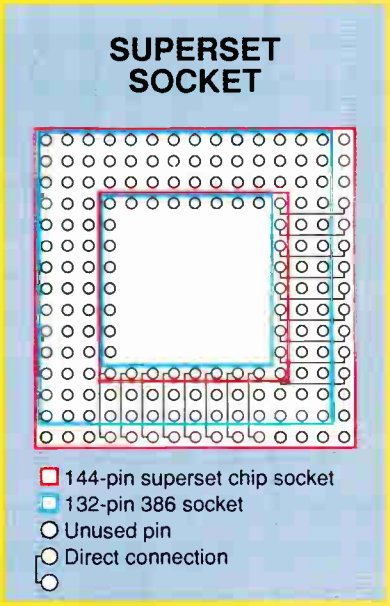

Figure A: *A special 176-pin socket will hold standard 132-pin 386 chips, as well as C&T's high-performance 38605 DX chip with 144 pins. C&T is encouraging manufacturers to incorporate such a socket into their motherboards, which would make it easier to design different versions of the same computer and provide customers with an easy upgrade path.*

like the Intel 486 and Motorola 68040, be able to zip along at their full clock speed.)

For even higher-performance applications, C&T designed the 38605 DX and the 38605 SX with a built-in 512-byte instruction cache (or I/Cache). According to the company, the I/Cache keeps the chip's pipeline fully loaded through every cycle and boosts its performance by as much as 40 percent. (The Intel 386 has no on-board cache, but it can use off-chip caches of varying size.)

The 38605 DX and SX also feature C&T's SuperState V, a hardware/software layer that will allow manufacturers to add features, such as power management and other system management functions, that are transparent to the chip and the software running on it.

Setting Up the Pins

To fit the added hardware onto the 38605 chips, C&T had to make them larger than a standard 386 and add extra pins, which presents a problem: How do you upgrade from one chip to the other? Do manufacturers have to incorporate different sockets for systems based on the different chips?

To address that problem, C&T developed a unique "superset" pin strategy. The 38600 DX (with 132 pins) is a pin-for-pin drop-in replacement for the Intel 386 DX. The higher-performance 38605 has 144 pins. A special 176-pin socket will hold either chip, as well as Intel's and AMD's 386 chips (see figure A). By incorporating the 176-pin socket into their motherboard designs, manufacturers will be able to build different computer systems using a single design and let customers easily upgrade to a more powerful chip. The 38605 SX uses a similar superset pin configuration.

How much will such a socket add to the cost of a motherboard? About $1, according to C&T—a price it says manufacturers will be glad to pay for the flexibility it will give them.

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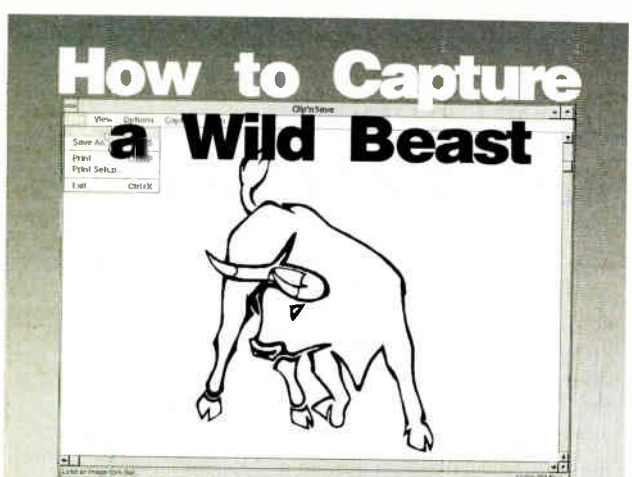

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Attack of the 386-Chip Clones *(continued)*

But Wait, There's Math

As if developing a single-chip PC and four versions of the 386 weren't enough, C&T has also announced the SuperMath 38700 DX and SX math coprocessors, designed to be 100 percent pin and software compatible with Intel's equivalent math chips. In spite of that compatibility, C&T says the chips contain additional floating-point hardware that will let them perform certain operations up to six times faster than the 387.

Like their companion chips, the 38700 DX and SX are fully static CMOS designs, easing their use in low-power settings, such as in laptop and notebook computers. The SX math chip will be available in 16-, 20-, and 25-MHz versions, while the DX chip will also be available in 33- and 40-MHz versions.

Designing a 386-compatible chip is no small task. It's to C&T's credit that it has been able to release a complete suite of new chips under the given design constraints. The Super386 and SuperMath chip families should allow manufacturers more flexibility in system design, and the availability of another source of 386 chips should make the market for powerful new systems even more competitive. Look for announcements of systems built around the C&T chips by the end of the year. BYTE will be sure to give you a first-hand look at them.

Kenneth M. Sheldon is BYTE's west coast bureau chief based in San Francisco. You can reach him on BIX as "ksheldon."

environments to provide inexpensive and simple DOS functionality (e.g., with RISC-based systems).

The other main way to differentiate is to add unusual functionality into the logic of the single-chip PC. This might include chips designed specifically for pen-based computers or for a particular type of palmtop. Designers could even integrate a PC into other products—for example, a full office-in-a-box system with a PC, telephone, fax machine, and laser printer.

The Future of the Single-Chip PC

The obvious next step is the single-chip PC based on the 386. This may come from Intel or AMD before it comes from C&T, but C&T is working on such a chip—an advanced 386 clone that includes a version of the SuperState mechanism called SuperState V (see the text box "Attack of the 386-Chip Clones" on page 158). Companies now need to integrate the more common advanced PC functions. A typical desktop system today is based on the 386, uses VGA graphics, and probably has a cache. These, plus the standard chip set used in such a system, could be implemented on a single chip, perhaps with the logic needed to drive an EISA or Micro Channel architecture bus.

More interesting are the future directions that could be taken with the incorporation of new architectures and modes such as SuperState. One possibility is the inclusion of a network interface in a single-chip design. Including the network interface on a single-chip PC would alleviate many of the problems you encounter when you attach a PC to a network. With the advent of SuperState and similar technologies from other single-chip suppliers, systems designers will have a lot of leeway in bringing innovative designs to the market. The only certainty about single-chip PCs is that their effects will be unpredictable. ■

Owen Linderholm is a BYTE senior news editor based in San Francisco. He can be contacted on BIX as "owenl."

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FEATURE

CLASSIC LANGUAGES, PART 3

Lisp

Even though it is from the same generation as COBOL and FORTRAN, Lisp is radically different in concept

DORIS APPLEBY

Just three years after the first high-level programming language, FORTRAN, was born, John McCarthy of MIT attended the 1956 Summer Research Project on Artificial Intelligence at Dartmouth College. There he heard the description of a language called IPL 2. IPL 2 inspired McCarthy to develop a new language in 1958 that he called Lisp (which stands for *list processor*). By then, FORTRAN was an established high-level language, relying on the notions of assignment (i.e., values are assigned to specific locations in a computer's memory) and sequencing (i.e., program results depend on the order in which statements are executed). But in Lisp, neither notion applies. Like IPL 2, Lisp was designed to process lists.

Why Lisp?

Any language based on assignment and sequencing can create an intellectual bottleneck instead of supporting thinking in larger conceptual units about a task at hand. McCarthy believed that the mathematical notion of combining powerful functional forms would free programmers from stupefying details unrelated to solving a problem and foster formally verifiable programs suited to solving problems involving common sense.

In 1956, AI systems were thought to depend entirely on formal logic. To some extent, this is still true, but new "fuzzy," or "nonmonotonic," logics have replaced the more rigid predicate calculus to better represent the uncertainty of decision making. Lisp was first devised as a language for AI, because McCarthy noticed that the system for making logical deductions could be represented and manipulated using lists. The two sorts of statements necessary for logic are (s_1 OR s_2) and (NOT s_1), where s_1 and s_2 are statements. EVAL (s) returns either T or F, depending on the truth value of s, and deduction depends on clearly defined rules. Lisp is well suited to use in AI systems if rules can be devised to manipulate and evaluate statements. It is used productively in, for example, expert systems and natural-language understanding programs.

Another important capability of the language is that a Lisp program can construct other programs and transfer control to them at run time. It is this property that makes the entire Lisp environment possible. One tool that lets a programmer introduce changes at run time is the Lisp debugger. A program can then continue without reloading or recompiling. It is this sort of programmer control that is so appealing and makes compile-time checking less important.

Early Days

Originally, Lisp had no data types but relied entirely on the symbolic-expression, or S-expression, playfully known as a Sex. A Sex is either an atom or a dotted pair ($s_1 \cdot s_2$), where s_1 and s_2 are Sexes. Some examples of atoms are THISISANATOM, X1, NUMBER, and 22. There are three special atoms, T, F, and NIL, that represent true, false, and the empty list (). (s_1 • NIL) is a list containing the single element s_1. In the first implementation of Lisp, there were no numbers at all. But natural numbers can be defined using the atom NIL to represent 0. You can then build the numbers 1, 2, and 3 as the lists shown here:

BYTE ACTION SUMMARY

From its launch in 1958, Lisp has grown from a language for theorists to an important tool for AI development. The Department of Defense's adoption of Common Lisp as one of its three official languages, the expected approval of a Common Lisp standard by ANSI, and the promise of an object-oriented extension for the language indicate that Lisp is becoming a mainstream language.

ILLUSTRATION: CATHARINE BENNETT © 1991

World Radio History

Original Lisp

This recursive function to add two natural numbers N1 and N2 will give you some of the flavor of the original Lisp:

```
(LABEL ADD(LAMBDA(N1 N2)
  (COND(((EQ N1 NIL)N2)
        ((QUOTE T)
         (ADD(CDR N1)
           (CONS (CAR N1) N2))))
)))
```

Following Alonzo Church's notation (see the main text), LAMBDA introduces a lambda expression, (*lambda parameter-list function-definition*). Here, the parameter-list, which is (N1 N2), can assume two specific values to which ADD can be applied. How this happens is explained below.

A recursive function is one that calls itself (or recurses). One of the requirements of recursive programming is that the recursive function must have a limiting condition so that it stops after a finite number of calls. For this recursive ADD function, recursion stops when (EQ N1 NIL) is true (i.e., when the list N1 is empty).

COND introduces a Lisp conditional expression. It has the general form (COND (p_1, p_2, . . . , p_n)), where each p_i consists of a pair, (b_i e_i). The first element of the pair is a Boolean condition; the second element is the expression that is returned when the condition is true.

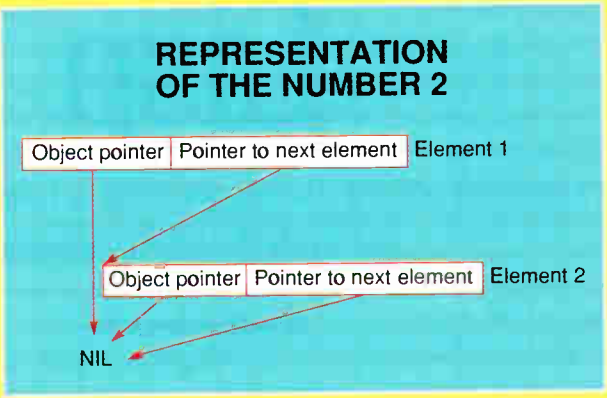
When a COND expression is evaluated, the p_i list is scanned in order until EVAL(b_i) = T. The value of the COND is then the value of the corresponding e_i.

There are two pairs to the COND expression in the definition for ADD: p_1 = ((EQ N1 NIL) N2) and p_2 = ((QUOTE TRUE)(ADD (CDR N1) ((CONS (CAR N1) N2)))). The condition half of the first element is b_1 = (EQ N1 NIL). If the condition half of the first COND element is true (i.e., if N1 is NIL), then the ADD returns N2. However, if the number contained in N1 is not NIL, the evaluation of the COND proceeds to p_2, where the condition half b_2 = (QUOTE TRUE) is always true and the value of the COND will be EVAL (e_2), a recursive call to (ADD N1 N2). In the recursive call, the new N1 is (CDR N1)—the old N1 with its first element, (CAR N1), deleted. Lisp constructs the new N2 from the old N2 by placing this deleted element at the front of the old N2: (CONS (CAR N1) N2). In the ADD program, Lisp concatenates the elements of N1 one-by-one onto N2, as N1 is traced down. Evaluation continues until N1 is empty.

The names *CAR* and *CDR* are related to the IBM 704 architecture, which had 36-bit words with the first 15 containing an address (i.e., contents of the address register) and bits 18–32 containing a decrement (i.e., contents of the decrement register). In Lisp, the CAR contains a pointer to the first element of a list, and the CDR contains a pointer to the rest of the list. Thus, you can construct the natural number 2 as shown in the figure. The interpreter used the remaining 6 bits for garbage collection, which means that words no longer needed in a computation are marked for reuse when free memory is exhausted. The EVAL operator determines a value for each Sex, and a Lisp interpreter is simply a read-EVAL-print loop.

Those of you who are not familiar with Lisp may be gasping by now, so here's an example you can try: Perform the ADD functions X = 1 and Y = 2. Remember that X = 1 = (NIL • NIL) and Y = 2 = (NIL • (NIL • NIL)). You might try following the Lisp code yourself using these definitions. To apply the ADD function to two particular numbers, you use the form (APPLY (LABEL ADD (LAMBDA (...))) X Y). Notice that applying a function to specific arguments once again uses the dotted pair (*lambda-expression • arguments*), with the dot implied rather than written.

```
ADD (1 2)
 EVAL ((EQ 1 NIL)) = F
 EVAL ((QUOTE T))  = T, return
  ADD (0 3)
  EVAL ((EQ 0 NIL)) = T, return 3
 return 3
ADD (1 2) = 3
```



In early Lisp, the number 2 was represented by a two-element list of NIL. The lists were constructed with pointers. Therefore, the number 2 was represented by the structure shown here.

```
1 = (NIL • NIL)
2 = (NIL • (NIL • NIL))
3 = (NIL • (NIL • (NIL • NIL)))
```

The representation of numbers as lists looks bizarre, but it is satisfying in a fundamental sort of way. The number 0 has zero pairs, 1 has one pair, 2 has two pairs, and so on. A value for (N1 + N2) is constructed by appending the list for N2 to the list for N1. The value of (N1 – N2) is built by removing the elements representing N2 from those of N1. (See the text box "Original Lisp" above for an example of how to add without having numeric data types.) Even though representing numbers as lists maintained the purity of the language's symbolic expression, numbers and arithmetic operations had been added to Lisp 1.5 by 1960. This was a bow to efficiency and recognition of the fact that arithmetic using lists is computationally too slow.

continued

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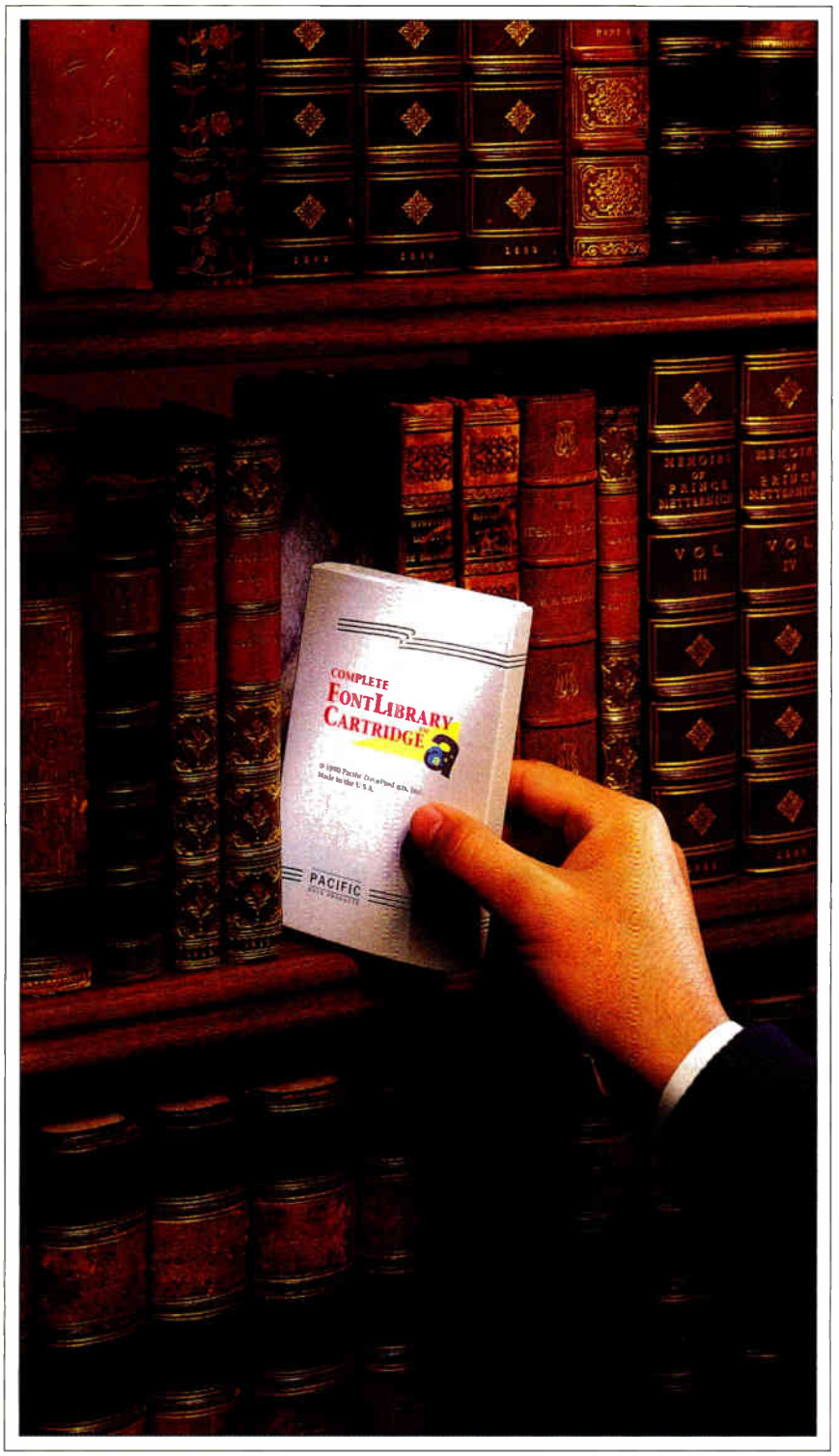

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In addition to lists, Lisp was influenced by the mathematical notion of recursive functions. A function is a rule that produces a single value, given certain input values; a recursive function is one that calls itself repeatedly. The theory of functions had been described in 1941 by Alonzo Church in *The Calculi of Lambda-Conversion*. McCarthy had studied with Church at Princeton University and found the notation of recursive functions convenient for representing functions in Lisp.

Beginning in 1962, the development of Lisp diverged into different dialects, with MacLisp and ZetaLisp at MIT; Franz Lisp at UC Berkeley; ICI-Lisp at Stanford University; and InterLisp, a commercial product of Bolt, Beranek, and Newman. A move to standardize Lisp began in 1978 at the University of Utah and culminated in Common Lisp, currently under review by the ANSI committee X3J13.

Pure and Practical Lisps

There has always been some tension in the Lisp community between those who love it as an object of beauty and those who want to do useful computing. To some extent, the first group has migrated to the Scheme dialect, developed by Harold Abelson and Gerald Jay Sussman at MIT, while the second group has adopted Common Lisp. Purists insist on one cardinal principle of functional, or applicative, languages: no side effects. This means that when $f(X_1, X_2, \ldots, X_n)$ is evaluated, a single value is returned for the entire expression, but none of the X_i is modified. To imagine the practical considerations of no side effects, think of a large database `D1` (with a particular record `R1` with the key `K1`) that needs updating. In a pure functional setting, `UPDATE (D1, K1, NewStuff)` would copy the database into a new environment and return an updated database, `D2`. Besides being slow, both the old database, `D1`, and the updated database, `D2`, would exist in memory at the end of the `UPDATE` call.

In addition to fewer side effects, Scheme adheres more closely to the Lambda calculus than do other Lisps, runs in very small memory, and is quick and easy to learn. As Guy Steele (author of the book *Common Lisp—the Language*) reports, Scheme and Common Lisp are to applicative languages as Pascal and PL/I were to imperative languages: Scheme is small, clean, and elegant, while Common Lisp is the powerful workhorse with many special features. Scheme includes the assignment expression `(set!` *name value*`)`. But—unlike imperative languages such as Pascal or C—this does not result in allocating a new storage location for *name*. The variable *name* is identified with the contents of the address register of a dotted pair and points to an object. If the object is already being pointed to by an object called `Y`, `(set! 'X Y)` defines a new pointer `X` with the same address as that contained in `Y`. Thus, Scheme objects have an identity independent of any names by which they may be known, they never die, and they may be returned as the result of a function or procedure call.

It is this last property that distinguishes Lisp from most other languages. Any object, whether it is a data item, structure, or function definition, is first class. The object may be the value of a function parameter or returned as a functional value. Thus, Lisp functions can create new functions at run time or alter old ones, depending on other parameters. Data is represented as an atom, a dotted pair, or a list, as are functions and programs.

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Lisp Now

The February 1988 issue of BYTE was devoted in part to Lisp. Harold Abelson and Gerald Jay Sussman stated in the conclusion of their article, "The truth is that Lisp is not the right language for any particular problem. Rather, Lisp encourages you to attack a new problem by implementing new languages that are tailored to the particular problem."

The first successful compiler was designed by Timothy Hart and Michael Levin and is the Lisp function (COMPILE *function-name*). Today, there are many Lisp compilers as well as dedicated Lisp chips and machines. Because Lisp is intended to permit the selection of programming methods best suited to a problem, Common Lisp and Scheme include various imperative and iterative programming conventions. You can proceed from statement to statement in Lisp and program DO loops. Both Lisps include arrays and vectors with random access methods in addition to lists with access only from the top down.

What's Next?

Lisp once languished in research labs, but it is now big business. Not least significant in its resurgence is the Department of Defense's interest in three official languages: Ada, Common Lisp, and the yet-to-be-developed prototyping language CPL—a high-level language for trying out experimental systems.

Richard Gabriel of Lucid reports that the new ANSI standard for Common Lisp, X3J13, is expected to be finalized within six months. It will include an object-oriented system known as CLOS (for Common Lisp Object System). CLOS is widely distributed today, and its significant features are the following:

- unified syntax derived from Common Lisp
- a multiple inheritance scheme
- generic function calls and message passing
- a combination of methods related to function composition
- class redefinitions and updating
- relationships between generic functions through a "meta object protocol"

Functional languages are well suited for parallel processing. If a function $f(X_1, \ldots, X_n)$ is free of side effects, values for the various X_i can be computed independently and simultaneously. A programmer using a functional language gives no thought to parallelism but simply programs functions. A smart compiler will pick out which parameters should be evaluated in parallel.

Lisp programs have traditionally been slow in executing and have used huge amounts of memory. Lisp machines, Lisp compilers, and some imperative features included in Common Lisp have improved this situation. Furthermore, the narrowing gap between mainframes, workstations, and personal computers makes Lisp quite practical on a variety of hardware. Lisp continues to have a devoted following among theorists and is moving slowly but surely into the mainstream. ■

Doris Appleby writes about mathematics, computer science, and pedagogy. She is also the chairperson of mathematics/computer science/information systems at Marymount College in Tarrytown, New York, and the author of Programming Languages—Paradigm and Practice *(McGraw-Hill, 1991). You can reach her on BIX c/o "editors."*

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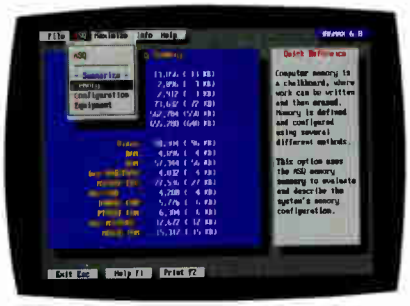

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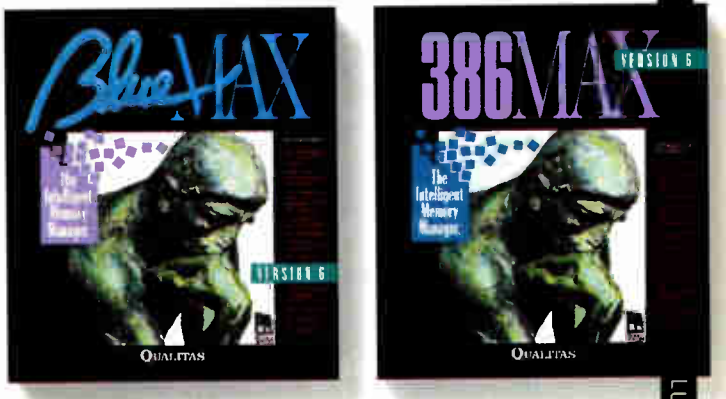

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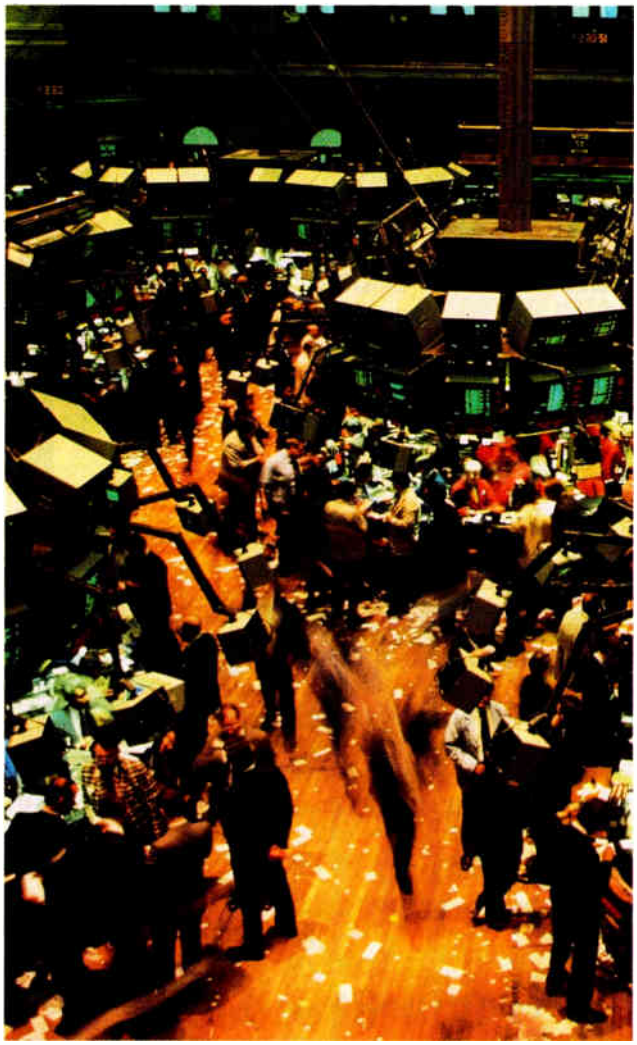

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FEATURE

Faster Packet Networks

A trimmed-down specification makes frame relay faster than a speeding X.25 packet

WILLIAM STALLINGS

The most important technical innovation to come out of the standardization of ISDN is frame relay. Compared to X.25, frame relay provides a streamlined technique for wide-area packet switching. It also provides performance superior to that provided by X.25 by eliminating, as much as possible, the overhead inherent in X.25.

Frame relaying differs from conventional X.25 packet-switching service in several key ways. Its call-control signaling is carried on a separate logical connection from user data. Thus, intermediate nodes need not maintain state tables or process messages relating to call control on an individual per-connection basis.

In frame relaying, multiplexing and switching of logical connections takes place at the data-link layer (OSI layer 2) instead of the network layer (OSI layer 3), eliminating an entire layer of processing. Additionally, hop-by-hop flow control and error control are lacking. End-to-end flow control and error control are the responsibility of a higher layer, if they're employed at all.

Frame relay takes advantage of the reliability and fidelity of modern digital facilities to provide faster packet switching than X.25. Whereas X.25 typically operates only up to speeds of about 64,000 bps, frame relay can work at access speeds of up to 2 Mbps.

Although frame relay was developed as part of the work on ISDN, it is now finding wide application in public and private networks and other non-ISDN applications, particularly in bridges and routers. (For more on the frame relay marketplace, see "On the Fast Track" on page 361.)

Frame-Relay Standards

The 1988 CCITT I.122 recommendation "Framework for Providing Additional Packet Mode Bearer Services" introduced a new form of packet transmission that has become one of the most significant contributions of the ISDN work reflected in the 1988 standards. This new technique is now generally referred to as *frame-mode bearer service*, or *frame relay*. The former term emphasizes the service being offered to you, and the latter emphasizes the protocol that implements the service.

Since 1988, significant progress has been made on frame relay. In 1990, CCITT published two interim recommendations: "I.2xy: ISDN Frame Mode Bearer Services (FMBS)" and "I.3xx: Congestion Management for the Frame Relaying Bearer Service."

The work on frame relay is more developed in the U.S., where ANSI issued one standard and two draft standards in 1990: "ANSI T1.606: Architectural Framework and Service Description for Frame-Relaying Bearer Service," "Draft ANSI T1.6fr: Signalling Specification for Frame Relay Bearer Service," and "Draft ANSI T1.6ca: Core Aspects of Frame Protocol for Use with Frame Relay Bearer Service." It is anticipated that the final CCITT recommendations will be closely aligned with the current ANSI standard and draft standards. This article draws on these documents and uses the ANSI specifications for details not provided by CCITT.

Why Frame Relay?

Transmitting data by X.25 packets involves considerable overhead. Figure 1a indicates the flow of data-link frames that are required for the transmission of a single data packet from the source end system to the destination end system, and the return

BYTE ACTION SUMMARY

Frame relay is a relatively new packet-switching technology, developed originally for ISDN. Its simplified architecture lowers overhead and increases throughput, perhaps by an order of magnitude when compared to X.25. It will be a significant data communications technology in the 1990s.

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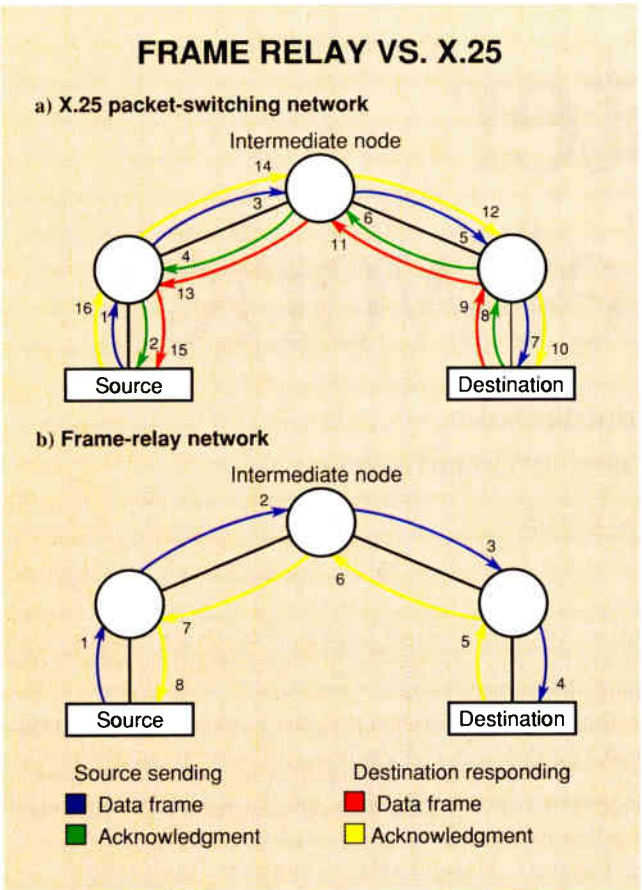

Figure 1: *Frame relay increases throughput by eliminating the need for every intermediate node to acknowledge every data frame.* **(a)** *With X.25, the transmission of a single data packet through one intermediate node requires 16 separate transmissions.* **(b)** *Frame relay requires half the transmissions to complete the transfer of the same data packet.*

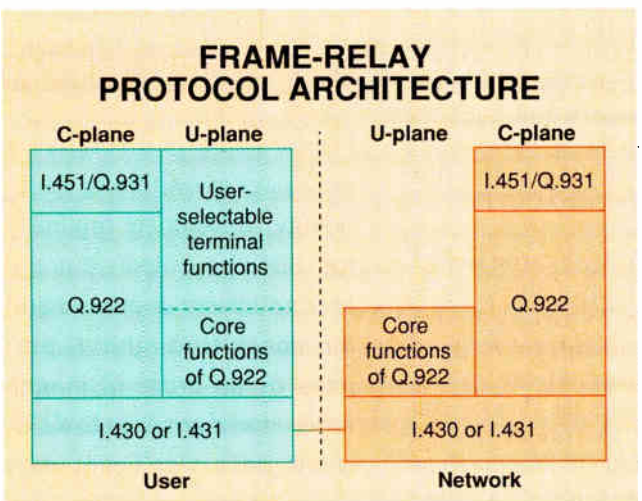

Figure 2: *The C-plane of the frame-relay architecture establishes, maintains, and terminates logical connections. The U-plane handles the transfer of data frames.*

of an acknowledgment packet. At each hop through the network, the data-link control protocol involves the exchange of a data frame and an acknowledgment frame. Furthermore, at each intermediate node, state tables must be maintained for each virtual circuit to deal with the call management and flow control/error control aspects of the X.25 protocol.

Figure 1b indicates the operation of frame relay. Here, one data frame is sent from the source to the destination, and an acknowledgment, generated at a higher layer, is carried back in a frame.

Consider the advantages and disadvantages of this approach. The principal potential disadvantage of frame relaying, compared to X.25, is that you lose the ability to do link-by-link flow and error control. (Although frame relay does not provide end-to-end flow and error control, this is easily provided at a higher layer.) In X.25, one physical link carries multiple virtual circuits, and balanced link access procedures (LAPB) provide reliable transmission from the source to the packet-switching network and from the packet-switching network to the destination at the link level. In addition, at each hop through the network, X.25 can use the link-control protocol for reliability. With frame relaying, you lose this hop-by-hop link control. However, with the increasing reliability of transmission and switching facilities, this is not a major disadvantage.

The advantage of frame relaying is that you streamline the communications process. You reduce the protocol functionality required at the user-network interface and the processing required by the internal network. As a result, you can expect less delay and higher throughput. Preliminary results indicate a reduction of an order of magnitude in frame-processing time. You can thus view frame relay as a streamlined version of X.25 that accomplishes the key functions of X.25 using only two layers of the OSI stack.

Frame-Relay Architecture

Figure 2 depicts the protocol architecture for frame relay. When discussing frame relay, you must consider two separate planes of operation: a control (C) plane, which is involved in the establishment and termination of logical connections, and a user (U) plane, which is responsible for the transfer of user data between subscribers. Thus, C-plane protocols operate between a subscriber and the network, and U-plane protocols provide end-to-end functionality.

The U-plane protocol controls the transfer of information between end-user interfaces. Frame relay employs a new CCITT recommendation, Q.922, which was issued for the first time on an interim basis in 1991. Q.922 is an enhanced version of LAPD (I.441/Q.921). Only the core functions of Q.922 are used for frame relay. These are as follows:

- frame delimiting, alignment, and transparency
- frame multiplexing/demultiplexing using the address field
- inspection of the frame to ensure that it consists of an integer number of octets prior to zero-bit insertion or following zero-bit extraction
- inspection of the frame to ensure that it is neither too long nor too short
- detection of transmission errors
- congestion control functions

The core functions of Q.922 in the U-plane constitute a sublayer of the data-link layer. This provides the bare service of transferring data-link frames from one subscriber to another. Above this, you can select additional data-link or network-layer end-to-end functions, although these are not part of the frame-

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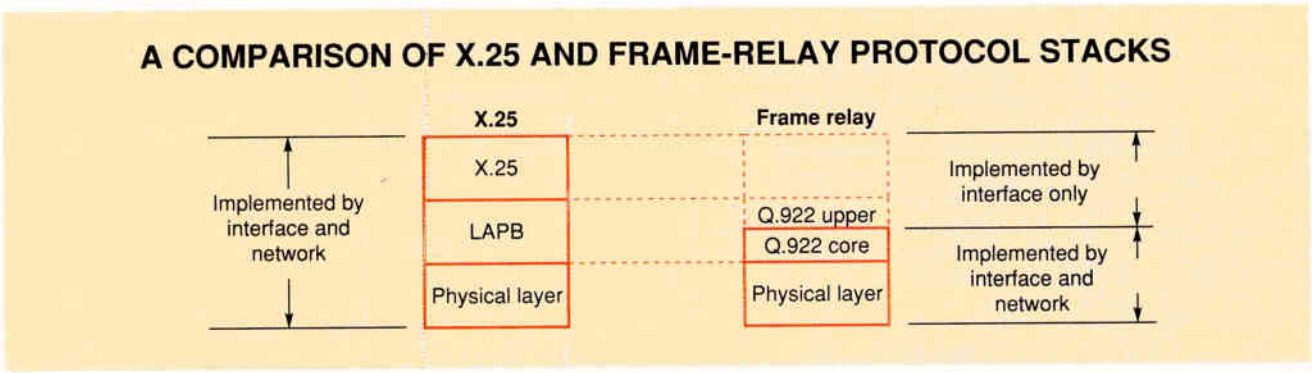

Figure 3: *One of the reasons the throughput you experience with frame relay is superior to that provided by X.25 is that the former eliminates all network-layer—and much data-link-layer—processing from the network. Frame relay moves much of the processing to the periphery of the network, letting the network do what it does best—move packets.*

relay service. Based on the core functions, frame relaying is a connection-oriented link-layer service with the following properties:

- preservation of the order of frame transfer from one edge of the network to the other
- nonduplication of frames
- a small probability of frame loss

In the control plane, Q.922 provides a reliable data-link control service, with error control and flow control, for the delivery of call-control messages. These messages constitute a subset of the ISDN call-control protocol defined in I.451/Q.931.

As you can see, this architecture reduces to the bare minimum the amount of work the network accomplishes. User data is transmitted in frames with virtually no processing by the intermediate network nodes, other than to check for errors and route frames based on the connection number. A frame in error is discarded, leaving error recovery to higher layers.

Figure 3 compares the protocol architecture of frame relay with that of X.25. The packet-handling functions of X.25 operate at layer 3 of the OSI model. At layer 2, X.25 uses LAPB. The table provides a functional comparison of X.25 and frame relay. As you can see, the processing burden on the network for X.25 is considerably higher than for frame relay.

Moving Data

You can best understand the operation of frame relay for user-data transfer by examining the frame format illustrated in figure 4. The format is similar to that of other data-link control protocols, such as high-level data-link control and LAPB, with one omission: There is no control field.

In traditional data-link control protocols, the control field performs several functions. Part of it identifies the frame type. In addition to a frame for carrying user data, there are various control frames. These carry no user data but are used for various protocol-control functions, such as setting up and tearing down logical connections.

The control field for user-data frames includes send-and-receive sequence numbers. The send sequence number is used to sequentially number each transmitted frame. The receive sequence number provides a positive or negative acknowledgment to incoming frames. Using sequence numbers allows the receiver to control the rate of incoming frames (i.e., flow control) and to report missing or damaged frames that can then be retransmitted (i.e., error control).

continued

X.25 AND FRAME-RELAY FUNCTIONS

Table 1: *The functions performed by X.25 and frame relay in their respective protocol stacks. No wonder X.25 is so much slower than frame relay; it has a lot more to do.* (●=*yes*; ○=*no.*)

Function	X.25 in ISDN (X.31)	Frame relay
Generate/recognize flags	●	●
Transparency	●	●
Generate/recognize frame-check sequence	●	●
Recognize invalid frames	●	●
Discard incorrect frames	●	●
Translate addresses	●	●
Fill interframe time	●	●
Multiplexing logical channels	●	●
Manage V(S) state variable	●	○
Manage V(R) state variable	●	○
Buffer packets awaiting acknowledgment	●	○
Manage retransmission timer T1	●	○
Acknowledge received I-frames	●	○
Check received N(S) against V(R)	●	○
Generate rejection message (REJ)	●	○
Respond to poll/final bit	●	○
Keep track of number of retransmissions	●	○
Act on reception of REJ	●	○
Respond to receiver not ready (RNR)	●	○
Respond to receiver ready (RR)	●	○
Manage D bit	●	○
Manage M bit	●	○
Manage Q bit	●	○
Manage P(S)	●	○
Manage P(R)	●	○
Detect out-of-sequence packets	●	○
Manage network layer RR	●	○
Manage network layer RNR	●	○

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FRAME-RELAY FORMATS

a) Frame format

Flag	Address	Information	FCS	Flag
← 1 →	←2–4→	← Variable →	← 2 →	← 1 →
octet				

b) Address field–two octets (default)

8	7	6	5	4	3	2	1
DLCI (high order)						C/R 0/1	EA 0
DLCI (low order)				FECN	BECN	DE	EA 1

c) Address field–three octets

8	7	6	5	4	3	2	1
DLCI (high order)						C/R 0/1	EA 0
DLCI				FECN	BECN	DE	EA 0
DLCI (low order)							EA 1

d) Address field–four octets

8	7	6	5	4	3	2	1
DLCI (high order)						C/R 0/1	EA 0
DLCI				FECN	BECN	DE	EA 0
DLCI							EA 0
DLCI (low order)							EA 1

FCS = Frame-check sequence.
C/R = Command/response; use is application-specific.
EA = Extended address field.
DE = Discard-eligibility indicator.
BECN = Backward explicit congestion notification.
FECN = Forward explicit congestion notification.
DLCI = Data-link-connection identifier.

Figure 4: *The most striking feature of the frame-relay format is its absence of a control field. Setting up and tearing down logical connections, packet sequencing, and error control must be handled at higher layers. Note that the address field can be either* **(a)** *10,* **(b)** *17, or* **(c)** *24 bits.*

The absence of a control field in the frame-relay format means that setting up and tearing down connections must be carried out on a separate channel at a higher layer of software. It also means that it is not possible to perform flow control and error control.

Apart from the absence of a control field, the frame is not unusual. The flag and frame-check-sequence fields function as they do in LAPB and other traditional data-link control protocols. The flag field is a unique pattern that delimits the start and end of the frame. The FCS field is used for error detection. When a frame is prepared for transmission, the sending system calculates the checksum and stores it in the FCS field. On reception, the checksum is again calculated and compared with the value stored in the incoming FCS field. If there is a mismatch, then the receiving system assumes that the frame is in

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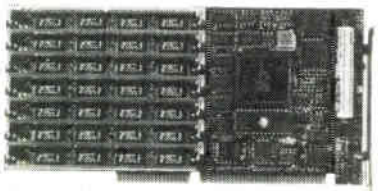

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error and discards it. The information field carries higher-layer data, which can be either user data or call-control messages, as I'll explain later.

The address field has a default length of two octets, and it may be extended to three or four octets. It carries a data-link connection identifier of 10, 17, or 24 bits. The DLCI serves the same function as the virtual-circuit number in X.25: It allows multiple, logical frame-relay connections to be multiplexed over a single channel. As in X.25, the connection identifier has only local significance: Each end of the logical connection assigns its own DLCI from the pool of locally unused numbers, and the network must map from one to the other. The alternative—using the same DLCI at both ends—would require some sort of global management of DLCI values.

The length of the address field, and hence of the DLCI, is determined by the address-field extension bits. The command/response bit is application-specific, and it is not used by the standard frame-relay protocol. The remaining bits in the address field have to do with congestion control, and they are explained later.

Frame-Relay Call Control

The details of the call-control procedure for frame relay depend on the context of its use. The standards assume the use of frame relay over ISDN. When frame relay is used over a point-to-point link between a pair of bridges or routers, a simpler protocol may suffice. Here is a summary of the essential elements of frame-relay call control.

As with X.25, frame relay supports multiple connections over one link. In the case of frame relay, these are called data-link connections, and each has a unique DLCI. Data transfer involves the following stages:

- establishing a logical connection between two end points and assigning a unique DLCI to the connection.
- exchanging information in data frames (each frame includes a DLCI field to identify the connection)
- releasing the logical connection

Frame relay establishes and releases a logical connection by exchanging messages over a connection dedicated to call control, with DLCI = 0; a frame with DLCI = 0 contains a call-control message in the information field. At a minimum, four message types are needed: SETUP, CONNECT, RELEASE, and RELEASE COMPLETE.

Either side can request the establishment of a logical connection by sending a SETUP message. The other side, on receiving the SETUP message, must reply with a CONNECT message if it accepts the connection; otherwise, it responds with a RELEASE COMPLETE message. The side sending the SETUP message can assign the DLCI by choosing an unused value and including this value in the SETUP message. Otherwise, the accepting side assigns the DLCI value in the CONNECT message.

Either side can request to clear a logical connection by sending a RELEASE message. On receipt of this message, the other side must respond with a RELEASE COMPLETE message.

Congestion Control

The challenge of congestion control is particularly acute for a frame-relay network because of the limited tools available to the frame handlers. The frame-relay protocol has been streamlined to maximize throughput and efficiency. As a consequence, a frame handler cannot control the flow of frames coming from a subscriber or an adjacent node using the typical

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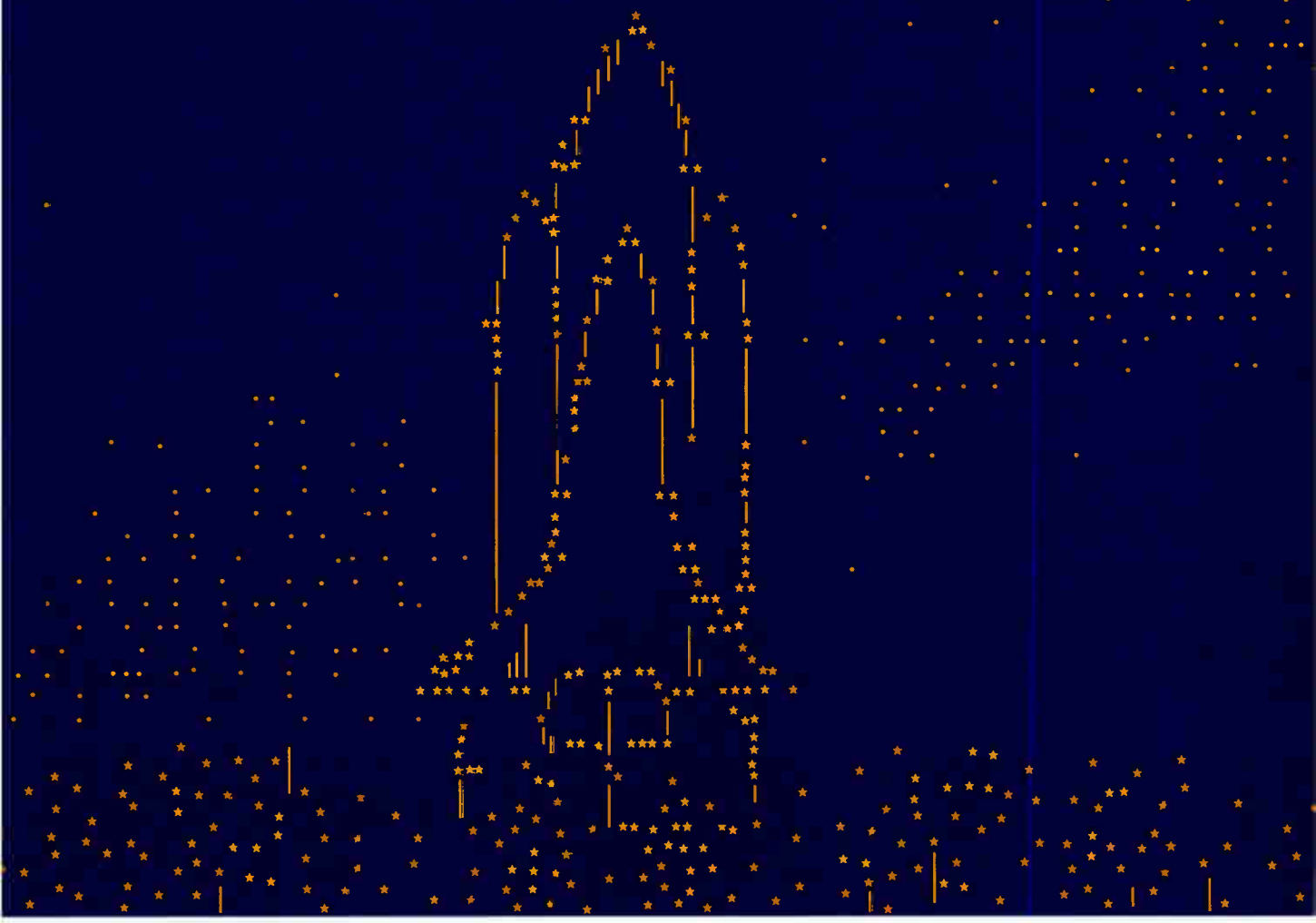

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INTEROPERABILITY
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If modern computing was born with the first electronic computer, incompatibility was born with the second. Computing was conceived of as a better way to process information, and distributed computing was conceived of as a better way to share information. But the vision of distributed computing depends on the unspoken assumption that computers can operate efficiently together to share information. Unfortunately, the assumption of *interoperability* hasn't been supported by the realities of today's computing. Computing is still a world made up of many technical directions, product implementations, and competing vendors. This diversity is causing growing problems as computers and networks proliferate. It is ironic that the real effect of computing is too often to prevent the sharing of data.

The culprits aren't overly restrictive system managers or security policies. The problems contributing to incompatibility are rooted in incompatible architectures, data formats, and communications protocols. Solving these problems is now the focus of widespread R&D efforts.

In "Interoperability Today," Barry Nance renews the significance of the overused term *interoperability* by providing a frame of reference for meaningful discussions. His overview of the state of interoperation highlights the need for further progress in many of the contributing technologies.

Networks form the basic links in any view of interoperability. In his article "Connectivity: The Sum of Its Parts," Peter Fetterolf, a consultant for Arthur D. Little, discusses networks and their interconnection in the context of integrated information systems.

Developing transparent communications at the network level won't be enough to achieve interoperability. Data must be made available for use by the many applications that define the processing capabilities of an information system. In "Transparent Data Exchange," Steven J. Vaughan-Nichols explores the meaning of interoperability for applications and application developers. He reviews the current approaches to and limitations of exchanging data between applications, and he discusses the various directions espoused by industry consortia and major vendors.

In "Portability and the GUI," Carnegie Mellon University's David M. Andersen and Bruce A. Sherwood focus on the shift to GUIs that has simplified life for users but complicated it for programmers. Developing an application that supports multiple GUIs—such as Macintosh, Windows 3.0, and Motif—now requires the programmer to use a variety of tools, many of which are platform-specific.

In "Distributed Open Environments," Mary Hubley, a senior editor of *Datapro Reports on Unix Systems & Software*, reviews the significance of two projects under way at the Open Systems Foundation and Unix International that will jointly allow the transparent sharing of data, resources, and services across heterogeneous networks.

Another major project is under way at the Microelectronics and Computer Technology Center. MCC's Carnot project is intended to define and create tools that allow the development of open applications. In "Integrating Distributed Information," Daniel W. Rasmus describes the Carnot project and its progress.

Ellen Ullman brings her considerable software engineering experience to "You Can't Run on Everything," discussing the choices faced by programmers selecting portability toolkits and long-term portability strategies.

The beginnings of common interoperability are emerging from the laboratories now. It will take a while before you'll be able to grab your keyboard, access the spot price on coffee, multiply it by the inflation rate in Europe, and tell the manager of your French subsidiary that the breakfast budget is wrong—all within the time of a telephone call. But it won't take as long as you think.

—John W. Donovan
Senior Editor,
State of the Art/Features

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order. But you'd never use the word to describe to your friends what you did. The same is true of every electrical appliance you've ever plugged into a wall outlet. The degree of interoperability achieved by telephone and utility companies is exceedingly high.

On the other hand, if you've ever tried to merge two LANs, one using IBM OS/2 LAN Server and one using Novell NetWare (and perhaps with some Macintosh workstations attached), so that all users get to share the same resources and files on all the servers, you know how far the computer industry has to go before it achieves true interoperability. In such a situation, you might find yourself using *interoperable* as an expletive while you try to make things work.

If you buy all your hardware and software from one manufacturer, your concern for interoperability is eased somewhat, although you can still run into things that don't work well together. For example, IBM produces charts and tables to show which of its products work together and, by implication, which do not. And you can't dismiss IBM's proprietary products from interoperability considerations; IBM is large enough that its specifications and guidelines often become industry standards. Interoperability is closely linked to the existence of accepted standards, whether they're the formal result of official standards efforts or the de facto result of industrywide acceptance.

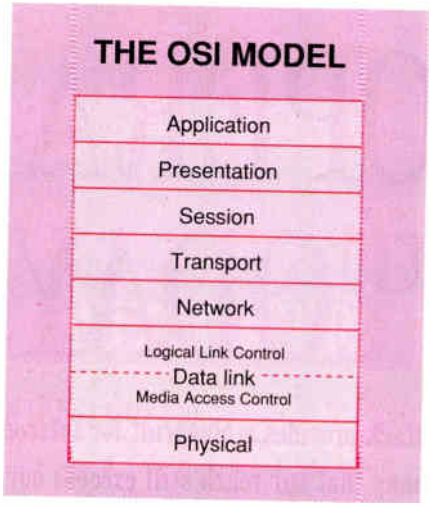

Figure 1: *Each layer of the OSI model presents a strictly defined interface to the adjacent layers, permitting pieces from different vendors to fit together seamlessly.*

Up the Stack

The most important standards in the interoperability arena are those encompassed by the Open Systems Interconnection Reference Model. It provides a framework that developers use to create interoperable products and that you can use to explore the current state of interoperability. Because many products are not yet OSI compliant, the correspondence between the OSI model and reality is not always exact, but it is the best reference available.

Briefly, the OSI model declares seven protocol layers and specifies that each be insulated from the others by a well-defined interface. From bottom to top, the seven layers (see figure 1) are as follows:

- *Physical*. The lowest level of the OSI model specifies the physical and electrical characteristics of the connections that make up a network. It encompasses such things as twisted-pair cables, fiber-optic cables, coaxial cables, connectors, and repeaters. You can think of it as the hardware layer.
- *Data link*. In this layer of processing, the electrical signals enter or leave the network cable. Bit patterns, encoding methods, and tokens are examples of elements known to this layer (and only to this layer). The data-link layer detects errors and corrects them by requesting retransmissions of corrupted messages or packets. Because of its complexity, the data-link layer is broken into a Media Access Control layer and a Logical Link Control layer. The MAC layer manages network access (e.g., token passing or collision sensing) and network control. The LLC layer, operating at a higher level, sends and receives the data messages or packets.
- *Network*. This layer switches and routes the messages to get them to their destinations. It is responsible for addressing and delivering messages.
- *Transport*. When more than one packet is in process at any one time, this layer controls the sequencing of the message components and regulates inbound traffic flow. If a duplicate packet arrives, this layer recognizes and discards it.
- *Session*. The functions that are defined in this layer let applications running at two workstations coordinate their communications into a single session. A session is an exchange of messages—a dialogue—between two workstations. This layer helps create the session, informs one workstation if the other has dropped out of the session, and terminates the session on request.
- *Presentation*. When IBM, DEC, Apple, Next, and Burroughs computers all want to talk to each other, some translation and byte reordering is needed. This layer converts data into (or from) a machine's native internal numeric format.
- *Application*. This is the layer an application program—and, therefore, the programmer—sees. A message to be sent across the network enters the OSI model protocol stack at this point, travels downward toward the first layer (the physical layer), zips across to the other workstation, and then travels back up the stack until it reaches the application on the other computer through that computer's own application layer.

What follows is a discussion of the current state of interoperability at each of the layers in the OSI stack. Notice that while the status of interoperability gets fuzzier as you go up the stack, the word *interoperability* is used (or perhaps abused) more frequently as you near the top.

Firm Foundations

Within each type of cable, physical interoperability is pretty well defined. If you indicate you've connected some computers with RG-58 A/U coaxial cable, there is a good chance that a network administrator will immediately think of thinwire Ethernet. Mention shielded twisted-pair (IBM Type 1) cable, and Token Ring will probably come to mind. Unshielded twisted-pair cable might be Token Ring, or it might be Ethernet's relatively new version (10Base-T). Fiber optics? Fiber Distributed Data Interface

BYTE ACTION SUMMARY

The Open Systems Interconnection Reference Model provides an established framework for network interoperability. Comparing current interoperability solutions to the model shows that while interconnecting different systems at the lower levels of the model is possible, getting applications to work together seamlessly across a heterogeneous network is not yet commercially feasible.

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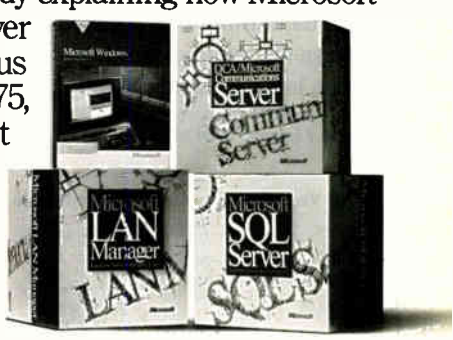

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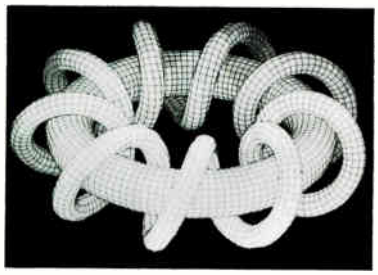

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FRAME TYPES

Ethernet frame

Preamble	Destination	Source	Type	Data	CRC
8	6	6	2	46–1500	4

Field length, in bytes

IEEE 802.3 Ethernet frame

Preamble	SFD	Destination	Source	LEN	Data	Pad	CRC
7	1	2 or 6	2 or 6	2	0–1500	*x*	4

Field length, in bytes

SFD = Start frame delimiter
Pad = Filler bytes to bring the frame to a minimum length
CRC = Cyclic redundancy checksum
LEN = Length of data field

IEEE 802.5 Token Ring token

SD	AC	ED
1	1	1

Field length, in bytes

SD = Start delimiter AC = Access control ED = End delimiter

IEEE 802.5 Token Ring data frame

SD	AC	FC	DA	SA	Data	FCS	ED	FS
1	1	1	2 or 6	2 or 6	Variable	4	1	1

Field length, in bytes

SD = Start delimiter
AC = Access control
FC = Frame control
DA = Destination address
SA = Source address
FCS = Frame-check sequence
ED = End delimiter
FS = Frame status

Figure 2: *Different LAN types encapsulate data differently, resulting in incompatibilities. The most significant difference between "true" Ethernet and IEEE 802.3 Ethernet is the Pad field. True Ethernet defines the smallest data field as 46 bytes; 802.3 Ethernet allows you to send a zero-length data field and pads the frame to the proper length. Token Ring is something else again: It has one frame definition for the token and another for the data frame. Given the differences between the Ethernet and Token Ring frames, it's no wonder that adapters of one type can't recognize frames of the other type.*

(FDDI) is new enough that you might just get puzzled looks.

In each case, though, the simple mention of the type of cable is often enough to define the entire physical appearance of the network components and to specify what will connect—interoperate—with what. If my computer has a Token Ring card and I want to connect to your network, I need ask only two questions to find out whether it's possible: "4 or 16 Mbps?" and "Shielded or unshielded twisted pair?" This level of interoperability is made possible by standards efforts managed by the IEEE. The 802.3 (Ethernet) and 802.5 (Token Ring) standards specify exactly how the physical layer of the network should behave, and these standards extend their reach into the data-link layer.

There are other physical standards that are highly interoperable. The best example is a parallel printer cable (which uses the Centronics interface). If you buy a printer with a parallel interface and it doesn't work with a computer and cable known to be good, it's certain that the printer is dead on arrival.

The standard for serial cables, RS-232, is equally rigorous and exacting. It defines Data Terminal Equipment and Data Communications Equipment, and it specifies exactly how to connect DTE and DCE to make them interoperate. I can buy a modem with an RS-232 interface, connect it to my RS-232 serial port with an RS-232 serial cable, and know that things are going to work.

continued

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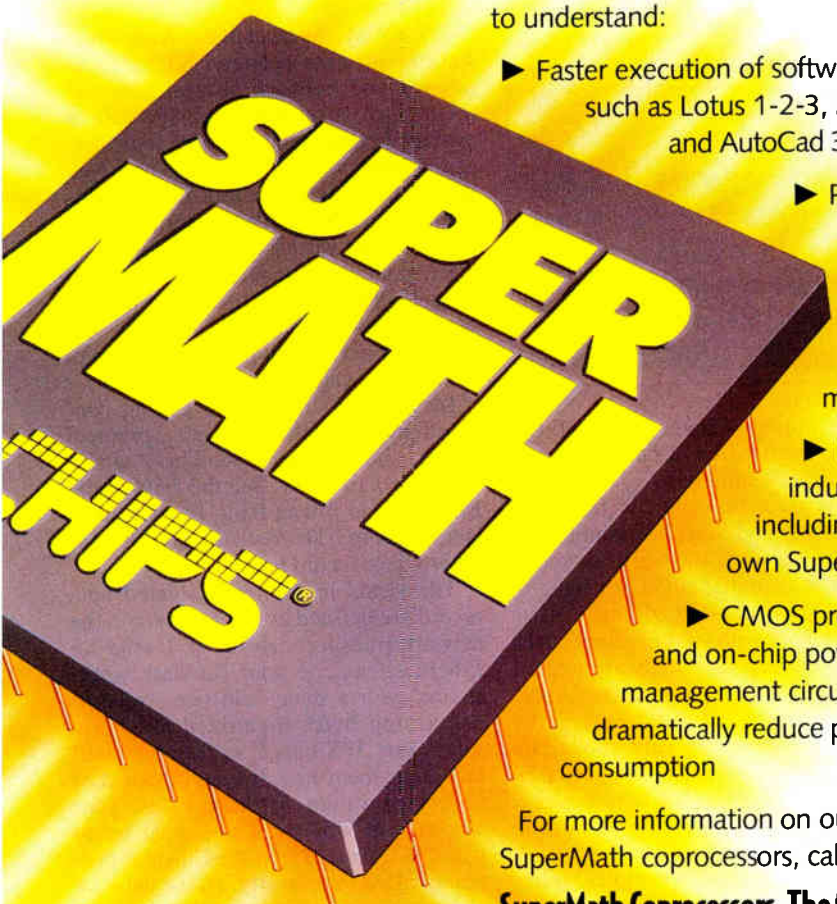

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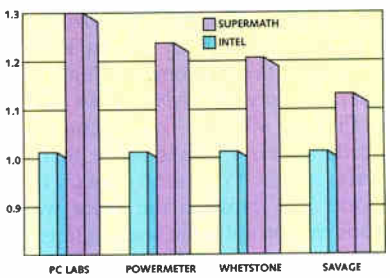

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Data Link: Defining Data Formats

Suppose I got out some spare chips and a soldering iron and somehow managed to connect my Token Ring–equipped computer to your Ethernet LAN so that the Ethernet message packets (*frames*) successfully entered my Token Ring card (don't try this at home!). Can I "interoperate" on your LAN? No way.

First of all, my Token Ring adapter needs to see a 3-byte *token* that it can claim before it can send data on the network. The cards in the other workstations rely on collision sensing to get their message across. But even forgetting about tokens and collision sensing, the basic format of the data is different.

Pascal programmers call it a RECORD. In C, it's a `struct`. Bare-metal assembly language folks might use a `struc <>`. COBOL programmers think of it in terms of a `Record Description`. Basically, it's the layout of the data in memory, the organization of the data bytes into fields within a data record.

Not only is an Ethernet data record or frame laid out differently from a Token Ring frame, IEEE 802.3 Ethernet is also slightly different from *true Ethernet*—the original Ethernet definition from Xerox and DEC. Figure 2 shows the differences. But within each standard (IEEE 802.3 Ethernet or IEEE 802.5 Token Ring), the degree of interoperability is high, permitting adapter cards of the same type from different manufacturers to interoperate seamlessly.

ARCnet data records (or frames), FDDI frames, and StarLAN frames are differently laid out, too—just as you'd expect. The essential point, though, is that my hybrid, jury-rigged Token Ring card won't work with your Ethernet LAN because these record layouts are understood by the ROM program code burned into each adapter. (If I did manage to modify the Token Ring card enough to make it work, it would no longer be a Token Ring card—it would have become the world's most expensive Ethernet adapter.)

What about non-LAN examples? If interoperability is such a slippery thing, why can I use my fax machine to send documents and pictures to you as if we had picked our equipment from the same assembly line? The answer, of course, is standards. Group 3 fax is a standard understood around the world.

The 9600-bps modems took a while to catch on, mostly because the standard for data representation was still evolving. Now we have CCITT V.32 modems from different manufacturers that reach out and touch each other reliably. However, some modems, designed before the CCITT standard stabilized, do not always speak clearly to other 9600-bps modems. An example is the USRobotics Courier HST modem; before USRobotics' Dual Standard, its modems didn't interoperate well with other 9600-bps modems. (The original HST used a proprietary modulation scheme that provided a 9600-bps forward channel and a back channel running at 1200 bps.)

Network and Transport Layers

People talk a lot about interoperability at the network and transport layers. If my earlier cynical observation is true, this means that interoperability is sporadic and elusive at this level. I'll test this theory here.

IPX.COM, the layer of NetWare workstation software between NETx.COM (above) and network adapter software (below), exists at this level. IPX has its own application programming interface, and applications software on one NetWare workstation can talk through this interface to other NetWare workstations. However, the workstation dialogue takes place in a unique dialect of network languages; other workstations may use the same cables and network adapters, but they can't participate if they don't speak the IPX language.

Incidentally, if you are getting confused by this talk of layers, protocol stacks, and interfaces, look back at figure 2 for a moment. See the field in the Ethernet and Token Ring frames that's labeled *Data*? The data field is yet another whole record layout.

The fields in this encapsulated data record are defined by the software in the network/transport layers. If I send an Ethernet frame to your NetWare workstation with a data field (i.e., record) containing bytes organized a certain way, your IPX-based workstation will recognize the frame. If I put incorrect or undefined values in those bytes, your workstation will not know what to do with the frame, even if the Ethernet portion is filled in correctly. At the network and transport layers, interoperability is defined mostly in terms of the definition of the data within the message packet.

IPX is a close adaptation of a protocol developed by Xerox, XNS. Novell uses IPX, of course, but I don't know of any other major players whose LAN products implement it directly. One way around this stumbling block to interoperability is to use the Clarkson Packet Drivers.

Supported by Novell, FTP Software (Wakefield, MA), much of the academic community, and other groups, the Clarkson Packet Drivers allow multiple protocols to use the same network adapter. IPX data packets are routed to IPX, Net-

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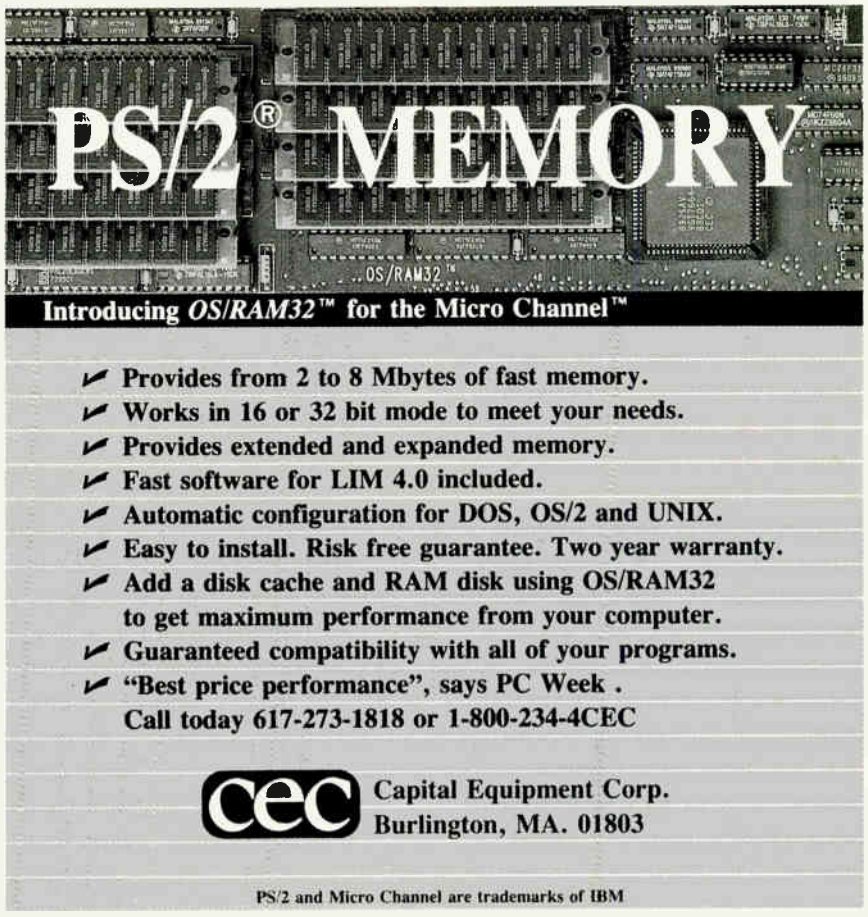

BIOS packets to NetBIOS, TCP/IP packets to TCP/IP, Network File System packets to NFS, and so forth. These drivers take up a little extra RAM, but they do a good job of providing interoperability at the network/transport layers—if you have multiple upper layers that all need to use the same network adapter.

TCP/IP is yet another piece of the interoperability puzzle. (If everyone used TCP/IP—or IPX, or NetBIOS—I probably wouldn't be writing this.) TCP/IP was developed with government money and is therefore in the public domain; this probably explains its popularity. TCP can be considered a transport-layer definition; IP fits more into the session layer. TCP, of course, is very different from IPX. In fact, the many different transport-layer definitions (record layouts and data field meanings) are the biggest obstacles to interoperability.

Another term that is used at this level is *transport independence*; it's another way of saying interoperability. Suppose you want to develop an application consisting of different modules that run on an IBM PS/2 under OS/2, a Mac, and a Unix box. You'd like to design the modules so that the calling interface—one module passing parameters and control to another—is completely transparent to the programmer. You need special glue to put these pieces together. This glue is called *remote procedure calls*, or RPC (see "In Praise of Remote Procedure Calls," March BYTE).

RPC lets different kinds of computers process different parts of the same application. Companies like SunSoft (a subsidiary of Sun Microsystems), NetWise, Novell, Hewlett-Packard, and Momentum Software are doing amazing things with RPC. American Airlines, for example, is using XIPC from Momentum to develop a new cargo-routing system that runs on a variety of computers.

Transport independence means that all the machines making up the entire application system are using the same transport-layer definition—IPX, NetBIOS, TCP/IP, or something else. RPC is great when the same transport layer is available for all the kinds of computers you want to use. You use the RPC tools to segregate your modules by target machine, and you link the modules with an RPC library on each target. Voilà—you have taken the best characteristics of each kind of computer and incorporated them into one system.

But suppose you'd *really* like to use one of those new Volga Boatman/2000 computers, which as everyone knows only support the F/X protocol, in your application. Your vendor of RPC tools shrugs and says, "Sorry." You start traveling to the trade shows, hoping to hear someone use the words "interoperability" and "Volga" in the same breath.

I've concentrated on IPX and TCP/IP, probably the two most widely used transport protocols. Another term you hear frequently in conjunction with TCP/IP and IPX is NetBIOS. Actually, though, much of NetBIOS works at the session layer, the next level of the OSI model.

Session Players

IPX.COM actually contains two protocols, IPX and SPX. As you'd expect, SPX is a layer on top of IPX and uses IPX to send and receive its data messages. SPX is session-oriented, like NetBIOS, but the similarity ends there. In my book *Network Programming in C* (Que Publishing, 1990), I explain NetBIOS programming techniques in one chapter and IPX/SPX techniques in another—the degree of interoperability between the two chapters is exceedingly low.

"Ah!" you say. "Novell supplies a NetBIOS.EXE program with NetWare that ought to solve the problem." I wish that it were true. If the various implementations of NetBIOS were interoperable, you could construct a protocol stack consisting of network-adapter support software, IPX.COM, NetBIOS, and different redirector modules from Novell (NetWare NETx.COM), Artisoft (LANtastic), Performance Technology (PowerLAN), IBM (DOS LAN Requester), and other vendors, and you'd be able to access just about any file server ever created.

Even if you had enough RAM to hold this protocol stack, you still couldn't use it to access anything. Each vendor expects its LAN software to work with the NetBIOS *it* implemented. I've gone only five-sevenths of the way up the OSI model, and already interoperability is out of focus and getting fuzzier by the minute.

While there are some differences in each of the programming interfaces of the NetBIOS implementations from various vendors, a bigger problem is the different data-record layouts that are used to shunt NetBIOS packets across the network. On a DOS workstation, the NetBIOS module from IBM is the device driver DXMT0MOD.SYS (part of the IBM LAN Support Program). Novell's, as I mentioned, is NETBIOS.EXE. Artisoft's NetBIOS for LANtastic is AILANBIOS. Performance Technology's PowerLAN NetBIOS module is named for the adapter it supports. The data records (i.e., the contents of the data record encapsulated inside the data field of the

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Ethernet or Token Ring frame) that each of these modules creates are completely different.

Presentation and Application Layers

The software on your LAN that gives you access to the file server is the network shell, or redirector. On a NetWare network, this is NETx.COM (where the *x* denotes the version of DOS you run). On an OS/2 LAN Server network, it's represented by DOS LAN Requester at DOS-based workstations. Other vendors' redirector software is usually called REDIR or NET. At this level, you can also talk about E-mail interoperability, along with the software mechanisms for sharing data in the Presentation Manager and Windows environments.

It goes without saying that NetWare LANs, OS/2 LANs, Banyan LANs, and peer-to-peer LANs are not easily interoperable at this level. Just as you'd suspect from the discussion of lower layers of the protocol stack, the lack of communication among different vendors' redirector software modules is mostly a matter of data definition.

NetWare workstations use the NetWare Core Protocol to request file services; servers respond in kind. NCP was highly proprietary until earlier this year, when Novell announced it would license the NCP specification for a fee.

IBM designed the Server Message Block protocol for use with the PC LAN Program. One of the best documents for understanding the SMB protocol is Volume 2, Number 8-1, of the *IBM Personal Computer Seminar Proceedings*. Printed in 1985, it's still a useful introduction to how SMBs are used. IBM currently uses the SMB protocol between OS/2 LAN Server and DOS LAN Requester workstations; a few vendors of peer-to-peer products (e.g., PowerLAN) also support SMBs. Like NCP, however, SMB is identified closely with one company. It doesn't have the clout to become a widespread standard.

Interprocess Communications

At the top of the OSI model, new products and new standards for application-level interprocess communications come into being so often that it's hard to get a handle on the current state of affairs. *Interoperable* is used to describe each new product and standard. As I've suggested, the frequent use of the word is perhaps significant, but not in the way that was intended.

Dynamic Data Exchange, an application-to-application protocol for the Windows environment, was designed by Microsoft for use in Excel, the spreadsheet program. It is described in the Windows Software Development Kit and is available to other applications that want to talk to each other. Microsoft also offers Object Linking and Embedding (OLE) for use under Windows. DDE has five mechanisms applications can use:

- *Hot link*. A server application sends data to a client application whenever data changes.
- *Warm link*. The server notifies the client that data has changed, and the client can then request it.
- *Request*. This is equivalent to a copy-and-paste operation between the server application and the client, without the need for the intermediate clipboard.
- *Poke*. This is a "back channel transfer."
- *Execute*. One application controls the execution of another.

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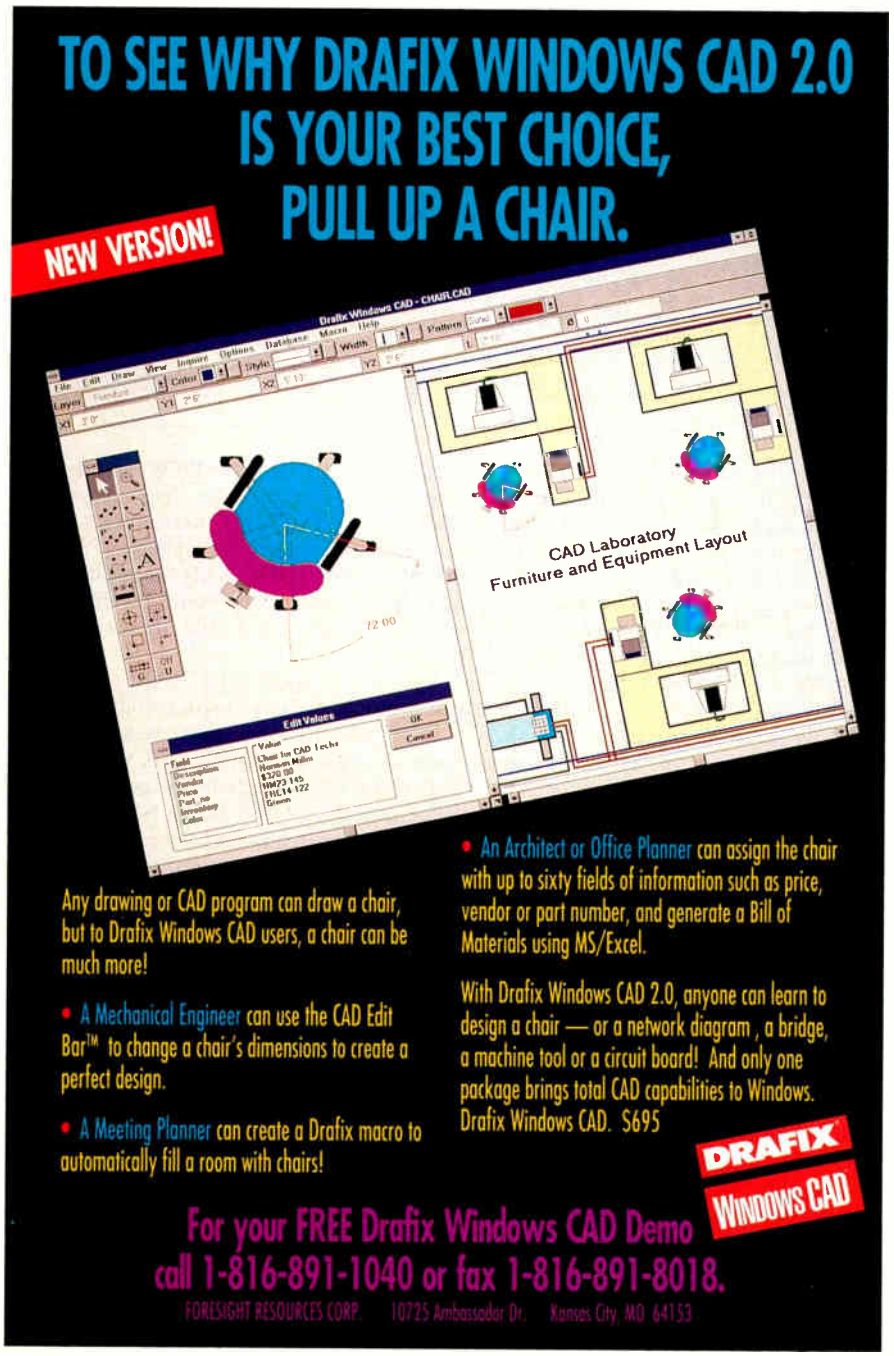

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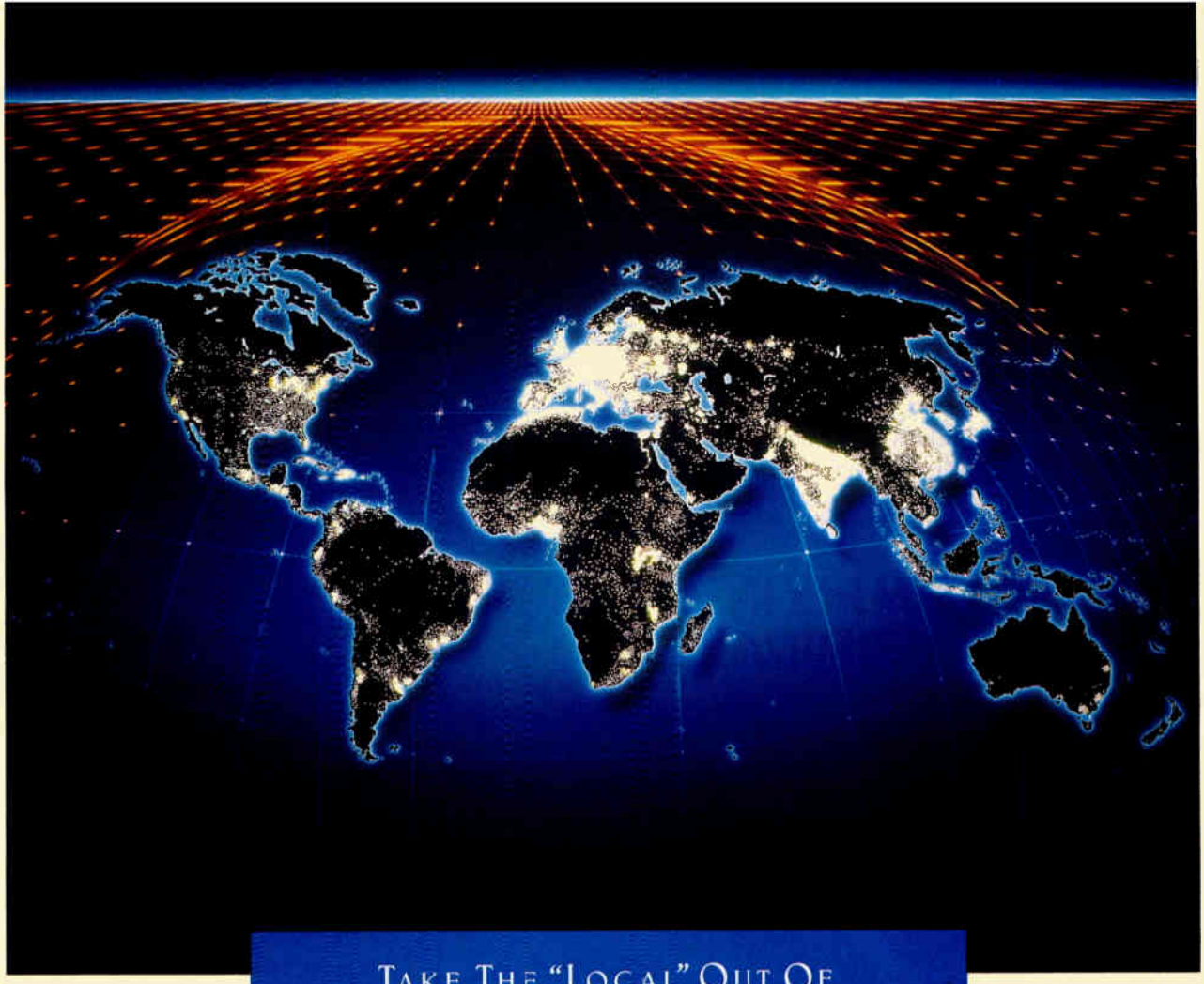

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For two applications to use DDE, they must agree on the format of the data to be exchanged. If the applications are from different vendors, this means the vendors must publish detailed specifications.

OLE is a layer on top of DDE that insulates the application programmer from some of DDE's tedious detail. One application puts data into a container that is located in the other application. The second application only needs to know how to display the data. If changes to the data are required, the second application invokes the first one through a special interface.

HP's NewWave is object-oriented. It uses the concept of agents, and it contains an intelligent link manager that resolves object names into file-system names. Version 3.1 of NewWave incorporates OLE. SunSoft's ToolTalk is another example of interprocess communications and object linking.

Interoperability among the various providers of interprocess communications facilities probably won't happen for a long time. Even within a single protocol like DDE, interoperability remains highly application dependent.

E-Mail Interoperability

E-mail is another application-level service that's feeling the interoperability push. Many commercial E-mail products adhere to the Message Handling System and/or the X.400 standard. MHS messages, for example, have a header, a body of text, and perhaps an attached file. The header contains a destination address, a return address, a postmark, and other information. Both addresses have a particular format: `<username>@<workgroupname>`. Applications that define data in this same format can interoperate with MHS. Similarly, applications that use X.400 conventions can interoperate with other X.400 applications and users.

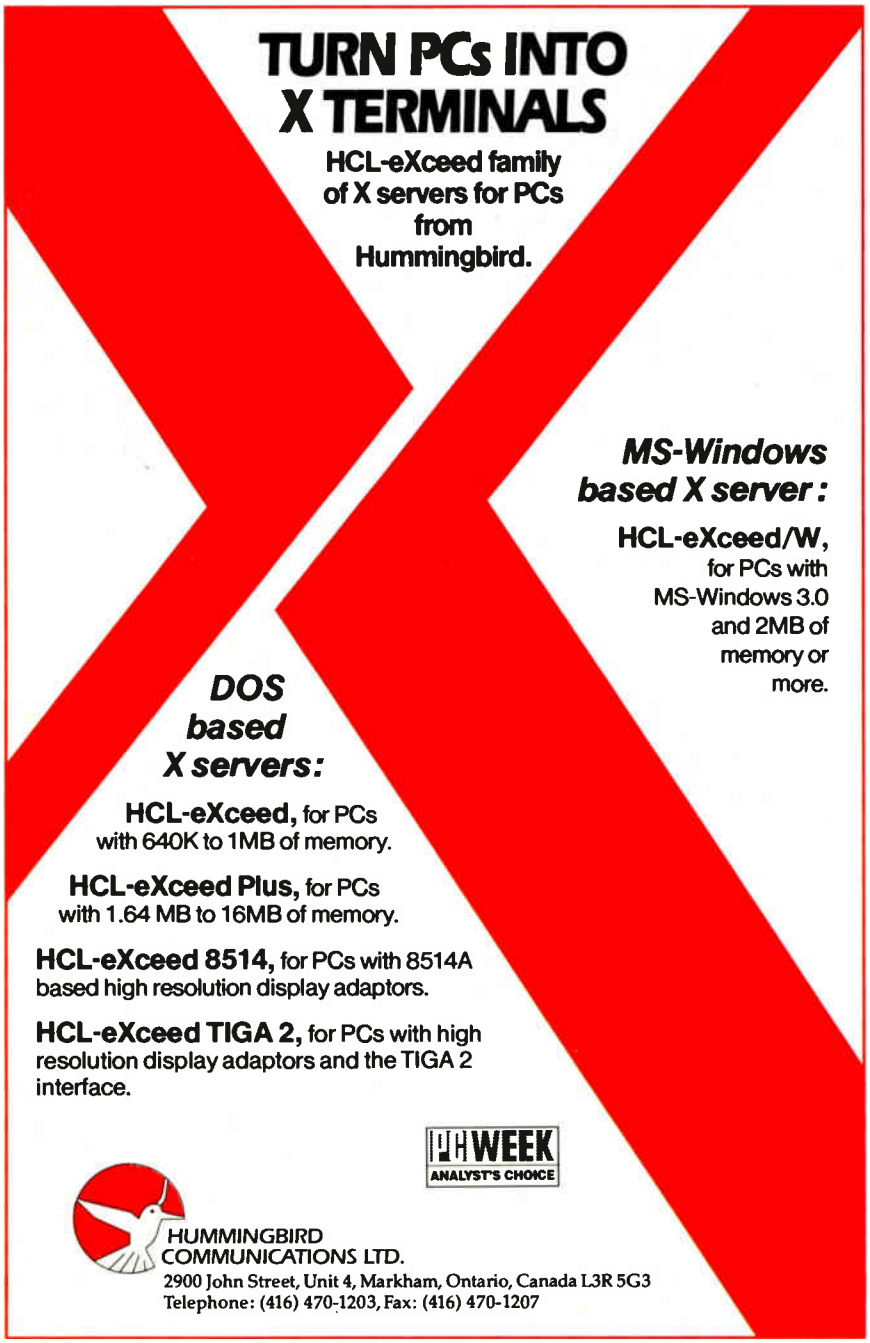
Of course, myriad other E-mail standards exist. Western Union has EasyLink, Telenet offers Telemail, and a rather popular one is PROFS from IBM. Interoperability among these systems is mostly a matter of reformatting data to look the way the other system expects. In E-mail, at least, some of the promise of interoperability has been realized.

Farther On Down the Road

Interoperability is a big issue; so big, in fact, that an annual trade show, called Interop, is now devoted to it. Run by the Advanced Computing Environment people, Interop has one overriding criterion for its exhibitors: Products must successfully interoperate with other products on a network. The show is the meeting ground of the technical people who sweat bullets to turn *interoperability* into a word you won't have to hear much of anymore.

And they still have a lot to sweat over. While interoperability solutions are solidly in place for the lower levels of the OSI stack, things begin to break down around the transport and session layers. Constructing a heterogeneous network today is not an impossible undertaking, but the day when any application can interact seamlessly with any other over your network still remains at least a few years off. ■

Barry Nance, a BYTE consulting editor, works in the R&D department at Programming Resources Co. in Hartford, Connecticut. He can be contacted on BIX as "barryn."



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The structure of modern networks

PETER FETTEROLF

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At last, though, there is hope! We are making headway connecting the worlds of wide-area networks (WANs), LANs, and metropolitan area networks (MANs). Bridges, multiprotocol routers, and other devices are the glue that is finally making the promise of network connectivity more than just a gleam in the eyes of MIS directors.

As a result, however, the world of network connectivity has become so intricate that if you understand all the pieces of the interoperability puzzle, you can hang out your shingle as a "communications expert." Here's a tour through the world of network connectivity.

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Wide-Area Networking

WANs, LANs, and MANs are all acronyms (see the glossary "Networking Names" on page 202) for an explanation of the data network technologies used to interconnect computers. WANs, which were developed as the first computer networks, are of two basic types: centralized and distributed.

Centralized WANs consist of a mainframe computer that serves remotely distributed dumb terminals. Network managers lease communications channels from a common carrier (e.g., AT&T,

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MCI, or US Sprint) and tie together terminals and the central computer using a star or tree topology. Since these networks consist of one smart computer (or mainframe) and lots of dumb (or nonprocessing) terminals, the communications protocol is fairly straightforward: The smart computer polls the dumb terminals to find out if they have anything to transmit, and then it controls data transmission so that there are no collisions.

As smart computers proliferated throughout organizations, users realized they needed a more sophisticated *distributed* network—an environment that would allow independent computers to have equal levels of control in the communications architecture. One of the first distributed WANs was the ARPANET, developed by the Department of Defense and used as a test bed for new packet-switching technologies.

The communications industry developed a layered architecture that allows software and hardware that perform different functions to be specified by network standards. (Standards are documents that specify protocols.) This approach was developed in the 1970s by ARPA, IBM, DEC, and other companies and then standardized by the ISO. This new set of standards, known as the seven-layer Open Systems Interconnection (OSI) model, was developed to provide an open system of interconnection between computers from various manufacturers. Thus, the field of data networking was born.

The physical layer of the data communications architecture could be a point-to-point link (e.g., voice grade, digital data service (DDS), T1, or T3), a satellite link, a point-to-point microwave link, an infrared link, and so forth. The data-link layer protocol might be high-level data-link control (HDLC), which provides for error checking, flow control, and retransmission of packets on a point-to-point data link.

In addition to the seven original layers of the OSI model, the IEEE 802 committee has recently broken up the data-link layer into two sublayers: media access control and logical link control. The LLC layer carries out the traditional data-link control functions. It is modeled after HDLC. The MAC layer is responsible for sharing media such as coaxial cable, fiber optics, packet radio, or satellite communications.

TCP/IP is typical of network layer and transport layer protocols. IP handles functions such as routing, fragmentation, and reassembly, as well as multilevel security for packets traversing a network. TCP provides for end-to-end error control, flow control, and packet-sequence control. There also are three other layers above the transport layer—the session, presentation, and application

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layers. (However, details of these are not relevant to this article.)

Local-Area Networking

LANs were soon to follow WANs. As users accumulated computer hardware at an astounding rate, it became clear that they would benefit from a high-performance, economic method of interconnection to provide resource sharing. The primary methods of LAN interconnection were subsequently specified by the IEEE 802 committee as the IEEE 802.3, 802.4, and 802.5 standards. IEEE 802.3 is the CSMA/CD protocol—also known as *Ethernet*—that provides a shared-bus topology.

On an Ethernet system, the protocol allows every machine to transmit at any time if no one else is using the bus. All stations listen to the bus (known as *carrier sensing*) and transmit only when the bus is free. Unfortunately, all physical communications media have finite propagation delays (limited by the speed of light). If the packet has not propagated all the way down the bus, it is possible for a computer to see the bus as free when it is actually busy. The stations must sense collisions, back off for a random time, and retransmit at a later time.

IEEE 802.3 works well as long as average network traffic is less than 40 percent of the bus capacity and interconnection distances are short. If the bus is constantly busy, users experience multiple collisions and wasted bandwidth. This eventually results in an unstable system. If transmission occurs over very long distances, carrier sensing will undergo unacceptable time lags because of cable-propagation delays, and optimum throughput levels will rapidly degrade.

IEEE 802.5 is another widely used LAN interconnection technique called the *token-passing ring*. In this type of system, a single token that is controlling the right to transmit circulates among stations around the ring network. When a station needs to transmit a packet, it takes control of the token, marks it *busy*, and appends the data to it (within the frame defined by 802.5). Other stations can sense that a busy token and data are circulating around the ring, and the destination station (whose address is specified on the frame) reads and stores the frame. The token is returned to the sending station, where the data frame is removed and the token is marked *free* and put back into circulation.

The 802.5 standard provides for point-to-point, multipoint, or broadcast transmission and priority queueing of frames at stations. One problem with 802.3 is that excessive collisions waste network bandwidth, because data transmission cannot occur during a collision. Token passing is advantageous, because it does not consume bandwidth with collisions; by using this approach, then, you can obtain higher levels of throughput. Cable length in the ring is still limited by the propagation delay. If usage is low, each station needs to wait for a token to propagate completely around the ring before it can transmit a packet.

The IEEE 802.4 standard also uses token passing; however, with this protocol, the network uses a bus topology. The IEEE 802.4 token-passing bus uses a logical ring specified by station addresses. The stations pass tokens from low-level addresses to high-level addresses. The token-passing bus provides for some elaborate token-recovery schemes as well as complicated protocols to add and

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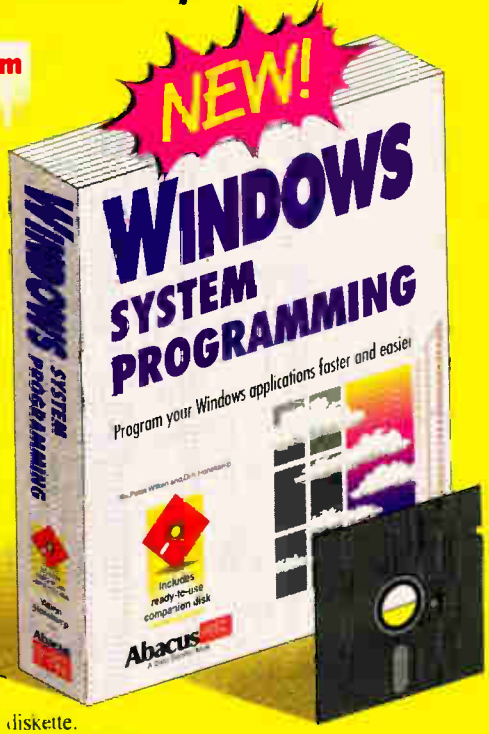

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Networking Names

Bridge A hardware and software device used to interconnect LANs. Bridges forward frames using media access control (MAC) addresses. Spanning tree bridges are transparent to users and perform automatic routing. Source routing bridges are dumb devices that depend on stations to specify routes for frames.

CSMA/CD Carrier sense multiple access/collision detection. In this protocol, stations listen to the bus and only transmit when the bus is free. If a collision occurs, the packet is retransmitted after a random time-out. CSMA/CD is used in Ethernet (IEEE 802.3).

DDS Digital data service. Digital leased lines with data rates between 2400 and 56,000 bps.

DQDB Distributed queue dual bus. A new metropolitan-area network (MAN) protocol that uses two unidirectional buses.

FDDI Fiber Distributed Data Interface. A 100-Mbps token-ring standard for transmission over fiber optics. FDDI uses counter-rotating rings for reliability and multiple tokens for high throughput.

Frame An IEEE 802 packet.

HDLC High-level data-link protocol. A fundamental data-link protocol that carries out flow control, error control, and transmission control between data-transmission equipment.

IEEE 802.x standards 802.1 specifies spanning tree bridges and the spanning tree protocol; 802.2 is the protocol based on HDLC used for link-level control for LANs and MANs; 802.3 is based on the CSMA/CD protocol; 802.4 uses the token-bus protocol; 802.5 uses the token-ring protocol; and 802.6 uses the DQDB protocol for MANs.

IP Internet Protocol. The network layer protocol that was developed by the Department of Defense in the ARPA project. It is widely used in conjunction with Transport Control Protocol (TCP).

ISO International Standards Organization. An organization that is developing the Open Systems Interconnection (OSI) standards for integrated networks.

LAN Local-area networks are typically high-speed (1 to 100 Mbps) networks used to interconnect computers within a building or a campus. Users employ LANs to share file servers and printers, to send E-mail, and to connect to wide-area networks (WANs).

LLC Logical link control. This protocol is the OSI layer that performs the traditional data-link control functions. It is modeled after HDLC.

MAC Media access control. This protocol is the OSI layer that controls access to a shared communications media.

MAN Metropolitan area network. High-speed public network that should show up in the next few years in metropolitan areas. MANs will provide LAN interconnection.

OSI Open Systems Interconnection. A layered protocol architecture specified by the ISO. OSI provides a uniform set of protocols that allow diverse computers to communicate with one another over short or long distances.

Packet Switching A type of network architecture that breaks long streams of data into packets and switches them throughout a network.

Router A sophisticated hardware and software device that interconnects WANs, LANs, and MANs. Routers route packets using network layer protocols. Multiprotocol routers can deal with heterogeneous environments by simultaneously using multiple protocols.

SMDS Switched multimegabit digital service. A new public service for carrying high-speed data traffic that will use IEEE 802.6.

TCP Transport Control Protocol. A transport layer protocol that provides end-to-end flow control, error control, and connection management.

T1 and T3 T1 is a digital line that operates at a rate of 1.544 Mbps. It carries high-speed data or 24 separate voice channels. T3 is a digital line that operates at 44 Mbps. It carries 28 T1s or one 44-Mbps high-speed data link.

Voice grade line An analog communications link designed to carry voice grade traffic. You can transmit data over voice grade lines with modems.

WAN Wide-area network. Used to interconnect computers over long distances. WANs typically use leased communications lines for common carriers and packet switches for interconnection of computers.

remove stations from the bus. IEEE 802.4 combines the advantages of a physical-bus topology with the bandwidth efficiency of a token-passing ring.

Metropolitan-Area Networking

MANs are relatively new members to the networking scene. The two major players are IEEE 802.6 and Fiber Distributed Data Interface (FDDI). IEEE 802.6 is a standard specifying a protocol known as *distributed queue dual bus*. DQDB is a novel network architecture that uses a pair of dual unidirectional buses to transmit information.

IEEE 802.2 frames are broken up into slots and transmitted on DQDB. A slot is a fixed-sized packet. A stream of slots is propagated upstream on one bus and downstream on the other bus. If a station has a frame or packet to transmit, it breaks it into segments and puts the slot in a queue for the downstream bus. At the same time, the station sends a request on the upstream bus, so that other upstream stations will know that a slot has arrived.

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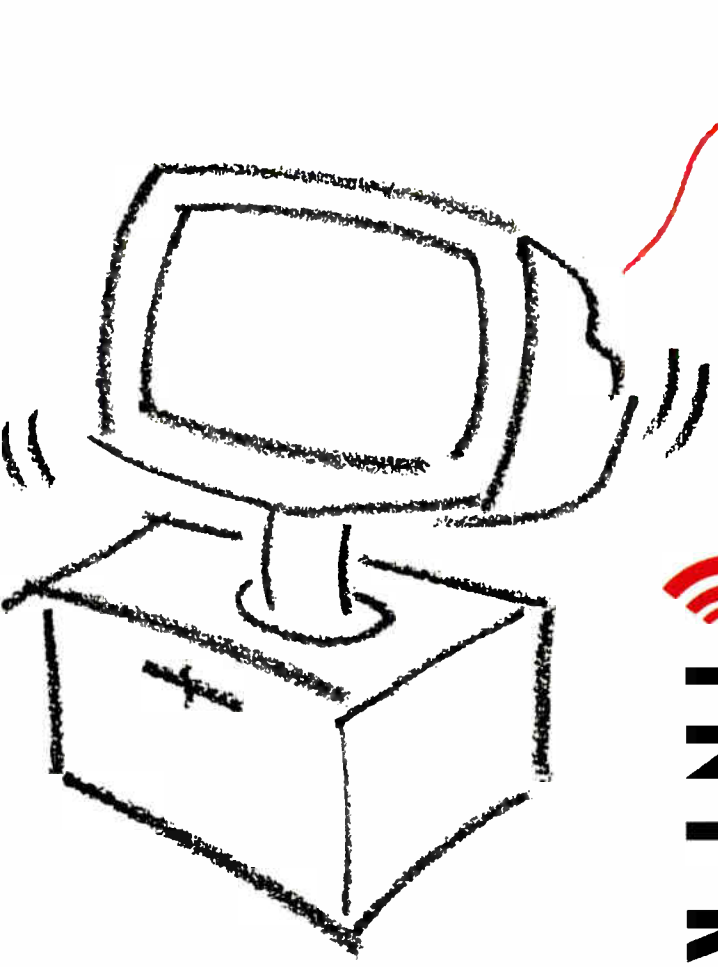

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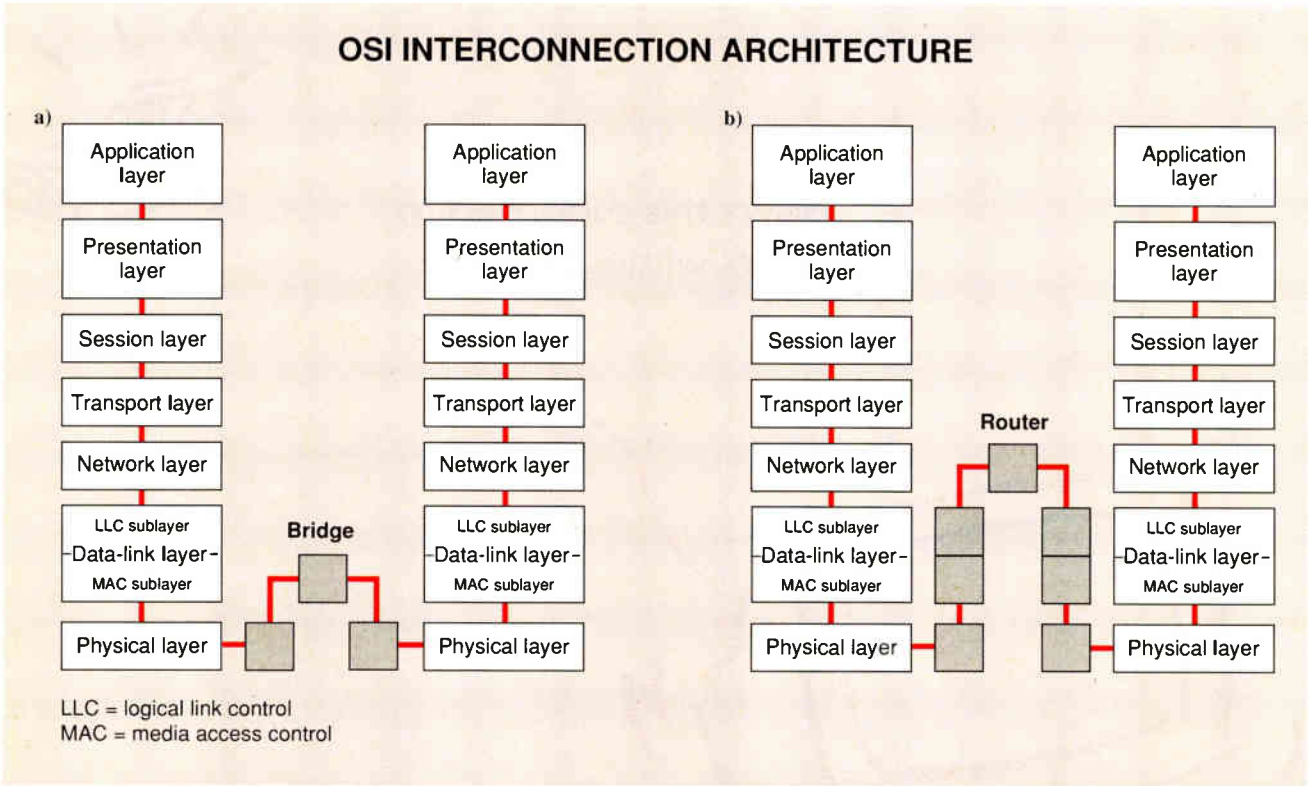

Figure 1: *Bridges route packets at the MAC sublayer of the OSI architecture* **(a)**, *while routers route packets at the network layer* **(b)**.

The DQDB mechanism supports four priority levels as well as circuit-switched voice traffic. Also, its performance is independent of distance and the number of nodes on the network. This makes DQDB a perfect candidate for transmission of high-speed LAN data. Many of the Regional Bell Operating Companies are considering using DQDB as a public MAN. This public MAN is known as *switched multimegabit digital service*.

FDDI is also being considered for use as a MAN as well as a high-speed LAN. The FDDI is a fiber-optic token ring that runs at rates of 100 Mbps. It's more complex than IEEE 802.5 in several ways.

For one thing, FDDI uses a survivable-ring architecture that employs counter-rotating rings. If one ring fails, the other can still transmit data. Also, if a cable is cut, the two counter-rotating rings can automatically reconfigure themselves to form a new ring.

In addition, FDDI uses a multiple token-ring protocol that allows the generation of a new free token at the end of a frame, so that the network can simultaneously transmit multiple frames. This feature is important if the ring covers a large metropolitan area. Otherwise, you would not be using the full ring bandwidth, because a frame occupies only a small percentage of the bandwidth.

The LLC Layer

IEEE 802.2 is an LLC protocol that rides on top of 802.3, 802.4, 802.5, 802.6, or FDDI. In brief, IEEE 802.2 is responsible for making sure that the network delivers frames without error from transmitting stations to receiving stations. It provides flow control; error control; multiplexing; and point-to-point, multipoint, or broadcast connections.

Flow control prevents a transmitter from overloading a receiver with data. The flow-control method used in 802.2 is called *sliding window flow control*: A certain number of packets can be sent without an acknowledgment. Once the source station receives an ACK, it moves the window and sends more packets. The LLC also carries out error control using a cyclic redundancy coding polynomial and provides multiplexing between higher-level processes (e.g., software).

Gluing It All Together

With all these types of communications architectures proliferating within organizations, there has to be some kind of glue connecting them. As you can imagine, that glue has to be pretty complex. In part, it is made up of bridges and routers. It's essential to know the difference between a bridge and a router so you know which one to use and when to use it.

A *bridge* is a high-performance device consisting of LAN interconnection hardware and fast-frame-forwarding software. Typically, it's used for LAN interconnection within a building or campus environment. It can also connect LANs over long distances via leased lines.

Bridges operate at the MAC layer of the protocol stack (see figure 1a). Bridge developers ignored the OSI notion that routing and interconnection should be carried out at the network layer and decided that routing could just as easily be done at the MAC layer. MAC addresses uniquely identify stations, and MAC bridges use simple but fast algorithms to route packets based on those addresses.

Bridges have found their place in campus internetworks. Some, using T1 or DDS interfaces, have provided interconnection between LANs over distances spanning the globe. But because bridges are designed to operate on compatible MAC frames, they are ideal for interconnecting homogeneous LANs (i.e., Ethernets or token rings but not mixtures of the

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two). Thus, they're not the preferred media for enterprisewide WAN/LAN/MAN interconnection.

Multiprotocol routers are a better choice for WAN/LAN/MAN heterogeneous interconnection. A *router* is a more complex device than a bridge: It consists of WAN/LAN/MAN interconnection hardware and more complex software to route packets and maintain the current status of a network topology.

Routers conform to the OSI model, in that they route packets at the network layer (see figure 1b). This architecture allows routers more flexibility in connecting different types of WANs, LANs, and MANs and networks running different protocols, such as TCP/IP, OSI, or DECnet. Routers are designed to provide end-to-end enterprise connectivity, whereas bridges are targeted at the connection of homogeneous LANs in a campus environment.

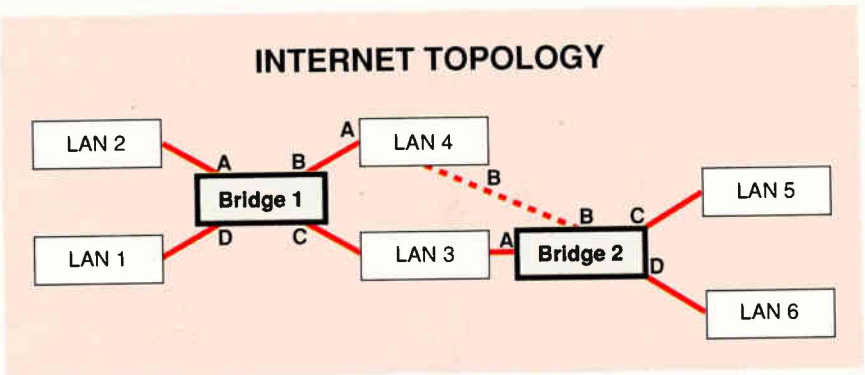

Figure 2: *Example of an internet topology connecting six LANs with two bridges. Solid lines are designated (or active) connections (i.e., they form a spanning tree), and the dotted line is a nondesignated connection. Nondesignated connections are activated only if a designated connection fails.*

Spanning Tree Bridges

The issues regarding whether to use a bridge or a router are complex in themselves. There are even two very different types of bridges that the IEEE 802 committee is standardizing: spanning tree bridges (IEEE 802.1) and source routing bridges (an addendum to IEEE 802.5). These bridges are different from, and incompatible with, each other.

Spanning tree bridges (also known as *transparent bridges* and *learning bridges*) are devices that automatically route packets without user intervention. They are designed so that neither users nor computers are aware of being connected to an internetwork of segmented LANs. In other words, the internetwork appears to be a single LAN.

A major issue concerns how transparency is maintained in a spanning tree bridge. The fundamental idea is simple: You configure an internetwork in a spanning tree topology (i.e., there is one and only one path between LANs) and maintain lookup tables that associate a bridge port with a particular set of hosts. When a packet comes in, the bridge checks the destination MAC address and routes the frame to the correct port. Consider the internetwork topology depicted in figure 2, in which bridges connect six LANs. The solid lines indicate the designated (or active) connections. They form a spanning tree bridge.

Bridge 1 has a lookup table that associates hosts on LAN 1 with port D, those on LAN 2 with port A, those on LAN 3 with port C, those on LAN 4 with port B, those on LAN 5 with port C, and those on LAN 6 with port D. The bridge monitors each LAN continuously. If it detects a frame that is not local to that LAN, it forwards it on the correct port. Then it reads the destination MAC address on the frame, checks the lookup table, and determines if the frame is local or remote. If it is remote, it forwards the frame on the correct output port.

Fortunately, the bridge takes care of building the lookup tables. It also checks the MAC source address on each frame and dynamically updates its lookup tables. For example, if the bridge sees a frame from a particular host on a particular port, it knows that the host is in the direction of that port. As you can see, the bridge doesn't need to know the correct route to send a frame; it needs to know only the correct port. Because the topology is a spanning tree, the frame will arrive at its appropriate destination.

Figure 2 shows both designated and nondesignated connections. It is obvious that the spanning tree is not a very robust topology. If a single bridge fails, the network will crash. Therefore, if the designated connections fail, the network can use nondesignated connections for backup. For example, if LAN 3 fails, the connection between bridge 2 port B and LAN 4 becomes designated.

This process is carried out by the spanning tree protocol, which is currently being standardized by the IEEE 802.1 committee. This group contends that spanning tree bridges are the preferred MAC-level interconnection devices, because users find them transparent. That is, any device that can talk to an Ethernet can talk to an internetwork of Ethernets.

Source Routing Bridges

Source routing bridges are designed to operate with IEEE 802.5 token rings. They are simple devices that examine each frame that arrives at the bridge and route the frame based on a routing-information field in the 802.5 frame. An internetwork path is constructed as follows.

Each LAN has a unique 12-bit number, and each bridge has a unique 4-bit number. Two bridges on the same LAN must each have different numbers. A route then consists of a sequence of LAN-bridge-LAN-bridge numbers. Each bridge on the LAN monitors all frames, and if a frame contains its bridge number preceded by the proper LAN number, it forwards the frame to the correct LAN.

Source routing bridges are simpler than transparent bridges because routes are prespecified in the MAC frame. Therefore, source routing bridges can operate at extremely high data rates. The disadvantage to this approach is that LAN stations need to use complex routing algorithms to specify the appropriate route in the MAC frame. Source routing bridges also work on MAC layer frames. However, they don't make routing decisions; they just follow orders.

The IEEE 802.5 committee has defined an approach that is also based on spanning trees. A source station transmits a discovery frame on a logical spanning tree, and destination stations respond. The bridges record the route by tracking the backward path through the network. Thus, source routing bridges are fast and simple to implement. However, they are in no way transparent to stations on LANs.

Source routing bridges assume that computers recognize that they are connected to an internetwork consisting of bridges and LANs. Source stations determine the best route across that internetwork, and bridges simply obey. Span-

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ning tree bridges, however, provide a transparent internetwork to source stations—that is, the internetwork appears as a single LAN. The network typically uses spanning tree bridges with 802.3 and source routing with 802.5.

Is a Router Better?

Basically, bridges are good for connecting a group of Ethernets or a group of token rings. They are not the devices of choice, though, for connecting a set of diverse WANs, LANs, and MANs that have various terminals and mainframes from different manufacturers and that are running dissimilar protocols. Multiprotocol routers are much more suitable for connecting heterogeneous internetwork environments.

Routers operate at the network layer of the OSI model. They are responsible for identifying upper-layer protocols, routing packets, and fragmenting and reassembling, as well as detecting faults and updating network topology lookup tables. Needless to say, routers are not as simple as bridges.

The disadvantage of using a router instead of a bridge is that it is slower than a bridge. This trade-off is due to the fact that routers use a lot of software to make intelligent decisions. Recently, new and more powerful router architectures have been developed. They are based on RISC processors and bit-slice processors and have been increasing throughput to levels that are capable of supporting high-speed LANs and MANs (e.g., FDDI and DQDB). Perhaps these new and improved routers will give bridges a run for their money.

Developers created multiprotocol routers to address the problems posed by heterogeneous networks—networks composed of many different types of protocols and hardware (e.g., TCP/IP, AppleTalk, and Systems Network Architecture). Two techniques are used to deal with the problems associated with heterogeneous networks: protocol conversion and multiprotocol routing. Protocol conversion is an extremely complex and unreliable process. Therefore, routers use multiprotocol routing.

As a step-by-step example, say you send an E-mail message to another user on a distant LAN that is connected by multiple WANs, LANs, and MANs. The E-mail message is processed by the high-level protocols and sent to the transport layer. That layer deals with establishing a connection with the destination host by passing packets to the destination.

The transport layer sends a packet to the network layer with the global-network address. The network layer sends the packet to the LAN layers where it is framed and transmitted by the LLC (or IEEE 802.2) protocol. The MAC layer carries out the transmission of the packet over the shared media—the bus, the ring, and so forth. If the packet is remote (i.e., it must traverse one or more routers), it is sent to the router.

The router establishes a MAC connection and an LLC connection with the source station and sends the packet to its network layer. At this point, the router determines the appropriate protocol to use and carries out the functions specified by the protocol.

The router then determines if it has a direct connection to the destination station. If it does, it sends the packet directly to the station. If it doesn't, it routes the packet to the next router on the shortest path to the destination. Eventually, the

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packet arrives at the destination and is processed by the layered protocols.

It is clear that the job of a router is complex. It must deal with a wide variety of interconnection and network topology issues. Routers must recognize when links are removed or added and change their routing procedures. They must also use efficient techniques to conserve expensive WAN bandwidth. Because multiprotocol routers are so flexible and diverse, they have become fundamental building blocks of modern data communications networks.

The Yellow Brick Road

WANs, LANs, MANs, bridges, and routers are all relatively new terms that have come into use in the last two decades. Changes in network technologies and the resultant ramifications have created a moving target and made PCs, workstations, minicomputers, and mainframes into elements of scalable information systems. You can now gradually build an information system by incrementally adding applications and expanding capacity.

In the past, a company might install a minicomputer, only to find a year or two down the road that its CPU is already utilized beyond its capacity. The company might then have to trash its investment and buy a mainframe. But with some new technologies, businesses now have alternative ways of creating robust information systems.

They can build integrated information systems by starting with several PCs and a file server and connecting them with an Ethernet. Then, as the organization and its need for processing horsepower grows, so too can the network and the processing power of file servers, minicomputers, and mainframes. What's more, in this scenario, users are not restricted by geography in making decisions about incremental system growth.

In the near future, computer communications should become as commonplace as telephone communications are now. Imagine that you are sitting at your desk writing a report with your word processor. Suddenly, an icon on your screen begins beeping—you have a call from Paris. You move your cursor to the icon and click on it. Instantly, your French colleague appears in a window and you start your conversation. There's no need to know French; the machine takes care of the translation.

In your conversation, a question comes up about coal mining technology in Brazil. You click on your global database, and a series of charts and pictures and a short video appear on your screen and your colleague's screen. You both determine that it's necessary to talk to one of the company's Brazilian experts. You call him, open another window, and set up a video conference. After you finish the conference call, you complete your report, E-mail it to your boss, and head for the golf course.

You may think I'm talking years away. In fact, most of the building blocks for this scenario already exist or are now in the works. In the next 10 years, we will see the personal computer transformed from an office automation tool into a global information and communications device. ■

Peter Fetterolf is a management and technology consultant specializing in networks and telecommunications for Arthur D. Little in Cambridge, Massachusetts. He can be contacted on BIX c/o "editors."

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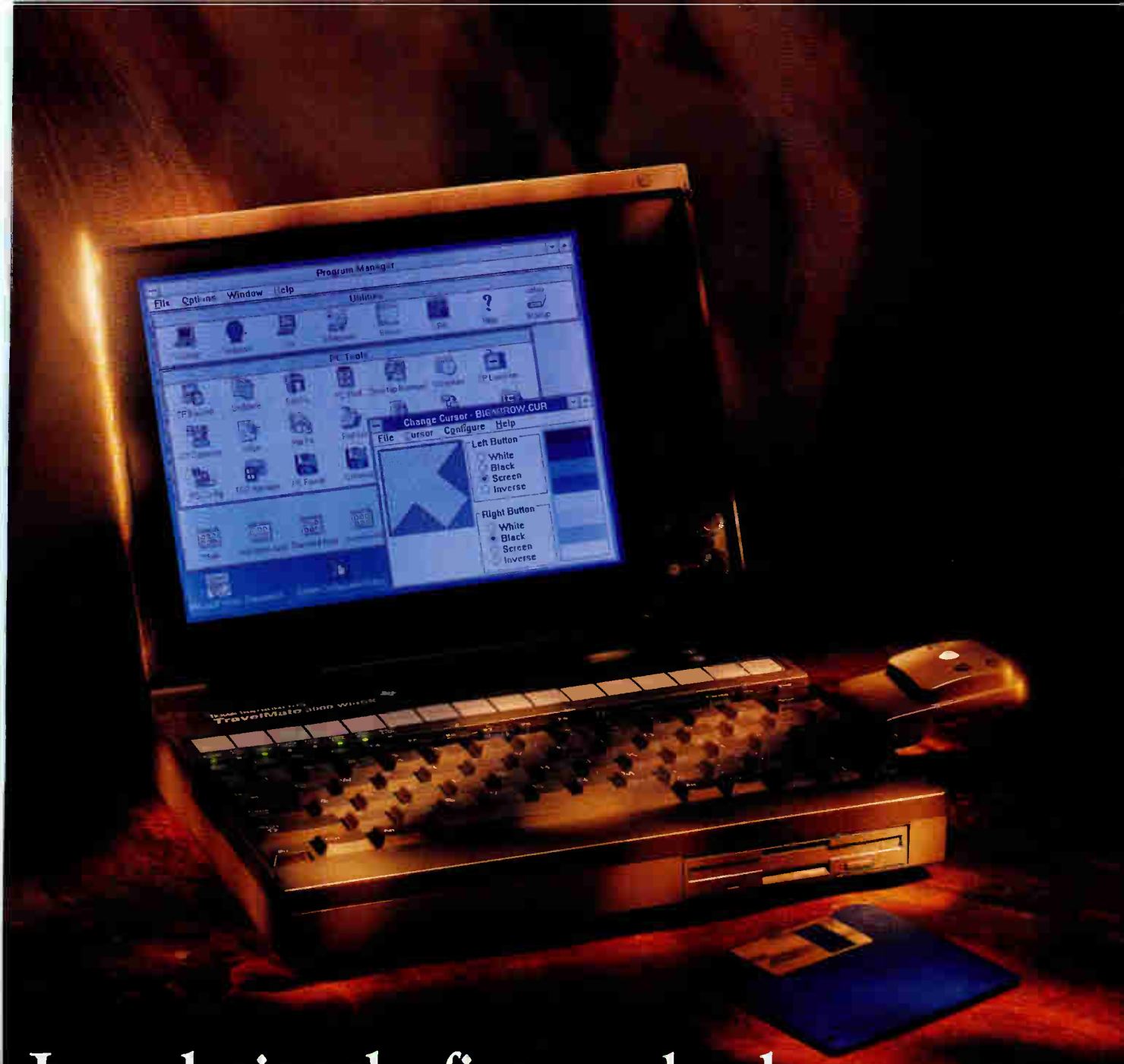

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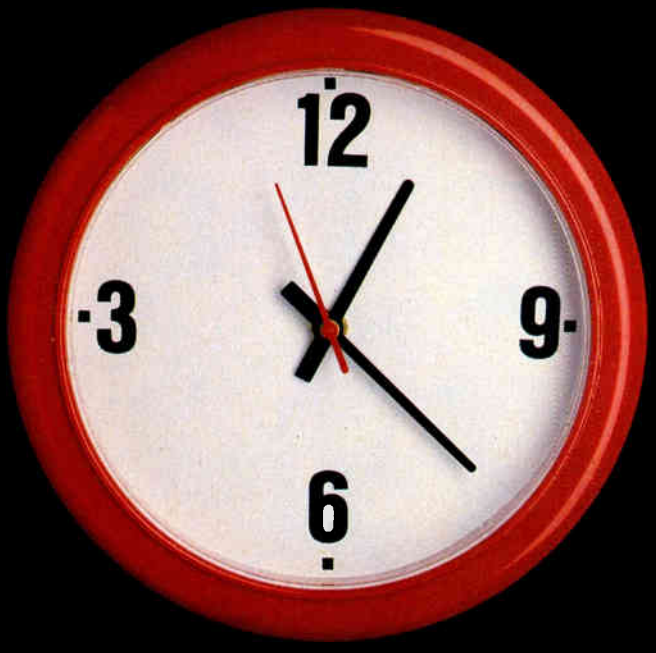

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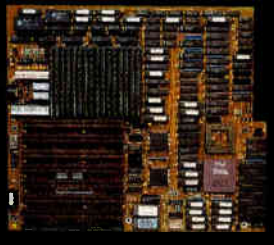

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TRANSPARENT DATA EXCHANGE

Data transparency frees your information from the bonds of a single architecture or operating system

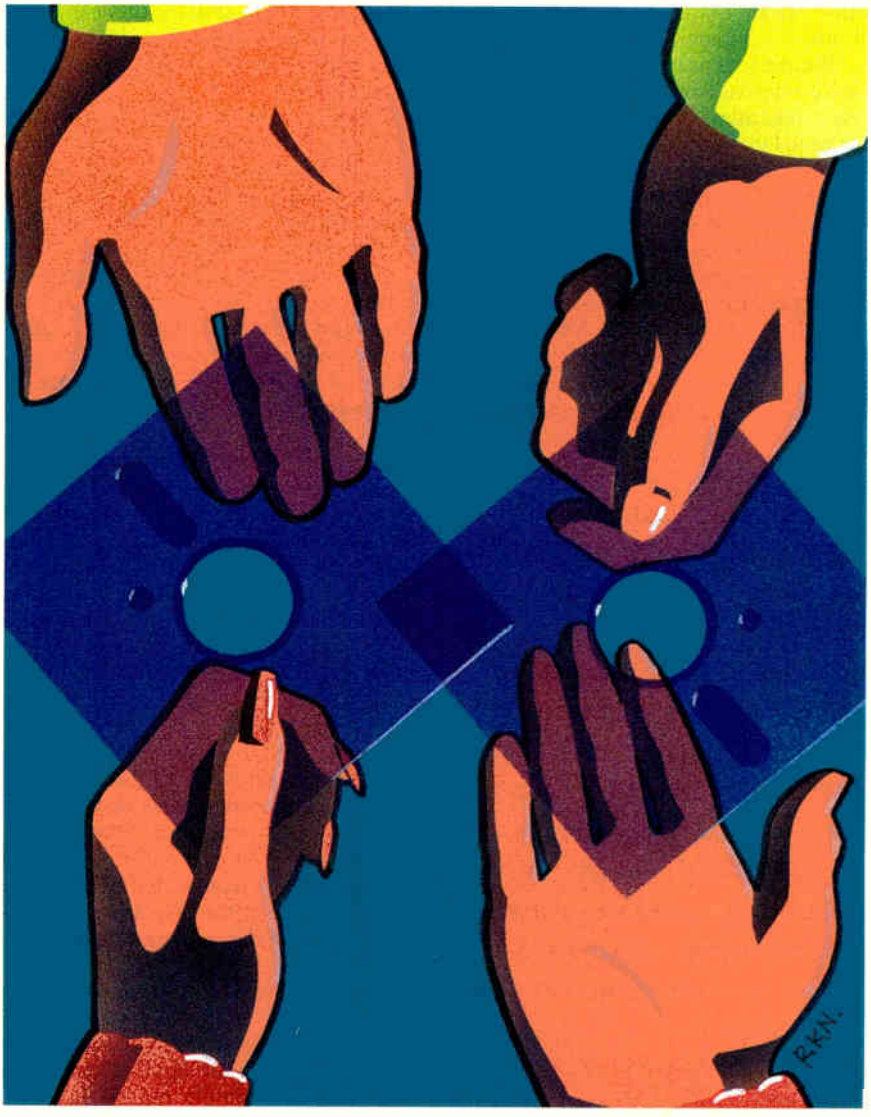
STEVEN J. VAUGHAN-NICHOLS

The Holy Grail of interoperability is data transparency. For years now, interoperability and its twin, open systems, have hovered on the computing horizon. Interoperability's promise of data that can be used throughout a heterogeneous network continues to tantalize system designers and users alike.

The first part of this decade has seen the removal of many of the roadblocks to interoperability. Standards, such as Network File System (NFS) from Sun Microsystems, the Distributed Computing Environment (DCE) from the Open Software Foundation, and IBM's Systems Network Architecture Advanced-Peer-to-Peer Communications LU 6.2 are now in place.

These standards let application programmers pour data from its current location to wherever it is needed. NFS, in particular, once only Unix's darling, now operates in many environments and stands an excellent chance of becoming the foundation upon which interoperability will be built.

Unfortunately, this approach doesn't go far enough. The problem is not simply that NFS, DCE, and LU 6.2 don't get along together. The problem is that mere access to files located on systems with different architectures isn't enough. You really need to be able to use data without worrying about where it is located or what format it's stored in.



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Look and Feel

Many programs that carry the same look and feel across differing operating platforms and systems provide a false start toward interoperability. Admittedly,

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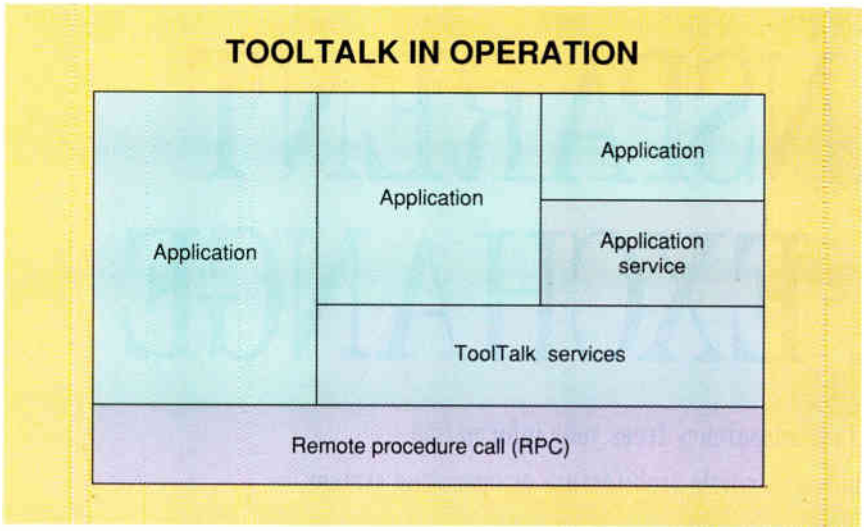

Most Sun networking applications currently call directly on the RPC services. Data is retrieved, and while the encoding will be intelligible thanks to Sun's External Data Representation, the data within may still be incomprehensible due to its formatting. Some applications will be able to call ToolTalk directly by using its API library. Still other applications will use a service built on ToolKit. This service would use ToolTalk as an object manager and communications backbone. The service itself would provide higher-order functions for applications that include object linking.

there are some small advantages (primarily in training costs) to being able to move from Lotus 1-2-3 under DOS to Lotus 1-2-3 under VAX/VMS or Unix.

But the real user benefits of interoperability derive from the ability to deliver data, regardless of its origin, to whomever needs to work with it. For example, a Lotus 1-2-3 user on a Unix-based system could pull in needed information from a spreadsheet on a DOS-based system as easily as from a local spreadsheet.

However, the restricted scope of these cross-platform applications limits their usefulness. For instance, while you can gather information from a dBase system on a Unix-based host while you're using dBase on a DOS system, this capability doesn't do you much good if most of the data that you need resides in an Oracle database.

One way to simplify the task of moving data from one application to another, most often seen in GUIs, is cutting and pasting. This method lets you transfer character and numeric values from one application to another.

Familiar environments that provide virtual cut-and-paste functions are the Macintosh interface, Desqview, DECwindows, and Open Look from Unix International. While it's workable, cutting and pasting is both crude and slow.

BYTE ACTION SUMMARY

Data transparency refers to that elusive goal of being able to use data residing on different types of systems connected by a network. We have made real progress in transferring the data between systems, but mere access to files located on systems with different architectures isn't enough. You need to be able to *use* the data no matter where it's located or what format it's stored in.

Transparency and Windows

Microsoft Windows' vaunted Dynamic Data Exchange also falls well short of providing the easy data access needed. The first problem with DDE is that it can be used only between true Windows applications. Programs that run with a DOS compatibility box can't use it. More critically, DDE is not really about data transparency. It is simply an interprocess message protocol.

In a way, DDE is similar to the transport and session layers of the Open Systems Interconnection networking model: It establishes connections between processes, but it does not concern itself with how the data is represented or encoded. Making sense of the data sent is the responsibility of the sending and receiving applications.

Thus, while you can achieve data "transparency" with DDE, you can only do it if you program each application to recognize the other applications' data formats. DDE simply masks the complexity of moving data from one application to another. It is not a data-transparency solution itself.

No one is more aware of this shortcoming than Microsoft. To better enable Windows programs to work together, Microsoft, with other software vendors, is developing the Object Linking and Embedding protocol. OLE presents an innovative approach to the problem of dealing with data in a multiple-application environment: It associates the data with the application that created it in the first place.

More specifically, in OLE, if you took an illustration made by ZSoft's Publisher's Paintbrush and imported it to an Aldus PageMaker document, you could still modify it from PageMaker with Paintbrush's tools. You wouldn't have to invoke Paintbrush. Pointers associated with the illustration notify OLE-aware applications of what you're trying to do and take care of that for you. While the illustration is virtually within your document, physically it remains a Paintbrush file (unless directed otherwise). All you are actually working with in PageMaker is a hot link direct to the illustration and its application.

OLE manages data by dividing information into two parts: objects and containers. Objects are instances of a user-defined class that hold data, its structure, and the actions that programs can perform on and with the data. Those actions that a program can perform with the data are called the object's appearance.

To manipulate and link objects to applications, Microsoft uses the container concept. Containers serve as the controls for objects. A foreign application doesn't have to worry about the exact properties of an object imported from another

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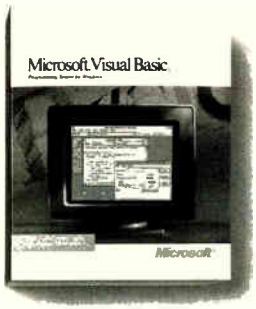

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At the 1991 Spring Comdex/Windows World, the editors of BYTE *judged Visual Basic the "Best of Show." In the July 1991 issue of* BYTE, *Editor-in-chief Fred Langa called Visual Basic "a milestone product."*

Microsoft

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Today's Problems, Today's Solutions

Many people don't need to worry about importing information from exotic computers across the country. Their far more mundane problem is how to transfer data between meat-and-potatoes DOS applications like Lotus 1-2-3 and dBase.

For these tasks, programs like AutoImport from White Crane Software are a welcome solution. AutoImport uses Lotus-style menus to simplify conversion of one file type to another. It isn't transparent, but at least it's easy.

AutoImport imports data from ASCII files and translates it into a variety of spreadsheet formats as well as dBase and Clarion database formats. AutoImport also supports a variety of ASCII-based data-interchange formats (e.g., SYLK and DIF).

When it's used with an asynchronous emulator, protocol converter, or LAN gateway, AutoImport can also bridge the gap between mainframe and microcomputer databases. You can use any midrange or mainframe DBMS that produces ASCII reports. In fact, the Tangent Group uses the data-translation programs behind AutoImport as the heart of its mainframe-to-microcomputer data transfer program, Catapult.

Catapult adds more functionality to the data-translation engine. More important, if you're coping with mainframe data, Catapult also includes a data-capture program that cleans out formatting characters and control codes from the mainframe data stream.

Both AutoImport and Catapult can export data globally and selectively. Unfortunately, while both programs make it simple to extract data ranges, they can't do complicated data queries. Still, for what they try to do, the programs are successful. Many users will find that either AutoImport or Catapult does all the data-interchange work that they need.

Gateways to Data

If you need more powerful tools, you will want to look further. In particular, if you are involved in downsizing, you will need to move data from mainframe database systems to their more familiar personal computer applications. Today's answer to this problem is a data gateway program.

DataLens Driver for Digital Networks from Soma almost brings the dream of data transparency to life. It lets Lotus 1-2-3 under DOS directly access DEC's Rdb/VMS and RMS data on VAX networks. Lotus 1-2-3 release 3.1 spreadsheets act as a front end for networked data. You treat the VAX-based data just as if it were another spreadsheet. You can query the data with Lotus's usual array of tools and even make multiple relational-database joins between Rdb and non-Rdb data.

Unfortunately, this iteration of the DataLens Driver falls short of true data transparency. Lotus 1-2-3 has only read access to the VAX data. While this product is a large step forward in data transparency, it needs further work before it provides a true data highway.

Micro Decisionware

The products of Micro Decisionware represent another step along the path to data transparency. This veteran database company supports bidirectional data interconnectivity among PCs, midrange systems, and mainframes.

PC/SQL-Link is a two-part program. The first portion resides with the relational DBMS (RDBMS). The program currently supports IBM's DB2, SQL/DS, OS/2 Extended Edition Database Manager, Microsoft SQL Server, and Teradata's DBC, among others.

The PC part of the program generates Structured Query Language queries via a menu-driven interface. PC/SQL-Link is fluent in several SQL variants, so you don't need to be conversant with the subtle but vital differences between dialects. The program transfers these queries to the mainframe DBMS and returns the resulting tables to the requesting PC. PC/SQL-Link then automatically translates the mainframe data into any of more than a dozen popular PC data formats. DOS applications can use these PC versions of the data as they normally would use native PC data.

When the PC applications have completed work on the data, PC/SQL-Link can ship the revised information back to the mainframe RDBMS. The program is neither automatic nor transparent, but it does possess two outstanding virtues:

program. To use OLE, all a programmer needs to know is how to use the container. If the container's simple controls aren't sufficient for the job, OLE calls the object's original application to do the work.

OLE makes everyone's life a lot easier. Programmers don't have to slug it out with DDE and fine-tune an application's format for every Windows application. And you can use the same old import and export data commands you're used to, but your control over the data becomes far more powerful.

However, OLE has a few problems. It relies on the rather rickety structure of DDE to support data communications. Of more immediate concern is that it's not easy to transport documents made from OLE objects. In the example above, if you move the PageMaker document to a system without Paintbrush, the illustration would vanish like the morning dew. OLE has the dubious distinction of being a data-transport tool that can create completely unportable files.

Catch the Wave

You can count on OLE's improving because it has competition: NewWave from Hewlett-Packard. NewWave is an object-oriented system that runs under Windows 3.0. NewWave integrates every system element to a high degree. It channels object control through the Object Management Facility (OMF). This centralized approach makes NewWave more robust than OLE. In the interests of compatibility, however, HP will support OLE under NewWave.

More important, NewWave's interprocess data communications methods provide interoperability with non-Windows systems. HP will soon release a NewWave version for Unix and a distributed network version in which the OMF runs on a server.

HP has loftier ideas than simply a true

World Radio History

It works, and it's a cinch to use. I was successfully pulling in data from a DB2 database within 4 hours.

Micro Decisionware hasn't been content to rest on its laurels, however. Its latest program, Database Gateway, builds on the success of PC/SQL-Link. With Database Gateway, applications that use the Microsoft SQL Server application programming interface can access DB2 resources.

Like PC/SQL-Link, Database Gateway is made up of two parts. The first, the main portion of the program, runs on an OS/2 server. OS/2 or DOS applications call on the program in the same way that they would call Microsoft SQL Server. Database Gateway then uses either DCA/Microsoft Communications Workstation/Server or OS/2 Extended Edition Communications Manager to send SQL statements to a Micro Decisionware DB2 server running under CICS on the mainframe via LU 6.2. The mainframe's response follows the same route back to the server.

In addition, Database Gateway can stage data between DB2 and SQL Server instead of going directly to the client application. With it, you can transfer entire relational tables from DB2 to SQL Server for quicker local service. Either way, you don't need to worry about the technical details. You can concentrate on using the data instead of the data stream itself. And isn't that what data transparency is all about?

Ally

Another approach to data transparency is evident in a fourth-generation language from Unisys named Ally. Used by Unisys as the foundation of its Unix-based real-time processing system, Ally was originally designed to facilitate access to multiple DBMSes.

Ally began life as an extension to the ANSI/X3/SPARC database model. This model described a generalized architecture for a DBMS and its interfaces. You can think of the basic architecture as an hourglass. At the wide top are all the ways data can be viewed, and at the bottom are the many ways that it can be stored. In the narrow middle are the relatively few ways that data can be viewed in the canonical model.

Every data field in a DBMS has a Data Source Definition. All the DSDs together provide the interface between the application and the underlying database. Every type of DBMS has its own set of DSDs. They include the canonical data types as seen from the application side, a description of the actual stored data type, and the mapping between the two. From the application developers' side, DSDs are easy to manipulate. As Eric Hale, lead technician for Infocel and one of Ally's designers, notes, "It's not psychic software, but it works."

While preexisting applications can't use it, Ally makes building applications easy. The Ally software development environment includes a Pascal-like language (ADL), a SQL look-alike (AQL), and a query-by-example mode.

One of the nicer features of Ally is that procedural code remains in the DSDs. Thus, a program could still run even if the underlying DBMS changed from Oracle to Informix if the equivalent DSDs were in place. If you don't have an established applications base and you need data transparency on Unix systems, I suggest you look at Ally.

object-based GUI that runs on a network, however. Together with Sun, the company plans on bringing true data transparency to heterogeneous networks. That is easier said than done, but Sun and HP are quite serious. And they're not doing it on their own.

The two Unix giants have submitted their plan for a Distributed Object Management Facility (DOMF) to the Object Management Group. OMG is a consortium of vendors and users seeking to establish a network object management architecture.

The cornerstones of DOMF are NewWave, Sun's Open Network Computing, and HP's Network Computing System. By building on established networking standards, DOMF's creators hope that it will quickly find support from both users and developers.

DOMF provides features that could make it a winner. It is designed to serve as an object request broker (ORB) on a network. Whenever an application manipulates an object, DOMF will not only locate the object, it will ensure that the requested operations take place while maintaining the object's original format. For instance, if you wanted to modify an object, say an Excel spreadsheet under OS/2, from an Ingres database manager under Unix, you would simply make the change. DOMF would take care of all the messy details.

Talking Tools

SunSoft, a subsidiary of Sun, has announced the first product based on DOMF principles: ToolTalk. This program lets Unix applications send network-spanning interprocess messages, either procedural or object. Applications interact with ToolTalk through its application programming interface, or API (see the figure). Neither you nor the programmer need to know anything about the application that requires the information. ToolTalk manages this for you.

Running on top of NFS's remote-procedure-call level, ToolTalk is a transitional path between procedure-oriented programs and object-oriented programs. While ToolTalk is not truly an object-based program, it does provide transparent data sharing between different applications.

Implementation of a Distributed Object Management Facility will revolutionize computing.

Successful implementation of DOMF will revolutionize computing. However, there's many a slip between theory and practice.

The Loyal Opposition

OMG includes another alliance in its own plan to bring data transparency to networks. This band, led by DEC and HyperDesk, supports DEC's Application Control Architecture (ACA).

DEC itself is certainly no stranger to data-transparency issues. Its Compound Document Architecture applications, like DECdecision and DECwrite, let you exchange data across VAX/VMS and Ultrix networks. Instead of DOMF's object-handling approach, CDA manages data by converting it all to DEC's Digital Data Interchange Format. Graphics, text, and numerical information are all

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grist for DDIF's mill.

However, as useful as the DDIF approach has been, DEC has chosen an object-oriented approach for ACA. Like DOMF, ACA provides a complete object-oriented command, control, and communications solution to the problem of data transparency. ACA uses DEC's LiveLink capabilities, proven viable in CDA, for data transfer and application links. Moreover, DEC is working with Microsoft to allow OLE- and DDE-compliant applications to work on an ACA-empowered network.

Under the hood, however, ACA's approach differs much from DOMF's. You can think of DOMF as an object manager of object systems. You add applications and objects to one of its networks with a class-definition language that bears a deliberate similarity to C++.

ACA, on the other hand, provides dynamic real-time binding for objects with its run-time API. This isn't clearly better than the more static Sun/HP approach that requires you to explicitly label every object. DEC's approach requires a preprocessor for each particular architecture on a network that connects new objects to the API.

With NewWave's OMF, the DOMF approach includes a distributed ORB. By providing hooks for new object models and managers, the Sun/HP ORB makes it easier to maintain object-data integrity while still allowing interapplication operation. ACA can achieve the same result, but it requires more effort.

A Smoldering War of Words

The differences between these two approaches that really matter, though, are not the technical ones. Both sets of companies want to further their own technologies for the advantage that it would give them in the marketplace. The result has been a smoldering war of words, with the offices of OMG companies as the battleground.

There has been talk of compromise between the two groups. One rumor says that the DEC forces would agree to the Sun/HP approach to the ORB in return for getting their own way at other levels of the proposed object management standards. Ironing out these differences is in everyone's best interests. The potential usefulness of true network data transparency is enormous. Either approach, or a compromise, would benefit everyone.

In the meantime, you still need to share information among disparate systems. Fortunately, several tools ease the task of moving data from application to application. While not quite transparent, these tools are certainly more practical than waiting for the resolution of the OMG conflicts (see the text box "Today's Problems, Today's Solutions" on page 214).

Clear As Mud

I wish I could say that we can look forward to seeing data transparency sometime soon. I can't, and the state of the art is not the hitch. The Sun/HP DOMF approach, in particular, shows promise of revolutionizing the field.

The real trouble is that there's no consensus on how to handle data transparency. Until there is, I'm afraid we will have to content ourselves with restricted access to networked data and make do with the data-transparency tools that are now available. ■

Steven J. Vaughan-Nichols is a freelance writer. You can reach him on BIX as "sjvn."

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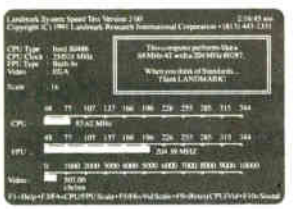

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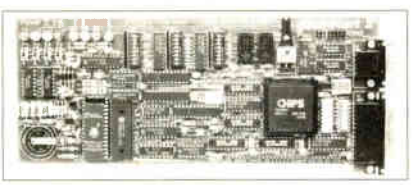

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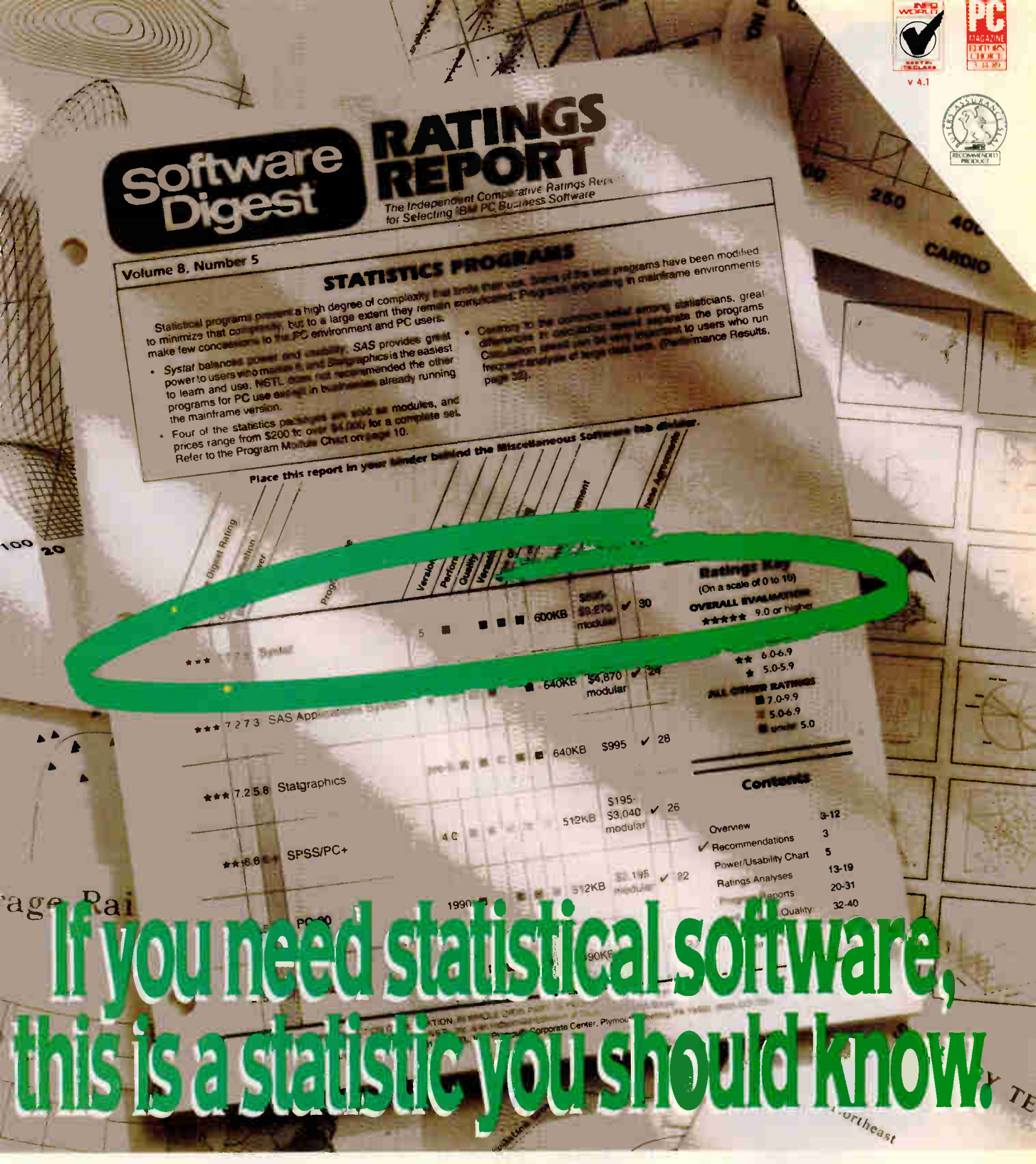

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PORTABILITY AND THE GUI

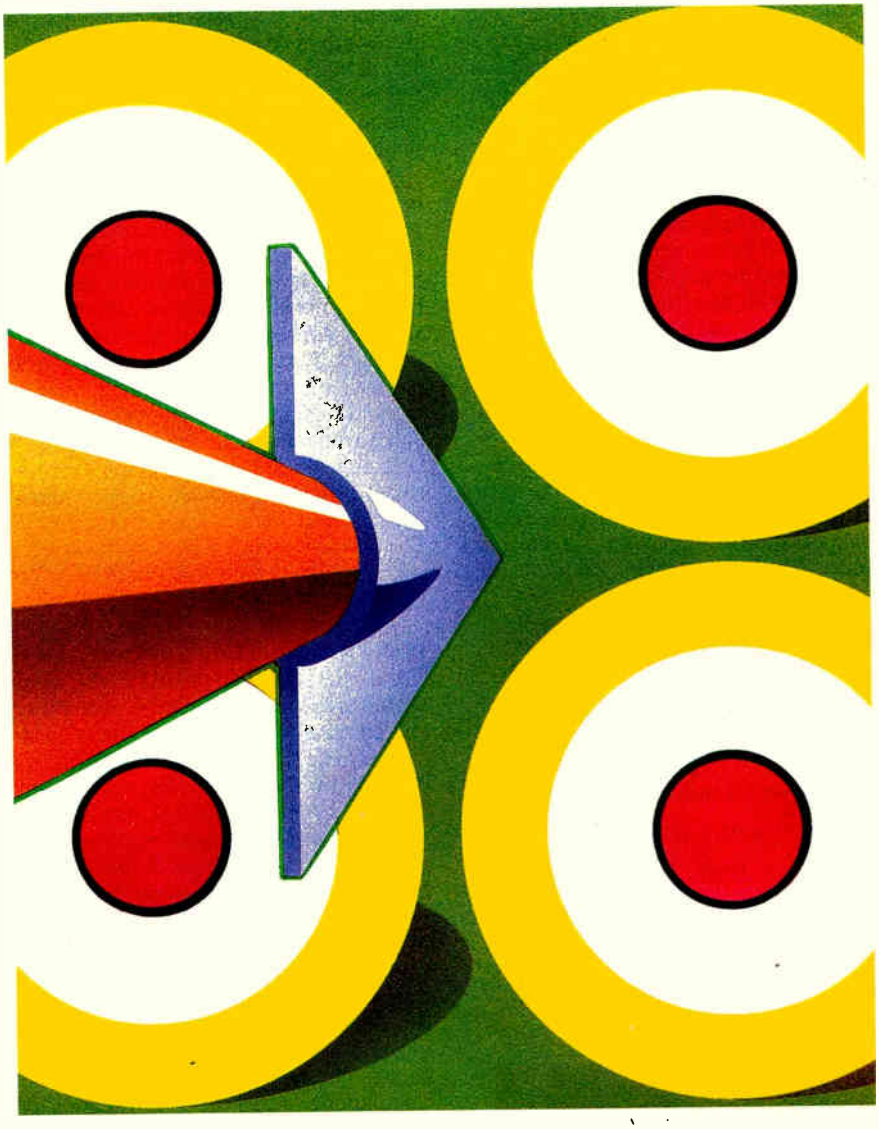
Multiplatform GUI applications can be easy to write

DAVID M. ANDERSEN AND BRUCE A. SHERWOOD

Many business and educational organizations have been unable to decide on just one computing platform, a fact that makes it difficult for them to obtain or create applications that run on all their machines. This problem is made worse by the growing dominance of the modern GUI, as typified by the Macintosh, Windows 3.0, and Motif.

In the past, a FORTRAN calculation or a COBOL accounting package often would run on many different computers, in part because the user interface was restricted to alphanumeric input and output. But such portability is difficult to achieve for GUI-based applications featuring mouse input and graphics output. Portability may become still more difficult as people's expectations expand with respect to multimedia and interapplication communication.

Although there has been significant convergence on the general nature of GUI features (e.g., windows, buttons, and scroll bars), implementation details for programming these features differ markedly across different platforms. As a result, creating compatible versions of applications for diverse platforms usually requires a large duplication of effort.



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Budget Is One Constraint

The modern GUI has made life much more pleasant for end users but more difficult for programmers. Developers have to climb a steep learning curve to produce an interactive graphical application. Even a full-time professional programmer may need several months to get up to speed on a GUI toolkit.

Most successful commercial develop-

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ers can afford the associated costs, and more and more popular applications are becoming available on multiple platforms (e.g., WordPerfect, FrameMaker, Mathematica, and Maple V). But even commercial developers are sometimes forced to ignore potential markets because of the high cost of porting to another system.

Furthermore, a lot of organizations cannot afford these additional development costs. Educational institutions, for instance, have found it impossible to decide on a single type of computer. Faculty members sometimes produce innovative special-purpose applications in the course of their research or teaching. But most faculty members cannot expend the effort to develop programs for multiple GUIs. Therefore, they may not be able to share a useful tool with colleagues who work on different platforms.

Years ago, almost the only thing you could do with a computer was to program it. Today, programming is the one thing that most people don't do, although some tools are coming into existence that provide significant user programmability of full GUI features. They include Apple's HyperCard and Microsoft's Visual Basic for Windows. However, many of these tools are entirely platform-specific.

It would be a major advance if applications could be ported from one GUI to another with no effort other than recompilation. It would also be a major advance if people who are not full-time programmers could produce modern, full-featured, intercommunicating, graphically oriented programs.

These two issues are linked, because one of the keys to portability is the identification and machine-independent implementation of higher-level abstractions (e.g., pull-down menus). An abstraction of the essence of a menu, when embodied in a high-level language or toolkit, can avoid many detailed complexities. As a result, even novice programmers are able to incorporate menus into programs.

BYTE ACTION SUMMARY

To run an application on a number of computing platforms, you'll need a toolkit or a user-friendly programming language that incorporates GUI capabilities in a machine-independent way. Here are the advantages and disadvantages of each.

A Locksmith

The problems faced in creating multiplatform versions of a specific application, such as a word processor, have been addressed in a number of articles. A key element of a successful attack on this problem is the clean separation within the program of necessarily machine-dependent GUI aspects from the machine-independent core.

For example, the computational heart of Mathematica is cleanly separated from the user interface, which varies from one platform to another. But beyond this fundamental strategy lies a daunting mass of detail. Consider the difference between a flat address space and the memory segmentation of MS-DOS, the differences in the length of integer variables in C on different machines, and the difference between a Macintosh handle (a pointer to a pointer) and a Windows handle (simply a number).

Even though the problems of creating a machine-independent application are many and complex, more problems arise in the design of a general programming language that incorporates GUI capabilities in a machine-independent way. Yet such an approach offers significant advantages. Porting the language to a new platform unlocks the applications written in that language—they automatically become available on the new platform.

In this article, we will emphasize the issues associated with language portability rather than application portability. The problems encountered with porting a single application are a subset of those involved in porting a language.

FORTRAN and C

The earliest compiler, FORTRAN, demonstrates the linkage between portability and ease of use. This "formula translator" transformed the familiar formulas of scientific and engineering calculations into the grubby details of moving bits into and out of processor registers. The formula, as a higher-level abstraction, made it much easier to write numerical programs.

An important side effect was the resultant portability. FORTRAN program statements were essentially machine-independent, and they could be translated into the assembly language of any machine. The need to perform numerical calculations led to the identification of appropriate higher-level abstractions in FORTRAN, with the obvious focus being the algebraic formula.

Later, the need for higher-level abstractions that would facilitate the writing of operating systems drove the development of C. As a result, C has become a powerful tool for system and application development. C exhibits striking machine-independence, even with respect to different operating systems and file architectures. You could say that C represents a machine-independent higher-level abstraction of assembly language programming.

C programs are by no means perfectly portable: The "standard" libraries are not, in fact, completely standard, the default size of integer variables differs across CPUs, and the peculiar structure of the Intel processor complicates matters under MS-DOS. A serious drawback of C is that it provides no support for GUIs except through toolkits, which are not standardized across platforms. Nevertheless, within its very broad range of applicability, C has established an admirable combination of power with portability.

C, Unix, and X11

Although C does not provide general portability across different GUIs, there is one arena in which, with a modicum of effort, graphically oriented C programs can be portable. With the advent of MIT's X Window System and the OSF/Motif user interface, the Unix world has achieved a high degree of portability.

With care to avoid Berkeley/System V and hardware dependencies, a programmer can write an interactive, graphically oriented program that will run on a range of Unix systems from virtually every hardware vendor in such as way as to require only recompilation. Unfortunately, this portability does not extend to the most popular platforms: An interactive, graphical program written for X11 is not likely to transfer to Windows or the Macintosh without substantial effort.

Portability Today and Tomorrow

To facilitate the programming of GUI applications beyond Unix, you must have a toolkit or a programming language that incorporates appropriate higher-level abstractions. These abstractions must include support for color, graphics, windows, pull-down menus, mouse interaction, and rich text (e.g., italic, bold, and multiple font faces and sizes).

The emerging emphasis on multimedia adds to this now-classic list of features the need to support pictures, video,

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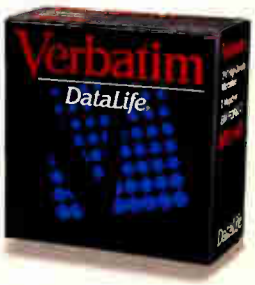

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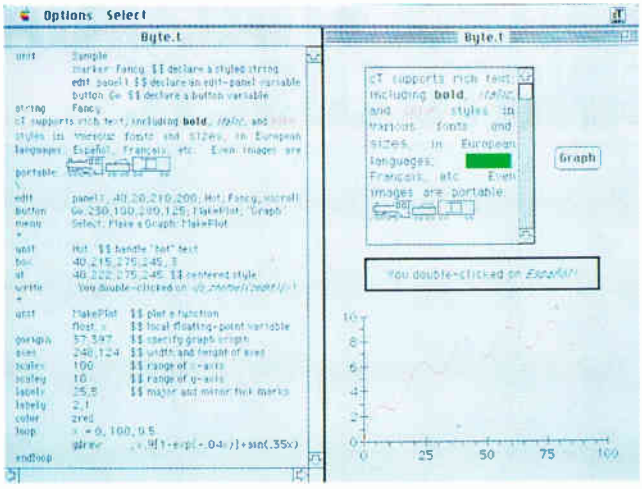


Screen 1: *The source code is on the left, and the execution of the program is on the right. When you double-click on the word* Español, *the "hot" style applied to this part of the text triggers the execution of the Hot unit.*

and sound in a platform-independent manner. Appropriately designed programming structures could provide portability and user programmability.

While the most urgent need is to provide portability across today's diverse GUIs, it is also extremely important to provide portability to next year's operating systems and GUIs. In the last few years, enormous upheaval has occurred in the GUI world, as illustrated by developments such as Windows 3.0, OSF/Motif, and System 7.0.

Programs with a GUI written in C just a few years ago may no longer work even on the same brand of machine! Again, implementation in terms of machine-independent higher-level abstractions can guard against such rapid obsolescence.

One drawback of striving for portability is that it often requires compromising on a least common denominator that may have too little capability to be interesting. Fortunately, all modern GUI environments have incorporated a broadly similar set of features, so their least common denominator is now adequate for a wide range of applications.

Unfortunately, the implementation details of the various GUIs have not converged at all. Each has different libraries and data structures. Adjusting to these differences is not merely a matter of altering subroutine calls, for in many instances, the internal architectures are incompatible (e.g., menus can be driven by event loops or by callback procedures).

GUI Portability via a Language

At the Center for Design of Educational Computing at Carnegie Mellon University, with Judith Sherwood and Kevin Whitley, we developed and implemented the cT programming language as a way of attacking the problems of portability and user programmability. (The *c* in cT stands for Carnegie Mellon, and the *T* stands for the Tutor family of computer languages.) The cT language (written in 1985) is the granddaughter of Tutor (written in 1967) and the daughter of Microtutor (written in 1977). The Tutor and Microtuor languages were developed within the context of the PLATO project at the University of Illinois.

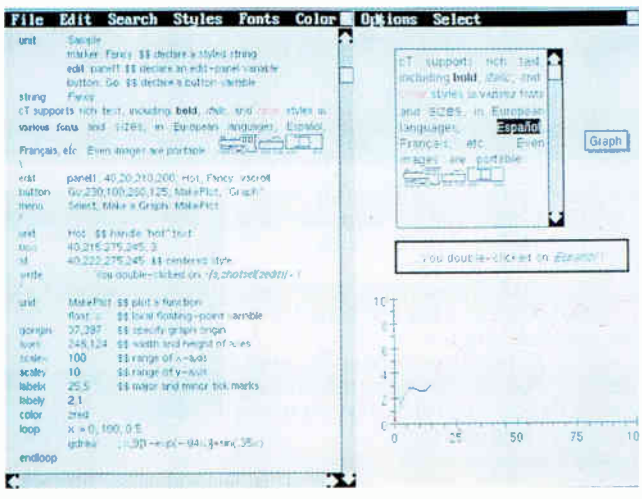
Even though cT (which is distributed by Falcon Software, Wentworth, NH) shares many elements of its predecessor languages and related dialects, it emphasizes the modern mouse-oriented GUI and aims for an extremely high level of platform independence. You could succinctly characterize cT as a general-purpose algorithmic language with two distinctive characteristics: the capability for ordinary mortals to write modern programs with it, and the portability of these programs among the PC, the Macintosh, and Unix with X11.

Screens 1 through 3 illustrate the cT programming environment on these different platforms. Note the higher-level abstractions in the source code (e.g., button, menu, and edit). Graphics and interactions are expressed in generic form. The execution of the program produces essentially the same output on all the platforms, but with minor differences to comply with the standards of each native GUI. For example, the syntax of the button command refers to the essential elements of a button, such as the text in the button and the subroutine that is called when you press the button.

You can see the direct representation in the source code of rich text, including not only bold and italic styles but non-English characters, color, and embedded graphics. You can import graphics into the source code from standard sources, such as the Macintosh Clipboard or a PCX file on a PC, at which point the graphics become completely machine-independent. The language also supports videodisk presentations in a machine-independent way, and work is in progress to provide portable sound files.

The appearance of a cT menu or button may vary on different platforms. People have well-developed expectations concerning the look and feel on their system of choice. Therefore, our philosophy is that portability should mean that, by default, programs should have the look and feel of each particular platform, not that they should look exactly alike. This concept does not apply if a specific feature isn't normally available on a particular platform. In that case, the feature may have the look and the feel of some other GUI.

In one important area—the handling of fonts—we found it difficult to preserve the native look and feel of the system. If you study the accompanying screens, you will see variations in text placement due to slight differences in the native fonts.



Screen 2: *When you click on the Graph button, it calls the MakePlot unit. There are slight differences between the Macintosh and the MS-DOS examples of native fonts.*

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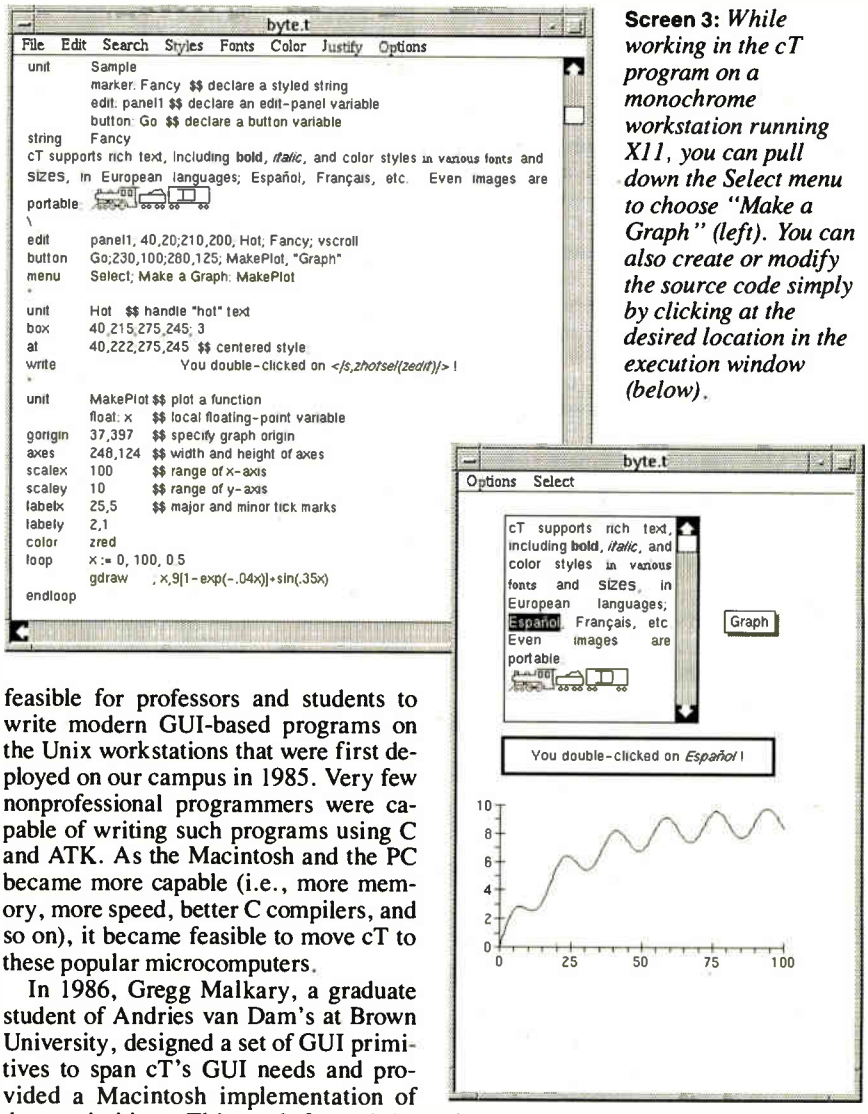
These differences can compromise portability. For example, if a program draws a box tightly around some text on one platform, the text may spill outside the box on a different platform.

The programmer can get around this dilemma by calculating the width of the text and the corresponding width of the box at execution time. This sort of adjustment is bothersome, and in more complicated situations, you may find it quite difficult to keep graphics and text in register.

The cT language offers automatic rescaling so that text and graphics remain synchronized in a variety of window sizes. Font rescaling is an attempt to adapt to the native screen size, but the use of native fonts can compromise this feature. In cT, we decided to provide a universal set of basic fonts that are exactly the same on all machines, giving programmers the option of easier control over fonts.



Screen 3: *While working in the cT program on a monochrome workstation running X11, you can pull down the Select menu to choose "Make a Graph" (left). You can also create or modify the source code simply by clicking at the desired location in the execution window (below).*

Toolkit Approach

An alternative approach to portability is to create a toolkit consisting of machine-independent GUI libraries to accompany C or other existing languages. We based our initial Unix-workstation version of cT on an early version of the Andrew Toolkit, developed by the Information Technology Center at Carnegie Mellon. ATK, then and in its modern form as well, consists of C libraries for professional programmers that offer an object-oriented implementation of major GUI features.

In order to be able to port cT to popular microcomputers (e.g., the PC and the Macintosh), we had to abandon ATK, which has been implemented only for Unix workstations running X11. Early in the course of our work we examined many other toolkits, but at that time we found none that provided us with the complete GUI coverage that we needed (although ATK came close on Unix machines) and none that gave machine independence across the platforms of interest to our users (Unix, Macintosh, and PC).

We thought that eventually someone would come up with an adequate universal set of GUI libraries for C, because such a toolkit would satisfy a major need of professional developers. Some companies have taken steps in this direction. A good example is the Extensible Virtual Toolkit (XVT) from the Advanced Programming Institute.

Building an Internal Toolkit

The original impetus for creating the cT programming language was to make it feasible for professors and students to write modern GUI-based programs on the Unix workstations that were first deployed on our campus in 1985. Very few nonprofessional programmers were capable of writing such programs using C and ATK. As the Macintosh and the PC became more capable (i.e., more memory, more speed, better C compilers, and so on), it became feasible to move cT to these popular microcomputers.

In 1986, Gregg Malkary, a graduate student of Andries van Dam's at Brown University, designed a set of GUI primitives to span cT's GUI needs and provided a Macintosh implementation of those primitives. This work formed the inspiration for the later development of our machine-independent toolkit for internal use by cT.

The toolkit is implemented on different depths on different platforms. For example, to bring up the file-selection box on the Macintosh, our internal toolkit simply calls the corresponding Macintosh Toolbox routine. On a non-Windows PC, the toolkit calls our implementation of a dialog box.

A more striking example of varying depths in this toolkit is cT's support of interprocess communications. On Berkeley Unix machines, this communication is done via sockets, but between Macintoshes in an AppleTalk zone, the mechanism is entirely different. The same cT internal toolkit call drives these entirely different schemes on the various platforms. The result is that a person writing in cT can fairly simply create connections between processes with a higher-level socket abstraction that runs without any change either on Unix machines or between Macintoshes in an AppleTalk zone.

Soon we intend to implement a version of cT for Windows and to upgrade the System 7.0 version. We anticipate that the same cT intercommunicating programs will then be able to run without change on a PC or a single Macintosh using Dynamic Data Exchange and interapplication communication.

Thus, the depth of our internal toolkit varies according to how rich the native toolbox happens to be. Variable depth is one of the ways that we avoid many of the limitations of a lowest-common-denominator approach. If the native environment doesn't provide an important feature present in other modern GUIs, we attempt to provide it ourselves. We have followed this principle with respect to

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such complex features as menus, mouse interactions, sound, video, and rich text.

Language vs. Toolkit

In principle, either a toolkit or a language can provide adequate portability, but each approach has advantages and disadvantages.

A potential advantage of a toolkit is that it can expose all of its internal status. A developer might offer a toolkit written in C for C programmers as source code, thus providing a completely open and extensible environment.

A disadvantage of using a toolkit to extend C is that it can be very awkward to represent rich text directly in a C program (ATK handles extremely rich text, but only in data files, not in C source code). Moreover, developers find it quite difficult to deal with diverse memory models on small and large machines when writing directly in C. In contrast, the cT editor and compiler are capable of handling rich text (including embedded graphics), and the cT run-time routines can page subroutines.

We found advantages to constructing a fully integrated programming environment based on a language rather than on a toolkit. The cT language uses incremental compilation at the subroutine level, so the turnaround time for testing a change is similar to that for an interpretive language. Also, with cT's graphics-editing feature, you are able to click in the execution window to create or modify coordinates in the source code. The cT language then immediately recompiles and executes the modified subroutine to display the result.

In addition, the cT compiler automatically converts and upgrades old versions of source code when necessary, as does a modern word processor when the vendor has made an incompatible change in the underlying document structure. As a result, cT programs written in 1985 that ran on a Sun-2 workstation with a locally produced window manager run without change today on a PC, a Macintosh, or an X11 machine.

A disadvantage to cT's highly integrated approach is that cT maintains a large amount of hidden status, such as which cT units are currently in memory, whether the blinking cursor in an edit panel is on or off, and what the current graphics copy mode is. Not all of this status is available to the cT program or to subroutines written in other languages.

Portability with Other Languages

Although toolkits such as XVT offer a degree of portability, we know of very few programming languages that offer broad GUI portability. Other than cT, one example we do know about is Smalltalk. Both ParcPlace and Digitalk versions of Smalltalk now run with full GUI capabilities on a variety of platforms. The object-oriented nature of Smalltalk contributes a great deal to GUI portability, because GUI features are encapsulated as very high-level abstractions.

The two Smalltalk versions reflect different philosophies concerning portability. ParcPlace has maintained broad portability for its version of Smalltalk, with the same look and feel on all machines (i.e., Macintosh, PC, and Unix), so applications look essentially identical on different platforms. The exceptions to identical look and feel are the use of native fonts and native window management for such user-interface features as moving or expanding a window. Binaries are fully portable, with the final stage of compilation to native machine code automatically occurring when the program is first executed.

Digitalk has chosen to work within the look and feel native to the particular platform. Applications look somewhat different on different platforms, but they conform to your expectation on a particular platform. There are Digitalk versions for MS-DOS, Windows, OS/2, and the Macintosh, but there isn't one for Unix. In the past, there have been differences across platforms that have required making a few adjustments when porting an application, but Digitalk is working on eliminating these discrepancies.

The use of native fonts means that, with the ParcPlace and Digitalk versions of Smalltalk, the programmer must take care to avoid the problems associated with differences in fonts on different platforms.

Among the various dialects of BASIC, only True BASIC (developed by the creators of BASIC at Dartmouth) offers portability of basic graphics across Amiga, Macintosh, and PC machines and some Unix workstations. But True BASIC does not support many basic GUI features, such as rich text or (with the currently available PC version) mouse interactions.

A True BASIC graphics program written on a PC will run on a Macintosh, but it won't look like a real Macintosh program. And if the program makes Mac Toolbox calls to achieve the Macintosh look and feel, it will no longer run on a PC. The True BASIC developers recognize a need to support a higher level of GUI portability and are moving in this direction. Although True BASIC doesn't currently handle all aspects of the modern GUI, it does far exceed the capabilities of most languages in the portability of basic graphics capabilities.

Even though it's not a programming language, Authorware is a development environment aimed at the training and education market, and it offers very high portability of graphics, fonts, video, animations, and sound between the Macintosh and machines running Windows.

Authorware is hard to categorize. It is a bit like the better-known Apple HyperCard for the Macintosh and the Asymetrix ToolBook for the PC in that display design is done directly, as in a drawing package. But Authorware also permits the direct creation and manipulation of animations and controlling the sequencing of the application, making it similar to a visual programming language.

Easier and Portable

The modern GUI has made programming more difficult. It has led to a lack of portability of applications across different platforms, and even on the same machine across different software generations. Even though major differences in programming details remain, there is now a similarity of basic GUI features on most major platforms, and languages and toolkits can begin to provide application portability.

People are beginning to expect multimedia capabilities and the sharing of data between applications. Therefore, simple and portable tools are needed to support these capabilities. ■

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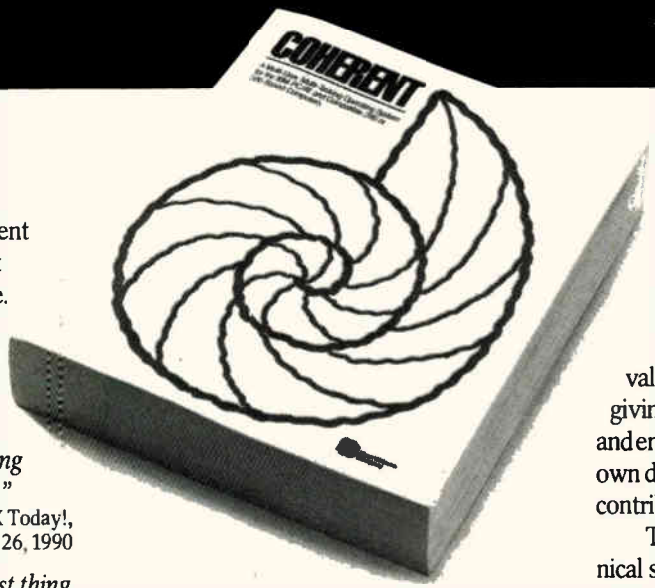

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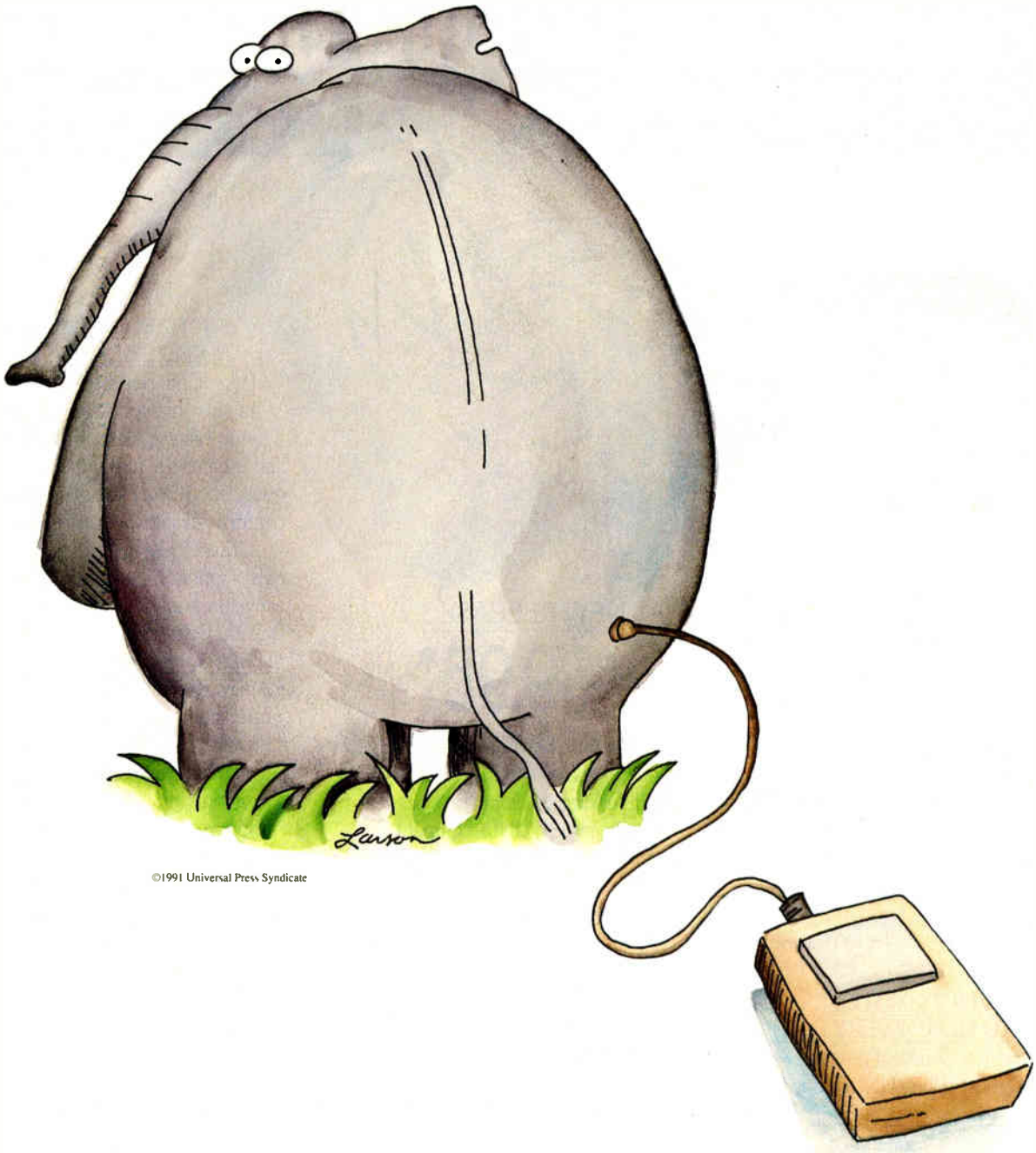

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DISTRIBUTED OPEN ENVIRONMENTS

Open Software Foundation and Unix International pave the way toward true interoperability

MARY HUBLEY

Distributed computing is a hot topic. It promises to solve the problem of getting heterogeneous systems to interoperate by enabling different systems to share processing, system resources, and applications across environments as diverse as VAX/VMS, Unix workstations, and DOS-based PCs. Distributed computing provides you with transparent access to the data and resources on all the systems throughout your company.

The importance of distributed computing becomes clear when you contrast how you currently use computers with how you will use them in the future. Presently, your organization's computing resources are probably a mix of different manufacturers' hardware and software. The computers are controlled by separate workgroups, many in different geographic regions, with little information and few resources shared between the workgroups. And because most of the systems are proprietary, it is virtually impossible to exchange information between them without major programming efforts.

In the future, distributed computing will let you share processing and data across heterogeneous environments. It makes a lot of sense for businesses that want to use resources located on different computers all around the company. For example, wouldn't it be nice to be able to access data that resides on another department's computer? Or simply to print out a document on a remote printer?

The current situation, where organizations have a hodgepodge of systems that are not interoperable, is causing a movement away from individual workgroup–

ILLUSTRATION: R. KENTON NELSON © 1991

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controlled computing. Already, companies and universities are migrating their systems to *distributed open environments* that share information and resources throughout the enterprise. The distributed open environment is the new wave of computing.

The Contenders: OSF and UI

In the past, distributed computing solutions have been proprietary, designed by major computer manufacturers to provide interoperability among that company's systems. Today, both the Open Software Foundation and Unix International are addressing the problem of providing a distributed platform that spans multiple architectures, protocols, and operating systems. OSF's solution is the Distributed Computing Environment (DCE); UI's effort is labeled the Atlas distributed processing architecture.

Although DCE and Atlas both address distributed computing problems, they are not parallel solutions. Here, at least, OSF and UI will not really be competitors; rather, DCE will provide basic distributed computing services, and Atlas will build on those basic services. The two solutions are also on different timetables: DCE is complete and available from OSF; Atlas is not yet available in a complete form, but most of its components are available individually through their developers.

DCE and Atlas will undoubtedly become recognized standards for distributed computing. In fact, DCE already has over 100 licensees. Its growing popularity reflects the frustration of users who are trying to create a distributed environment on their own—DCE solves the problem. Another boost for both organizations is that they have backing from their member companies, which constitute most major vendors in the computer industry—more than 200 organizations, all with a large stake in the future of computing.

Even though most customers have yet to see the products, optimism about DCE and Atlas is high. Before standard products like these, companies that wanted distributed computing either hired outside firms or employed in-house staffs of system programmers and communications experts to do the job. Either way, building a distributed environment was enormously complex and expensive. OSF and UI are eliminating the need for end users to do their own development.

Although UI and OSF are best known for their competing versions of Unix, DCE is independent of any one operating system; it works as well on Macs as it does on Unix. Atlas will also provide interoperability with other operating environments besides Unix. UI and OSF are actually *open-systems* organizations in which Unix is only part of the broader open-systems philosophy. Like distributed computing, this philosophy is based on interoperability, scalability, portability, and compatibility among different architectures.

To support this view, UI has expanded its charter to encompass a more global computing effort. Its new charter has moved the organization from simply controlling Unix System V to defining an entire open-systems architecture. And although OSF's other products (i.e., the OSF/1 operating system and OSF/Motif) are sold to the Unix marketplace, OSF's primary strategy has always focused on open systems.

OSF and UI are propelling their open-systems initiatives with distributed computing. Noninteroperable systems will now be able to communicate and share information. Sun Microsystems' SunOS, for instance, will enjoy symbiosis with IBM's AIX and Systems Application Architecture (SAA). DEC's Ultrix, VMS, and Network Application Support (NAS), along with multiple architectures from Bull, Hewlett-Packard, and Siemens-Nixdorf, will be among the first to be incorporated into DCE. And, significantly, UI is planning to encompass OSF's DCE into Altas's basic structure. This means that UI will take advantage of the interoperability work that OSF is doing—a safe move by UI, considering that DCE is already proving very popular.

How Do the Pieces Fit?

The architectures beneath the evolving distributed open environments are similar to client/server architectures, where clients can request data and facilities from a server. In client/server environments, relationships are fairly simple. Clients are workstations or PCs located

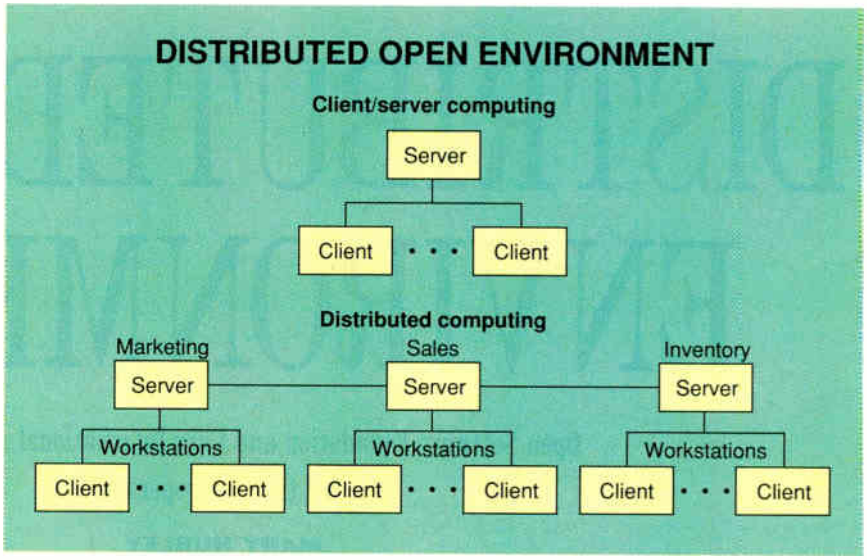

Figure 1: *Two or more client/server relationships constitute a distributed open environment. The existence of more than one server enables you to split applications, services, and data; modularize them; and distribute them among various systems.*

BYTE ACTION SUMMARY

You once had only two ways to create an enterprise-wide distributed computing system: You could build your own from scratch, or you could hand over the future of your company's computing systems to a single vendor. DCE from OSF and Atlas from UI represent open-systems solutions to distributed computing. They will be important standards in the 1990s.

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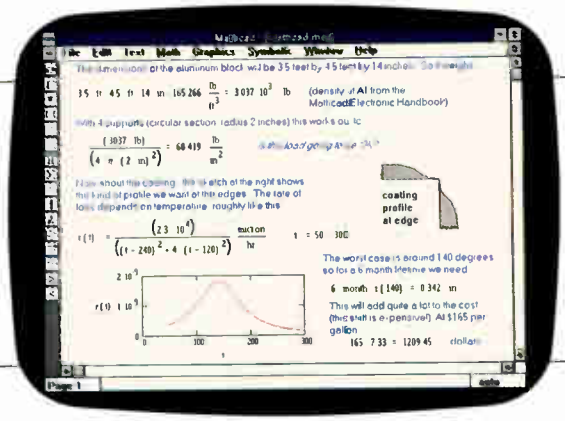
Calculations.



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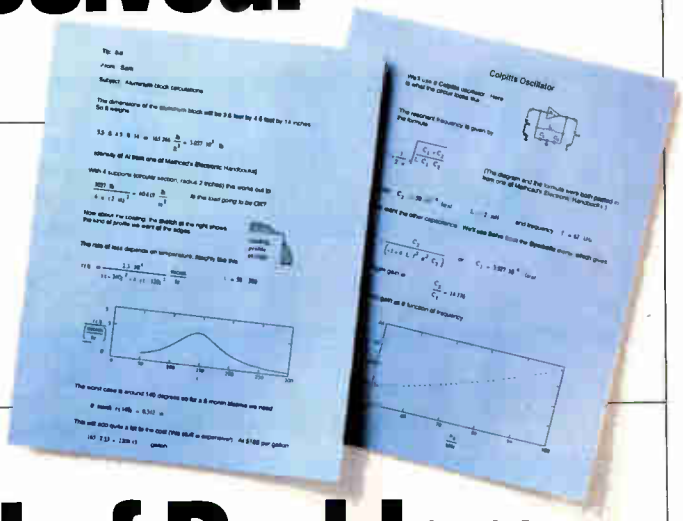
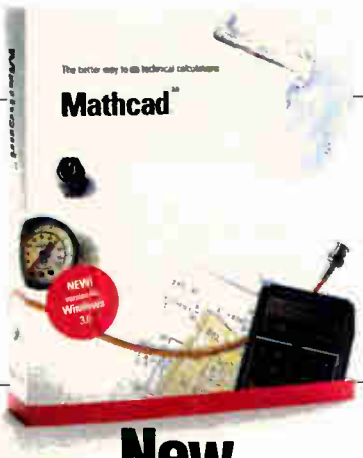


Easy.



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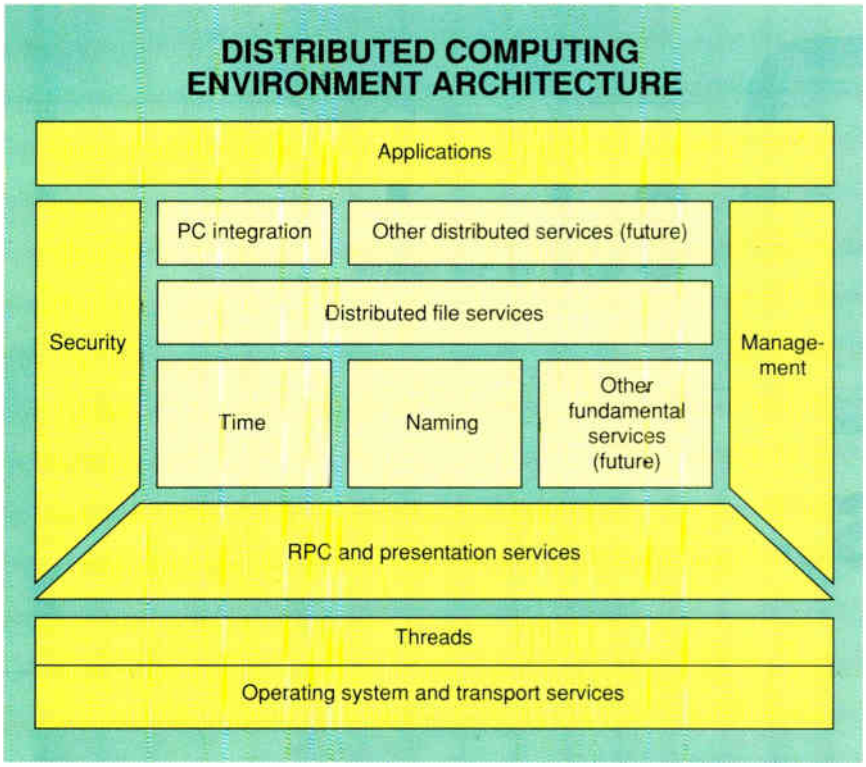

Figure 2: *OSF's DCE lets applications access a number of common facilities and services. The glue between different operating systems and networks is a common RPC facility.*

on the desktop that provide front-end interfaces and applications. The server is the central computer that provides back-end processing and data manipulation for many clients.

A distributed computing environment includes two or more client/server environments in a potentially huge network. With more than one server, you can split, modularize, and spread the applications, services, and data across the servers. Servers can then pass information among themselves on request from each other, effectively making servers clients to one another. (See figure 1.)

A distributed environment consists of several important elements. Communications is the backbone; while both DCE and Atlas recognize and support OSI networking protocols, they also support others, such as TCP/IP and X.25. Another important element of a distributed environment is a remote procedure call architecture. RPCs manage communications between applications distributed across a heterogeneous network. Also necessary are name or directory services to manage and control location changes of resources, applications, and even users, and time services to synchronize the clocks (and therefore the actions) of the various computers in the distributed environment.

Another necessary component is a distributed file system (e.g., Sun's Network File System [NFS] and OSF's DCE AFS) that provides global file access. As with any network, you also need authorization and authentication services for security. Finally, a distributed environment needs to make all the above elements transparent to the user through a consistent user interface to all distributed and local resources.

The Goal: Distributed Applications

The surge of interest in distributed computing technology is a direct result of the emergence and subsequent proliferation of LANs. They represent an inexpensive platform for the development of distributed applications, allowing users within a workgroup to communicate with each other. RPCs, transport protocols, and network authentication methods are among the technologies that have been developed to provide interoperability over a LAN.

Taken individually, these technologies are only partial solutions. Although many companies have tried to piece them together into a coherent whole, the challenges are daunting. Which protocol works with which naming service? On what platform? Which authentication service works with which operating system? Will it work on the installed base? Which is best? There are myriad levels to consider when building a distributed environment.

This is where OSF and UI come in. DCE incorporates the various technologies into an integrated product. Atlas extends DCE with additional functionality. Thus, OSF and UI are taking on the task of piecing together the puzzle into working architectures. DCE and Atlas offer the most complete picture yet of a standardized distributed computing environment.

Distributed environments provide a platform for distributed applications. Distributed applications that are in place now are generally simple ones, such as E-mail and distributed file systems. Currently, the most common use of distributed systems is the sharing of facilities such as printer services. But as the technology evolves, distributed computing is sure to become a focus of software developers.

The most important feature of a distributed application is its ability to transparently access all the data it needs. Where the data comes from (i.e., where it is located on the network) must be transparent to the user, even if it is scattered across many systems located on several continents.

For example, assume that your company's marketing department is connected to one server, the sales department to another, and inventory control to a third. You can create a single database application with data distributed across all three servers even though the individual workgroup data resides on the individual servers. When you want to incorporate marketing information, sales figures, and inventory levels into one report, your application requests the information from your workstation. You need never be aware that the request actually goes first to the marketing server, which requests and receives the sales figures from the sales server and the inventory level from the inventory control server. To you, all data seems locally stored.

DCE: Here Now

DCE from OSF is the early favorite in distributed open systems. In addition to being supported by most major vendors, it has the added advantage of being available now. "The interest in DCE has been incredible," says OSF's Jonathan Gossels. In addition to IBM, DEC, Bull, HP,

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Siemens-Nixdorf, and Hitachi, more than 100 companies are licensing DCE, representing some of the most influential computer manufacturers in the industry. End users adopting it include the European Commission, American Express, Nippon Telegraph and Telephone, and Boeing.

The end-user interest is especially important to OSF. "The objective of DCE is to make it easy to create, use, and maintain applications in heterogeneous distributed systems. And DME [OSF's Distributed Management Environment, which is under development] will complement that by making the environment manageable," says Gossels. "These technologies are important because over the last 10 years, companies have made investments in computers and networking technologies. They have very complex environments. Users are excited about DCE and DME because it is the first time a set of technologies will let them get control of their computer environment. And it doesn't force them into a single technology or vendor approach."

OSF's multitechnology and multivendor approach was achieved through OSF's Request for Technology process, which solicits technologies from the computer industry at large. Interested companies submitted their technologies; from those submitted, OSF chose the ones to be included in DCE. They include products that OSF judged to be the best in the industry and come from various sources—start-ups such as Transarc, OSF members DEC and HP, and even UI member Sun. Specifically, DCE's technologies include the following:

- enhanced Network Computing System/RPC from HP and DEC
- DECdns name service from DEC
- DIR-X X.500 directory service from Siemens AG
- Kerberos security service from MIT with HP extensions
- PC-NFS from Sun
- AFS 4.0 distributed file system from Transarc
- LM/X PC integration technology from Microsoft
- Concert Multi-Threads Architecture from DEC
- DECdts time service from DEC

DCE's set of services is organized into two categories: Fundamental Distributed Services and Data-Sharing Services. The former category contains the tools that software developers use to build end-user services and applications; services in the latter category, which are based on the Fundamental Distributed Services, provide end users functionality without the need for extra programming. The architecture is shown in figure 2. The Fundamental Distributed Services include the following:

- *RPC.* The RPC allows you to build applications that use individual procedures running on computers across a heterogeneous network. It includes two components that assist in building client/server applications: an RPC facility to provide simplicity, performance, portability, and network independence; and a compiler that converts interface descriptions

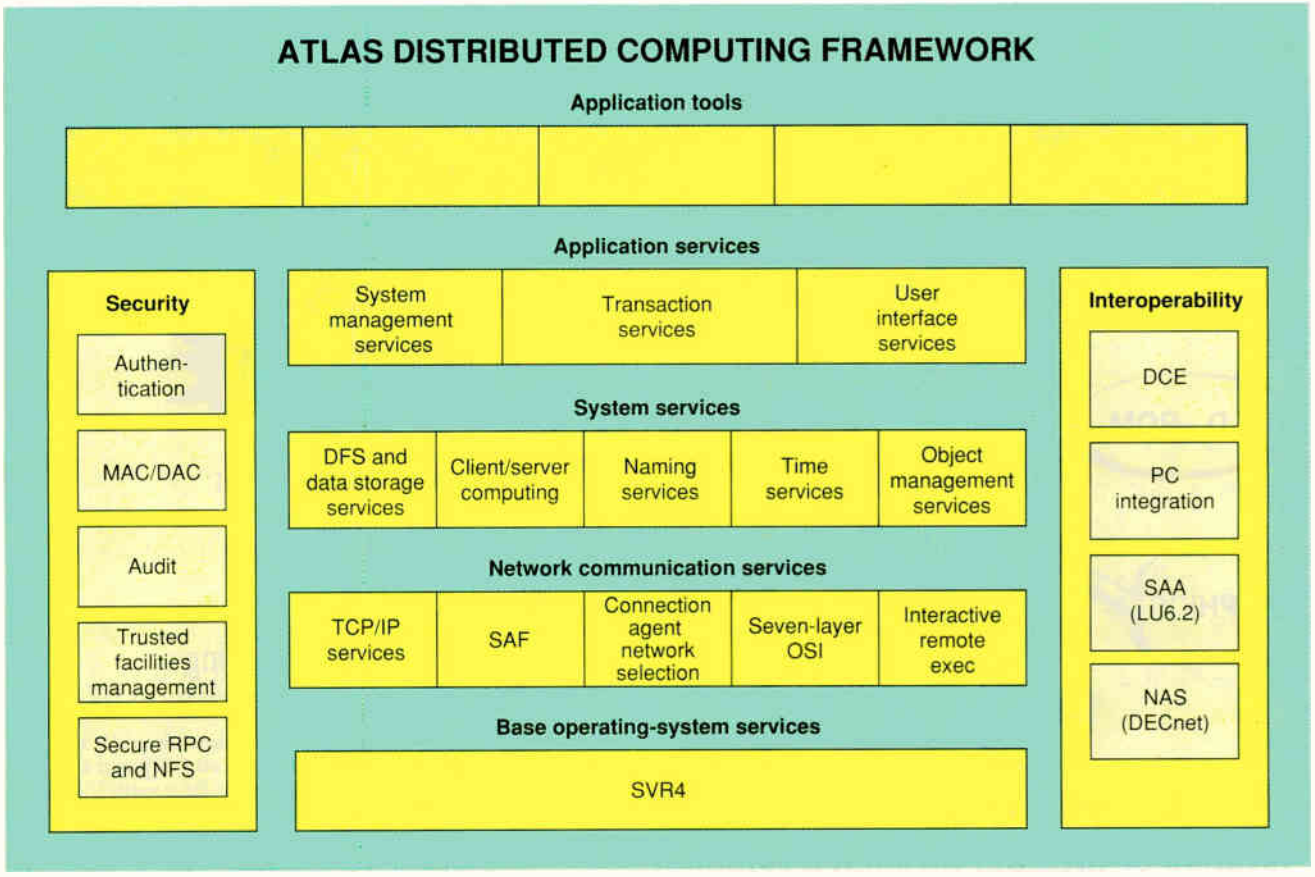

Figure 3: *Unlike DCE, Atlas is built on a single operating system, SVR4. Thus, it can offer a more robust and coherent set of services, although at the price of limiting the number and types of systems that can take advantage of these services. Atlas interoperates with non-SVR4 systems via DCE, PC integration, SAA, and NAS.*

World Radio History

of the remote procedures into C source code, causing RPCs to behave in the same way as local procedure calls.

- *Directory service*. The directory service provides a single naming model for resources such as servers, files, and disks across the distributed environment.
- *Time service*. DCE maintains a distributed time reference to synchronize activity and events among the different computers on a network.
- *Threads service*. Threads control program flow; they allow an application to process many commands simultaneously, thus allowing programmers to use parallelism within distributed environments. Thread service is also a natural in client/server control, because a server can initiate many threads to clients.
- *Security service*. This service authorizes, authenticates, and manages user access to individual hosts on the distributed network. It includes secure RPC to protect the integrity of communications, Kerberos authentication to validate the identity of a user or service, authorization tools that control user access to resources, and a user registry to manage user account information.

Because Atlas encompasses DCE, applications will be interoperable and portable.

The Data-Sharing Services available through DCE include the following:

- *Distributed file system*. This is the key information-sharing component. It joins the files and directories of individual workstations and provides a consistent interface.
- *Diskless support*. The distributed file system supports diskless workstations and provides protocols for diskless support.
- *Personal Computer Integration*. PCI allows Unix, MS-DOS, and OS/2 users to share files, peripherals, and applications.

Atlas: Looking Toward the Future

To carve a niche for itself, Atlas focuses on technologies that DCE doesn't currently handle. But that doesn't mean that UI will ignore the work OSF has done—quite the contrary.

"Unix has always had to interoperate with IBM, Digital, and now HP systems," says Peter Cunningham, Unix International president. "We have little option but to incorporate DCE in some base-level services. We have taken DCE services and mapped them to other services in such a way that applications portability and interoperability are assured. We would also expect as technology moves ahead that Atlas will be picked up by OSF companies. We are concentrating our efforts on advanced technology that will provide value-added services for UI members."

What extras can users expect? In addition to DCE functions, UI says, Atlas will provide facilities such as support for

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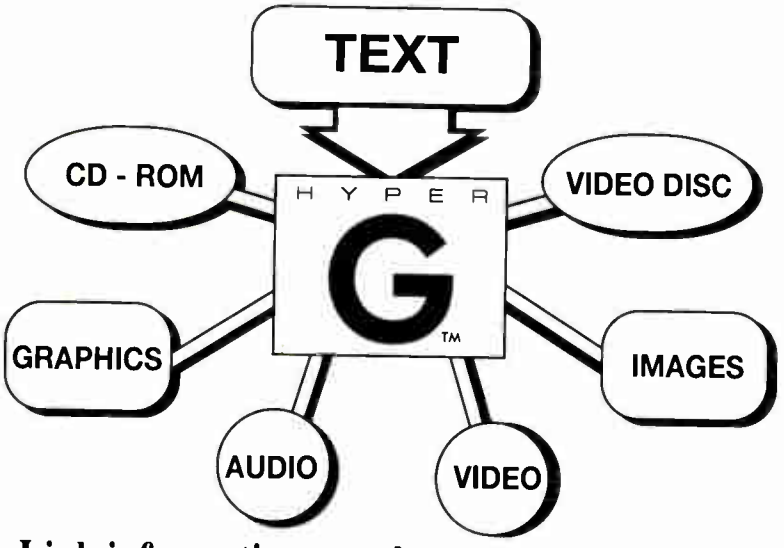

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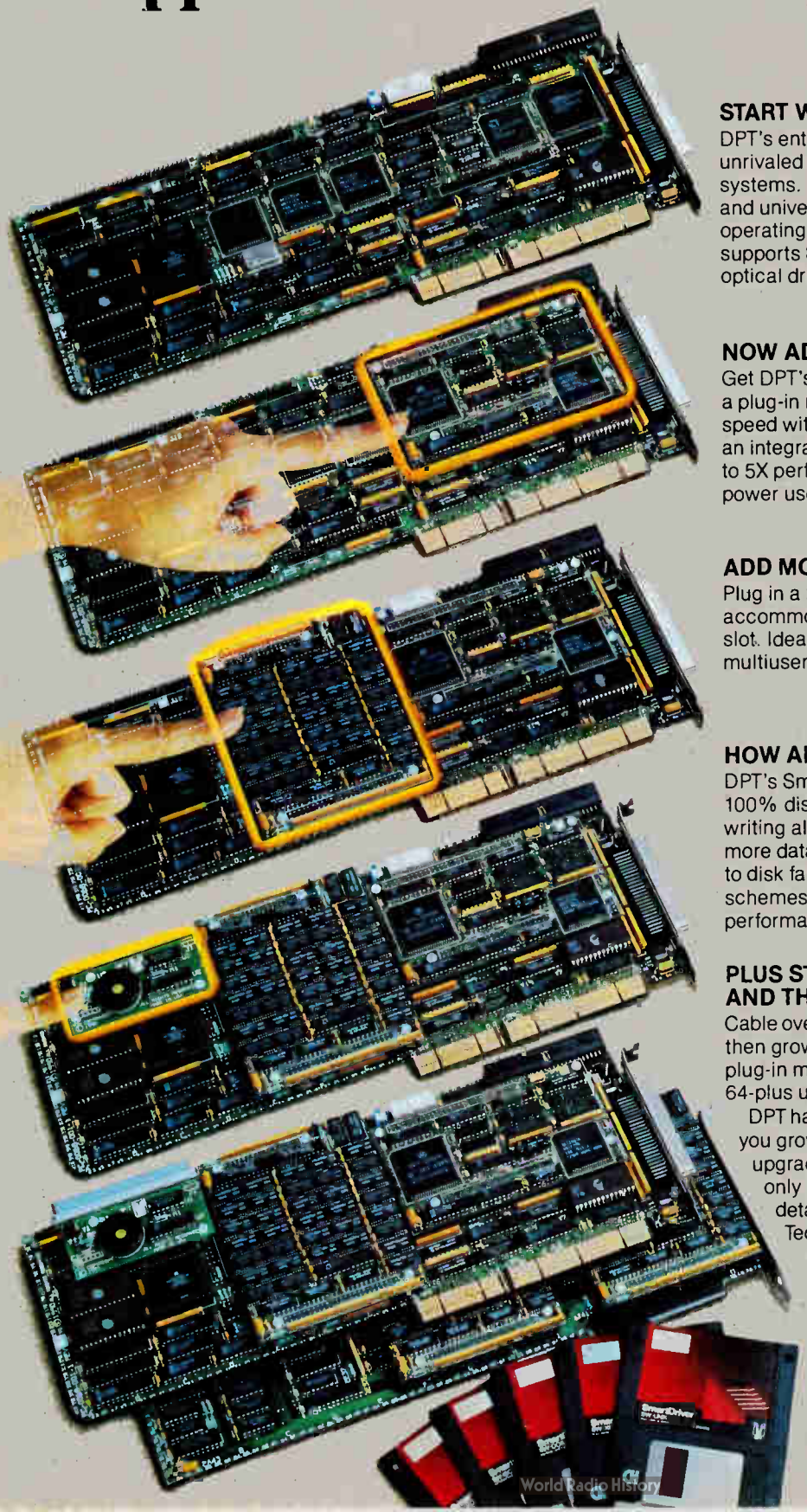

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UI says that because Atlas encompasses DCE, applications will be interoperable and portable between them. When DCE systems are migrated to Atlas, UI says, applications will easily migrate, since existing application programming interfaces (APIs) in DCE will be supported in Atlas. However, when Atlas systems are migrated to DCE, only the applications that limit use to DCE will be portable; Atlas functions that are not currently available in DCE will not be portable.

Atlas is based on Unix System V facilities and existing technologies in the marketplace. It follows a hierarchical structure (see figure 3) in which common functions are grouped together in layers and are visible to other layers through APIs. Atlas is currently in development (it will be released in modules over the course of the next few years), but it is being based on UI's functional specifications. You can expect the finished product to follow them closely. The specifications include the following:

- *Operating System and Network Communications Services Layers*. System V release 4.0 represents Atlas's backbone operating system. The Open Systems Interconnection (OSI) protocol stacks and tools from the ISO will extend SVR4 to enable standardized communication among heterogeneous systems. It will include support for X/Open APIs, UI- and Unix System Laboratories-defined service and provider interfaces, Government Open Systems Interconnect Profile-conforming protocol stacks, tools to manipulate stacks and data, and tools to assist in migration from TCP/IP to OSI.
- *System Services Layer*. UI defines this layer as the core of the distributed computing environment and the foundation on which are built the components that support distributed applications and tools. It includes the following:

Directory file-system and data-storage services. These provide transparent access to different distributed file systems. UI will integrate support for standard file systems to provide access to both Unix and proprietary systems.

Client/server computing. The client/server framework forms the basis for providing Atlas services. The most important part of this framework is RPC, which provides the mechanism for the distribution of applications that are split and scattered across multiple systems.

Naming services. These control references to systems and network resources.

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Atlas follows the ANSA and European Computer Manufacturers Association standards' federated naming model, which provides for composite names consisting of components from different naming models rather than a single syntax. This allows easier porting of applications that have been written under different naming schemes.

Time services. These services, which provide the synchronization of system clocks, are necessary for proper communications among disparate systems.

Object management services. Object technology provides transparency and incorporates leading-edge technology into the framework.

• *Applications Services Layer.* This layer includes the user interface, a transaction monitor, and network management. These services support the top Atlas layer, Application Tools. The user-interface service supports X Window System–based GUIs, including Open Look and Motif. Transaction processing services are supported from mainframe-class machines as well as local workstations. Network management provides administrative control over the network.

• *Security Services Layer.* Two mechanisms will address security—authentication, which verifies users and applications across the distributed system, and access control, which manages access to data and applications.

• *Interoperability Layer.* This layer includes network services to allow interoperability between disparate systems. It will include OSF's DCE, IBM's SAA, DEC's NAS, and PC LANs.

The Road from Here

DCE and Atlas are important advances in distributed open systems, but there's still a lot of work to be done. Even though OSF and UI recognize the ISO/OSI standards as key to global interconnectivity, ISO is only one level of a distributed system. Both OSF and UI are committed to providing software that meets X/Open guidelines, but X/Open doesn't offer a total solution. DCE and Atlas support other ISO standards, such as the Remote Operations and Association Control Service Elements and the ISO presentation and session services. They also support Internet TCP/IP transport and network protocols, the Domain Name System, and Network Time Protocol.

The problem with standards, however, is that technology changes so quickly that standards groups haven't yet effectively tackled the problem of overall distributed computing. Yes, there are ISO standards and X/Open guidelines; but these do not offer a single clear route to building complex distributed processing systems. And standards aren't created overnight; some take years to define.

Both OSF and UI are adhering to standards, at least for the most important modules that make up their architectures. And since many technologies become standards simply because they are the most used, the probable outcome is that for basic distributed computing services, DCE will become a de facto standard. It is just as likely that for value-added services and current NFS sites, Atlas will be the technology of choice. ■

Mary Hubley is senior editor of Datapro Reports on Unix Systems & Software, *a publication of the Datapro Information Service Group (McGraw-Hill) devoted to the Unix and open-systems markets. You can reach her on BIX c/o "editors."*

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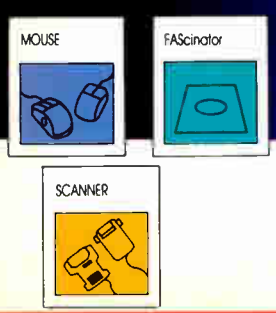

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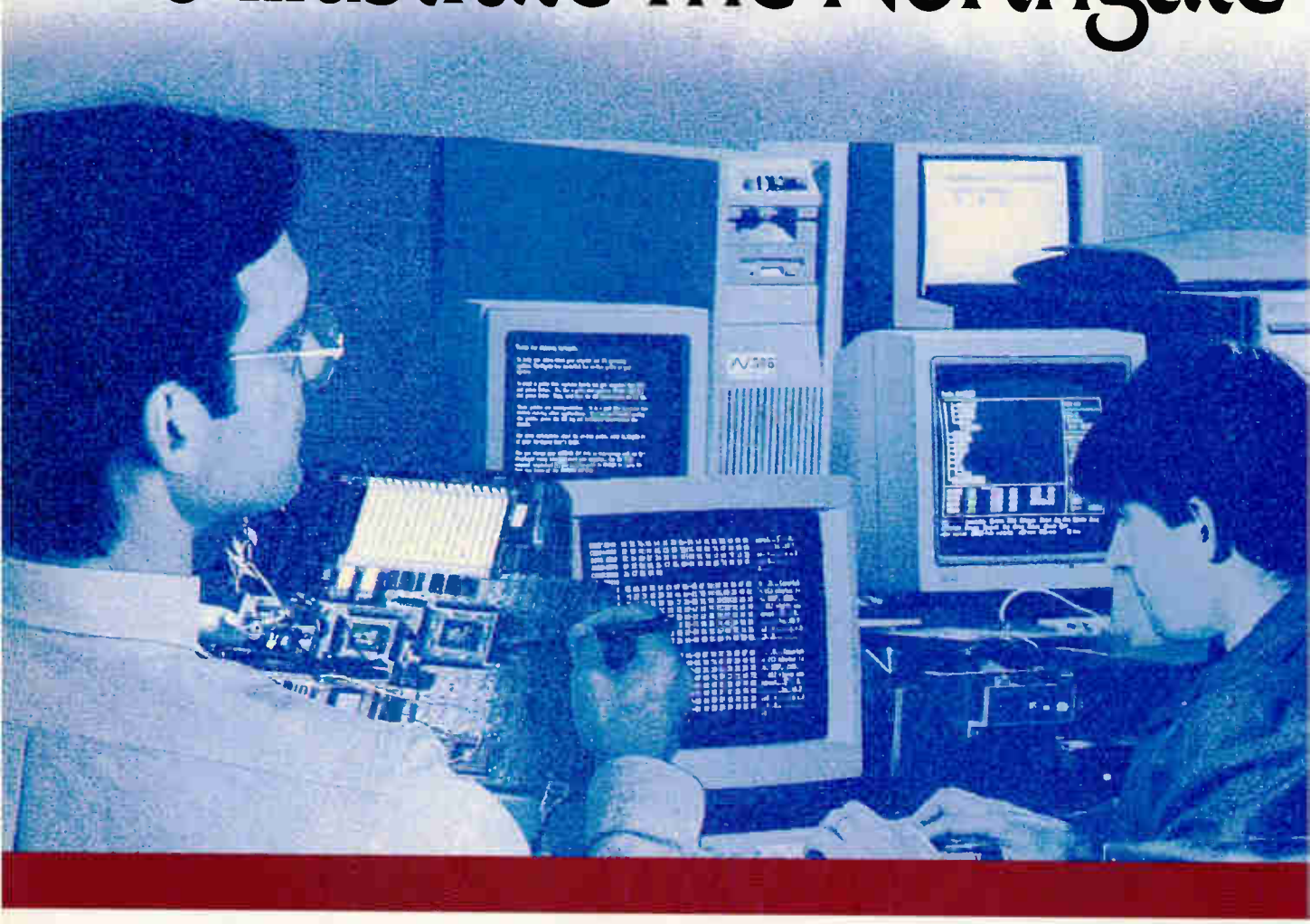

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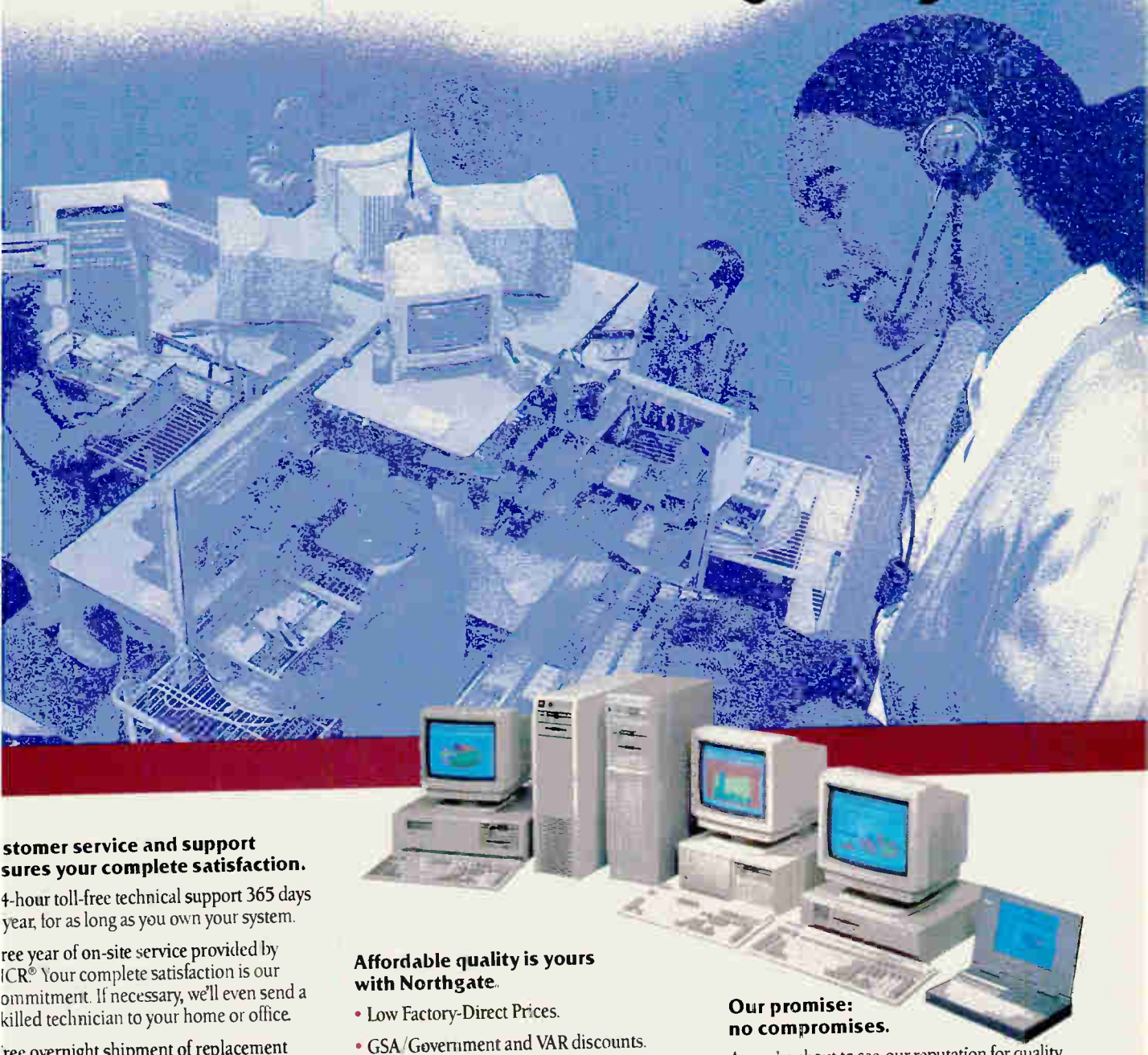

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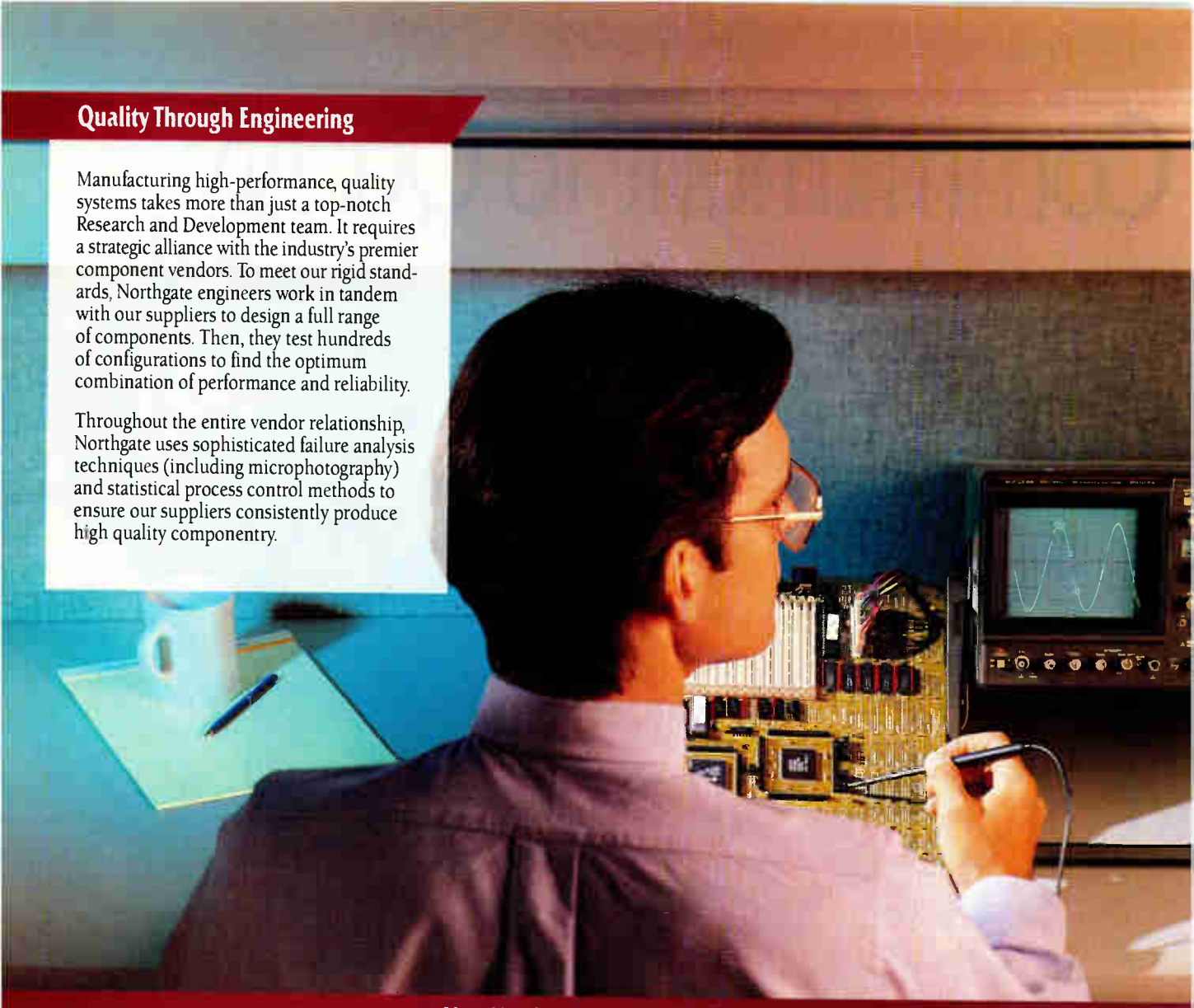

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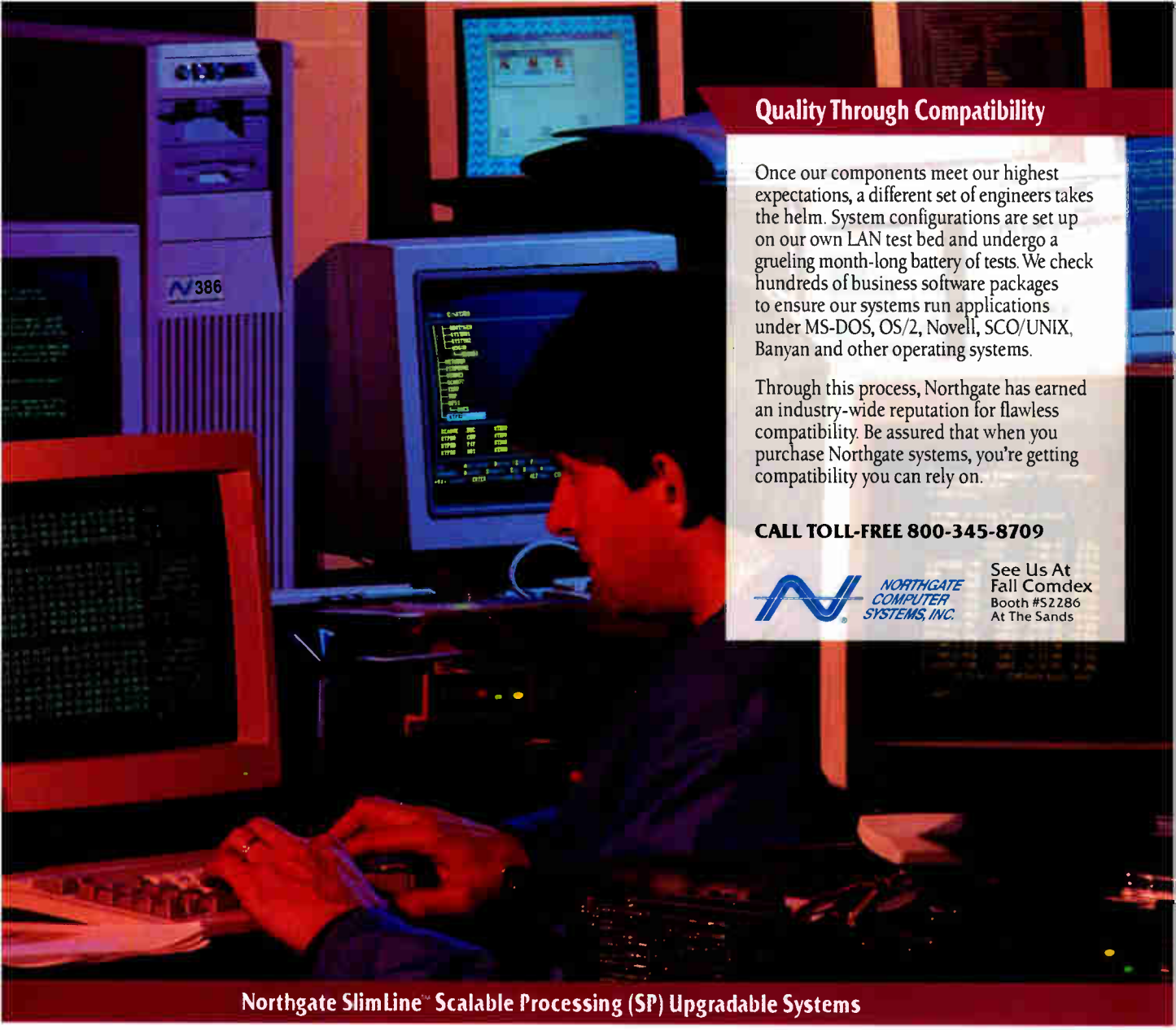

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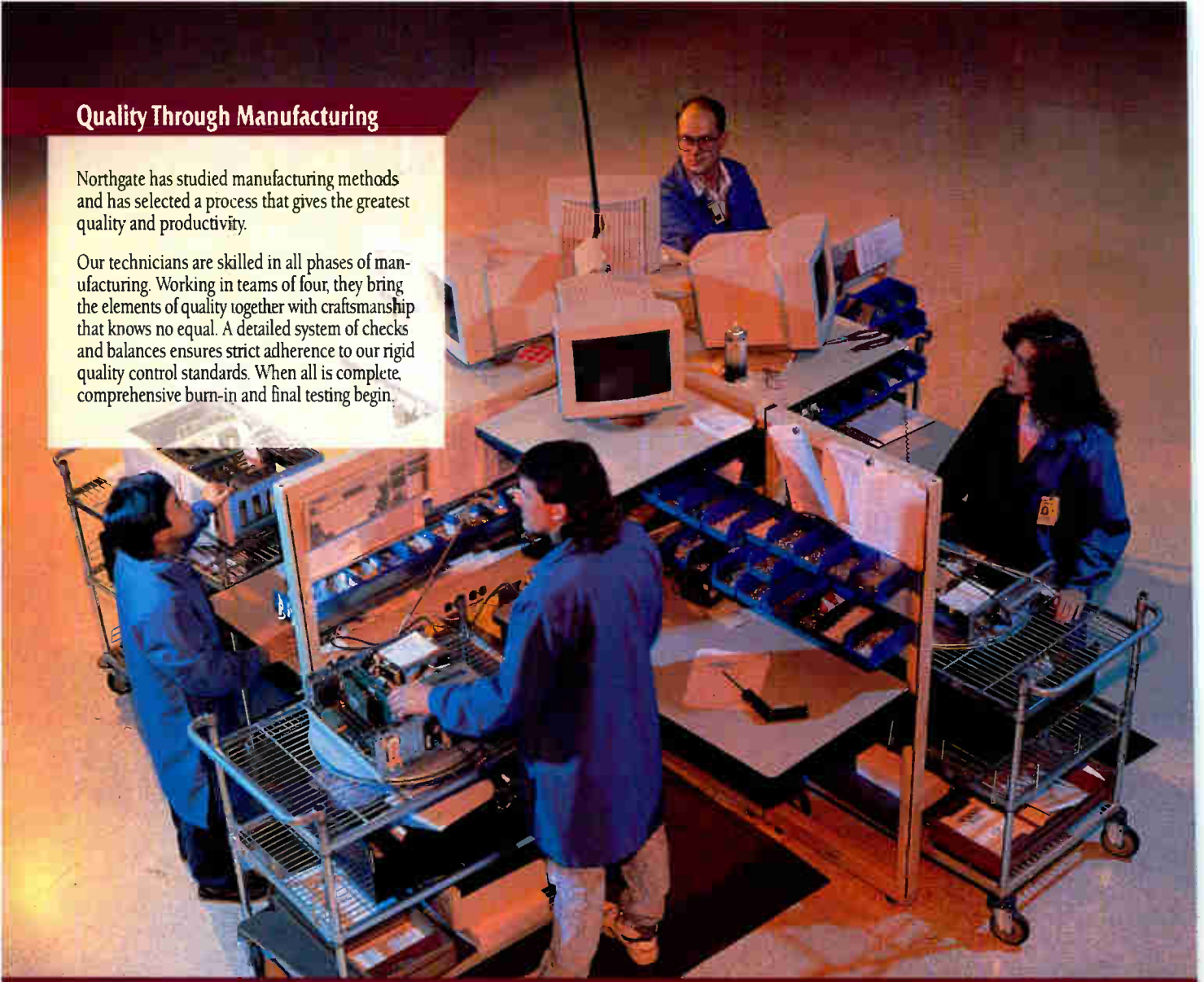

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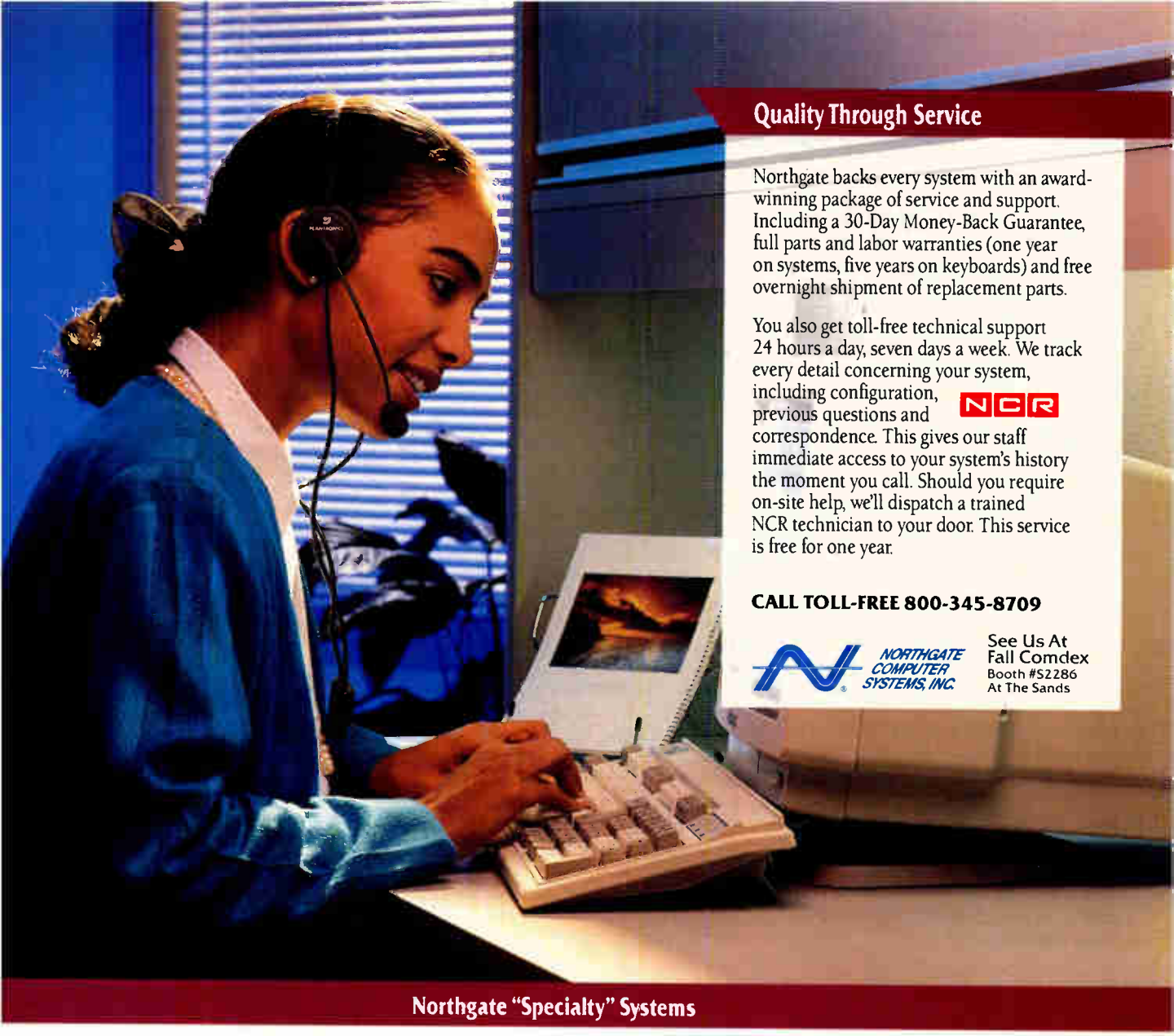

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INTEGRATING DISTRIBUTED INFORMATION

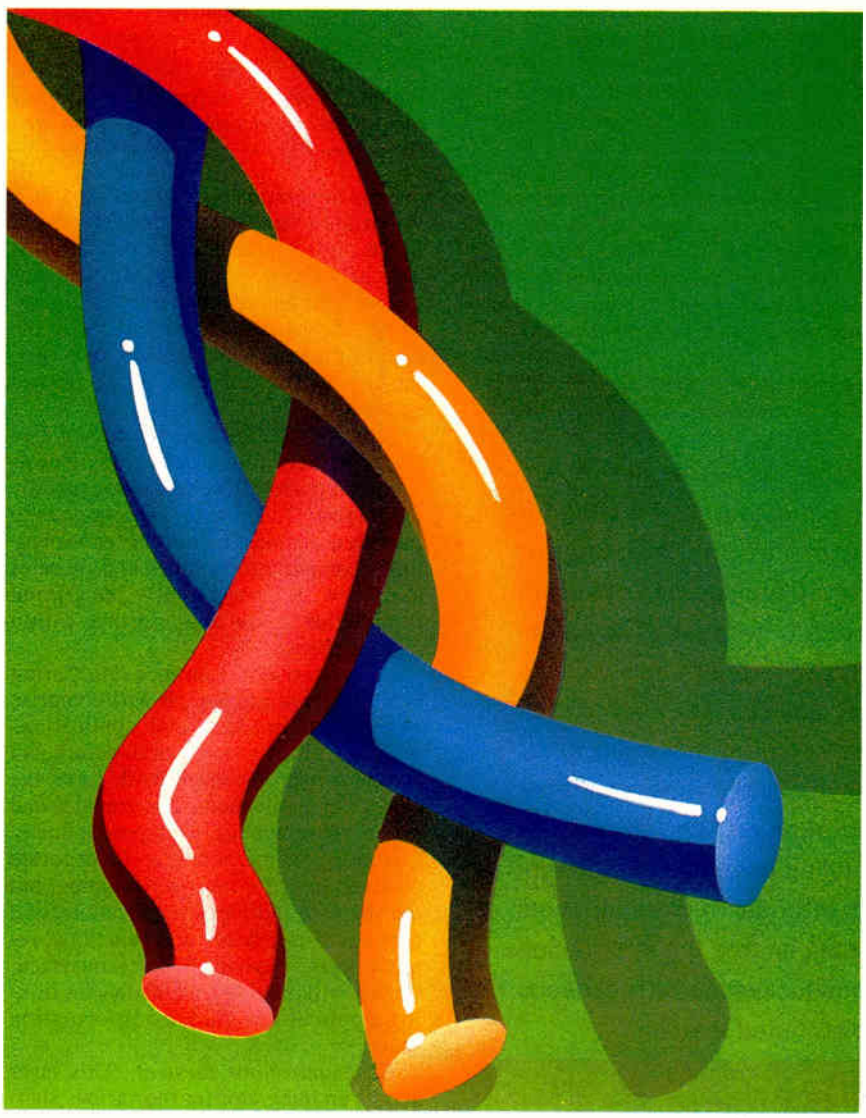
Merging information from diverse sources sometimes takes just a little common sense

DANIEL W. RASMUS

I recently walked into a chip-making facility and found several people performing database tasks. At a VT320 terminal, a production analyst was reorganizing the database. At a Macintosh, another analyst was preparing reports for the government from downloaded data. A manager working on an AT system emulating a VT100 extracted records, transferred them to disk, and printed them using the appropriate VAX/VMS command. I shook my head in amazement.

Everywhere you look, information hides within data, waiting only for the right set of circumstances to reveal itself. IBM 3090 computers house large IMS and DB2 databases. Hewlett-Packard, Sun Microsystems, and DEC workstations hold a combination of Ingres, Oracle, Sybase, and other relational database files. PCs keep information within personal reach (but hide it from other uses) in local dBase, Paradox, and Lotus 1-2-3 files. And on Macs, a multitude of database products serve individual and AppleTalk users across a company.

No technology that's available today can display the information from these disparate sources as an integrated whole the instant a user requests it. Local- and wide-area networks put some data into play on the corporate field. Some companies resort to consolidated databases that bring extracts together into a common data structure. These solutions may satisfy some short-term corporate needs, but they do not solve the problem. Database proliferation and local structure changes threaten the long-term existence of corporate monolithic consolidated databases.



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One answer to this problem may be the Carnot project from Microelectronics and Computer Technology Corp. MCC was founded in 1982 to solve large common software and hardware problems. No corporation in the 1990s can commit resources to solve diverse, heterogeneous data problems alone. Through Carnot, MCC pools the resources of several large American firms to cooperatively pursue basic research in unified database integration. The project's ultimate goal is to develop a basic mechanism for heterogeneous database access.

Introducing Carnot

The Carnot project intends to provide its sponsors with open applications development tools that tightly integrate the information found in today's closed systems. The tools that are developed during Carnot's five-year life cycle will help sponsors implement solutions on a variety of systems. These tools will build on existing technologies, including the Open Systems Interconnection (OSI), TCP/IP, X.400, X.500, Electronic Data Interchange (EDI), and knowledge-based systems technologies, including MCC's own Cyc knowledge-based system. All these technologies and standards exist or are sufficiently developed to contribute concrete results to the Carnot project.

The Carnot project focuses on synthesizing the diverse data resources already in place in today's corporations to facilitate the integration of computer data. It is important to understand that the project is not aimed at building a new DBMS, data repository, fourth-generation language, transaction monitor, or framework. These are outside the scope of the Carnot project. And Carnot is not fueling the centralized view of distributed systems.

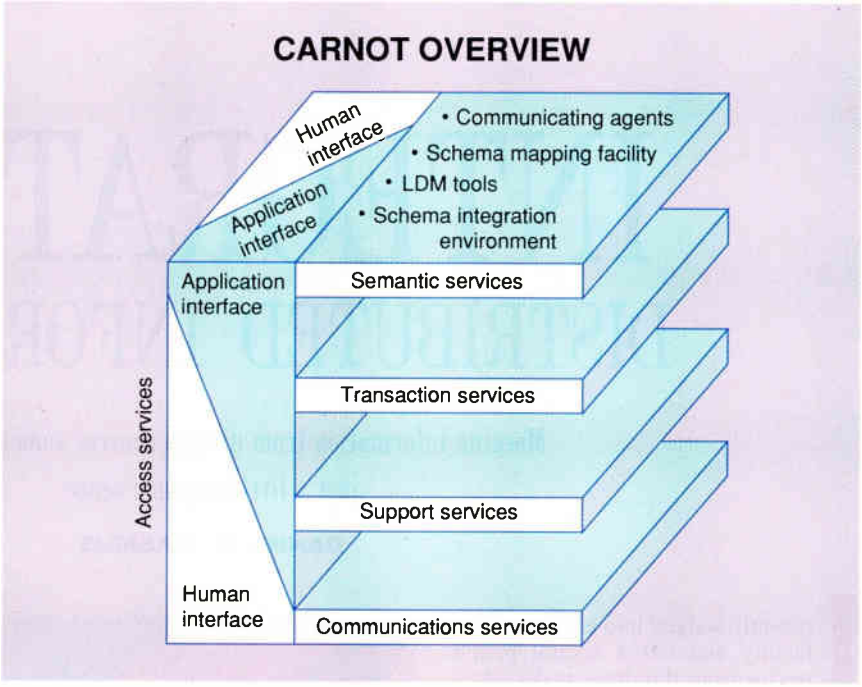

Figure 1: *Carnot consists of five layers. The access services layer provides both human and application interfaces to the core services.*

Carnot's architecture consists of five layers, or services: access, communications, support, transaction, and semantic (see figure 1). These layers cooperate to provide a seamless transition between today's computing resources and those of tomorrow by transparently integrating information access and exchange within an enterprise.

Access services. Entrance into Carnot will require a gateway. It will comprise existing applications and applications built on Carnot's innate architecture. No common user interface will glaze the surface of applications, but graphics and object manipulation will predominate. Carnot's designers might incorporate common tools for interface building, but the shape of individual applications will depend on user desire and functional requirements. Beyond the user interface, Carnot will provide a set of tools for linking applications into its information space.

Communications services. This layer acts as an integrator for the various standard protocols available, or soon to be available. These standards include OSI, TCP/IP, Open Software Foundation's Distributed Computing Environment, and MCC's own ESP.

Support services. Directory services, as described in X.500, will act as a central model for personal database access. Carnot will also support global electronic messaging for individual messages and eventually for enterprise-to-enterprise information exchange via X.400 EDI standards. Remote databases will make data from any server appear as a local file.

Transaction services. Carnot supports traditional transaction services and adds tools to accomplish more sophisticated, time-delayed updates or future-compensating transactions. These tools include the distributed query generator, the distributed transaction generator, and the declarative resource constraint base—which describes a business's rules and environment information. At the heart of this layer lies the Rosette work-flow scripting environment. Rosette's coordinates control work and data flow among support services' various facets.

Semantic services. This layer binds the databases of an enterprise together by means of a common representation of data, its location, and its meaning. How Carnot accomplishes this integration is a fascinating story.

continued

BYTE ACTION SUMMARY

Many businesses are drowning in data while thirsting for information. The uncontrolled proliferation of incompatible databases is a real threat to their decision-making abilities. The Carnot project pools the resources of several large American firms to pursue basic research in unified database integration. It intends to provide tools that can free the information now locked in heterogeneous distributed systems.

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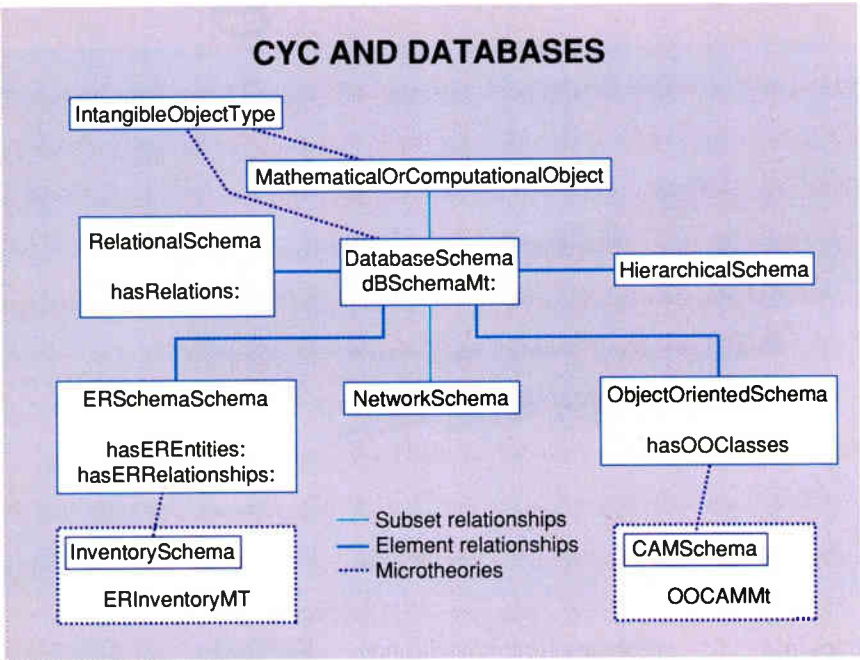

Figure 2: *Cyc has captured the understanding of basic database types—relational, network (CODASYL), entity-relations, hierarchical, and object-oriented—and mapped this information into its common-knowledge base.*

The Carnot Ideal

An imaginary corporation's manufacturing sites dot the globe. MIS has never achieved a unified material-requirements planning installation. In Ireland, IBM's COPICS dominates. Puerto Rico uses Ask's MANMAN, and Gardena, California, runs with Comserve's AMAPS. Senior management is concerned about inventory. The question "What is the consolidated inventory by part number?" goes forth.

A hundred inventory analysts around the globe clamor for hundreds of pages of inventory reports. Boxes of paper appear at the doorsteps of unsuspecting corporate accountants. Days go on and numbers are added, subtracted, verified, and denied. An almost accurate report, some 30 days later, sits meaninglessly on the requesting executive's desk.

Another approach might be that the company depends on MIS programmers to develop extract and consolidation reports. Data files beam through telephone cables, and tapes arrive via overnight mail. Data from all corners of the globe churns through a custom program. The final answer is printed 15 days after the request. Several thousand dollars pass through the books as overtime.

The process is fundamentally different when Carnot is used, because it acts as the facilitator for the request. The inventory request passes through an application into Carnot. Its semantic services interpret the request and compile information from a wide variety of databases on several hardware platforms. A few minutes tick by. The screen refreshes, and the application presents the requester with the results. Carnot acts as a corporate intelligence network, consolidating diverse data resources and synthesizing varied information formats into a semantically common whole.

Carnot seeks to transform ad hoc queries like this one into everyday occurrences. From an information viewpoint, the enterprise essentially becomes a single entity. You don't need to request information from half a dozen sources. Carnot can tie the business data together through its understanding of corporate information relationships. Semantic services transform current databases into Carnot's representation of a unified enterprise.

Semantic services are a challenge, but they are also the source of Carnot's highest payback. Today's intelligent database tools, like Carnot's semantic services, find their homes in laboratories. Tomorrow, Carnot will bring them to corporate MIS departments.

The Semantic Services

Four main components form Carnot's semantic services layer: the Cyc knowledge base, schema integration tools, database design tools, and communicating agents. Each of these areas addresses specific integration problems existing in today's MIS architectures. Practical AI solutions provide the common thread throughout semantic services. From intelligent agents to the Cyc knowledge base, understanding the world of computers and how to navigate through that world is the central idea of semantic services.

The Cyc knowledge base. Cyc acts as the prototypical representation of an enterprise's information resources. This knowledge base (which will eventually contain 10^8 axioms) maps databases, their fields, and their relationships into a global schema.

Schema integration tools. Rather than rely on human intervention to map discrete database tables and class structures into Cyc, Carnot's developers are attempting to build tools that automatically examine the structure of a database and find the most suitable matches in the Cyc global schema.

Database design tools. Carnot addresses the difficult problem of logically maintaining global schema integrity when a local database's definition changes. An even more difficult problem involves propagating global schema changes to local levels. For instance, perhaps the global schema is missing an important data definition. You may add that definition at the global level, but the data's permanent home remains undefined. The database design tools work with local and global analysts and architects to maintain Cyc's global integrity.

Communicating agents. Neither you nor your programs will know enough about a local data organization to always ask the right question or navigate the right path. Carnot's directory service, a worldwide phone book, may take different forms depending on the local telephone service or government regulations. Communicating agents provide knowledge sources within the Carnot structure that contain sufficient local knowledge to navigate through various telephone services.

In manufacturing systems, for instance, agents might solve the problem of how to request a bill of materials—a solution that requires constructing various Structured Query Language (SQL) queries unique to each database design. An Ask agent would navigate MANMAN's DBMS-32 database, while an IBM agent would negotiate passage through a COPICS database.

Carnot is not an attempt to remake the world. The distributed databases that

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exist today and those that will exist tomorrow form a common history in Cyc, not a common structure. Rather than building a large central database that encompasses all corporate data, Carnot builds a semantic model of a corporation's data resources. It deduces correct access paths and requests syntax for databases by seeing how Cyc maps these resources.

The Continuing Evolution of Cyc

Cyc incorporates the latest techniques and ideas in AI research. It is MCC's most ambitious program. Today Cyc's knowledge base incorporates well over a million items of information. Each item is entered after extensive review and analysis by knowledge engineers. Carnot prototypes rely heavily on Cyc and its rich frame-based representations, but future implementations may use other knowledge-based systems.

Biologically oriented AI researchers hope to create algorithms that will enable Cyc to suddenly awaken—like a child—and start absorbing knowledge. Doug Lenat and his team at MCC enter common knowledge into Cyc. They hope their careful tutelage will provide a basis for it to identify holes in its knowledge and request clarification from its teachers. Cyc captures the understanding of basic database types and maps this information into its common-knowledge base.

Cyc is designed to accept any knowledge provided through its editors. It currently knows about such things as time, money, historical events, various environments, a few hundred specific people, and several other diverse areas referred to as common knowledge. Cyc, however, is not limited to ordinary common knowledge. The rich representation language called CycL is capable of representing very specific domain knowledge as well.

Carnot researchers recently taught Cyc about entity-relationship schemas, relational schemas, and object-oriented schemas (see figure 2). It uses this information to extend its representation into Carnot's global schema (see the table and reference 1). Cyc facilitates the global-schema definition by encoding in its knowledge base general knowledge used to find similarities, dissimilarities, or incompatibilities at a high level of abstraction (see reference 2).

Cyc's understanding of common knowledge forms the prototypical link between Carnot and the outside world. The massive data representation that Carnot delivers would strain individual analysis efforts. The success of human reasoning in understanding the relationships within heterogeneous environments diminishes as the environments grow more complex. Carnot will use Cyc often for database consultations.

Enhancing traditional information models also becomes easier with Cyc. Rather than relying strictly on the schema of local databases, Cyc calls on all the knowledge sources available about a particular database. This information may include intelligence about the schema and its constraints, resource knowledge like the data dictionary, the data model, and even the data itself. Knowledge about the organization may also contribute by codifying rules about the database and its acceptable usage.

Cyc's final contribution to Carnot is a set of articulation axioms that map information resources into the global schema (see reference 3). These axioms enable both global and local views to be maintained. Applications make requests for data through Carnot's mechanisms. Cyc acts as the mediator among databases by translating incoming requests into local queries. Its translations merge database locations, names, field names, data types, and query syntax. Cyc's knowledge of databases may discover information that is not explicit in local program statements and transform those statements into declarative constraints to

CYC DATABASE STRUCTURES

A breakdown of Cyc's structures for representing database components in entity-relationship schemas, relational schemata, and object-oriented schemata.

Data model concept	Cyc structure
Object class	Collection
Object instance	Individual
Object attribute	Slot
Object method	Predicate
ER entity	Collection
ER relationship	Collection
ER attribute	Slot
Relational table	Collection
Relational attribute	Slot
Relational tuple	Individual
Hierarchical segment	Collection
Hierarchical record	Individual
Hierarchical field	Slot
CODASYL record type	Collection
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It's All in How You Ask

A Carnot query begins as either a direct call to the global schema or a local query. A query directed at local resources, with global intent, begins by translating the local data-manipulation language, such as Oracle Structured Query Language (SQL), into the Global Cyc Language. GCL's syntax is first-order predicate logic with extensions. The second phase of the query involves mapping the GCL phrase and its equivalents in the global schema. GCL refers to these equivalences as *articulation axioms*. The general form of an articulation axiom is

$$ist(Cyc,\phi) \longleftrightarrow ist(C_{db},\psi)$$

where ϕ and ψ are logical conjunctions and *ist* means "is true in the context." *Cyc* is the global schema representation, and C_{db} is the local schema to which the articulation axiom applies.

In many cases, Cyc's existing knowledge about the world may prove sufficient to supply the global schema with its semantic information. In the case of restaurants and hotels, for example, Cyc already has complex representations in its Lodging and Restaurant collections. It knows that some lodgings have restaurants. It also knows that lodgings have phones and that places with phones have phone numbers. The following example illustrates how Carnot interprets and then distributes a local SQL query.

Scenario: A production line is down. A senior materials analyst asks the local database about parts availability. Carnot intercepts the request and searches all related databases for available parts.

Figure A describes a portion of the worldwide databases of the fictitious M.F.G. Manufacturing. The global schema knows all the descriptions of the systems. The materials analyst submits the following SQL query to the DBAustin relational database:

```
SELECT quantity, warehouse FROM
MFGPart WHERE part_no = "1934-345-
001"
```

First, the SQL-GCL syntax translator restates this local SQL query in GCL:

```
aIO(?M MfgPart) AND part_no(?M
?PN) AND = (?PN "1934-345-001") AND
warehouse(?M ?W) AND quantity
(?M ?Q)
```

Carnot then maps this GCL expression with articulation axioms into a new expression whose semantics are known globally:

```
aIO(?M ManufacturedPart) AND iden-
tifier(?M ?PN) AND = (?PN "1934-
345-001") AND locationOfStor-
age(?M ?W) AND cardinality(?M ?Q)
```

This query is meaningful to the global schema and is translated into the

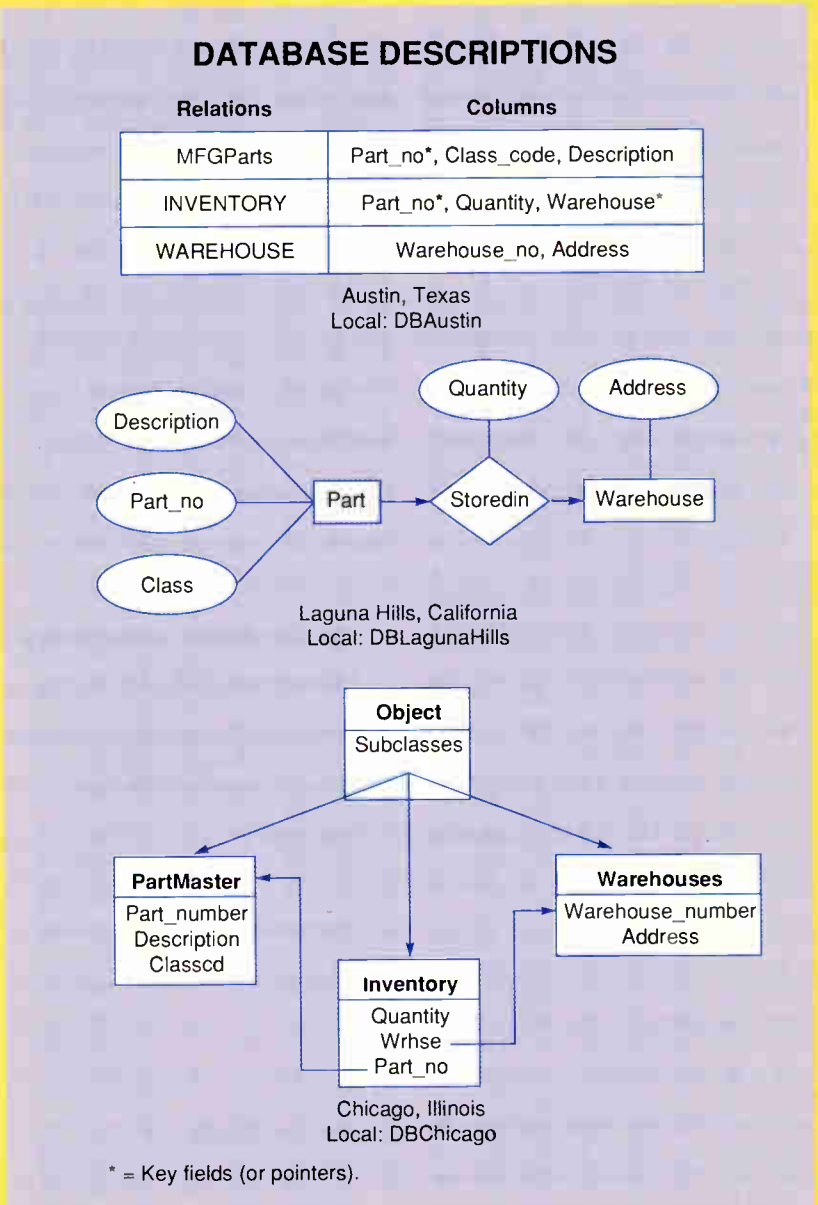

Figure A: *M.F.G. Manufacturing uses different types of databases at different sites: a relational database in Austin, an entity-relation system in Laguna Hills, and an object-oriented database in Chicago. Carnot makes it possible to combine data from all three databases.*

World Radio History

appropriate local queries using the appropriate articulation axioms. The translation to the DBLagunaHills local schema (an entity-relationship model) is as follows:

```
aIO(?P Part) AND aIO(?S StoredIn)
AND aIO(?W Warehouse) AND in-
stored(?P ?S) AND storedAt(?S ?W)
AND part_no(?P ?PN) AND = (?PN
"1934-345-001") AND quantity(?S
?Q) AND address(?W ?A)
```

The translation to the DBChicago local schema (an object-oriented model) is

```
aIO(?I Inventory) AND aIO(?P Part-
Master) AND aIO(?W Warehouse) AND
instored(?I ?P) AND warehouse(?I
?W) AND part_no(?P ?PN) AND = (?PN
"1934-345-001") AND quantity(?I
?Q) AND address(?W ?A)
```

Carnot then translates these queries syntactically to appropriate local data-manipulation languages before sending them to the databases.

The final query that is sent to the DBLagunaHills database is the following SQL-like entity-relationship expression:

```
SELECT quantity, address FROM
Part, StoredIn, Warehouse WHERE
Part.part_no = "1934-345-001"
```

The final query sent to the DBChicago database is the following object-oriented expression in ITASCA syntax:

```
(SELECT ((Inventory quantity)
(Warehouse address))
(= (path (Inventory part part_no))
"1934-345-001"))
```

The final SQL query that is sent to the DBAustin database does not require regeneration from the global schema, because it is the same as the original SQL query.

Carnot takes advantage of its understanding of the world, via Cyc, to generate appropriate queries to remote locations. The knowledge required of the developer remains constant for SQL. Carnot enhances the developer's current knowledge with its own knowledge of the company and the meaning and relationships of its databases.

synchronize related databases.

Its global view of the world creates the illusion that Cyc is a single immense database. Using it directly, however, will force programmers to learn its internal representations—a difficult task. Early Cyc adopters may find common SQL queries the most efficient way to use it. This method requires no rewriting of existing software and takes advantage of the global schema without a steep learning curve (see the text box "It's All in How You Ask" at left).

The Promise of Carnot

Carnot is one of computing's most exciting developments. Prototypes and demonstrations of its various technologies already exist, and its architecture is well defined. Significant work is currently under way toward developing more sophisticated prototypes with complete support for existing standards. As various bodies define new standards, Carnot will integrate them with its ongoing development.

Carnot is driven by a common and visible business need. Between now and the time it arrives in your company, hundreds of new databases will sprout from the disks of MIS, end users, and vendors. Short-term solutions, like large central extract facilitators, may help ease the burden of reporting, but they don't provide the answer to long-term integration.

The computer industry made distributed-data structures possible during the 1970s. Carnot is one way to make distributed data truly productive. ■

ACKNOWLEDGMENTS

Special thanks to Dan Simchuk for coordinating information from MCC and to Wei-Min Shen for help with the example of Carnot.

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Daniel W. Rasmus is a freelance writer in Laguna Hills, California. You can reach him on BIX c/o "editors."

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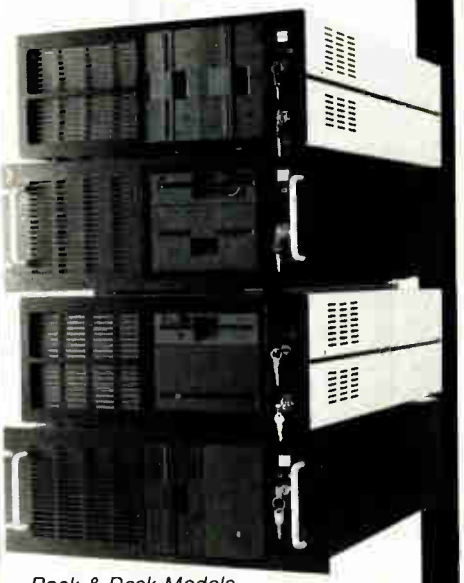

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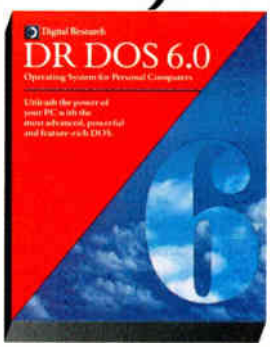

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YOU CAN'T RUN ON EVERYTHING

How to choose a portability toolkit or decide on a long-term portability strategy

ELLEN ULLMAN

Like all programming, portability begins in the mind as a platonic ideal. "We will run on everything," my boss once said. Then he sat back and imagined our system running on far-off architectures and traveling to machines he had yet to dream of. I liked my boss, so I didn't interrupt his reverie. But in my heart I knew that programming starts out like philosophy but ends up more like plumbing.

My boss was the applications director at a start-up company that was preparing to build relational database management software. I was the first one he hired and was charged with writing the front end to a database server.

We were going to do something no one else had done before—or so we thought—and we were going to do it on everything: Unix, VMS, and who-knows-what operating systems; Sun workstations, inexpensive ASCII terminals, and everything in between; and with or without a mouse, joysticks, light pens, digitizers, and foot pedals—maybe. I was lucky. That was before Windows 3.0, or that, too, would have been on the list. My boss showed me a few transparencies to give me his idea of the system, and then he asked, "What do you think it will take?" I went off to my office and thought about being able to run on "everything."

Plumbing 101

Soon I got to the part of programming that's more like plumbing. Other programmers were waiting for my work. I just had to get the system up and running. There was no time to investigate all the possible architectures and no time for a perfect design. The platonic ideal of

ILLUSTRATION: R. KENTON NELSON © 1991

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portability drifted away, and I started writing code.

One year later, the front end ran on bitmapped devices and ASCII terminals, with or without a mouse (the joysticks and foot pedals never materialized, fortunately). However, even as the system ran, I had an uncomfortable idea of what lay ahead. Someday a portability group would look at my code, shake their heads ruefully, and say, "Forget it. We can't port it. We'll have to rewrite it."

Anyone who has tried to write portable applications software will recognize the outline of this story, especially the two contradictory demands on the designer: the need for the software to run on multiple platforms and the need to get the product out the door as soon as possible. Over the years, the pressure has been increasing on both sides of this contradictory situation. The recession is squeezing time to market.

With the advent of GUIs, developers need to write portable applications more than ever. People who were once happily unaware of operating systems, frameworks, and environments now know all about them, and they have *opinions*. They want a Mac or Windows or Motif or Open Look, and developers are expected to accommodate those preferences.

With a portability strategy like the one I'll propose here, it is possible to satisfy some of those preferences. I cannot offer a single solution—no magic toolkit that will carry your code to all platforms. Rather, I'll address the thought process that might help you choose a portability toolkit or decide on a long-term portability strategy, and I'll discuss the thinking that precedes design—a stance you assume to get ready for multiple platforms, in much the same way as someone who practices martial arts stands ready to receive an attack.

Characterize the Application

As simplistic as it sounds, you should start by understanding your application. I don't mean understanding what the application looks like to a human being—the tasks it will perform and the reports it will produce—I mean understanding what the software looks like to the machine. For example, you shouldn't just see a spreadsheet; you should see a process that is memory-, display-, and storage-intensive.

Clarify the important features of your application—the functional and performance goals that make it unique. Is it a stand-alone program or a component that will communicate with other components? How many other components? Does it run on a single processor, or is it distributed? Is the application graphical? If so, at what level of resolution? And so forth.

The goal is to see your application as a generic machine process or processes. The greater the detail in this generic characterization, the better you will be able to judge the platforms that are appropriate for the application.

BYTE ACTION SUMMARY

Ideally, you should be able to write portable applications, but you may find it more practical to rewrite the software for specific platforms. Portability is a goal, not an edict.

Imagine the Machine

The next step is arriving at a conceptual definition of the target architecture. Now you need to define the type of architecture that will provide those generic processes.

For example, you might say that your application requires an operating system with virtual memory or preemptive multitasking. You may need a certain number of millions of instructions per second or an event-driven environment or extensive network support. Perhaps your application relies on an object-oriented model; in that case, the platform must provide message-passing capabilities.

The goal here is to define a virtual target machine. As in characterizing the application, try to see this machine in as much detail as possible. Even a simple requirement like a monochrome character terminal can be specified in detail (e.g., the number of lines you need or the essential visual attributes). Again, the more detailed the definition, the better will be your choice of target environments.

Rule Out the Impossible

Every definition is a boundary between what's inside the definition and what lies outside of it. Now that you've defined the target architecture, like it or not, you've implied what will *not* be the target architecture. Immediately rule out any environment that does not conform to your virtual machine.

Not all architectures will work for all applications, and not all architectures will work well together. For example, I have often heard the idea that X/Motif "looks like" Windows 3.0. This surface resemblance might lead you to assume that there is a fair amount of portability between these graphical, windowing platforms.

But the underlying architecture of the X Window System is very different from that of Windows 3.0. X is predicated on the idea of distributed processing, with the client and server processes running on the machines best suited to host them. Windows 3.0, on the other hand, assumes that the user interface is running on the same processor as the rest of the system.

This difference in architecture may not matter if your application is a word processor. However, if you are writing three-dimensional rendering software and need to do calculations on a powerful host and display the results on a high-resolution graphical device, you will have some trouble with Windows 3.0. You just might get your software to run on the Microsoft platform, but you may not want to admit that you're the one who wrote it.

Writing beautiful, portable C or C++ code will not dissolve the underlying differences among incompatible architectures. It's best to simply accept that from the outset and recognize that you can't run (well) on everything.

The Primal-Platform Problem

Once you decide which target platforms are appropriate, you face a more significant question: Which platform will you use for the first implementation?

From the standpoint of portability, the best initial implementation is the platform that offers the *fewest* features—the barest machines and terminals. The absence of built-in features will force you to write your own, and you will be able to design them in a portable manner.

However, the choice of the first platform is often made without regard for portability. The product marketing department specifies what it believes will be the biggest seller. The development group wants to start with a powerful programming environment—Unix, perhaps. Reality dictates porting order (e.g., PenPoint is likely to be released before Microsoft Windows for Pen Computing, a probability that will mandate your porting direction).

Whatever the rationale behind your choice of the first platform, you must observe one principle: Beware of getting too attached to your first implementation. You'll have a natural tendency to

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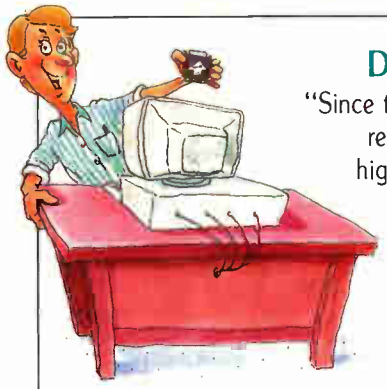

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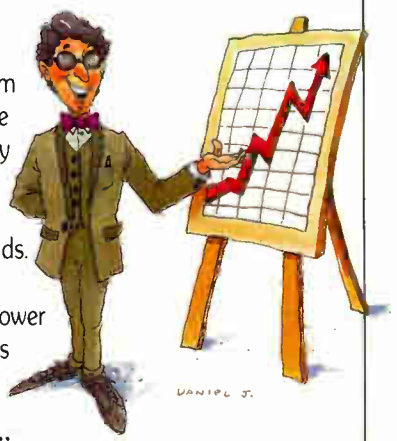

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think of it as the primal platform, the home planet, the mother ship. Quite unconsciously, you will absorb its design assumptions into your application. Try to minimize this process. There is no easy way to avoid being influenced by the platform except to know that you *will* be influenced and to remain as aware as possible. Remember: You will have to leave home.

I must stress one other principle: Take as few features from the environment as possible. If the platform is a rich one and full of powerful goodies, you will be greatly tempted to use built-in features. Fight this temptation. The central irony of software portability is that the more a platform offers you as a developer, the less you can take advantage of it.

Isolate Machine Dependencies

After considering platforms, you can return to application design. To plan for portability, think of your application as consisting of three parts: a user interface, an operating-system interface, and everything else—the broad, application-specific "middle." The user and operating-system interfaces are machine-dependent. Everything else is potentially independent of the architecture.

To maximize its portability, the application-specific middle must stay separate from machine-dependent portions of the application, and it must communicate with the user and operating-system interfaces *only* through well-defined, published interfaces.

The machine-independent portion of the application must request generic system and user I/O services. Think of operating systems as things that perform abstract services like `read`, `write`, and `allocate`, and think of user interfaces as things that perform `readinput`, `draw`, and `refresh`. Notice that the generic system services are a refinement of the virtual machine definition discussed earlier. Now you are identifying the abstract primitives the application needs from the environment.

These primitives have the potential of becoming the basis of two application programming interfaces: one to the operating system and one to the user interface. When your design is finally completed, you may not use these APIs at all. You may decide instead to purchase an applications framework or toolkit (the option of buying a toolkit is discussed later). However, you can use these preliminary APIs to understand your requirements and to evaluate any vendor's portability approach.

In order to test the tentative APIs, you have to document them and attempt to use them—actually write out the instructions that are required to test them. Then choose a number of significant application modules, ones that are difficult to write and representative of the application (go back to your original characterization of the application; the modules you select should reflect the machine-process view of the software). Using pseudo-calls to the published APIs, attempt to write the selected modules. If you can't write them, redefine the APIs until you can.

A Higher-Level Framework

According to Ed Birss, senior vice president of object-based systems for Apple Computer, "When you have different paradigms, you typically retreat to a higher level of abstraction." Birss is talking about the problem of writing a portable operating system—the future Apple/IBM joint venture—but the same method

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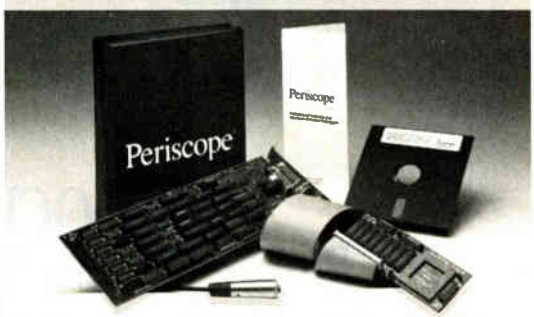

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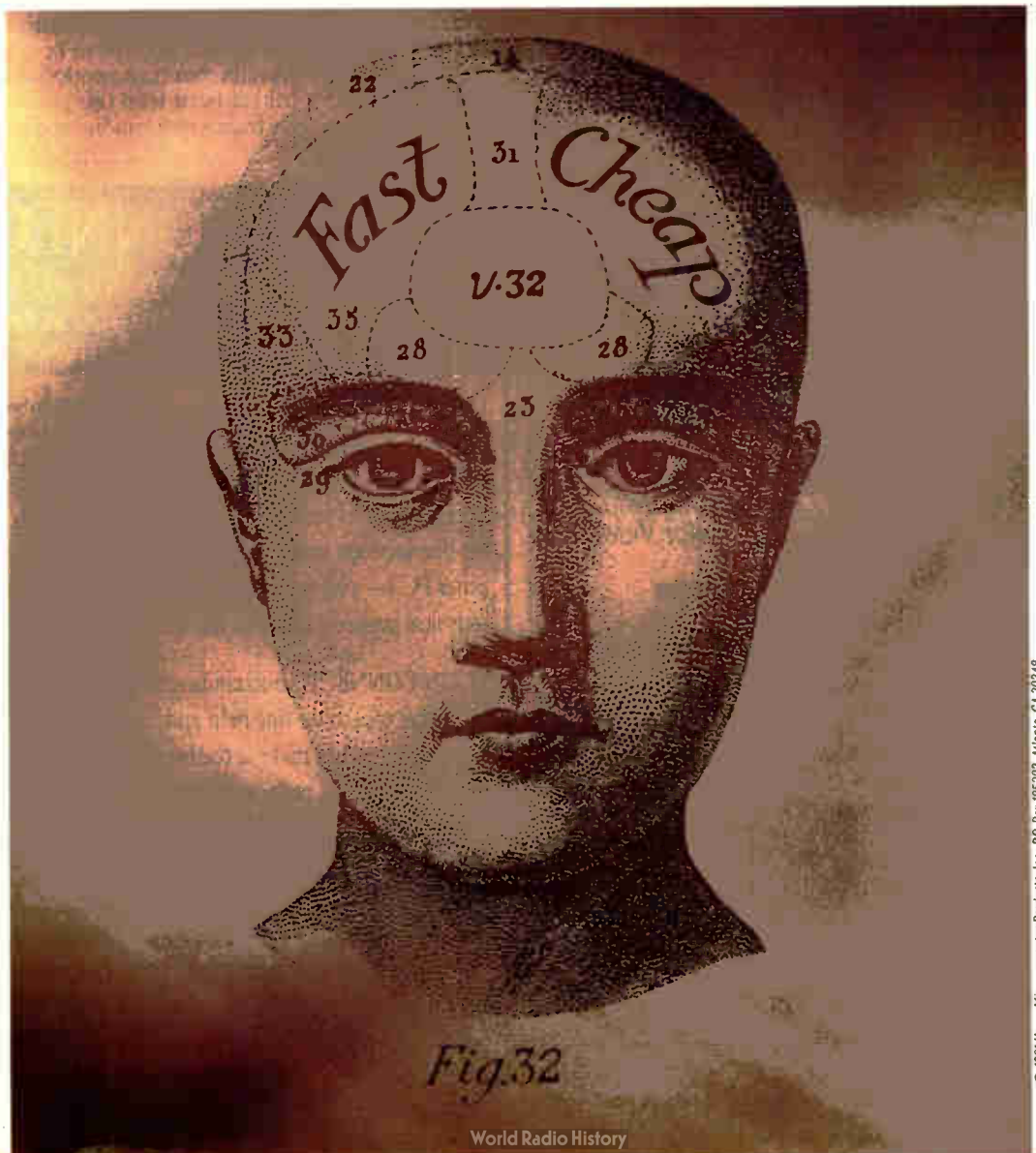

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applies to portable applications. When the underlying architectures don't match, you abstract them, and your code then addresses the abstraction.

You have been using the same thought process as that described by Birss: creating a generalized framework through which you interact with the user interface and the operating system. Now it's time to make these thoughts concrete and turn the tentative APIs into an actual framework.

You can buy such frameworks or build them yourself. User-interface frameworks are available from suppliers like Neuron Data (Palo Alto, CA) or XVT Software (Boulder, CO). You buy the toolkit and talk to the user interface using the framework's API. You can then port the front end to various platforms, such as Windows 3.0, Macintosh, Motif, and Open Look.

Notice that the purchase of a toolkit does not obviate the need for the three-part application design. Additionally, a toolkit cannot do away with underlying architectural incompatibilities. What toolkits do provide is an abstract set of user-interface functionalities (e.g., inputs, widgets, and windows) that are mapped to the look and feel of the target platform.

In addition, many application generators are available that provide varying degrees of portability. These are worth investigating. However, my experience is that such generators often lock you too tightly into the design process of the tool, and they may limit long-term portability. But your particular programming needs will determine the usefulness of applications generators.

As for the operating-system interface, future portable environments may eliminate the need for abstract APIs. Microsoft's Windows NT, which is scheduled for release next year, and the Apple/IBM joint-venture platform, which isn't expected until 1993, will run on multiple processors. Desqview/X for Quarterdeck will extend X to DOS.

If you can wait, and if the range of environments covered by these platforms is sufficient for you, your portability problems are solved. If not, you will have to construct your own higher-level framework for operating-systems integration. Toolkits for operating-system interfaces may be on the market now, or at least on their way to market.

To build your own framework, return to the API you designed and write the machine-dependent routines. For example, the device-independent portion of the application might call a function termed `readrec`, which is part of the published interface. The `readrec` function is a routine that uses system-dependent calls to communicate with a database, read a number of bytes from disk, or perform other environment-specific tasks.

Whether you build or buy a higher-level framework, you should recognize the costs of any toolkit. Your first consideration is the performance price. A better framework will minimize the overhead, but there is always some loss of speed.

Second, any toolkit is bound to lag behind the native platform, because vendors release new versions of user interfaces and operating systems. You or the vendor will attempt to keep up with the changes, but frameworks will tend to lag behind by at least one generation. Also, no framework can be an exact duplicate

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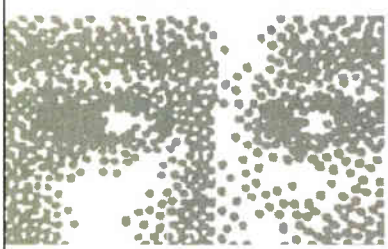

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of the native platform, especially in the case of GUIs. GUI users have become extremely sensitive to the details of their environments, and the abstracted framework may not meet their exacting expectations.

Remember that once you purchase a framework, you have traded one dependency for another. You are freed from particular platforms, but you are now dependent on the continued success of the toolkit vendor. If it's possible, try to negotiate rights to the source code, in the event the vendor stops selling or supporting the kit.

Deciding to Rewrite

Considering the drawbacks of higher-level frameworks, the cost of writing your own toolkit may be too steep for you. You may want to write a portable application but instead decide to rewrite the software for specific platforms. This decision is perfectly valid. Portability is a goal, not an edict. The important part is planning for multiple platforms. The exact solution will be your own.

Writing and maintaining a higher-level framework takes a great deal of work. You may start out saying that, despite the costs, you will build one. But then it may occur to you that you are in the applications software business, not the toolkit business.

Even if you remain undaunted by the prospect of building a toolkit, you can not resolve all the paradigms through higher-level abstractions. There are occasions when the underlying paradigms are simply too different, and the resultant abstraction would be so "high" as to render the system characterless. You may lose the sense of fit and appropriateness that comes from a well-designed native system.

Consider the example of pen computing. Currently, there are two competing paradigms, PenPoint and Windows for Pen Computing. PenPoint is an object-oriented system with reentrant code. Although Windows for Pen Computing is evolving toward an object-oriented model, it is still based on DOS and the desktop metaphor. Perhaps the only thing these two operating environments have in common is the use of the stylus for user input. It is worth asking whether one version of an application is even appropriate for both platforms.

If you decide to rewrite the software rather than port it to other platforms, the problems become less technical than managerial. The role of product management assumes new importance. The product manager must make sure that all the significant features in one version are carried over to another. Version releases will have to come close together in time to avoid alienating users of any one platform. Management will have to work hard to keep communications open between technical groups. Rewriting holds the danger of dividing the company into "foreign" technical cultures that don't understand each another and don't work together.

It is not fashionable to say you are rewriting an application. The great platonic ideal of portability still lingers somewhere just out of reach. You may feel that you need to have someone's approval. For what it's worth, you have mine. Go ahead—be a plumber if that's what it takes. ■

Ellen Ullman is a BYTE news editor based in San Francisco. She is a former senior software engineer and consultant. You can reach her on BIX as "ullman."

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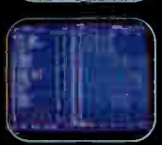

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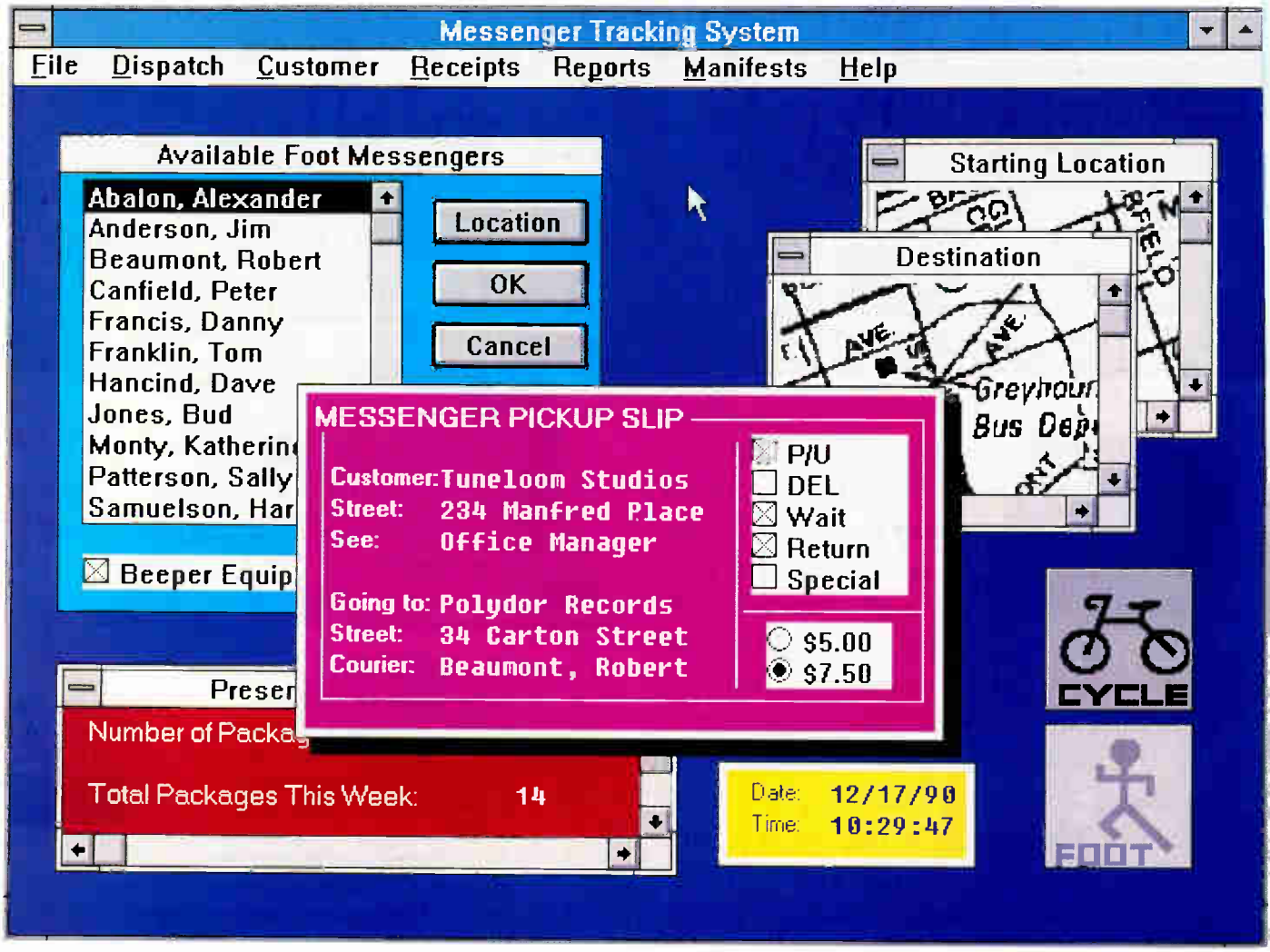

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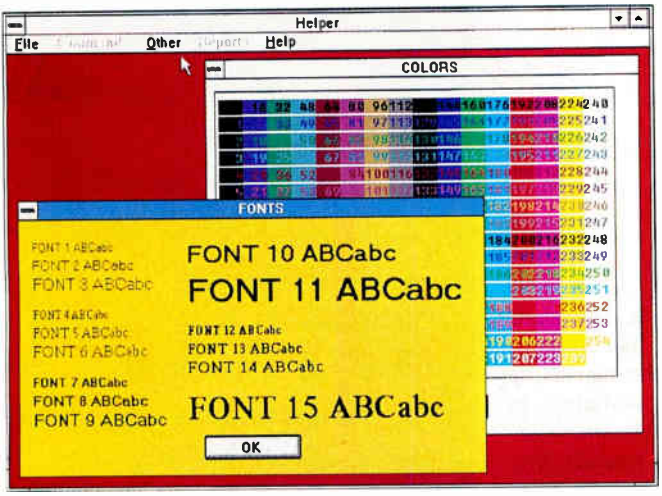

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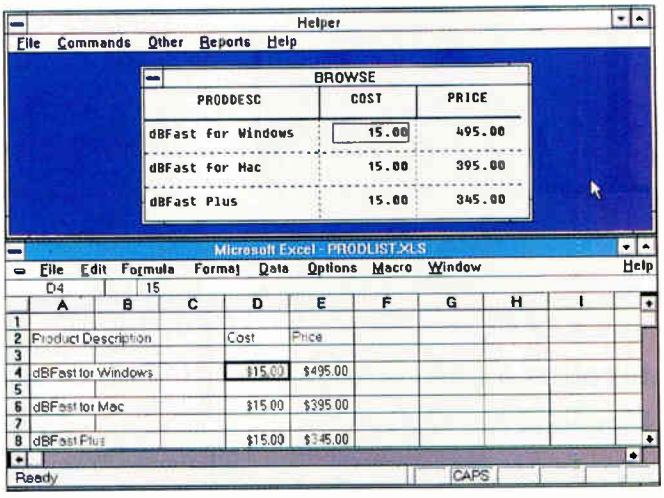

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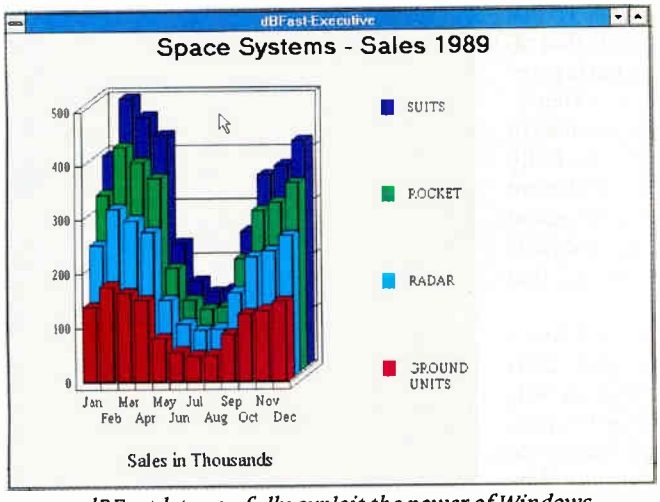

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MIX 'N' MATCH LAN

The BYTE Lab puts together a LAN for Unix, Mac, and NetWare clients

JON UDELL, TOM THOMPSON, AND TOM YAGER

The business computing landscape today is like a loose federation of republics—Macs in the marketing department, Unix workstations in engineering, PCs for general business applications. There are good reasons why that's so. Each brand of hardware suits its niche well. The challenge for LAN managers is to unite these republics without compromising their individuality. To that end, we explored a set of products that offer common file- and printer-sharing services to PC, Macintosh, and Unix clients.

BYTE's PC, Macintosh, and Unix LANs represented three populations in need of unification. (They also mirror configurations of many of BYTE's readers. Fully 51 percent of surveyed readers say they're using NetWare, and many of those are also running Unix and AppleShare LANs.) To join our three groups, we added servers, gateways, and clients from among the many interoperability products available to us. Both NetWare and Unix provided the file and printer services that we exported to disparate clients.

NetWare 3.11 supported our DOS PCs and provided the NetWare NFS (for a definition of NFS and other terms, see the Connectivity Glossary on page 274) and NetWare for Macintosh pieces that connected Unix and Mac clients to NetWare. On the Unix side, we tested three NFS clients for DOS: FTP Software's PC/TCP with InterDrive, Novell's LAN Workplace for DOS with Beame & Whiteside's BW-NFS, and Sun Microsystems' PC-NFS. Another product, Locus Computing's PC-Interface, replaces NFS with its own server daemon. Although we emphasize TCP/IP and NFS in this review, there are other ways to attach DOS clients to Unix hosts. See "Atlantix, Altos Fill DOS-to-Unix Connectivity Gaps" (April BYTE) and "Powerfusion Provides the Glue for Networking DOS and Unix" (March BYTE) for discussions of Unix-based SMB servers and Portable NetWare.

Cayman Systems' GatorBox CS with GatorShare and Shiva's FastPath 5 with-InterCon Systems' NFS/Share routed packets between AppleTalk and Ethernet

PHOTOGRAPHY PAUL AVIS © 1991

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BYTE ACTION SUMMARY

- **WHAT THESE INTEROPERABILITY PRODUCTS DO**
  They extend the reach of NetWare 3.11, Unix, and AppleShare file and print services to nonnative clients.
- **LIKES**
  These products successfully implement transparent cross-platform file sharing and printing.
- **DISLIKES**
  Getting all products to work together wasn't as easy as we'd like. GatorShare and NFS/Share don't support the NFS lock manager.
- **RECOMMENDATIONS**
  NetWare 3.11 and Cayman Systems' GatorBox CS with GatorShare offer the most transparent server solutions. NetWare supports all three client types. GatorShare connects Macs to Unix hosts. For the PC side, we recommend Locus's PC-Interface and Sun's PC-NFS.

segments and connected Macs to NFS hosts. We also tested a beta copy of Information Presentation Technologies' Sun Partner, which creates a Unix AppleTalk Filing Protocol server and accommodates both Unix and Mac AppleShare clients (see the text box "Sun Partner" on page 277). We chose representative products; prices appear in the Company Information box. Applications that we ran on the three platforms included Wingz, dBase IV, Lotus 1-2-3, and WordPerfect.

Interconnectivity doesn't always imply interoperability. Even when we had Macs, PCs, and Unix workstations talking to the same file server, we weren't always able to run dBase IV on all three clients and have them access the same data without overwriting each other's records. See the text box "A Tale of Two LOCKDs" on page 275 for details.

Networking with NetWare, Unix, and Macintosh System 7.0

NetWare's support for foreign clients has a long history. Even DOS, the original and still predominant NetWare client, is foreign to Novell's proprietary operating system. When NetWare 2.15 added Mac support, Novell just mapped in another name space and file-access protocol. Version 3.0 initially lacked that capability. Now NetWare 3.11 recaptures the

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Connectivity Glossary

AFP (AppleTalk Filing Protocol) A protocol that allows applications to use native file-system commands to manipulate files on a remote Mac node.

FTP (File Transfer Protocol) A high-level protocol for transferring files between machines on a TCP/IP network.

gateway A device that connects two dissimilar networks or network devices.

IP (Internet Protocol) The standard internetwork routing protocol in the TCP/IP stack.

IPX (Internetwork Packet Exchange) Novell's packet assembly and routing protocol, which more or less corresponds to the data link and network layers of the OSI reference model.

MIB (Management Information Base) See SNMP.

NDIS (Network Driver Interface Specification) A Microsoft/3Com protocol-multiplexing scheme, analogous to Novell's ODI and the packet driver specification.

NFS (Network File System) Sun Microsystems' protocol for sharing file systems among networked machines.

ODI (Open Datalink Interface) Novell's protocol-multiplexing scheme.

router A device that routes traffic between similar networks.

SMB (Server Message Block) The file- and print-service protocol for MS-Net/LAN Manager networks.

SNMP (Simple Network Monitoring Protocol) A protocol for monitoring and configuring network devices. It includes a reporting *agent* that resides in each monitored device and a *management information base*, or MIB, that resides in the management system.

TCP/IP A family of network and application protocols originally developed by the Department of Defense and now a de facto industry standard.

zone A logical subset of nodes on an AppleTalk network.

Macintosh support and adds support for a third class of client: Unix.

As NetWare has evolved into a near-universal file and print server, it has borrowed some of the best ideas embodied in other operating systems. Dynamic linking, a Windows and OS/2 technique that is also now available in System V release 4.0 (SVR4) of Unix, dramatically simplifies the procedure for loading and reconfiguring NetWare drivers and processes. Threads, another OS/2 feature, give NetWare processes like the new TCP/IP and NFS modules efficient and fine-grained multitasking.

On the Unix side, we called on many of the machines in residence in the BYTE Unix Lab. The two systems on which we relied most heavily were a Sun IPC and its CompuAdd counterpart, the SS-1. BYTE's Unix systems became the center of activity in our research because most of the DOS and Mac clients we tested expected Unix connections. There's a good reason for that expectation. TCP/IP, the heart of Unix networking, is fast, stable, very widely implemented, and moderately easy to configure (once you set up that crucial first link).

Besides a Unix system's suitability as a combined provider and consumer of network services, the constant decline in Unix workstation prices (as performance and standard configurations improve) makes them better choices for some demanding applications than desktop PCs. Unix's push into the commercial workplace will accelerate the trend toward heterogeneous networking.

The real strength of the Macintosh is on the client, not the server, side. However, with the introduction of System 7.0, the Mac easily acts as both a server and a client simultaneously. Its built-in file-sharing mechanism provides ready peer-to-peer networking services for Macs and any other computers that speak AppleTalk. A set of Control Panels gives you complete control over access rights and user passwords. Little touches, like the way shared folder icons display network cables and then present a face icon when clients link to those folders, set a standard of simplicity and intuitive behavior that the other major-league network operating systems should uphold.

Extending NetWare

We ran NetWare 3.11 on a 4-MB Everex Step 486SX and exported its services via an Ethernet connection to four populations of machines: PCs on the BYTE editorial department's NetWare 2.15 LAN, Macs on its AppleShare LAN, Unix hosts in the Unix Lab, and the mixture of PC, Mac, and Unix machines in the LAN Lab. The 3.11 server ran NetWare for Macintosh and NetWare NFS concurrently, thus delivering file and print services to every machine on the network.

Because the Macintosh LAN uses LocalTalk, we could have had the 3.11 server use two physical connections—one Ethernet, one LocalTalk—as does our permanent 2.15 server. Instead, we used the GatorBox and the FastPath (interchangeably) to route traffic between the two physical networks. As a result, the 3.11 server required only a single Ethernet adapter.

Although you're not likely to want to make a lone adapter carry IPX, EtherTalk, and TCP/IP traffic, it's interesting to note that it actually works. When you want to tune the allocation of protocol stacks to network adapters, no operating system makes the job easier. We had a pair of NE2000 boards in the server and were able to conduct load-balancing experiments by simply unloading and reloading protocols while the server continued to run.

NetWare 3.11's AppleShare Services

NetWare for Macintosh incorporates both a protocol stack and a router. As with any AppleTalk router, there is the possibility of confusion if network numbers and zone names are not consistent throughout an AppleTalk internetwork. Because our Macintosh LAN had been zoneless until we introduced the GatorBox and the FastPath, we tripped over this problem ourselves.

First, we failed to make NetWare's external AppleTalk network number match that used by the other routers. Second, because we failed to coordinate the use of AppleTalk zone names among all routers, we experienced the "now you see it, now you don't" behavior that plagues

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misconfigured AppleTalk internetworks. In all fairness, the NetWare for Macintosh manual does a good job of explaining these issues; had we taken time to read it more thoroughly before starting, we would have saved ourselves some trouble. The menu-driven ATCON utility proved to be a great help in sorting things out. It can test node-to-node connectivity, perform Name Binding Protocol lookups (like the Mac's Chooser), list visible zones, and monitor routing tables.

To use NetWare's file and print services, AppleShare clients need run only the software required to connect to a Mac-based AppleShare server: System, Finder, Chooser, AppleShare Workstation, and LaserWriter. As soon as you load the necessary drivers and protocols on a properly connected NetWare server, Mac users can go to their Choosers and select the volumes and print queues exported by NetWare. Optionally, Mac clients can run NetWare-specific Mac utilities. The NetWare desk accessory gives Mac users access to NetWare messaging, print-queue monitoring and control, and access rights. The NetWare Control Center mimics the graphical system administration tools of AppleShare while performing essentially the same functions as NetWare's SYSCON: user, group, and account management.

A Tale of Two LOCKDs

If you can get Macs, PCs, and Unix workstations to talk to the same file server, you ought to be able to run multiuser DBMS software on all three clients. Both dBase and FoxBase/FoxPro, for example, offer Mac, PC, and Unix versions. These programs rely on byte-range locking to prevent users from stomping on each other's records. If a file server that supports heterogeneous clients can honor those clients' lock requests in terms of its own native locking scheme, then everything should work.

NetWare handles locking without any fuss. We pointed a PC client running FoxPro at a database stored in a NetWare directory, pointed a Mac client running FoxBase+/Mac at the same database, and verified that NetWare 3.11 did the right thing: When the PC had locked a record, the Mac couldn't get at it, and vice versa. We used a simple test program to prove that NetWare Network File System (NFS) clients also respected the locks held by NetWare on behalf of Mac and PC clients.

This result was exactly what we had expected. When we repeated the experiment with Unix as a server, we never doubted that we'd see the same behavior. We used Cayman Systems' GatorShare to mount a SunOS directory on a System 7.0 Mac and pointed FoxBase+/Mac at a database stored in that directory. Then we pointed a PC running FTP Software's InterDrive at the same directory and fired up FoxPro 2.0. The Mac successfully locked the first record in the database, *but so did the PC*. Puzzled, we switched the PC client to Beame & Whiteside's BW-NFS and then to Sun's PC-NFS, but that didn't help. Switching to a different Unix host didn't help, either. Nor did using InterCon's NFS/Share instead of GatorShare to attach the Mac to a Unix host. What was wrong?

NFS byte-range locking depends on a server-side daemon called LOCKD. NFS clients talk to LOCKD by way of Sun's remote-procedure-call mechanism. When a PC-NFS client asks DOS to lock a range of bytes on an NFS volume, for example, the network software translates that request into an RPC call to the NFS host's LOCKD. The lock daemon fields the request and grants (or rejects) the corresponding Unix byte-range lock.

What vendors of NFS client software found, unfortunately, was that Sun's lock daemon did not—until recently—work properly. That caused a great deal of confusion. Some vendors, like Cayman Systems, deferred support for locking. Others decided to support an alternative lock daemon developed by Beame & Whiteside. Still others remained committed to Sun's now-functional lock daemon but struggled to adapt their clients to its protocol.

If we hadn't tested the Mac-and-PC combination first, we'd have figured things out sooner. Once we upgraded the SunOS host to the new LOCKD, we verified correct locking between various pairs of DOS-based NFS clients. The real problem was GatorShare. GatorShare, we eventually found, does handle locking, but only in the AppleTalk Filing Protocol sense. Two Macs running FoxBase against an NFS-resident database exported by GatorShare did exhibit the correct locking behavior relative to one another. But other NFS clients wouldn't respect a lock held by the Mac. GatorShare doesn't send RPC lock requests to the NFS lock daemon; it just keeps its own lock table as though it were a pure AFP server. Cayman cited problems with Sun's LOCKD as the reason for this approach and expects to support NFS locking in a future release. Until then, you have to view GatorShare—in terms of locking—as an AFP, not an NFS, server.

Like GatorShare, NFS/Share appeared to honor lock requests but didn't communicate them to the lock daemon. Then we noticed that NFS/Share comes with the alternative lock daemon BWNFSD, which also ships with BW-NFS. When we swapped BWNFSD for LOCKD, the combination of NFS/Share and BW-NFS clients played the locking game correctly. This was the only Mac/PC combination that did work, however, since the other DOS-based NFS clients we tried do not recognize BWNFSD. However, InterCon Systems says that, by the time you read this, NFS/Share 1.1 will support Sun's LOCKD.

In general, PC clients shouldn't have any trouble interoperating with each other and with Unix hosts if you've got the right lock daemon. But note that Sun doesn't distribute the source code for LOCKD, while Beame & Whiteside does ship the source for BWNFSD. If your Unix host isn't a Sun, you might need to go with BW-NFS in order to acquire a lock daemon. However, that choice limits the types of clients that you can attach to the host to those compatible with BWNFSD. The situation is fluid at the moment, so check carefully with your dealer before you buy.

continued

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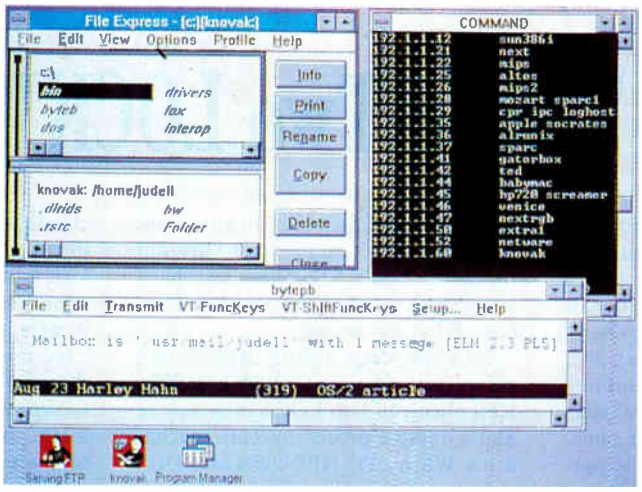
We set up queues for a LaserWriter on the LocalTalk LAN accessible by way of a router. These LaserWriter queues appeared to all Mac users in the Chooser and to Windows users in the Control Panel's printer setup accessory; they were also available to DOS users by way of the NetWare CAPTURE command. Because the AppleTalk Print Services module creates its own print server and queues based on information you supply in a single configuration file, we found that AppleTalk-connected printers were easier to set up than local or IPX-connected printers.



File Express displays the local C drive and a remote directory on a CompuAdd SS-1. In a DOS window, a listing of the local F drive shows files on a Swan PC running Interactive Systems' Unix, thanks to BW-NFS. The Unix mail reader `elm` *runs in a Host Presenter session connected to the Swan. Additional Host Presenter sessions connected to other Unix hosts run as icons, as does Serving FTP, Novell's File Transfer Protocol server for Windows.*

NetWare Meets Unix

Experienced Unix networkers will find NetWare's new TCP/IP services to be very straightforward. Beginners may find NetWare NFS an easier introduction to basic Unix networking than Unix itself, thanks to superb documentation and menu-driven system administration. NetWare 3.11's TCP/IP stack loads and unloads simply and is able to share an Open Datalink Interface–compliant adapter with other stacks. The TCP/IP manual proceeds from the simple scenario we implemented—the NetWare server as an IP end-node—to more complex ones: the NetWare server operating as an IP router and the NetWare server connected via an IP "tunnel" to remote NetWare clients.

An SNMP agent loads with TCP/IP and exports various information (IP, ICMP, TCP, and UDP statistics; routing, address-translation, and TCP connection tables) to SNMP-aware applications. One such application is NetWare's own TCPCON, which we used to monitor the NetWare server as well as two other SNMP agents: the GatorBox and the FastPath.

With NetWare's FTPSERV module, we enabled Unix hosts to open FTP connections to NetWare and transfer files back and forth using standard FTP subcommands like `put` and `get`. NetWare's line printer daemon (LPD) module made the AppleTalk print queues available to Unix clients. An entry in the `/etc/printcap` file was all our CompuAdd/SunOS machine needed in order to print to a LaserWriter on the LocalTalk LAN by way of a NetWare queue using the Unix `lpr` command.

NetWare NFS in general presents the correct face to Unix clients, although there are a few subtle exceptions. Once we established a mapping from NetWare users and groups to Unix users and groups, we could use the Unix `mount` command to link directories exported by NetWare to the file systems of any of our Unix machines. NetWare's NFSADMIN presents a menu-driven interface to the key administrative text files HOSTS and EXPORTS. You can also use it to add NFS users and groups; NFSADMIN will automatically enter corresponding users and groups to the NetWare bindery.

One behavior that might surprise Unix users concerns file ownership. NetWare, unlike Unix, changes ownership as users touch files. NetWare NFS follows the NetWare rule, so when we used the `vi` editor to change a file in a NetWare-mounted directory, its Unix uid (user ID) became that of the current Unix user. Since there can be no perfect mapping between the two systems, Novell had to make several choices like this one. None struck us as ill-conceived or unworkable, and we rate Novell's Unix support as very impressive.

LAN Workplace for DOS

With Novell's LAN Workplace (LWP) for DOS, PCs can establish terminal sessions into, exchange files with, run commands on, and print files to Unix or VMS hosts. The TCP/IP protocol stack runs over ODI and can share an adapter with the ODI-compliant version of IPX that ships with the product. ODI works like the packet driver and NDIS protocol-multiplexing schemes, but because it's newer, it has less widespread support. Novell ships only NE2000, 3Com, and Excelan ODI drivers with LWP for DOS.

Novell's TCP/IP kernel for DOS weighs in at a trim 20 KB, although you'll need another 20 KB if you load Tel-API, the Telnet substrate that LWP's DOS- and Windows-based terminal emulators use. LWP does not include an NFS client, but Novell recommends Beame & Whiteside's BW-NFS—which can talk to LWP's TCP/IP stack—as a complementary product. We tested LWP and BW-NFS together.

LWP also offers a NetBIOS that rides on the TCP/IP layer. That enables programs written to the standard INT 5C interface to communicate over TCP/IP networks. Commendably, all three drivers—IPX, TCP/IP, and NetBIOS—can unload.

LWP features a trio of Windows applications: an FTP client (File Express), an FTP server (Serving FTP), and a terminal emulator (Host Presenter). File Express wraps a double-paned graphical shell around the FTP subcommands (see the screen). When we opened a connection to a Unix host, bidirectional file transfer became a point-and-click affair. You are able to search remote directory trees, copy trees, and send remote ASCII text files to the current Windows printer.

The FTP server runs as a Windows task, enabling remote systems to initiate file transfers with your PC. If the PC connects to both NetWare servers and Unix machines, as ours did, Serving FTP makes it a nondedicated gateway between the two. Unix clients see the same NetWare drives and enjoy the same NetWare rights as the PC. If necessary, an LWP user can restrict to the PC's local and remote drives by means of an authorization file.

Host Presenter makes use of Windows 3.0's Multiple Documentation Interface to get elegant multisession terminal emulation. We opened sessions with several Unix hosts simultaneously and stowed each one as an icon on Host Presenter's MDI desktop. Host Presenter handles

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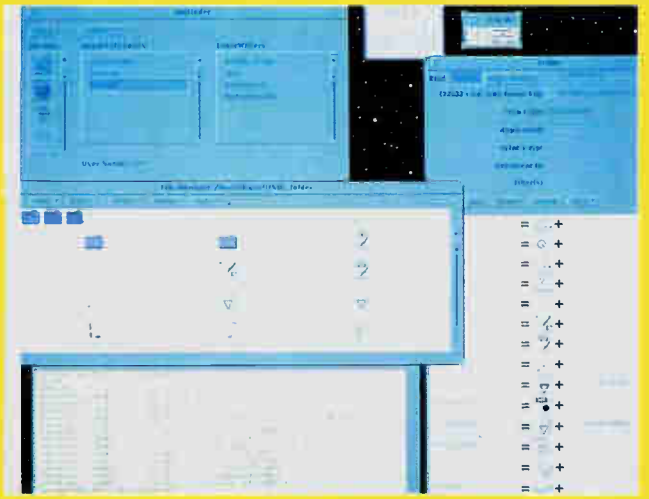
Sun Partner

Two things mark Sun Partner as unique. It is the only product we have seen that makes Unix a *client* of AppleShare. And it links Sun's OpenWindows environment to AppleShare in ways that Macintosh users will instantly comprehend. For example, a Chooser analog called NetFinder lists local and AppleTalk-attached printers as well as AppleTalk Filing Protocol (AFP) servers (see the photo). To select a printer or mount a volume, you point and shoot much as you do on a Mac. That's a step in the right direction for SunOS, which, despite OpenWindows, demands that users master a lot of Berkeley Standard Distribution lore.



Sun's File Manager displays a folder exported by a System 7.0 Macintosh. A `shelltool` *instance shows the contents of the folder as seen from the traditional Unix perspective. The icons that appear in the folder also show up in the Sun's Binder tool, so SunOS users can associate Unix applications with them. NetFinder lists the AppleTalk printers available on the network, including those exported to Mac clients by Sun Partner.*

Partner can export multiple AFP servers, each of which can present multiple volumes (Unix directories). You can specify the AppleTalk zone in which each AFP server appears. If you register a Mac client as a Unix user, Partner publishes the user's Unix home directory along with its other exports. The home directory becomes a private volume visible only to its owner. Like all nonnative AppleShare servers, Partner has to emulate the resource/data duality of the Mac file system. An `.rsrc` subdirectory in each folder stores Mac document resource forks safely out of the way of Unix users who might otherwise inadvertently trample them. As a result, Mac users get the icon bindings they expect when they open folders on Partner volumes.

In a Bind

What's really nifty is that icon binding works for Unix users, too. OpenWindows binds documents, icons, and applications by way of a text database keyed on filename patterns. After installing Wingz on the CompuAdd SS-1, for example, we used OpenWindows' `binder` to associate the pattern *.WKZ with the Wingz icon and the Wingz program. Partner achieves the same effect, by sleight of hand, when you point Sun's file manager at a Macintosh directory. When mapping Mac filenames into the Unix file system, Partner tacks on type and creator tags. For example, a Wingz document that we created on a System 7.0 Mac as REVENUE became, when we mounted that Mac folder on the Sun, REVENUE_WKSSWNGZ. Sun Partner then added an entry to the Sun's binder database mapping the pattern *_WKSSWNGZ to the Wingz icon. What if an icon isn't already available on the Sun? Partner acquires new icons on the fly, automatically converting Mac icon resources into Sun icon files. It really is transparent, except that every Mac-resident file gets a nine-character suffix when seen from Unix.

Lost in Transit?

Now suppose you create a Wingz document in a Unix directory, using the Unix version of Wingz, and then move it to the Mac. Since native Unix files don't have resource forks in which to stash icon data, won't the icon get lost in transit? In many cases, yes. However, multiplatform applications such as Wingz, FrameMaker, and WordPerfect like to stamp their data files with creator and type tags. Partner scans the tops of files headed from Unix to AFP volumes for these tags and, using its own binder database, creates Mac icons when possible.

Partner can publish print queues as well as AFP servers. We exported both local and network printers to each of our AppleTalk zones by way of queues defined in another Partner database. You use normal Unix commands like `lpq` to manage these queues. Mac clients of Partner get the same level of queue control as normal AppleShare clients: none.

Seeing Is Believing

From a Unix perspective, Partner may seem anachronistic. The programs that Information Presentation Technologies (IPT) cites as demonstrations of Macintosh-to-Sun interoperability—Wingz and FrameMaker—happen to be X Window System programs that work across a variety of Unix (and other X-conforming) platforms. We were able to start up Wingz on a Sparcstation and make it display on almost any Intel, SPARC, Motorola, or Mips box in the BYTE Unix Lab—without ever moving a data file across the network.

Once you've seen this stuff work, you know interoperability isn't just about emulating file servers on foreign hosts. Nevertheless, IPT's approach makes great sense from the Macintosh perspective. X won't help value-added resellers sell SPARC machines in today's Mac strongholds. Sun Partner will.

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connection profiles and terminal preferences nicely and provides a very strong scripting language.

LWP supplies DOS versions of the FTP client, the FTP server, and the terminal emulator. Other DOS utilities support remote command execution and remote printing. LWP's printing commands use a neutral syntax that, by way of a configuration file, translates into the local commands that Berkeley Standard Distribution (BSD), System V, and VMS systems use to print, query queues, and delete from queues. You can run all the DOS programs in Windows 3.0 enhanced-mode DOS boxes if you load the Windows virtual device driver that LWP provides.

We were able to run a windowed DOS terminal session and a Host Presenter terminal session side by side while printing to a Unix queue from a second DOS window. High-quality documentation, reliable behavior, and superb Windows adaptations of Unix chestnuts like `ftp` and `telnet` make LWP for DOS a pleasure to use.

BW-NFS

Beame & Whiteside offers a complete TCP/IP and NFS implementation for DOS. A subset of that product set extends NFS client support to LWP for DOS. BW-NFS adds the ability to mount NFS volumes on PC local drives and to run Unix-style commands, such as `cat`, `ls`, `chmod`, `chgrp`, and `df`, against both local and remote drives. The NFS kernel uses a relatively modest 48 KB, and we were able to high-load it under DOS 5.0.

BW-NFS employs a vaguely MS-Net-like syntax for mounting NFS volumes and connecting to Unix print queues. The familiar NET USE command, for example, lists redirected drives and printers. With the Windows network driver BWNET.DRV loaded, you can mount and unmount NFS volumes from within the Windows File Manager.

Of course, if you are communicating to NetWare and Unix concurrently, as we were, you will have to choose between NETWARE.DRV and BWNET.DRV, since Windows can't handle enhanced support for two networks at once. We particularly liked B&W's `exports` command, which queries a Unix host for the list of mount points that it exports to NFS clients.

PC-Interface for DOS

In PC-Interface, Locus Computing takes a significantly different approach to PC/Unix file sharing. PC-Interface, or PCI as the company calls it, uses a *proprietary* scheme to set up file sharing, print services, and remote computing. For a Unix host to act as a PCI server, it must be running Locus-supplied daemons that provide the service. This might seem like a drawback, but Locus has managed to get its server bundled with many popular releases of Unix, including the coming SVR4.

On the DOS side, PCI is mostly a joy to use. To connect to a remote machine, you invoke the `login` program, which presents a list of Unix hosts running PCI server software. There's no need to preload a list of host names and Internet addresses—welcome relief for users whose primary environment *isn't* Unix. There's also a command-line version of `login` that bypasses the logo and host selection screens. Selecting a host, however you do it, is enough to get that host's root directory (/) mounted as a DOS letter drive. From there, you can go anywhere you want within the limits of your access

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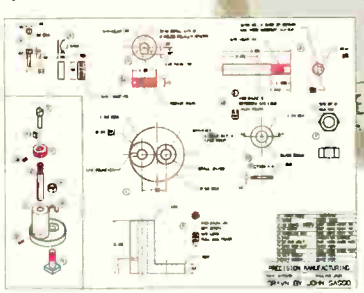

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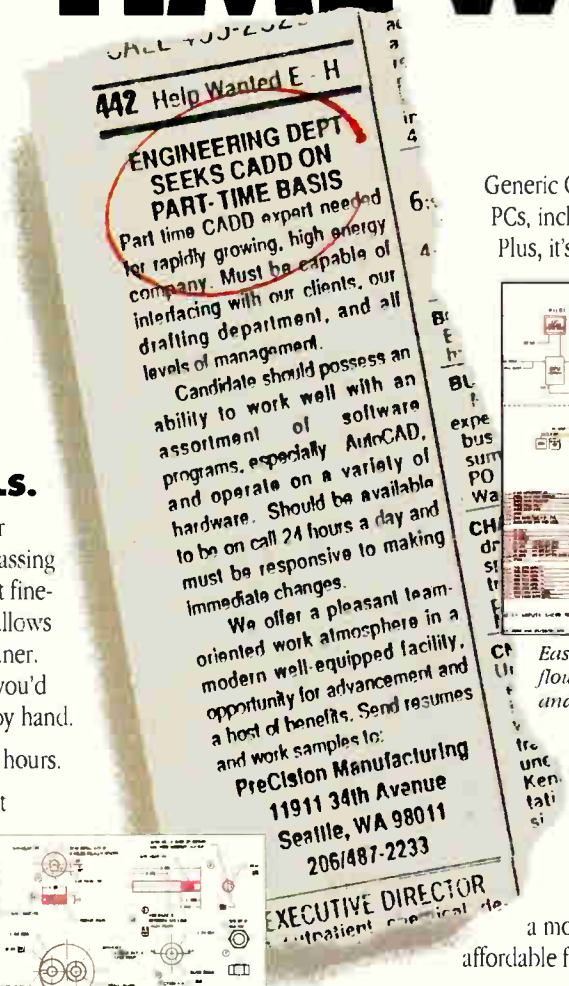

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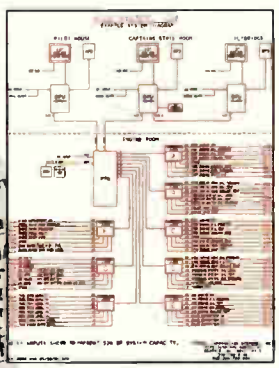

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rights. Very straightforward, very painless.

The only drawback here is that, because PCI mounts the Unix host's root directory, you have to navigate through the file-system hierarchy from the top to get to where you want to go. That task is made a great deal more difficult if one of the directory names along the way does not fit into the crippled DOS eight-dot-three-character, non-case-sensitive format.

In addition to file sharing, PCI offers DOS users terminal sessions, remote command execution, and print services. PCI's `em2` program makes a terminal connection to a remote Unix host, but unlike TCP/IP-based DOS client software, you can connect only to a host that's running the PCI server.

PCI's print services are basic but versatile. When you configure PCI to send DOS printed output to a Unix printer, you tell it what Unix command to use to print the output. That's particularly useful for mixed networks of BSD and System V machines; the print commands and options are very different.

Also worth noting is PCI's remote execution capability. The `on` command directs a remote Unix host to execute a command on the DOS client's behalf. While that command is running, it can be aborted or placed in the background with a keyboard sequence. Remote background jobs are "remembered" and managed by the PCI client software, and a program called `jobs` lets you check their status or reconnect to a selected job. The `kill` command does what it says, sending a Unix signal to a selected PCI-spawned remote job. This is a nice touch, and the documentation clears up some potential user misunderstandings about the way DOS and Unix redirection and pipes work together.

Finally, PCI further distinguishes itself with its carefully crafted Windows 3.0 support. There's a catch to that, though: PCI uses the networking hooks that Microsoft (and other vendors) gave it, and some of the interface wrappers are ghastly. To mount a new remote drive under Windows, for instance, you have to use the File Manager. Configuring a new network printer is a far worse procedure, driving you through a maze of pop-up dialog boxes that offer you little feedback and not nearly enough on-line help. But given what it had to work with, Locus did a fine job.

Of the packages we've seen, PC-Interface offers the most manageable DOS-to-Unix connection for users who aren't schooled in the vagaries of Unix. Both the interactive and command-line interfaces (except in Windows, where Locus still did its best) are clear and simple, and the connection to the host is fast and transparent.

PCI also offers, for PC users without Ethernet cards, the ability to connect to a Unix host through a serial port. That has its obvious drawbacks, but this, along with all the other benefits of PC-Interface, bring it high marks for ease of use and effectiveness.

PC-NFS

Sun Microsystems invented NFS, so it's only fitting that it should have its own NFS client for DOS machines. At its heart, as with some of the other DOS clients reviewed here, is a command-line-driven file-sharing scheme in the MS-Net tradition. That's not news in itself, because the command-line interface is downright ugly. What *is* news about the latest PC-NFS is its menu-driven shell,

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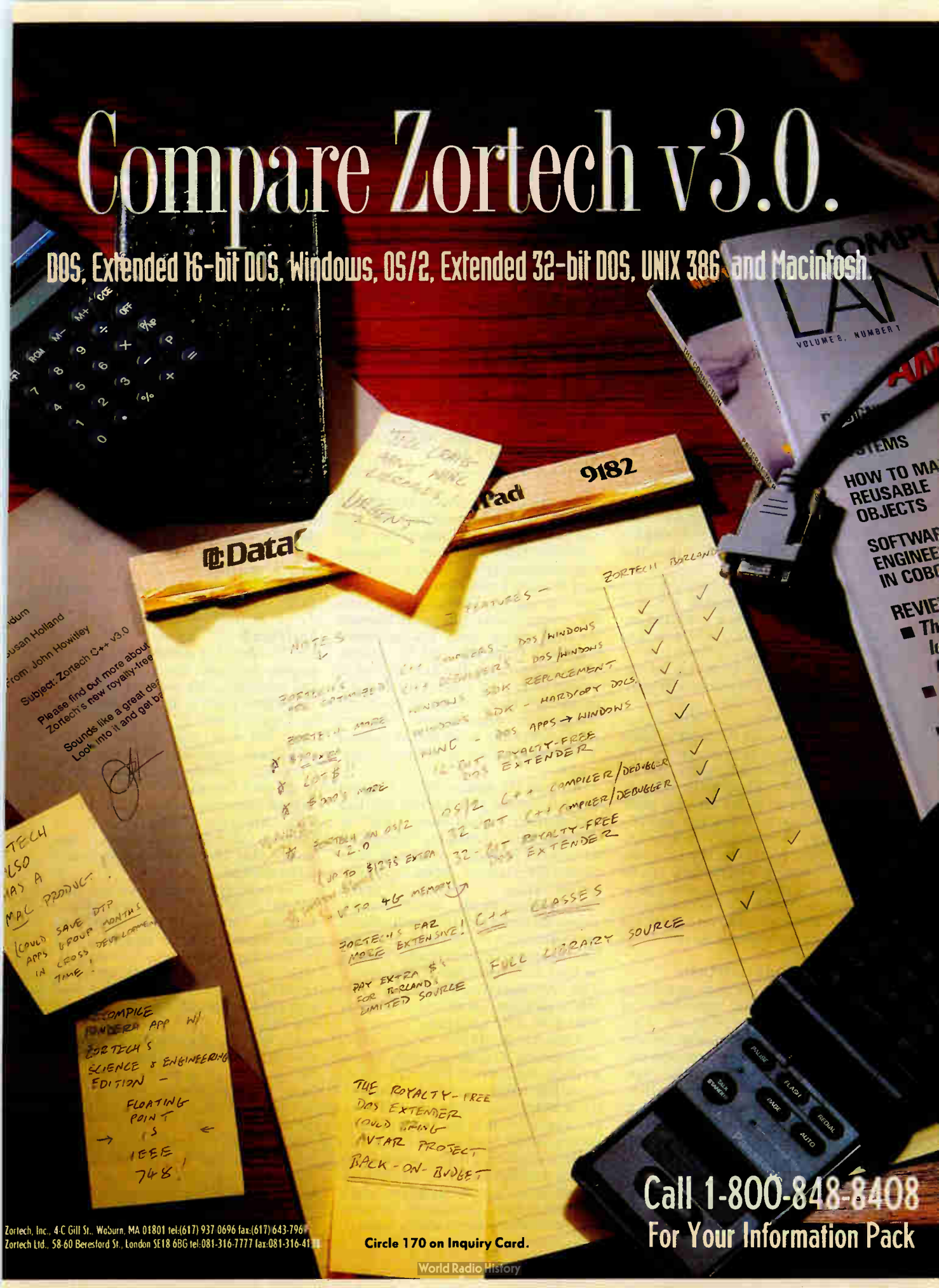

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nfsconf. It's a full-screen wrapper that handles all the various mounts, dismounts, and printer assignments and even lets you set defaults that are automatically reinstated when you reboot.

Throughout, we were impressed with nfsconf, enough so that even though we knew the command-line interface well, we passed over it in favor of the full-screen interface. With nfsconf, we were able to modify the settings on a remote file system or a printer definition, automatically unmounting and remounting it to make the changes for us. Now Sun needs to concentrate on making Unix this easy.

PC-NFS is also blessed with a suite of TCP/IP commands designed after their BSD counterparts. These are welcome, and we missed them in PC-Interface. The ftp, telnet, and rcp commands and a host of others are implemented and are generally well done. We were surprised to find that the ftp in PC-NFS is significantly more complete than that from FTP Software.

PC-NFS's approach to print sharing is sufficient but not as versatile as that of PC-Interface (in which a command can be specified). In addition to providing authentication services, pcnfsd handles remote print requests by storing the output in a file on the Unix host and triggering the local print service.

The major twist to PC-NFS is that DOS systems running the client software can be configured as print servers, following the BSD model. Again, this requires that you load up a file with the configurable particulars for your printer, but once you have done that, any PC-NFS client can print files on your system's printer. Moreover, any Unix host capable of working with the BSD lpd remote printing mechanism is able to get to your printer as well. It has its drawbacks, like the 130 KB of memory it eats up, but it provides a much-needed service.

PC/TCP Plus and InterDrive

FTP Software has long been regarded as one of the most faithful implementers of BSD-style Unix networking for DOS. PC/TCP delivers file transfer, remote log-in, mail, and remote command execution services that work exactly as experienced Unix users expect them to. However, PC/TCP concedes little to DOS users unfamiliar with Unix networking conventions. Of the four DOS-to-Unix solutions we looked at, it's the most Unix-centric. That can be a plus or a minus; it depends, of course, on your perspective.

InterDrive, the optional NFS client, consists of a 57-KB resident kernel and a suite of command-line-driven tools that you use to mount and manipulate NFS volumes. InterDrive's idmnt command requires more typing than the others, in part because it associates a file-system name, as well as a DOS drive letter, with the remote volume (the name becomes the DOS volume label). You can embed profiles of frequently used file systems in a configuration file and arrange to mount several of these with a single mount command. InterDrive won't help you navigate remote systems, however; you have to know or be able to discover through other means what you are looking for.

Photo 1: *Shiva's FastPath 5 LocalTalk-to-Ethernet gateway supports AppleTalk Phase 1 and 2, TCP/IP, and DECnet Level 1 protocols. Rather than implementing an NFS gateway within the FastPath, Shiva bundles a copy of InterCon's NFS/Share NFS client, which runs on each Mac.*

We used the generic PC/TCP kernel that talks to the packet driver interface FTP Software helped invent. Don't be fooled by the ominous label "Unsupported Network Software" on the disks containing the Clarkson packet driver collection. These drivers support nearly every adapter on the market and are among the crown jewels of freely distributed software. A recent fix spans the difference between Ethernet packet framing on Unix and on NetWare LANs, so, as with LAN Workplace for DOS, we were able to communicate with Unix and NetWare hosts at the same time.

Although PC/TCP's services don't hook into the Windows interface, there is a virtual device driver that enables command-line utilities to run in enhanced-mode DOS boxes. We ran the FTP server, ftpserv, in a background DOS session and accessed it from a Unix host while conducting a foreground telnet session with another Unix host. This setup, which you can use as a poor man's NetWare-to-Unix file transfer gateway, benefits from ftpserv's ability to handle multiple Unix clients concurrently.

Like the Berkeley mail program it emulates, FTP Software's mail lets you name your own text editor—we're always glad to avoid vi. Also included is a version of tar, which you can use to back up a DOS directory tree directly to a tape drive on a Unix host.

Printing support comes in two flavors. With lpr, we shipped print jobs to LPD servers on NetWare and on several Unix hosts and then used lpq to monitor the remote queues. There's also a print redirector that you can use to point a PC's parallel port at a Unix host, specifying the program responsible for sending data to the host. PC/TCP does not, however, offer an LPD server for DOS, as does Sun's PC-NFS.

FTP Software also offers an OS/2 version of PC/TCP that includes LPD, Telnet, and NFS servers along with versions of all the client-side programs that are in the DOS package. So if IBM's forthcoming OS/2 2.0 lights your fire, you won't have to sacrifice the Unix connectivity FTP Software so capably provides under DOS.

FastPath 5

The FastPath 5 is a dedicated hardware gateway and router that joins LocalTalk and Ethernet LANs and handles AppleTalk Phase 1 and 2, TCP/IP, and DECnet Level 1 protocols. The FastPath is a small box with diagnostic and traffic LEDs on the front panel and a mini-DIN-8 LocalTalk connector and power switch on the back (see photo 1). An ingenious internal connector accommodates thick-wire, thin-wire, 10Base-T, or Apple Ethernet Cable System interfaces; you simply plug in the appropriate transceiver module.

The basic system includes either thin and thick Ethernet modules or a 10Base-T module. Inside, a 10-MHz 68000 processor handles address resolution and protocol translation, and a dedicated 10-MHz Z80181 I/O processor increases LocalTalk throughput. The unit comes with 128 KB of ROM and 512 KB of battery-backed RAM, which is expandable to 8.5 MB. The RAM holds the routing table information and allows the FastPath to reconfigure itself after a power failure. The ROM boots the FastPath; the operating code resides in static RAM (SRAM).

This design lets you install software enhancements and fixes by downloading new code images rather than replacing ROM chips. That's a blessing for managers whose networks include dozens of FastPaths. When it is installed on an

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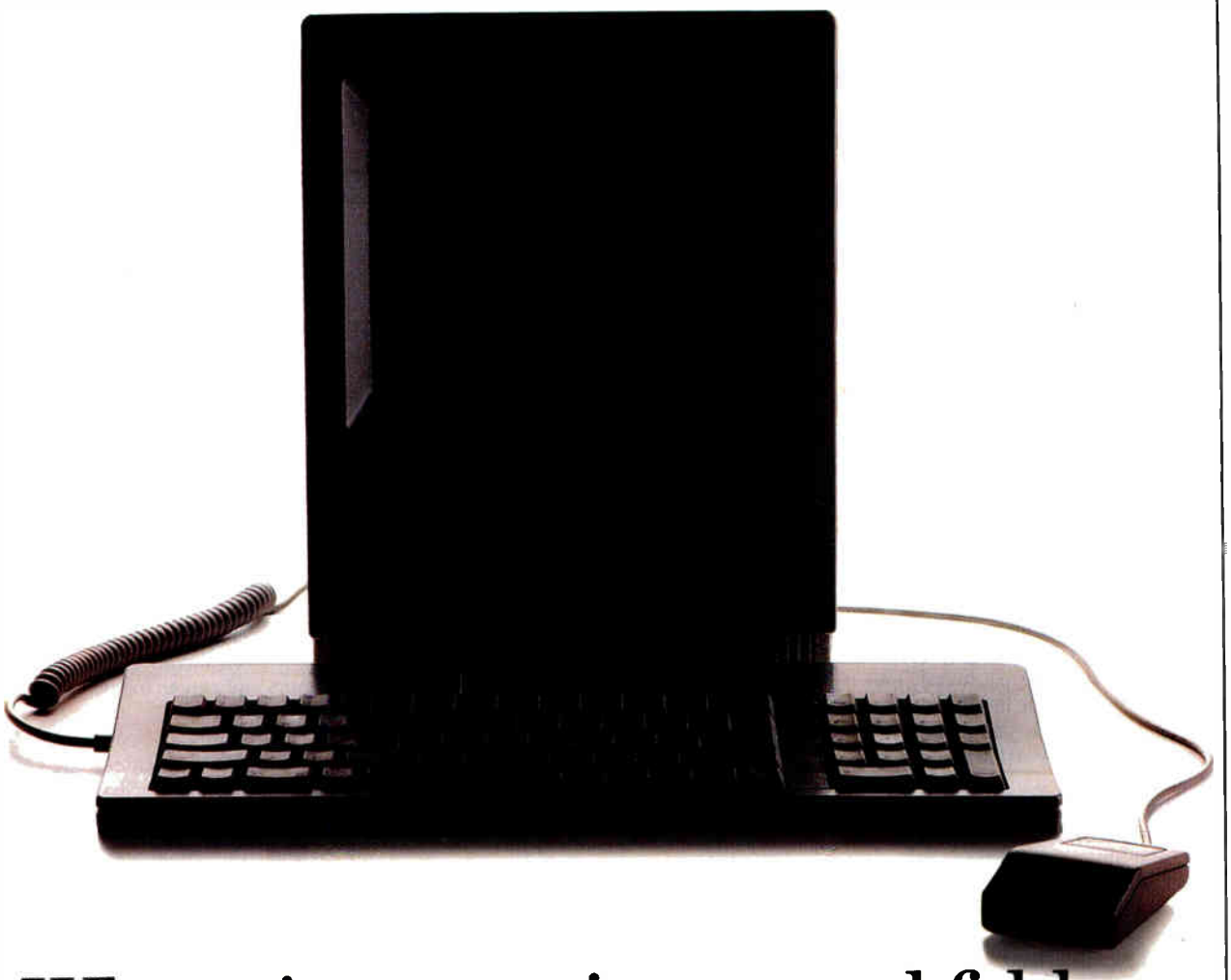

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AppleTalk Phase 2 network, the FastPath starts up in auto-configure mode, snooping on network traffic for routing information and zone names from other gateways. If you're joining one LocalTalk and one Ethernet segment together and trust the default AppleTalk zone names that the FastPath assigns, gateway installation is practically a plug-and-play affair. Auto-configuration only goes so far, however. If you're using the unit to connect large networks with multiple zones and gateways, you'll have to sit down and supply most network information manually.

The Shiva Net Manager 2.0 and FastPath Manager 5.3 help you enter information and manage the gateway. Both applications let you set up, retrieve, and change the routing tables; display an activity log; set a gateway password; and update the operating code in SRAM. The Net Manager also helps you keep track of the network. The FastPath supports SNMP and includes four Management Information Bases (MIBs): Internet Standard, AppleTalk Experimental, Ethernet, and Shiva Enterprise.

The Net Manager tries to put a friendly face on a complicated procedure. Checkboxes let you select routing options. The Mac interface implies that you're free to change settings at will, but this isn't the case. For example, past a certain point the Net Manager informs you that it hasn't downloaded new AppleTalk zone names to the FastPath. This is apparently a safety feature, since you can severely addle a network if you alter AppleTalk zones and network addresses on the fly. This happens frequently when you're fumbling through your first installation. You'll want to follow one of the many step-by-step examples in the manuals to configure the FastPath properly.

The FastPath also includes a coupon for a free copy of NFS/Share, InterCon's NFS client software for Macs. With NFS/Share, Unix workstation volumes resemble AppleShare volumes in the Chooser, and Mac users connect and manipulate files by pointing and clicking. The free copy is for one user: InterCon sells additional copies for $295 per user, or $2200 for 10 users.

NFS/Share runs on top of MacTCP 1.0.1, Apple's TCP/IP software. MacTCP adds some wrinkles to what might have been a seamless file-sharing process. The network manager must install and configure MacTCP on every Mac. MacTCP also has problems with System 7.0: You must put the INIT in the System folder (not the Extensions folder), and you can't dismount an NFS workstation volume by dragging its icon to the Trashcan. If both your Macs and Unix workstations already share a single Ethernet, however, you can use NFS/Share without the FastPath router.

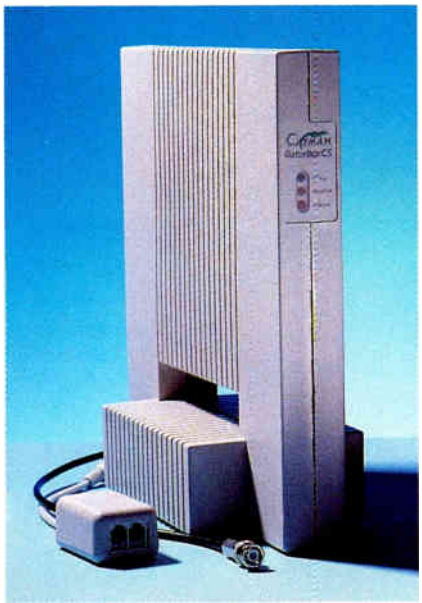

Photo 2: *Cayman Systems' GatorBox CS is a LocalTalk-to-Ethernet gateway. Optional GatorShare software turns the device into an NFS gateway for Mac clients.*

Cayman Systems GatorBox CS

The GatorBox is another combined gateway and router that connects LocalTalk and Ethernet networks; it too supports AppleTalk Phase 1 and 2, DECnet Level 1, and TCP/IP protocols. The unit resembles a large high-tech bookend, with diagnostic LEDs up front and a serial port, LocalTalk port, thin Ethernet connector, and thick Ethernet connector at the rear (see photo 2). The GatorBox's 10-MHz 68000 CPU handles transaction processing. The operating code and configuration information fit into 1 MB of nonvolatile flash EPROM. This lets the GatorBox resume operation automatically after a power failure and lets you upgrade or fix the operating code by downloading a new code image. The 1 MB of RAM (expandable to 2.5 MB) serves as temporary storage for packet assembly and routing tables.

Like the FastPath, the GatorBox starts in an auto-configure mode. It can quickly configure itself as an AppleTalk router between a LocalTalk and an Ethernet network. More complex networks require that you manually enter routing information. The GatorInstaller and the GatorKeeper CS applications let you update and manage the GatorBox from either LocalTalk or Ethernet. GatorInstaller downloads code updates or optional service software into the flash EPROM. GatorKeeper CS lets you configure TCP/IP protocols, set routing addresses, add zone names, assign a gateway password, check gateway status, and retrieve diagnostic messages.

The GatorBox's built-in Telnet shell enables any networked computer to establish a session and view the unit's status, routing tables, and diagnostic log. The GatorBox also supports SNMP and includes a MIB that supports network management tools from DEC, Sun, and Cabletron. For serious problems, you can establish a VT100 terminal session via the serial port and run an extensive suite of hardware tests.

Two optional software packages, GatorShare and GatorPrint, extend the GatorBox's capabilities. GatorShare lets the GatorBox operate as an AppleShare-to-NFS gateway: Designated Unix volumes appear as AppleShare file servers in the Chooser. GatorKeeper downloads this software to the gateway, configures the NFS mount points and authentication method for users, and then restarts the GatorBox.

Mac users access Unix files exactly as they would on remote AppleShare volumes. Network managers will find GatorShare especially attractive because it consolidates an NFS gateway within the GatorBox. You don't have to install special software on any Mac clients. The $1995 price isn't cheap, but the license allows unlimited users.

GatorPrint, which is bundled with GatorShare, allows Unix systems that use the `lpr` remote printer protocol to print to LocalTalk printers. GatorPrint eliminates administrative hassles because GatorBox does the work.

Adding the GatorBox or any other gateway to your network without bringing it down is a challenge. You should have all zone name and network address information in hand before attempting to set it up. You'll also need a Unix wizard by your side to supply any Unix-specific information, such as the flavor of TCP/IP, workstation addresses, and NFS mount points for GatorShare.

If you enter an incorrect network address or zone name, the GatorBox transmits the bogus entry to the routing tables in every gateway on the network. This results in sluggish network performance and can cause outright crashes as Mac applications try to access a nonexistent

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zone and time out. Each gateway automatically purges bad entries by aging them over time and removing them after about 20 minutes of inactivity. This means that you'll either have to be very patient when correcting a configuration error or coordinate matters so that you can reset every router promptly.

Value Judgments

If you value transparency above all, the two most compelling server-side solutions are NetWare 3.11 and Cayman Systems' GatorBox with GatorShare. Neither requires any effort on the part of its clients. NetWare's scope is broader, as it encompasses all three classes of client. If you want to use GatorShare to hook Macs to Unix hosts and also want PCs to play, you will need NFS client software for the PCs. On the client side, Locus's PC-Interface and Sun's PC-NFS both do a good job of shielding the user from the Unix system on the other end of the connection.

Of course, you likely won't be starting with a clean slate. What you need will be a function of what you already have. If NetWare is already the hub for your DOS and Mac clients and you want to integrate Unix workstations, NetWare NFS is a solid—but very pricey—solution. If Unix is already a strong presence in your environment, there's no shortage of client-side products for PCs and Macs. From a Mac perspective, the gateways will kill two birds with one stone: They make AppleTalk networks manageable and provide a substrate for Unix connectivity.

While many technical problems are now solved, interoperability still isn't as painless or as automatic as we'd like. The future looks bright, however, because most of these products do work hard to simplify thorny cross-platform issues. That's a trend that's bound to continue, and it can only result in reduced stress for all who work in mixed environments. ■

Jon Udell and Tom Thompson are BYTE senior technical editors at large. Udell manages BYTE's NetWare LAN. Thompson manages BYTE's AppleTalk network. Tom Yager is a BYTE technical editor and oversees BYTE's Unix Lab. He is also the author of UNIX Program Development *(Addison-Wesley, 1991). You can reach them on BIX as "judell," "tom_thompson," and "tyager," respectively.*

COMPANY INFORMATION

Beame & Whiteside Software, Ltd.
P.O Box 8130
Dundas, Ontario,
Canada L9H 5E7
(416) 648-6556
fax: (416) 648-6556
BW-NFS for LAN Workplace (2.20) (per user) *$245*
BW-NFS for DOS (includes TCP/IP) (per user) *$349*
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Cayman Systems, Inc.
University Park at MIT
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(617) 494-1999
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GatorBox CS *$2795*
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GatorShare (includes GatorPrint) *$1995*
GatorPrint ..... *$595 per gateway*
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FTP Software, Inc.
26 Princess St.
Wakefield, MA 01880
(617) 246-0900
fax: (617) 246-0901
PC/TCP Plus for DOS 2.05 (includes InterDrive, an NFS client for DOS) (per user) *$400*
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InterCon Systems Corp.
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Suite 420
Herndon, VA 22070
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fax: (703) 709-9896
NFS/Share (per user) *$295*
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NetWare NFS 1.1 ..... *$4995*
NetWare for Macintosh 3.0 ..... *$895–$1995*
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LAN Workplace for DOS 4.0 (per user) *$450*
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These NFS client products, not reviewed here, are also available:

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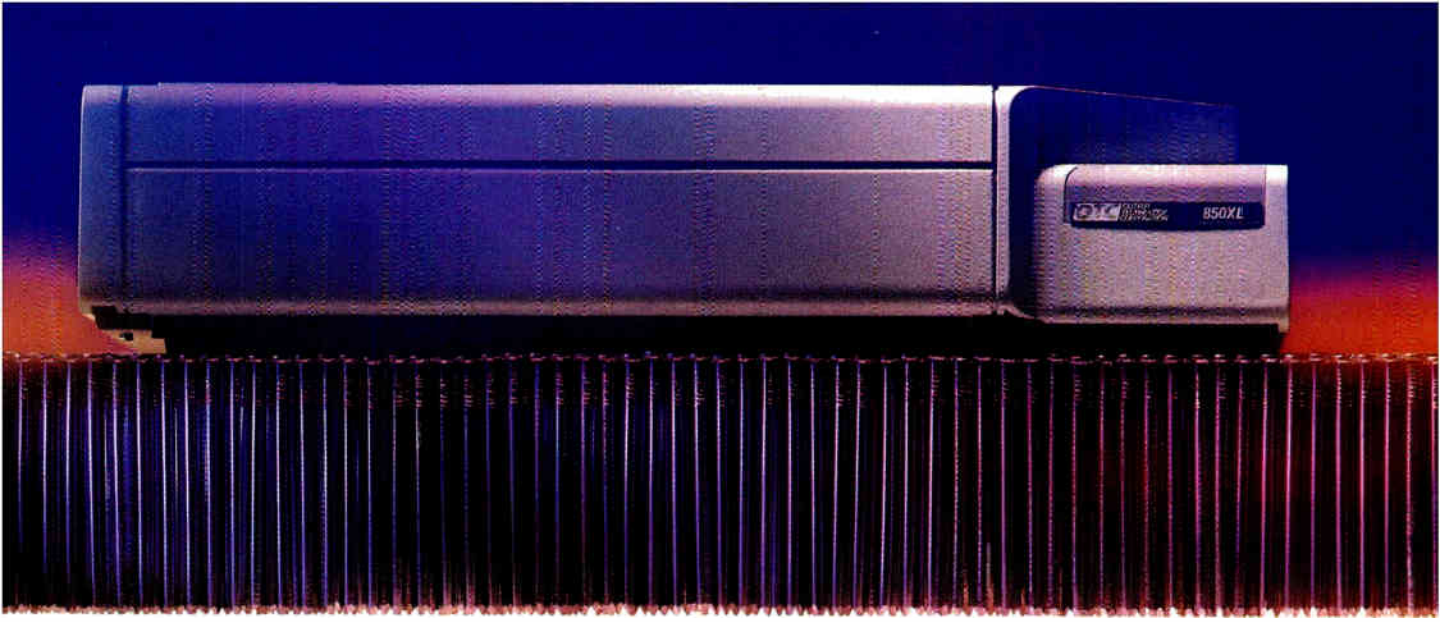

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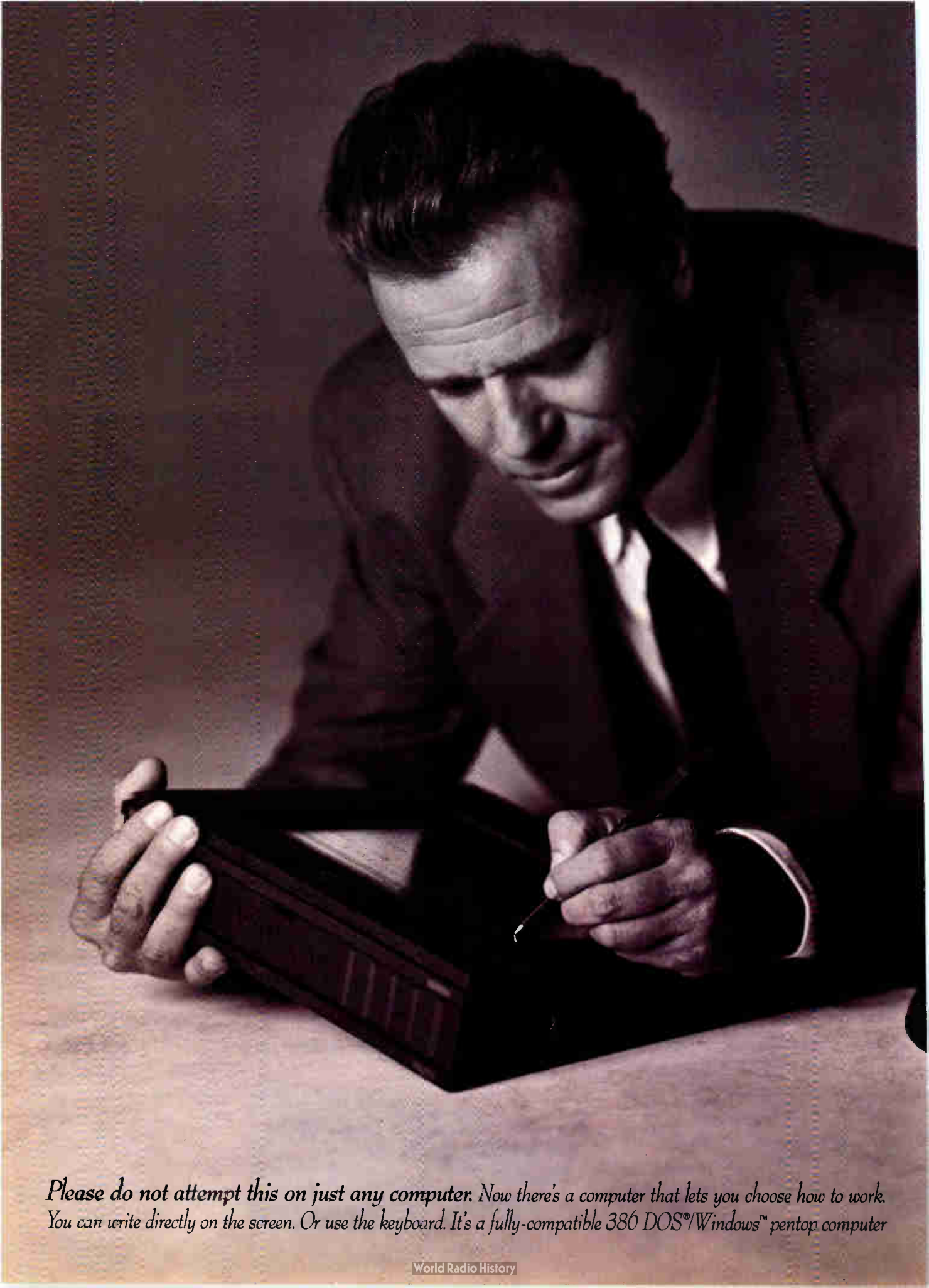

Please do not attempt this on just any computer. *Now there's a computer that lets you choose how to work. You can write directly on the screen. Or use the keyboard. It's a fully-compatible 386 DOS®/Windows™ pentop computer*

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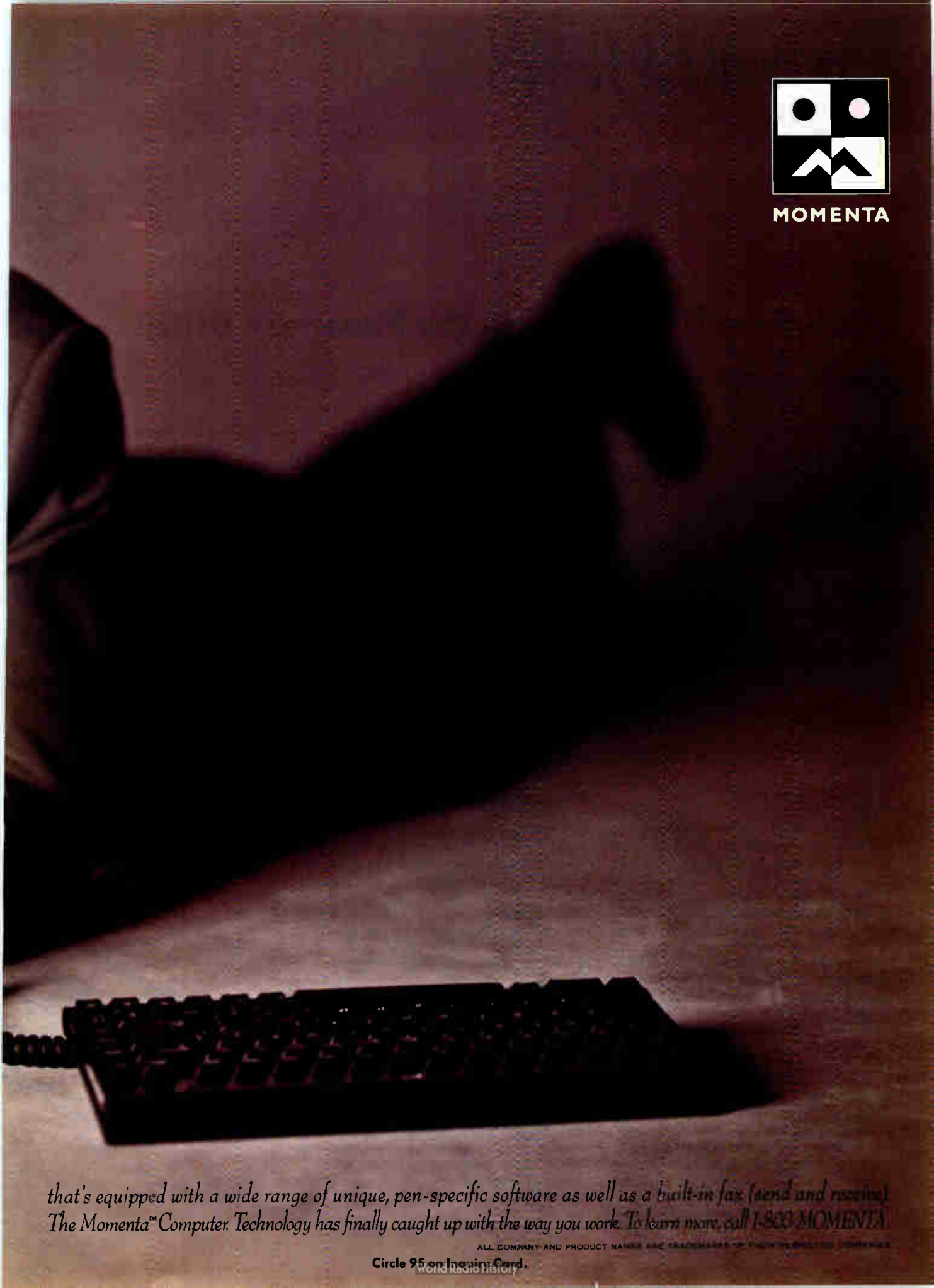

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SOFTWARE

The Next Best Thing to the Paperless Office

HOWARD EGLOWSTEIN

Businesses would simply fall apart if it weren't for purchase orders, time cards, payroll sheets, and other printed forms. Unfortunately, the volume of paper generated can drown a healthy business. Office automation can't quite eliminate paperwork—the paperless office remains a myth—but automating forms processing can help stem the overwhelming flow of paper. Until the paperless office arrives, we'll settle for an effortless form.

For this review, I looked at eight best-selling forms packages that handle the complete forms process, from composition to data collection. These products allow you to design forms on-screen, present them electronically to people in your office who regularly fill out forms, and collect form data in a central database.

Fish, Fowl, or Form?

Forms packages are hard to categorize. They combine desktop publishing elements with database processing features. However, they don't have quite enough flexibility in either their layout tools or their database functions to completely replace more conventional DTP or database products. For example, a full database manager usually has a dedicated programming language to do sophisticated data manipulation; with the exception of Bloc Development's F3, these packages don't.

The database functions in most forms packages allow you to have a given field filled in with data from an external database, but only through simple lookup functions. A programming language lets you create a field's contents through complex calculations.

So when do you need a forms package, when do you need a database, and when should you choose DTP software? Before you consider a forms package, consider whether your data-handling needs require a full-blown database. If you don't care how nice your data-entry screens look, you may find that database software gives you better control over data management. If you don't need to fill in your forms electronically, you would have more control with a DTP package; however, you'll have to climb a steep learning curve and may end up spending more money.

At the minimum, all forms products will give you a graphical design tool to create on-screen templates that look like the forms that you already use in your office. Once you have arranged all the text and graphics, the field definition tools take over, letting you assign data types and formats to each of the data fields.

Database functions vary from package to package. All the products let you access other forms to look up simple variables. Sophisticated products like F3 also give you a programming language and direct manipulation of linked databases. For example, most order forms have the customer's name and address. When you enter a customer number in one field, the software automatically fills in the customer's name and address. Likewise, a part number can automatically call up a product's description and price and calculate the final price with shipping charges.

You can also use these packages as output handlers for existing databases. If you can export databases to ASCII or dBase format, most of these packages will import data directly into the proper fields. Consider the difficulty of the alternative—trying to get your database software to place printed output precisely into little boxes on preprinted forms. If you need to integrate the forms package with an existing database, check its list of features in the table to see if it supports your database format. Using forms software could also save tons of money by allowing you to print forms only as you need them, eliminating the stockpile of preprinted forms.

Forms software uses terminology borrowed from the database, DTP, and forms design industries. A form field is analogous to a database field, and a form is a collection of fields and graphical elements. Data fields hold character or numeric data, sometimes restricted to specific formats (e.g., date and ZIP code). A picture field is a restricted character or numeric field that has to follow a user-defined format. For instance, if you wanted to specify that an item's price is to be displayed as a five-digit number with commas

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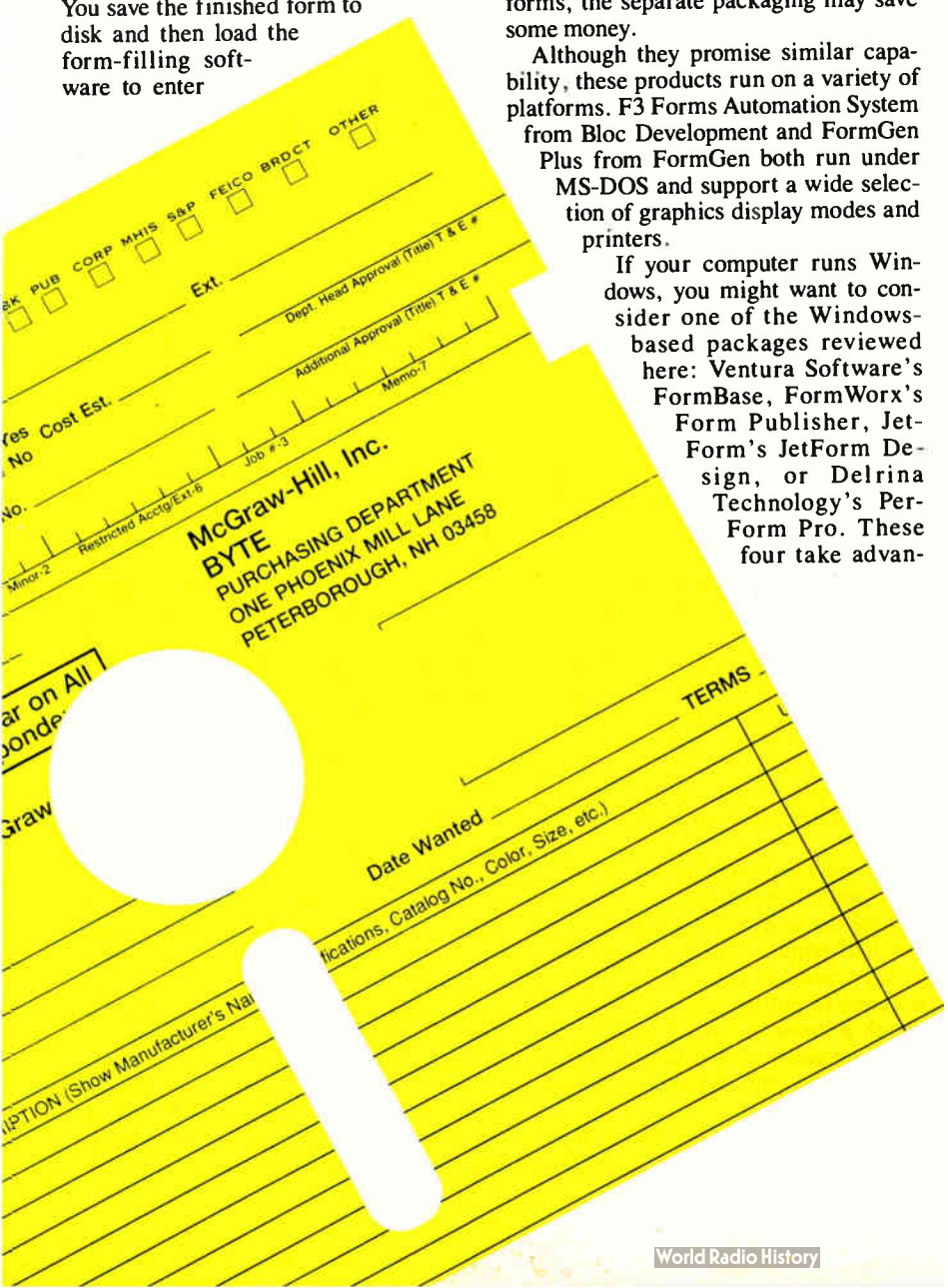
and cents, you might specify $ZZ,ZZ9.99 as a picture. The $ inserts a leading dollar sign, each Z will be replaced by a digit with leading zeroes suppressed, and each 9 will be replaced by a digit even if it's zero.

Most of these packages split the forms management job into two pieces. The forms design software gives you drawing tools to lay out your fields and graphics. You save the finished form to disk and then load the form-filling software to enter the data. The form filler is usually smaller than the design software and less demanding of computer resources. Most offices will have one or two people creating the forms and a larger group entering the data.

In some cases, the design and filler software are sold separately; others combine them in one package. For large organizations where few people design the forms, the separate packaging may save some money.

Although they promise similar capability, these products run on a variety of platforms. F3 Forms Automation System from Bloc Development and FormGen Plus from FormGen both run under MS-DOS and support a wide selection of graphics display modes and printers.

If your computer runs Windows, you might want to consider one of the Windows-based packages reviewed here: Ventura Software's FormBase, FormWorx's Form Publisher, JetForm's JetForm Design, or Delrina Technology's PerForm Pro. These four take advantage of the Windows environment to give you large-screen support and access to a wider selection of printers.



BYTE ACTION SUMMARY

- **FORMS PROCESSING SOFTWARE**
- **WHAT IT DOES**
  Forms software gives you tools to create form-like templates on-screen, to fill in data and provide a simple interface to databases.
- **LIKES**
  Electronic forms processing provides a convenient way to computerize a paper operation with a minimum of retraining.
- **DISLIKES**
  Some products have awkward user interfaces that don't conform to Macintosh or Windows conventions.
- **RECOMMENDATIONS**
  Informed was my overall favorite for ease of use. Of the PC packages, JetForm Design combines the best group of functions with the most Windows-like interface.

Finally, I have included two Macintosh products: SmartForm from Claris and Informed from Shana. Both are System 7.0 compatible; Informed uses System 7.0's Publish/Subscribe mechanism to link forms to other Macintosh applications.

Borland's ObjectVision, though sometimes considered a forms package, does not quite fit in with this group. ObjectVision's target market consists of end users seeking to develop Windows applications. Unlike forms software, ObjectVision treats forms not as target results but as devices for providing a starting point and a consistent user interface for developed applications.

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FORMS SOFTWARE FEATURES

Table 1: *Forms packages offer a variety of layout and design tools, and varying levels of support for electronic forms.* (●=*yes*; ○=*no*)

Product name	F3	FormBase	FormGen Plus	Form Publisher	Informed	JetForm	PerForm Pro	SmartForm
Version	1.3a	1.1	5.5	2.0	1.2	2.21		1.1 version 2
Prices	Designer, $1495 Pro Designer, $3000 Filler, $300	$495	$279	$195	Designer, $295 Manager, $195	$495	$495	Designer, $399 Assistant, $49
System requirements	PC (286 or higher); 640 KB RAM; EGA, VGA, or selected Super VGA; hard drive; mouse; DOS 3.1	PC running Windows; hard drive; mouse; DOS 3.1	PC (XT or AT); hard drive; mouse; DOS 3.2; Hercules, CGA, EGA, or VGA	PC running Windows; hard drive; mouse; DOS 3.1	Mac Plus; System 6.0.3; hard drive	PC running Windows; hard drive; mouse; DOS 3.1	PC running Windows; hard drive; mouse; DOS 3.1	Mac Plus; System 6.0.x; 2 800-KB floppy drives
Field layout								
Graphics fields	●	Windows Clipboard	●	○	●	○	●	●
Multiple page forms	●	●	●	○	●	●	●	●
Calculated fields	●	●	●	●	●	●	●	●
Mandatory fields	●	●	●	●	●	●	●	●
Comb fields	●	○	○	○	●	○	●	●
Bar codes	○	○	Code 39	●	○	●	●	○
Design Tools								
Graphical elements	TIFF format	○	PCX or TIFF format	PCX, TIFF, or MSP format	EPSF, PICT, or TIFF format	PCX, MSP, or TIFF format	GEM, PNT, PCX, BMP, EPSF, or TIFF format	Clipboard, PICT format
Graphics tools	●	○	Lines only	●	●	●	●	●
Step and repeat	●	○	●	●	●	●	●	●
Color support	●	●	●	●	●	○	●	○
Grids	●	●	●	●	●	●	●	●
Cursor status	●	●	●	●	●	●	●	○
Registration marks	●	○	○	○	●	○	●	○
Import formats								
Delimited ASCII	●	●	●	●	●	●	●	○
dBase	●	●	○	●	○	●	●	○
Lotus 1-2-3	○	●	○	○	○	○	○	○
Other	None	None	None	Formatted ASCII	Informed Exchange	Formatted ASCII	○	None
Export formats								
Delimited ASCII	●	●	●	●	●	●	●	●
dBase	●	●	●	●	○	●	●	●
Lotus 1-2-3	○	●	○	○	○	○	○	●
Other	None	None	None	None	Informed Exchange	None	None	SmartForm Merge, DIF
Printer support								
Dot matrix	○	●	●	●	●	●	●	●
HP LaserJet	●	●	●	●	●	●	●	○
PostScript	●	●	●	●	●	●	●	●

F3 Forms Automation System 1.3a

Bloc Development's F3 Forms Automation System comes in three parts: the forms design package, a forms design/mapping package, and a form filler. In most cases, a few people in your office would make use of the design package to create the form layout, and another person might use the design/mapping package to assign data fields to the form. Most people would only need to use the form filler package to enter the data.

F3 leans toward complete, enterprise-wide forms automation. It's designed for large companies to handle the thousands of forms that these firms need in order to operate. It's also expensive; the forms design package is $1495, the design/mapping package is $3000, and filler software sells for $300 per copy. But you may only need to equip one workstation in your art department with the design software and one in MIS with the mapping software.

Bloc's Pilot program will get you up and running with a single copy each of the design and design/mapping software and 50 copies of the filler software. In addition, the program includes professional design services for your first five forms and training, for a total cost of $25,000.

F3 is predominantly keyboard-based. About half of the design functions are available through pull-down menus; the other half require function keys or control-key combinations. I'd rather have the option of pulling down any function through a menu or having *all* the commands mapped to control keys. Having to switch between the menus and the keyboard is annoying.

Interface aside, F3 is a capable forms package. The basic tool set lets you draw rectangles and rules, and it lets you place text and graphics files. Unlike the other packages in this review, however, F3 won't let you control the data flow and database access without some programming. Most forms design software lets you select a database filename, shows you a list of the fields, and lets you make your link with a mouse-click or two. Specifying the actions of fields in F3 requires programming in Blade, Bloc's Pascal-like programming language (see screen 1). Blade gives you more control over the linkage, but it requires a bit more effort on the part of the forms designer.

According to Bloc, F3 provides automation control far beyond that of the other software I reviewed. Filler modules are available for several platforms, and the system is designed to allow smooth flow of information throughout the forms-handling process.

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Product Feature	PerForm	PerForm PRO
WYSIWYG	GEM (included)	Windows 3.0
Additional filler products	yes	yes
Multi-platform fillers	no	yes
ASCII/dBASE database export/import	yes	yes
Read/write directly to database	no	yes
Intelligent field calculation features	9	74
Electronic security	no	yes
Fast mode for form filling	yes	yes
Support for printer macros and cartridges	no	yes
Color support	no	yes
Font software included	yes	yes
On-the-fly font scaling	no	yes
Over 100 standard forms included	yes	yes
Suggested list price	$149	$295

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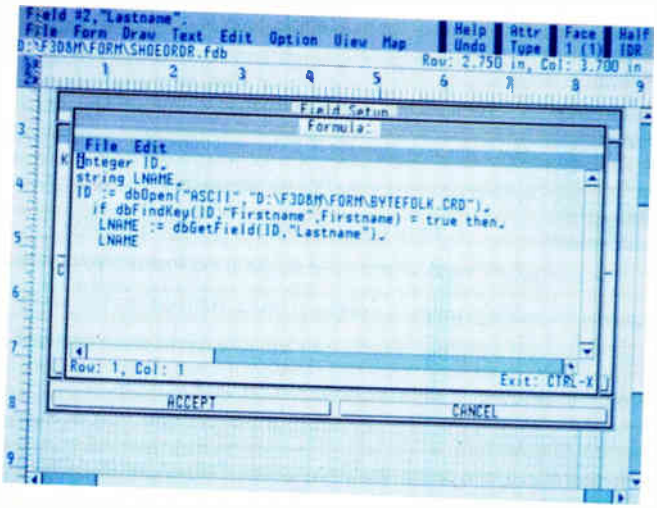


Screen 1: *F3's programming language, Blade. To access another database from within a field, you have to write some code. Searching on a first name to look up the last name requires only a few lines.*

FormBase 1.1

Ventura Software's FormBase ($495) has a Spartan interface. There isn't any toolbox to speak of. To create an object on your form, you pick a spot, click with the mouse, and enter a field name. Then you tell FormBase what kind of field you want and set the size and other parameters. That's not the way a Windows package is supposed to work.

Any place on a form that will be used for data entry is treated as a data field. FormBase data fields can consist of one of a number of standard data types. In database terminology, the form itself is a database record; data fields on the form become database fields. Data tables handle larger blocks of tabular data, and if you need to break a field down further, you can define a field to look like another complete form. Putting forms within forms gives you control over your database structure that none of the other packages offers. For output, FormBase supports ASCII, Lotus 1-2-3, and dBase file formats.

FormBase's weakness is its complete lack of graphics drawing tools. There's no tool for drawing rectangles; you have to define a field with no data and specify a border. If you need a single horizontal or vertical line, you specify just part of a border. You can place graphics, but not circles and arcs. FormBase's limited graphics capability makes it hard to reproduce existing forms.

FormGen Plus 5.5

When you run FormGen, you start with a blank screen and simply paint the image of the form with cursor keys. Like F3, FormGen uses function keys for most functions, and if you forget the key assignments, the pull-down menus won't help—only about half of the functions can be accessed through the menus. I found it easier to abandon the mouse and stick with the keyboard.

After you paint the form's image, you switch to another editor to define the form regions. Regions need not correspond with the graphical elements of the form image. Each region can be one of several data types, a graphical image, or a database lookup.

To enhance printing on Hewlett-Packard LaserJets and compatibles, FormGen includes Glyphix, a font-generation package. The test documents I sent to an old LaserJet Plus printed beautifully.

FormGen, which lists for $279, is small and quick, but there are a few things you may not like. When defining a calculated area, you have to specify regions by number. Instead of letting you specify, for example, `Total Price` as `Quantity * Unit Price`, FormGen requires the numeric reference `[27] * [30]`. FormGen's screen shows region numbers, but the lack of named regions makes FormGen needlessly difficult. The character-mode editor and graphics-mode preview also require too much mode switching for my taste.

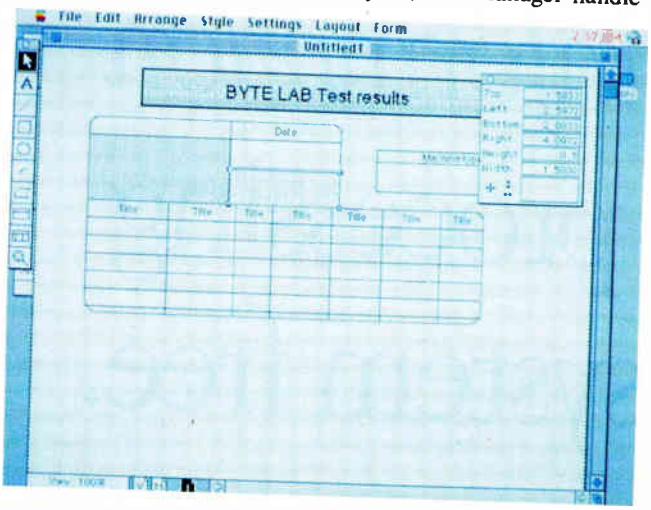
FormPublisher 2.0

FormWorx's Form Publisher for Windows ($195) is another package that separates the forms layout from data-field mapping. The layout package, Form Publisher, has a full complement of drawing tools, broken down into four tool palettes. The Draw palette lets you choose between 56 predefined objects. Paint, Text, and Data take care of colors, text styles, and data fields. Unfortunately, the user interface isn't very effective without a color monitor. Each of the different object types is coded in a different color, and trying to distinguish between them on a monochrome monitor is almost impossible.

After you finish your layout, Form Publisher prepares your form for the Fill & File package. Form Publisher can also output your form as a Printer Control Language printer macro, allowing you to merge finished forms with an established database. You download the macro to your printer before running the database manager and then have the database software activate the macro before printing the data. The printer automatically recreates the form, and the database software fills in the blanks. This is a neat idea, but it will only work on HP-compatible printers.

The Informed Series 1.2

The Informed Series from Shana consists of Informed Designer ($295) and Informed Manager ($195). Designer takes care c the forms layout, and Manager handle



Screen 2: *Informed's specification toolbox. To set the height of the lightly shaded rectangle, I typed in a measurement of ½ inch. Note also that selected corners are rounded on the various fields.*

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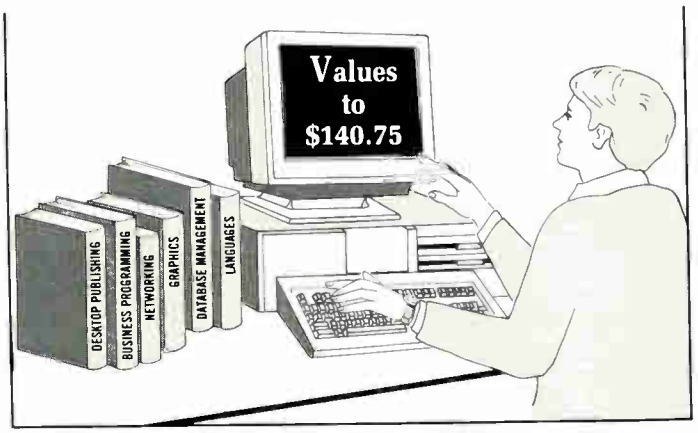

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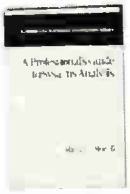

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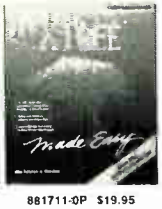

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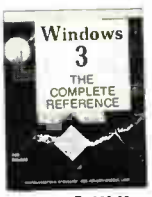

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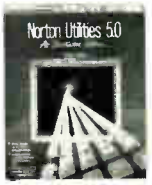
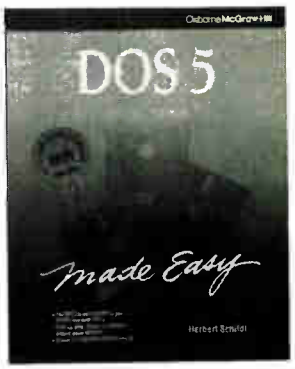


3720 $26.95

10041P $29.95

881622-XP $17.95



881690-4P $19.95

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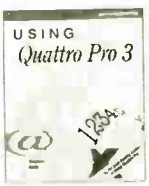

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3628 $26.95

3057P $15.95

10035 $49.95
Counts as 2

881670-XP $29.95
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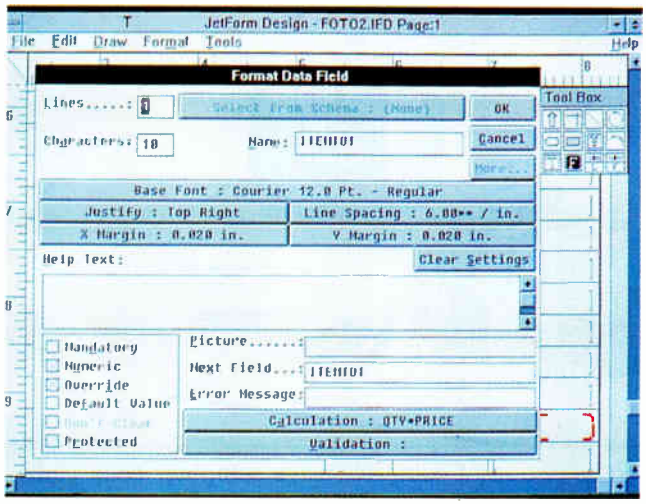
the data entry.

Unlike many of the reviewed packages, Informed (and the other Macintosh package, SmartForm from Claris) stayed true to the conventions of Macintosh and Windows user interfaces. As a result, I was able to start up Informed and create forms without opening the manual.

Besides the standard menu choices and mouse-clicks, Informed Designer adds a few extra toys to make layout easier. Pressing an arrow key nudges a selected object a small amount. Selecting a rectangle gives you the option of rounding each corner individually; this level of control allows you to treat a group of rectangles as a single visual object.



Screen 3: *Formatting a data field in JetForm. The field on the right (highlighted in red) is defined as a calculation. Two other fields will be multiplied together and placed in the field.*

Designer's specification toolbox shows you the current mouse location as well as the size and position of the current object. Other packages display this, too, but Designer lets you select the text in the display and relocate elements by typing in a new location (see screen 2). This precise numerical control makes it easy to get exact layouts. Shana obviously put a lot of effort into Designer's interface.

Designer and Manager are System 7.0 compatible and support Publish/Subscribe and Apple events to share data with other applications and networked machines. For simple imports and exports, however, you're limited to ASCII or delimited-field formats.

It would have been nice if the import/export feature had been extended to dBase format as well. Many Macintosh database products handle that format directly, and it would save the user the trouble of redefining all those database fields.

JetForm 2.21

JetForm ($495) has a clean, intuitive interface that works like that of many other Windows packages (see screen 3). To draw a data field, bar code, rectangle, or one of JetForm's other elements, you select the tool from the toolbox and place the element with a click-and-drag motion. The Readout option surrounds the cursor with a constantly updated display of the cursor position. When you are drawing, the Relative Readout option shows you the size of the object. Other packages have this feature, but having it as part of the cursor is especially handy.

There are two companion packages for form filling: the WYSIWYG, Windows-based JetForm Filler/G, and the character-based JetForm Filler/C. JetForm Merge, a fourth module, lets you use information from existing databases as forms input. Merge also lets you print filled-in forms from the DOS command line or from a non-DOS machine.

PerForm Pro

Delrina Technology's PerForm Pro ($495) has a reasonably standard Windows interface. The toolbox icons are not exactly obvious, but they work as expected. Of particular note is PerForm Pro's wide selection of bar code types. When you place a bar code field, you select from eight different kinds of codes. The bar code fields can also be calculated or generated from other databases, so it's easy to make the data on your forms com-

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puter-readable. Graphics data fields let you place graphical images on your forms the same way you would place any other data.

PerForm Pro's distinguishing feature is its electronic signature capability. You can configure PerForm Pro to require identification and a password before allowing a user to fill in selected fields. If the user doesn't have a valid password, his or her entry is rejected and the field is left blank. You can also make a valid entry lock its field and related fields on a form. For instance, you might allow anyone to enter dates and destinations into a travel authorization form. Then, as soon as a supervisor "signs" the form, dates and destinations are locked so that no one can add any extra trips.

SmartForm 1.1 version 2

Claris's SmartForm Designer ($399) and SmartForm Assistant ($49) are far and away the easiest to use of the packages I reviewed. A moderately experienced MacDraw user could pick up SmartForm and be up and running in minutes.

SmartForm gets the job done. After you finish your layout, you save it to disk and load it into the SmartForm Assistant. The Assistant takes you through the fields, fills in the data, and saves the collection of forms as a database. You can use this database as a source of data for other forms or export it in various formats for other applications.

Forming an Opinion

One thing that the computer industry promises with the graphical interface revolution is software that's easy to use. Macintosh and Windows software should put similar functions in similar menus to cut down the learning curve.

The two Macintosh products that I looked at, SmartForm and Informed, come much closer to this ideal than their Windows competitors do. SmartForm handles more export formats, but Informed feels more like a high-quality drawing package. While both are superb, I was drawn to Informed.

On the PC, I was disappointed that most of the Windows packages seemed to stray so far from the suggested interface standards. Every package will help you automate your forms, but JetForm is the most like other Windows software and is the easiest to use. ■

Howard Eglowstein is a testing editor for the BYTE Lab. He is also a desktop publishing consultant. He can be reached on BIX as "heglowstein."

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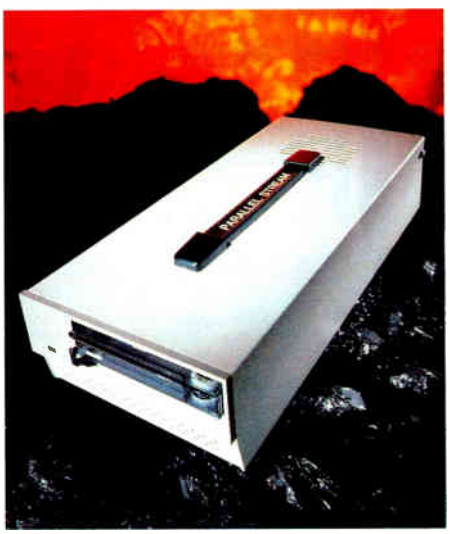

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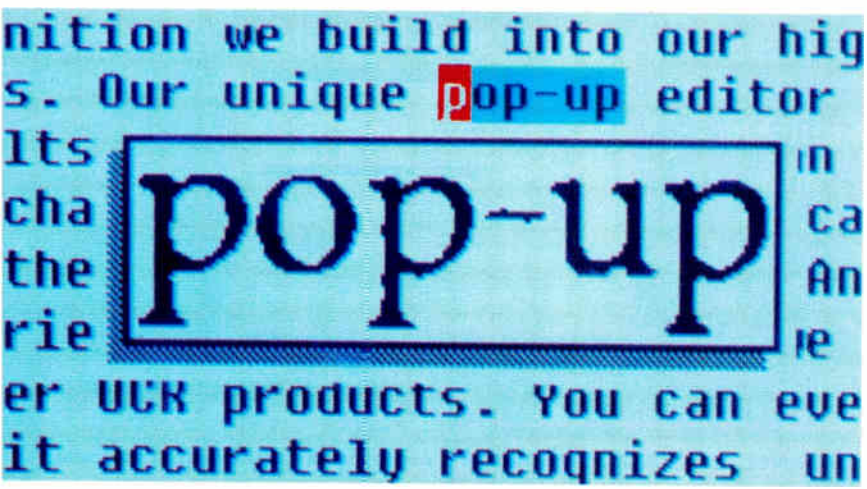

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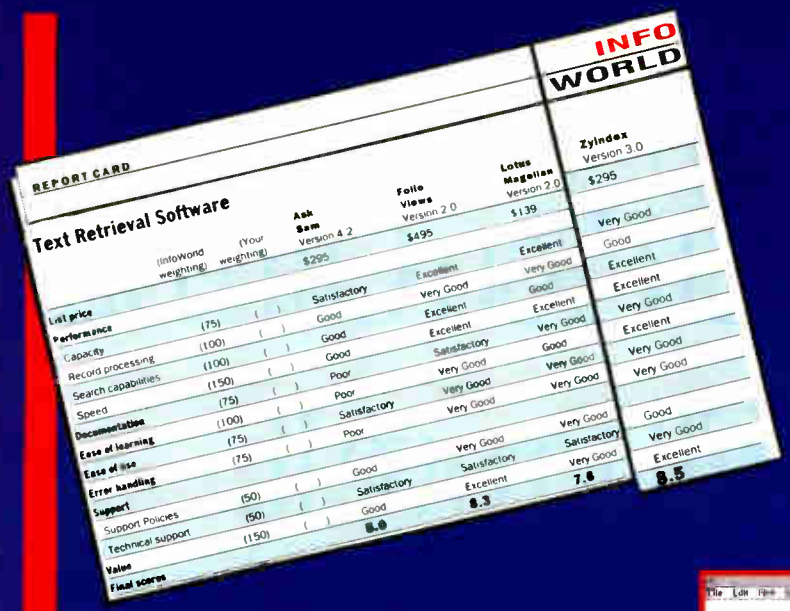

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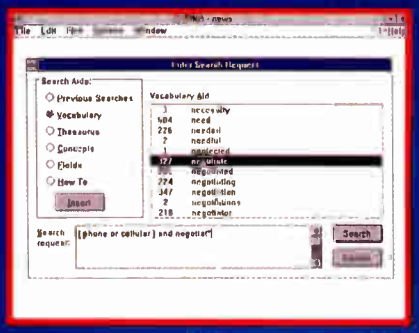

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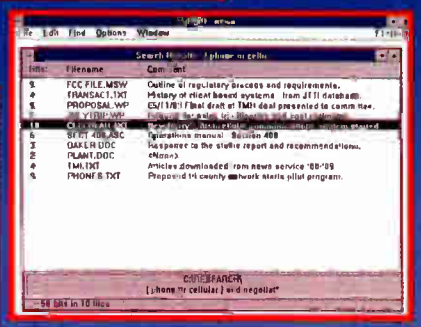

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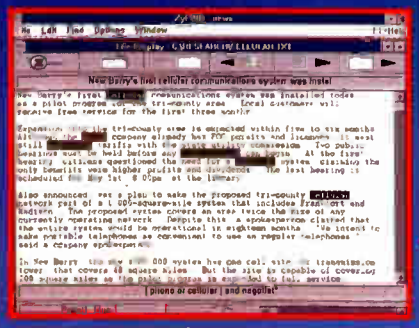

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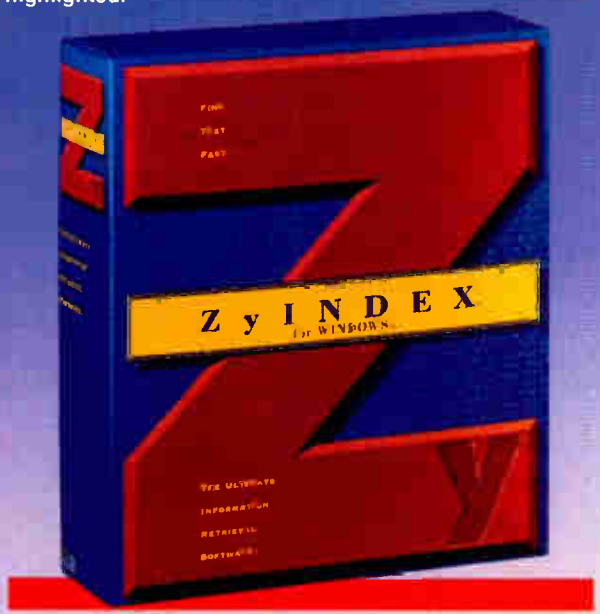

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SOFTWARE

Peer LANs Offer a Low-Cost Network Alternative

BARRY NANCE

A manager at a large NetWare installation recently told me that he'd buy peer-to-peer LANs for his smaller workgroups if he could find one that was reliable, easy to administer, and inexpensive. With these words in mind, I set forth to test peer LAN operating systems. I came away impressed.

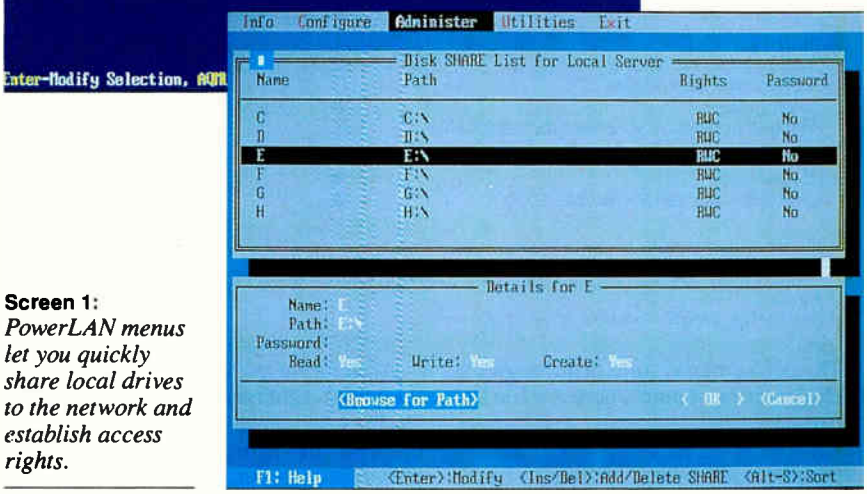
In a network of peers, any workstation can share its hard disk and printer with any other workstation. The users create names for their local printers and disk volumes and designate them as shareable on the network. Other users map printer ports and DOS drive letters to these resource names from the command line or through a menu system.

Unlike server-based products such as NetWare, these products allow you to share resources attached to any workstation without going through a central file server as an intermediary. Peer LANs make it easy to back up each user's hard drive.

I tested the following five products: Performance Technology's PowerLAN 2.10, Accton Technology's LanSoft 2.10, WebCorp's Web 2.55, Artisoft's LANtastic 4.0, and LANstep 1.0 from Hayes Microcomputer Products. All provide peer-to-peer services, include E-mail, and will run on a variety of industry-standard hardware, from inexpensive ARCnet to higher-performance Ethernet and token-ring products. Industry-standard network adapters will work with NetWare and other high-performance LAN operating systems, should you outgrow your peer LAN.

These products all cost less than NetWare 2.2 ($895 for five users; $1995 for 10 users). The exact cost per node depends on the number of workstations you have, the adapters and cabling that you choose, and each vendor's licensing arrangement. The features table includes the average price per node for a five-user LAN, excluding network adapters and cabling. It also tells you which products will coexist with Windows, how much memory you will need for a client-only or a client/server configuration, and whether you can load the software in high memory under DOS 5.0. Several products recognize an attached uninterruptible power supply (UPS) and perform an orderly server shutdown during a power failure. Most also support a shared CD-ROM drive, include a print spooler, and offer user- and group-level security.

Screen 2: *LANtastic's User Information menu has options for establishing permanent or temporary user accounts for resources you want to share. You also assign passwords and access rights from here.*



Screen 1: *PowerLAN menus let you quickly share local drives to the network and establish access rights.*

LAN Exams

I ran each product through a test suite designed to evaluate reliability, application compatibility, performance, and peer-to-peer communications (see the figure). The reliability test concurrently copies 1000 files totaling 15 MB between several machines to test for file errors under load; all products passed this test.

The compatibility suite of tests checks for compliance with DOS file sharing, record locking, machine name retrieval, and remote drive detection conventions specified in the *DOS Technical Reference*. A LAN operating system that passes these tests should work fine with Paradox, dBase, FoxPro, Lotus 1-2-3, Excel, WordPerfect Office, Microsoft Word, and any other application that uses DOS file I/O functions.

continued

BYTE ACTION SUMMARY

- **WHAT PEER-TO-PEER LAN OPERATING SYSTEMS DO**
  They allow any PC to share its hard drive and printer resources with all other PCs on a LAN.
- **LIKES**
  They are more convenient to use, less expensive, and easier to set up than NetWare and other server-based LANs.
- **DISLIKES**
  Installing network hardware is still a lot of work.
- **RECOMMENDATIONS**
  PowerLAN offers the best mix of features and performance.

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PEER LAN OPERATING-SYSTEM FEATURES

PowerLAN and LANtastic offer the most features. LANtastic is the only product that offers a Windows interface. The price per node reflects software costs for a five-user LAN. It doesn't include network adapters and cabling. Memory usage includes all necessary network software, including device drivers and the DOS Share program. (● = yes; ○ = no.)

	LanSoft 2.10	LANstep 1.10	LANtastic 4.0	PowerLAN 2.10	Web 2.55
Price per node (five users)	$100	$120	$20[1]	$160	$100
Network software					
Client-only memory usage (KB)	38	22/95[2]	34	49	70
Client/server memory usage (KB)	57	0	60	69	70
Loads high (DOS 5.0)	○	○[3]	●	●	○
Server disk cache	○	●	●	●	●
Maximum users	64	255[4]	300	255	255
Recognizes a UPS	○	○	●	●[5]	●
Can share CD/ROM	●	○	●	●	●
User interface					
Command line	●	○	●	●	●
Other	Menu	Icon	Menu, Windows 3.0	Menu	Menu
Windows-compatible	●	●[6]	●	●	●
Printing					
View print queue	●	●	●	●	●
Modify queue	●	●	●	●	●
Security					
Log-in time restrictions	○	○	●	○	○
Log-in expiration dates	○	○	●	●	○
User groups	●	○	●	●	○
Restrict access by volume/subdirectory/file	V/S/F	○	V/S/F	V/S	V/S/F
Other features					
E-mail	●	●	●	●	●
Diskless workstation (remote boot)	●	●	●	●	○

[1] $99 per LAN license applies only if you buy Artisoft's network adapters. Artisoft charges $99 per workstation for LANtastic/AI, a version that supports other vendors' hardware.
[2] Uses 22 KB for LANstep workstation; 95 KB for DOS workstation.
[3] Will load high using QEMM or other 386 memory manager.
[4] 128 simultaneous users; 255 network addresses per network.
[5] Requires a dedicated server.
[6] Runs in real mode only on LANstep workstations.

The performance suite determines the LAN operating system's network file I/O performance by reading and writing files of random sizes. I set up a 32-KB disk cache for products that included a cache option. LANstep determines cache size automatically; it set up a cache of just over 1 MB in my system.

The final suite tests PC-to-PC communications using NetBIOS for LANtastic, LANstep, LanSoft, and PowerLAN, and IPX for Web. Many LAN utilities, remote control programs, and E-mail packages depend on this capability.

Choosing Hardware

For consistency, I tested each LAN operating system on the same hardware and under the same conditions—with one exception. I let each vendor recommend an Ethernet adapter. My reasoning is simple: If performance is all-important to you, you'll probably use the network adapter that your LAN operating-system vendor recommends. If you're like most users, however, you are probably not using network-intensive applications, and performance is less of an issue. For word processing and occasional printing, slower, but less expensive, ARCnet cards will do just fine.

Accton, Hayes, and Artisoft selected their own Ethernet cards. Performance Technology chose the Federal Technologies Exos 105 adapter. WebCorp had no preference, so I used the LANtastic AE-2 in NE2000-compatibility mode. The test-bed consisted of a PC Brand 486-25 computer, a Gateway 2000 386/33, an ATronics 12-MHz 286, an original 6-MHz 286 IBM AT, and an original 4.77-MHz 8088 IBM PC. I ran the Network File I/O tests with the Gateway as the server and the ATronics as the client.

PowerLAN 2.10

PowerLAN's performance left most of the other products in the dust, posting times almost as fast as those of NetWare 2.2. The product achieves its top performance through well-written software—its NetBIOS implementation is one of the best on the market. The package includes cc:Mail, a full-featured E-mail package, and supports both dedicated and nondedicated servers. Dedicated servers offer more performance options and support a UPS. Any PowerLAN server will support a shared CD-ROM drive.

The $795 license fee allows up to 255 peer workstations—the maximum NetBIOS supports. The per-node cost is high for small workgroups, but you don't pay extra to add users. Performance Technology does charge more for dedicated servers; the basic license allows five connections.

The brief user's manuals need screen illustrations but are otherwise helpful and to the point. The character-based PowerLAN user interface presents pull-down menus and dialog boxes (see screen 1). It complies with IBM's Systems Application Architecture/Common User Access specifications.

A PowerLAN workstation requires NetBIOS and redirector software. To share files, you also load the Server and DOS Share programs. You select other modules during installation to share printers, set up a disk cache, and run the remote control program. PowerLAN required 69.1 KB of RAM on my fully configured workstation/server. I then used DOS 5.0 to load everything except NetBIOS (29 KB) into upper memory.

PowerLAN passed all compatibility tests, and its NetBIOS behaved properly. PowerLAN offers a range of security options. You can't restrict access to individual files, but you can grant users or groups read/write/create rights for disk drives and directories, assign passwords

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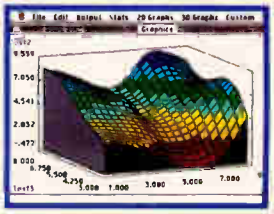

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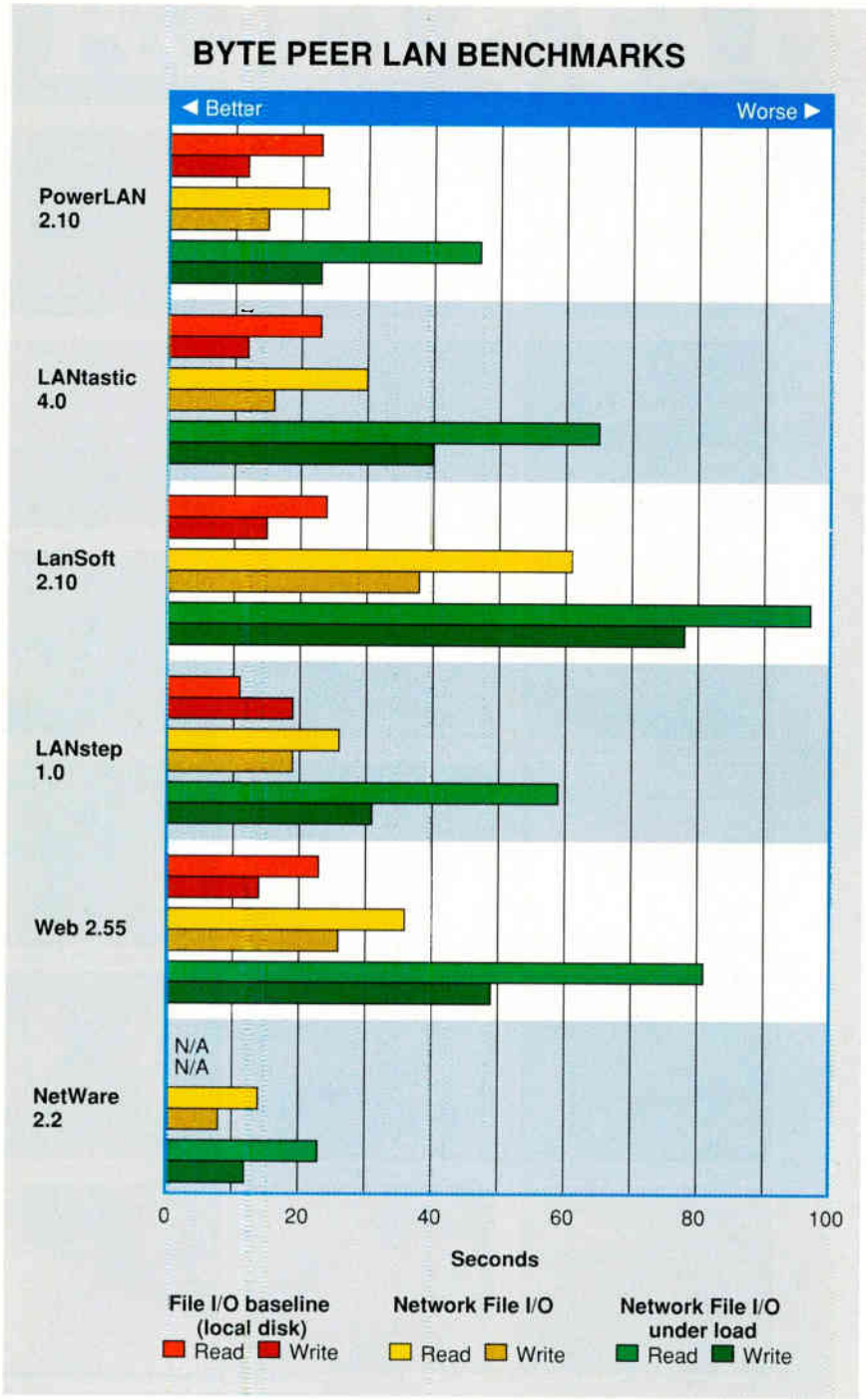

Performance results from BYTE's Network File I/O benchmarks give PowerLAN a substantial advantage. See the text for configuration details. Results are in seconds; lower times are better. The NetWare 2.2 baseline test shows the results when measured locally on a Gateway 2000 386/33's hard drive. The second test executes from a 12-MHz 286 client and accesses the Gateway 2000's hard drive through the LAN. The third test adds file I/O traffic from three other machines on the network. I added test results for NetWare 2.2 for comparison. (N/A = not applicable.)

to shared printers, and restrict multiple concurrent server log-ins.

LanSoft 2.10

Accton Technology's LanSoft is inexpensive and easy to install. The eight-user version sells for $499. Accton offers French, German, Japanese, Korean, and Spanish versions of LanSoft. The English version is relatively new, and the product manuals suffered in the translation. Passages such as the following are common: "Connect pseudo drives with subdirectories that are of ten accessed to." The manuals also lack an index.

LanSoft isn't the best choice for running network-intensive applications. It trailed in the Network File I/O tests, performing about half as fast as PowerLAN. The product did prove reliable, however, and ran through the compatibility suite and NetBIOS tests without problems. LanSoft works with DOS 5.0, but you can't load it high. The workstation software occupies 38 KB of RAM. It consists of an adapter-support/NetBIOS TSR program and a redirector TSR. A server uses 62 KB of RAM. Each file server requires Share, a client-/file-server program, and a print-server module.

LanSoft's menu system is easy to use and includes LanMail, a simple E-mail program that lets you broadcast messages, forward mail, and attach files. LanSoft is Windows-compatible and lets you restrict access to specific files as well as to subdirectories.

Web 2.55

WebCorp took the user's point of view when designing Web. Other products map a different DOS drive letter to each remote drive. Web creates a single W: network drive with subdirectory names for each shared drive. The package restricts access to shared drives, directories, and files and supports a UPS. The well-written documentation covers all the bases. A five-user license costs $495.

Web correctly implemented file sharing and record locking but didn't pad the machine name (from DOS function hexadecimal 5E00) with spaces, as specified in the *DOS Technical Reference*. This could cause problems with some applications. WebCorp sent me a patch that corrected the problem. Web also doesn't get along with pop-up TSRs. I suffered occasional machine crashes with products like Sidekick. Also, workstations automatically check for new E-mail when they log in, and they will receive error messages if the user on the designated "post office" workstation is using a pop-up TSR. WebCorp was checking into the problem as this went to press.

Web uses NetWare's IPX protocol to send and receive file data, so it should work with just about every network interface card on the market. During installation, Web links itself with the IPX.OBJ file that comes with your network adapter. You won't be able to use IPX-based utilities and applications, however, because Web doesn't implement either interrupt 2F (subfunction 7A) or interrupt 7A IPX entry points. WebCorp is working on a version that will support the IPX entry points.

continued

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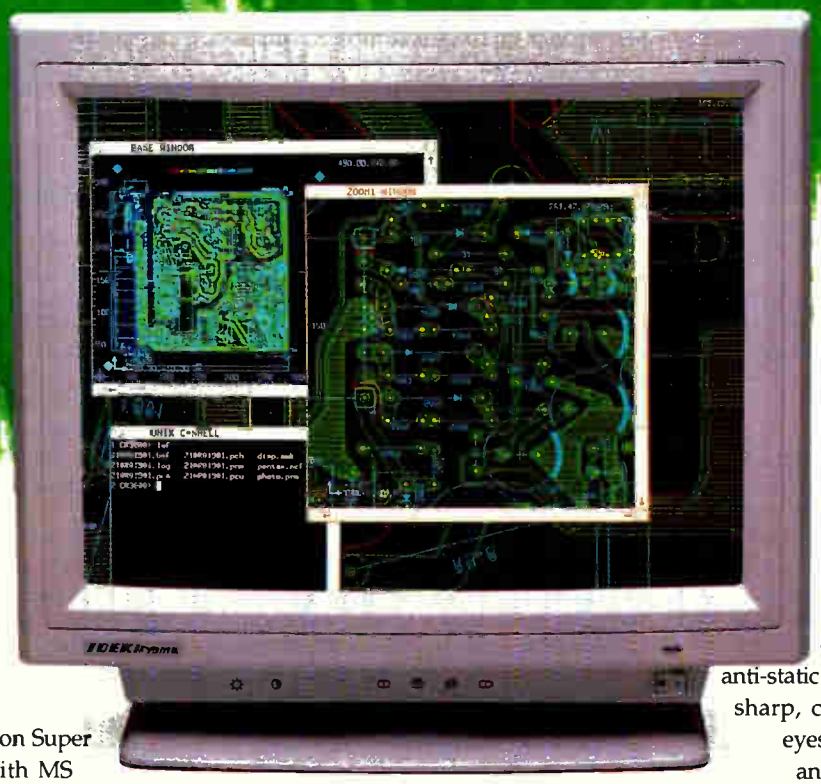

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The network software consists of a single 70-KB TSR that calls portions of itself into memory as needed. The Station Manager is a 4-KB menu TSR for managing print queues and doing other network tasks. You can't load Web high under DOS 5.0 because it uses program overlays. The next release will load high, according to a WebCorp spokesperson.

Performance was slow—only LanSoft performed more slowly during testing. That's surprising, since IPX is a fast protocol. Web's optional packet compression brought a slight improvement, but you'll need a relatively fast machine to overcome the overhead involved in processing compressed packets.

Web's E-Notes E-mail program worked fine, but it limits messages to only 14 lines and does not support file attachments.

LANtastic 4.0

LANtastic is the peer LAN market leader. Version 4.0 offers a true Windows interface and other features that should ensure its continued success. The Windows interface makes print queue management, network management, E-mail, and other tasks as simple as pointing and clicking.

LANtastic is easy to install and administer. The documentation is clear and easy to follow but fails to mention that you need to use LOADFIX to install LANtastic on computers running DOS 5.0. The index could also use improvement.

If you purchase Artisoft's network interface cards, LANtastic's $99-per-network software license is a bargain. If you want to use non-Artisoft adapters, you must buy LANtastic/AI, which costs $99 per workstation. That puts LANtastic's pricing in the same range as Web's and LanSoft's. LANtastic's 16-bit Ethernet card sells for $299. LANtastic/AI includes device drivers for dozens of popular ARCnet, Ethernet, and token-ring adapters.

A workstation needs only about 34 KB of RAM, including the device driver, NetBIOS, and the redirector and Share. The server module adds 26.5 KB, for a total of about 60 KB. If you're using DOS 5.0, you can load everything high on a 386 computer.

LANtastic passed the compatibility and NetBIOS tests. When I rebooted a workstation/server PC, however, the other LANtastic machines had trouble reconnecting. No other product had this problem.

LANtastic came in third in the benchmark tests. I used LANcache, LANtastic's disk-cache program, during testing. LANtastic supports a UPS and comes with an easy-to-use E-mail program. You can set up as much or as little security on a LANtastic network as you need (see screen 2). If you use the Windows interface, you point and click to grant permissions and rights to drives, subdirectories, or files.

LANstep 1.0

Hayes's LANstep is a rewrite of Waterloo Microsystems' Port software (Hayes acquired Waterloo last spring). LANstep falls somewhere between peer-to-peer and server-based LANs. It requires a primary, nondedicated server that runs LANstep's proprietary multitasking operating system and requires a special hard disk format. Other workstations on the LAN can also share their printers and files, however. LANstep does not support a shared CD-ROM drive.

The primary server functions as a normal DOS workstation by running DOS as a task. Other workstations with shared drives must also run the LANstep operating system. They, too, run DOS as a task, and shared files must reside in a specially formatted LANstep partition. LANstep workstations can multitask network processes but can't multitask DOS applications. LANstep also supports standard DOS workstations, which can only share their printers.

Workstations running the LANstep operating system require a 286 or faster system with at least 1.5 MB of extended memory. A license for five simultaneous users costs $599.

The LANstep user interface uses the concepts of doors and rooms. Doors are character-based icons that guide you around various network tasks. Rooms contain groups of icons that launch specific applications. The icon interface is novel but no easier to use than LANtastic's Windows interface or the other products' menus. LANstep workstations can run Windows in real mode, but I was unable to get DOS workstations to run Windows in any mode.

The E-mail facility includes most common features, including binary-file attachments. Also, you can restrict or permit access to applications on the LANstep server—a unique feature.

The product supports any network adapter that has Microsoft LAN Manager's Network Driver Interface Specification drivers. LANstep's manuals include chapters on network performance and preparing for network growth that will serve you well as your LAN gets bigger.

LANstep performs its own formatting

ITEMS DISCUSSED

LanSoft 2.10
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LANstep 1.0
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(404) 441-1617
fax: (404) 449-0087
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LANtastic 4.0
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Artisoft, Inc.
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PowerLAN 2.10
Unlimited peers or five users per dedicated server, $795; 15 users, $1790; unlimited users, $3195
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Web 2.55
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on the server hard drive to get around DOS's relatively slow file system, which has a file allocation table. This should have given LANstep the advantage in the performance tests, but PowerLAN did slightly better. The version of LANstep I tested didn't support DOS 5.0 (Hayes was working on this as this article went to press); I used DOS 3.3.

Normal disk utilities won't work on a LANstep server, and Hayes doesn't offer any. LANstep does attempt to ensure data integrity on the file server by not caching disk writes and by performing transaction rollbacks when a power failure occurs. LANstep doesn't recognize UPS signals.

Because the LANstep server software resides in extended memory, a user on a LANstep server has more memory available to run applications than does a user on a LANstep workstation. My primary server system had 570 KB of memory free. A LANstep workstation requires 22 KB of RAM. On a regular DOS workstation, however, the LANstep TSR uses about 95 KB of RAM, which reduced usable memory to 465 KB on my test machine. Fortunately, you can use QEMM or another 386 memory manager to load LANstep high.

LANstep's DOS client sessions ran flawlessly. I loaded and unloaded several TSRs on top of DOS on the server, some of which captured the timer tick and keyboard interrupt. All functioned perfectly. The file sharing, record locking, and NetBIOS tests show that LANstep correctly implements LAN specifications. From a technical viewpoint, LANstep is an excellent network operating system, but it requires a great deal of administrative effort.

PowerLAN over NetWare

As a longtime NetWare user, I'm surprised by the usefulness and versatility of peer LANs. In situations where peer access makes sense—say, within small, cost-conscious groups that need to share drives equally—I'd recommend PowerLAN over NetWare 2.2.

PowerLAN is a little more expensive than the other peer LAN operating systems for a five-user workgroup, but you won't have to pay extra to add users, and its speed, ease of use, and many extra features make the package stand out. ■

Barry Nance is a consulting editor for BYTE. He manages a 70-node NetWare LAN and is the editor of the IBM Exchange and moderator of the lans conference on BIX, where you can reach him as "barryn."

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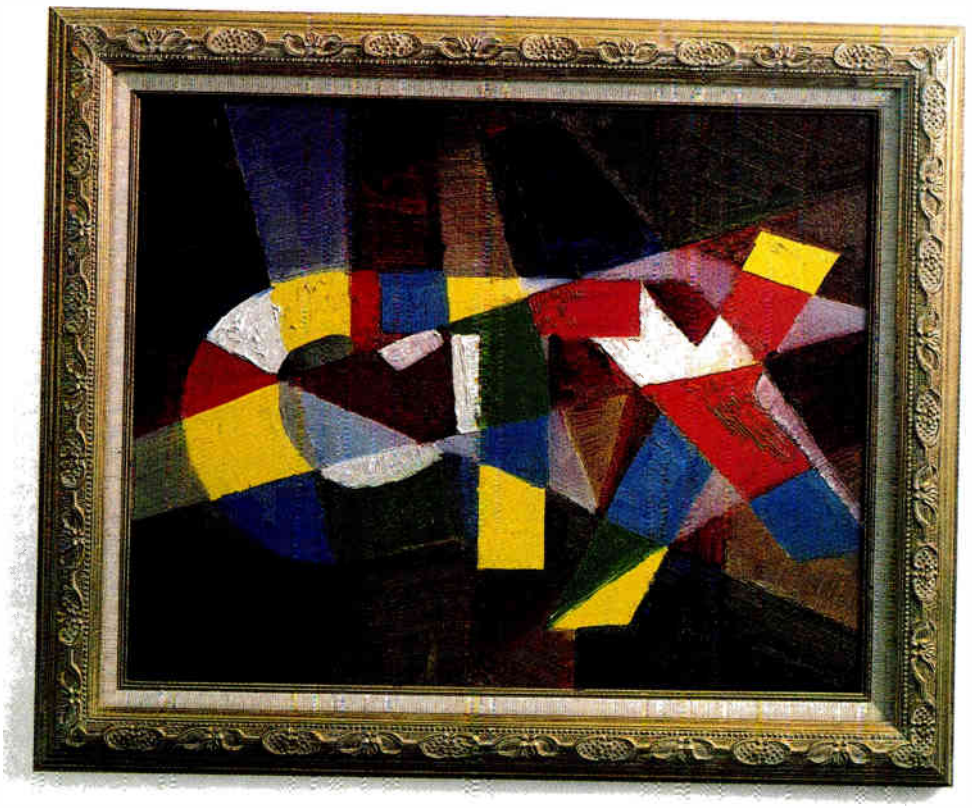

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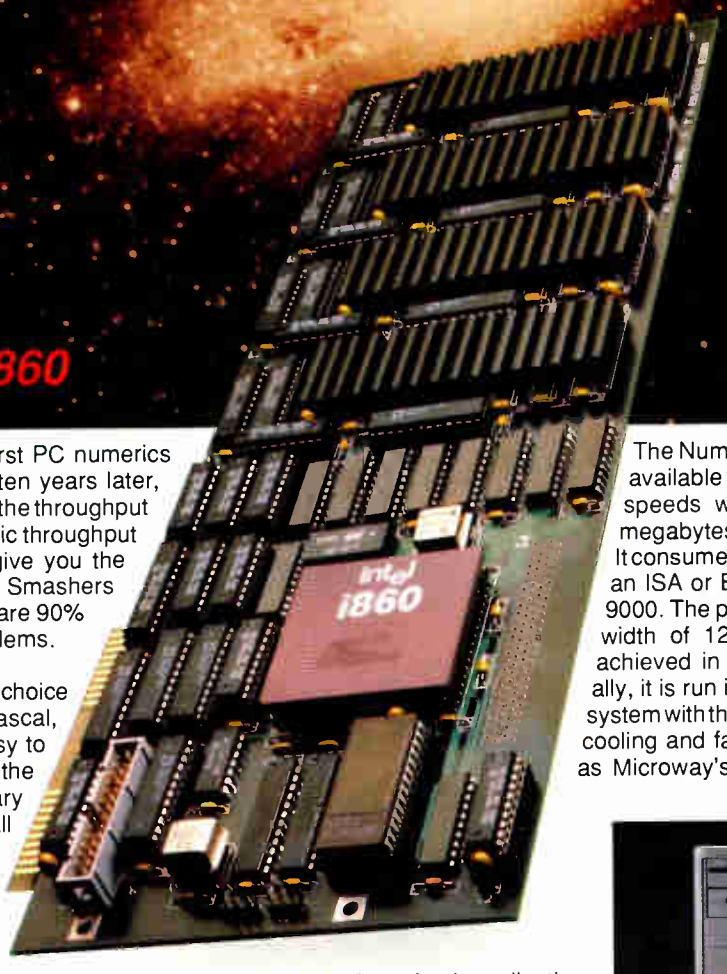

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HARDWARE

New 3-D Graphics Engines Give PCs Workstation Power

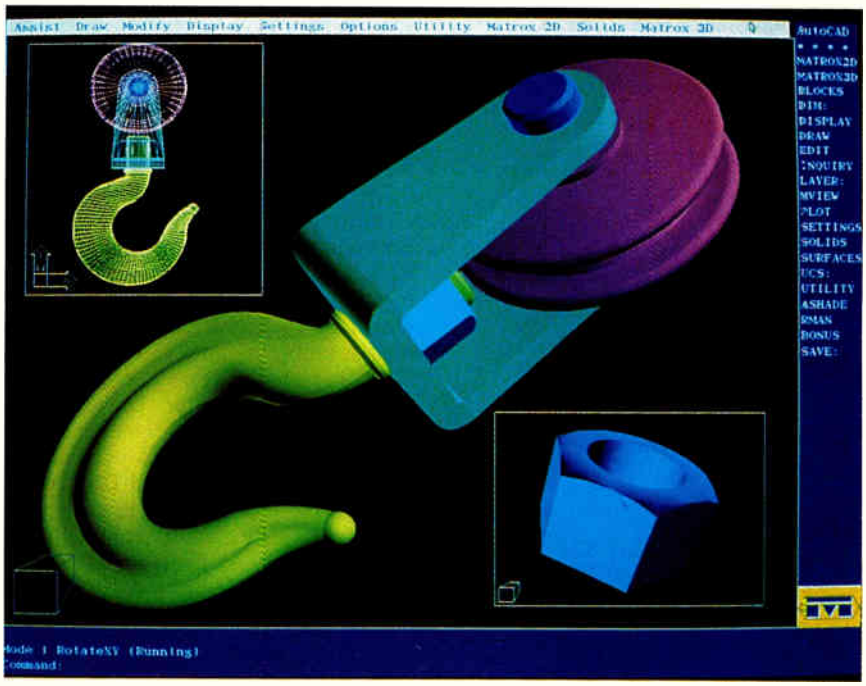
GREG LOVERIA

Two new three-dimensional graphics accelerators from Silicon Graphics and Matrox Electronics use hardware and software muscle to make PCs perform almost like high-end graphics workstations. For now, that means AutoCAD users can spend less money to display animations and speed display-list processing and zoom/pan redraw functions. In the future, when Windows 3.0 and other drivers become available, these boards could be integral to the work of graphic artists, architectural designers, and desktop color separators.

To achieve their performance wonders, Matrox's MG-3D series and Silicon Graphics' IrisVision boards take over graphics-intensive algorithms from the main system. Both adapters have massive amounts of on-board video RAM for display-list storage: 5 MB on my test version IrisVision/24 and 8 MB on the MG-3D Ultra (counting on-board DRAM, each adapter held 9 MB of total memory).

The adapters are essentially 24-bit frame buffers with Autodesk Device Interface (ADI) drivers. Their primary role is to enhance AutoCAD 386 release 11 protected mode using Phar Lap's 386 DOS Extender. Besides turbocharging normal AutoCAD operations, these two adapters offer real-time walk-through animations of 3-D models. (See the text box "Vermont Micro's Vibrant Alternative" for a look at a third accelerator—one that doesn't support animations but offers impressive performance and a wide range of drivers.)

The IrisVision adapter is a postprocessor. IrisView, its AutoCAD external program, allows shading and animating of exported DXF files. The MG-3D animation software is integral to its ADI driver and functions within AutoCAD. In animation mode, both boards double-buffer images: While one RAM buffer is being displayed, the other buffer is being redrawn.



Screen 1: *A 3-D wireframe block-and-tackle model shown inside AutoCAD release 11 using Matrox's MG-3D Ultra adapter and ADI driver. Models can be viewed in separate viewports within AutoCAD in wireframe or Gouraud-shaded modes.*

Workstations on a Card

The hardware on these adapters is more commonly found on Unix-based SPARC and Iris workstations. The Matrox boards use the Texas Instruments DSP-30 chip, the speedier predecessor to the TMS340x0 Texas Instruments Graphics Architecture family. The DSP-30 accelerates the drawing of primitive functions to around 20,000 Gouraud-shaded polygons per second. Other chips include four Matrox proprietary large-scale-integration gate arrays (one address-processing unit and three data-processing units) and Brooktree's Bt463 RAMDAC for 8-, 12-, and 24-bit color display output.

IrisVision's geometry subsystem uses triple 8-bit D/A converters, a TMS-340C30 processor, and a Weitek floating-point coprocessor to speed graphics operations. Silicon Graphics rates the adapter at 14,000 Gouraud-shaded polygons per second (a measurement based on adding color and light shading attributes to a wireframe model).

Along with the revved-up hardware, the ADI drivers with both boards function as mini-software applications and iconified pop-up enhancements within AutoCAD. Both drivers have birds-eye-view (BEV) functions, which allow you to examine minute drawing details without lengthy zooms or redraws. Although these functions aren't unique, they're especially swift with the hardware muscle in these boards. Collectively, this should appeal to AutoCAD users, animators, and architects.

Both boards support standard AT-bus platforms, but each vendor has staked out different territory when it comes to bus architectures. IrisVision comes in ISA and Micro Channel versions. For ISA-based machines, the IrisVision/8 ($3495) displays 256 colors and the IrisVision/24 ($4995) displays 16.7 million colors (24-bit). The Micro Channel version costs $3995 and supports 256-color output. Matrox's MG-3D series includes ISA and EISA boards: The ISA-based MG-3D, which offers 12-bit dithered color images, costs $3495. The EISA-based MG-3D Ultra sells for $5995. All

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BYTE ACTION SUMMARY

- **WHAT 3-D ADAPTERS DO**
  They boost AutoCAD performance with 386 protected-mode ADI drivers.
- **LIKES**
  For CAD and animation applications, your PC becomes a virtual graphics workstation.
- **DISLIKES**
  With large and complex Gouraud-shaded models, animation and manipulation functions perform slowly.
- **RECOMMENDATIONS**
  If your work involves AutoCAD animations, the 3-D boards from Matrox and Silicon Graphics are both winners. If you don't do animations but need to accelerate graphics applications, consider Vermont Microsystems' X/Series 256.
- **PRICE**
  Matrox MG-3D (ISA/AT), $3495
  Matrox MG-3D Ultra (EISA), $5995
  IrisVision/8 (ISA), $3495
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the products require 386 or 486 systems; IrisVision requires a math coprocessor. All, including the Micro Channel adapters, support AutoCAD 386 release 11.

The $95 IrisVision driver bundle includes AutoCAD 386 releases 10 and 11, AutoShade2/RenderMan, and 3D Studio. CADKey, MicroStation, and SCO Open Desktop drivers are an additional $95 each. The MG-3D series comes with drivers for AutoCAD 386 release 11, AutoShade2, and 3D Studio. According to Matrox, 24-bit display drivers for Windows 3.0 will soon be shipping with the boards.

Cramped Quarters

Both adapters work with one or two monitors. Using VGA pass-through, I tested them both using supplied cabling with a single 21-inch Nanao FlexScan 9500 multiscanning monitor at 1280-pixel by 1024-line resolutions. The 15-pin D-shell pass-through cables connected externally to a Diamond SpeedStar Plus Super VGA adapter VGA-out connection. Another 15-pin-to-4-BNC cable connects the MG-3D to the monitor. The IrisVision uses the same setup with a 5-BNC monitor cable. I performed my tests on Zeos International's 486/25 EISA system with 8 MB of memory and a 344-MB hard drive. My pointing device was a Wacom tablet with a four-button puck.

The MG-3D Ultra's two-board configuration is just under 1½ inches wide; the massive four-board IrisVision assemblage is about 1¾ inches thick. Because of the extra board widths, I worried about components touching and possible heat buildup. But both adapters installed easily, and by carefully selecting adjacent slots, I achieved acceptable board clearance even for the IrisVision. After hours of operation, both adapters' heat buildup was minimal, although this could be attributed to the Zeos system's 450-watt dual-fan power supply.

Fluid Walk-Throughs

You configure the first slot for the Matrox EISA adapter as an EISA bus and the second slot as an ISA bus. You then install Matrox's ADI driver, AutoCAD menus, and communication-link software, and reboot.

After you start an AutoCAD drawing, Matrox's ACAD menu loads from the command line to access Matrox pop-up box functions and sidebar enhancements. The BEV function brings up a miniature dynamic zoom window. You use BEV mostly when you are zoomed deep into drawings and see the overall view in the BEV window, thus eliminating a zoom-out regen.

The Spyglass function opens a small overlay window where you can magnify complex details: Hitting Enter brings your entire drawing to that zoom extent instantly. Additional pop-up functions include scroll buttons for 256-color palette options, zoom ratios, and check-box toggles for readout/update of display-list functions. Other toggle boxes activate viewport slider bars that are reminiscent of Windows 3.0 sliders, except that they perform instantaneous zooms as well as pans.

You access commands for real-time 3-D walk-throughs through pull-down menus or the command line. When you enter render mode, the adapter Gouraud-shades the model (you can also view the model as a wireframe; see screen 1). The materials option sets numeric RGB shading values for color and ambient and diffused lighting properties.

Starting either dynamic view or walk-through invokes horizontal and vertical target bands centered over the active viewport model. In dynamic view, cursoring left, right, up, or down rolls the model, real-time and shaded, in Cartesian coordinate space as if you were holding the model in your hand. Centering the cursor between target-band intersections slows or stops model rotation. In walk-through mode, the model pans left, right, up, or down as you move the cursor. Pressing the plus key moves you closer to the model; the minus key moves you out. I called up a 3-D model of a house and performed walk-throughs that were very fluid and smooth. I found this feature fascinating. It feels like you're manipulating the model in zero gravity using the plus and minus keys as retro-rockets.

Invoking Matrox's 3-D command set disables the normal AutoCAD and 2-D features. You can, however, fully shade models in one viewport, exit 3-D mode, and still perform normal AutoCAD/2-D functions in another viewport. Even though the board is 24-bit, its shading quality lies somewhere between AutoShade's flat shading and the Gouraud-shaded objects I've seen in other animation/rendering packages. This aside, the fluid, real-time movements of the dynamic and walk-through functions are superb. Combined with the increased AutoCAD speeds, this makes the board a winner.

Authentic Shading

The IrisVision/24's Geometry Engine board connects to a three-board raster

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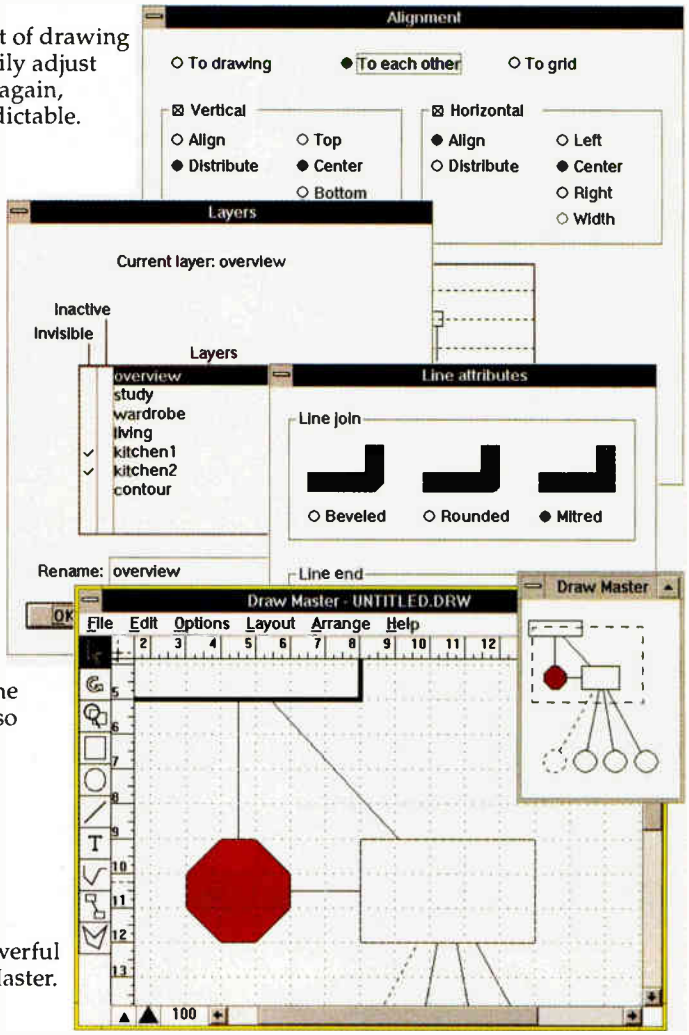

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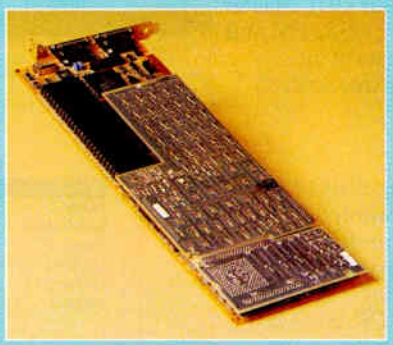
Vermont Micro's Vibrant Alternative

With the X/Series 256 adapter, Vermont Microsystems offers a scrappy contender in the CAD-acceleration market. Although it does not have the animation capabilities of either the Silicon Graphics or Matrox adapter, at $2995 it provides many of the same AutoCAD ADI display-list-management and speed-enhancement tools for a substantially lower investment.

ADI drivers for the X/Series 256 adapter sport iconified pop-up utilities, including bird's-eye-view functions and a real-time zoom in/out magnifying glass. Also, if you're short on motherboard adapter space, the X/Series 256's two-board backplane assembly occupies only one slot, and it installs easily.

In addition to ADI drivers for AutoCAD 386 releases 10 and 11, the board ships with drivers for AutoShade 2.0 with RenderMan, CADKey, VersaCAD, Micro Cadam 3D, 3D Studio, and Vermont's AutoMate installation software.

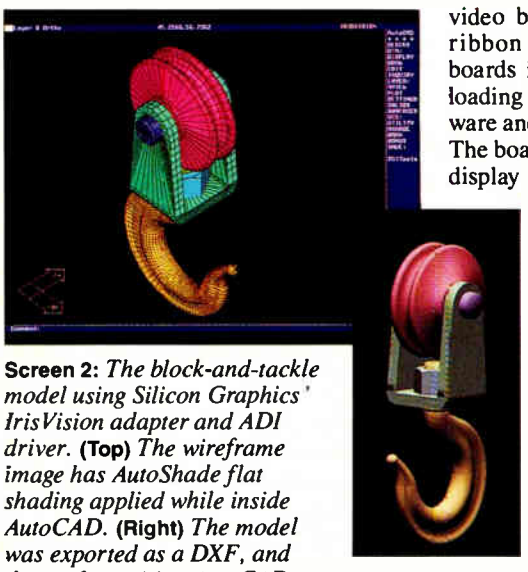
X/Series adapters use a proprietary VCAD accelerator chip to enhance on-board 60-MHz TIGA 34010 processor functions. This chip commits common CAD primitive functions to hardware, including Professional Graphics Language commands and Gouraud shading. The board simultaneously displays only 256 colors from a palette of 16.7 million. But the VCAD chip performs a proprietary Berkes-Pilcher shading routine to provide "perceived" 24-bit color depths by eliminating 256-color-space banding problems. The dithering algorithm, called ReadyRender, worked exceptionally well in my evaluations.



The X/Series 256 adapter.

In my 3D Studio tests, work screens looked sharp at the higher resolutions, and final renders were vibrant. Except for some slight fuzziness, you'd be hard pressed to distinguish the difference between 24-bit and dithered 256-color ReadyRender images. In AutoCAD 386 release 11, the results of my topographical drawing benchmarks were also impressive. With one viewport open, redraws took 0.62 seconds and regens took 16.05 seconds. With four viewports open, redraws took 2.46 seconds and regens took 43.74 seconds for the respective commands.

Vermont Microsystems has come up with a slick product that's less expensive than the offerings from Matrox and Silicon Graphics. I recommend that you take advantage of this economy if your work doesn't require animations, if you use more CAD packages than just AutoCAD, or if your motherboard has only one slot to spare.



Screen 2: *The block-and-tackle model using Silicon Graphics' IrisVision adapter and ADI driver.* **(Top)** *The wireframe image has AutoShade flat shading applied while inside AutoCAD.* **(Right)** *The model was exported as a DXF, and then, after exiting AutoCAD, Gouraud shading was performed using IrisView, Silicon Graphics' real-time animation and walk-through software.*

video backplane assembly via supplied ribbon cables. Placing the coupled boards in adjacent 16-bit ISA slots and loading the necessary configuration software and ADI drivers all went smoothly. The board supports 8- and 24-bit color at display resolutions ranging from 640 by 480 lines through 1024 by 768 lines to 1280 by 1024 lines.

IrisVision's pop-up palette box contains 20 command buttons ranging from real-time monochrome and color BEV windows to panning and zooming functions. As with Matrox's driver, you can change AutoCAD working and layer colors and view display-list memory usage.

I preferred the appearance of IrisVision's pop-up command palette box to that of the MG-3D Ultra. However, with the IrisVision, there is no spyglass feature other than zoom window functions. But to reduce eyestrain, IrisVision lets you choose enlarged font sets that directly affect AutoCAD's working desktop (I have always disliked squinting at AutoCAD's little command-line readout at higher resolutions).

To perform real-time animation and shading, you export 3-D models via DXFOUT, exit AutoCAD, and use IrisView software. For those working exclusively with AutoCAD, this may present problems; however, I liked the idea of allowing users of alternative CAD packages access to the board's shading and animation capabilities via DXF transport files.

Invoking IrisView brings up a large center viewport surrounded by pull-down menus and icon sidebar buttons. Loading DXFs brings up the model as a wireframe. From the pull-downs you choose shading types: Gouraud, flat, or wireframe (see screen 2). You set lighting attributes via a pop-up window that includes a wireframe globe. Up to six lights can be toggled off or on with intensity and ambient values. You position the lights by placing and dragging them on the globe. Using a home model, I toggled

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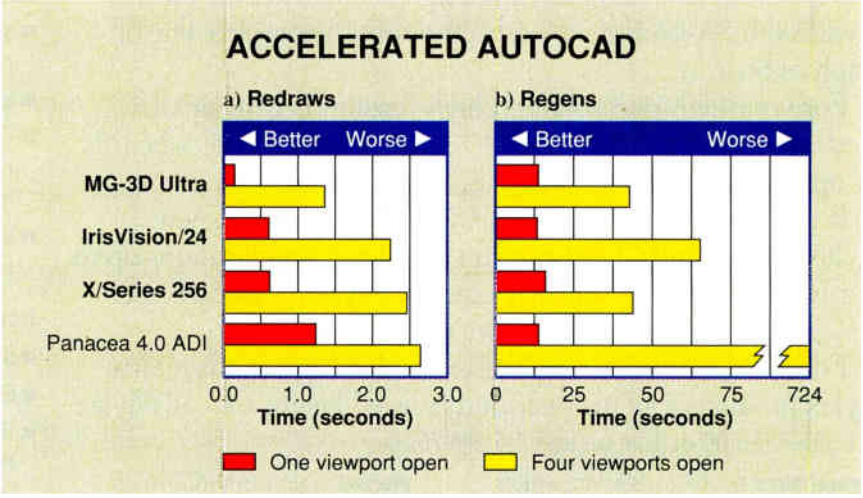

Matrox's MG-3D Ultra outpaced the competition in most redraw and regen benchmarks. The tests used a complex mesh drawing consisting of 20,800 entities. Three boards were compared by timing redraws and regens with one and four viewports open. Panacea's software-based 4.0 ADI driver was timed for comparison.

model drawing layers off and on by color, which made exterior walls invisible. This allowed unobstructed views of the shaded interior.

You manipulate models using sidebar buttons for pan, zoom, rotate, tilt, and walk. For pans, cursoring left or right moves the image likewise; up and down zooms in and out. To rotate the model around the *x* and *y* axes, you drag in the desired direction; tilting "pinwheels" the model around its *z* axis.

Walk allows you to move around and through your drawing. Holding down the left button and dragging up zooms in, while dragging down zooms out. Depressing any other puck button and dragging in any direction pans the camera view direction.

IrisView's script function records model/camera actions to disk, and script files play back the animation, unattended in real time. With Silicon Graphics' $795 StudioVision, an NTSC/PAL/S-Video encoder box, you can record animations directly to videotape.

Gouraud shading in IrisVision looks somewhat more authentic than with the MG-3D. However, real-time movement can be jerky (you must make your cursor movements slow for fluid model motion in IrisView). Both adapters tend to choke on larger, complex models. A topographical test model made both operate extremely slowly, and movement was not fluid.

To gauge redraws and regens, I opened a complex topographical landscape mesh drawing consisting of 20,800 entities. I then compared the two boards by timing redraws and regens with one and four viewports open (see the figure). For comparison, I used Panacea's 4.0 ADI driver (an exceptionally fast, 1024- by 768-pixel software-only ADI) using only a SpeedStar Super VGA adapter (I configured the ADI as I normally use it, with 4 MB of system RAM for display-list storage). Although the MG-3D Ultra outperformed the competition on most tests, the hardware-based accelerators posted similar results.

Workstation Power

In the end, I found it almost impossible to choose between the ISA offerings of these two boards. If you've already standardized on either EISA or Micro Channel architecture, you'll do well with the respective MG-3D and IrisVision products.

Even though they're pricey, I highly recommend these boards if you animate CAD models and send the output to videotape. The added processing power can shave hours off the time it takes to render your animations. The boards are also valuable if you require real-time walk-throughs to develop your designs. To have this power without purchasing a graphics workstation makes these products even more significant. ■

Greg Loveria is a computer graphics and desktop publishing consultant, animator, and technical writer in Binghamton, New York. He can be contacted on BIX as "loveria."

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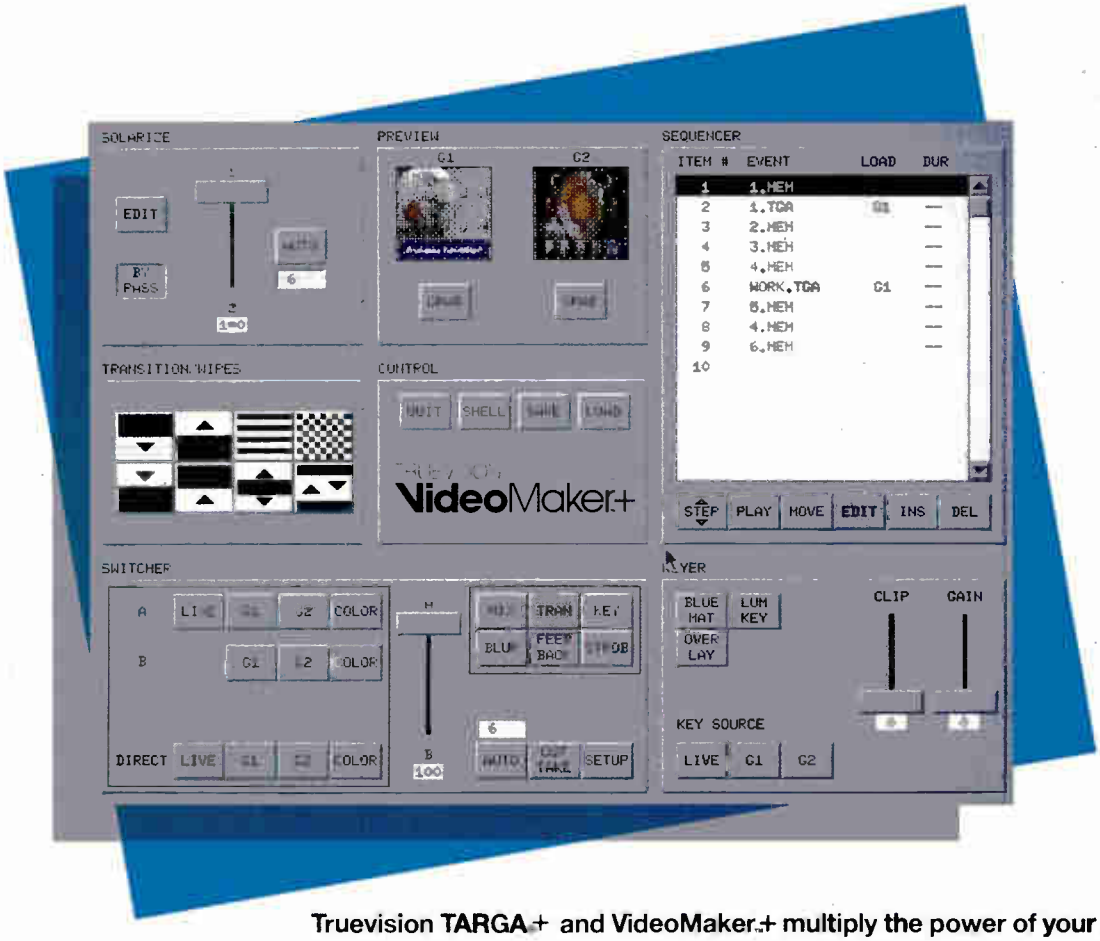

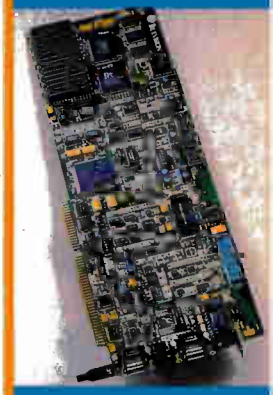

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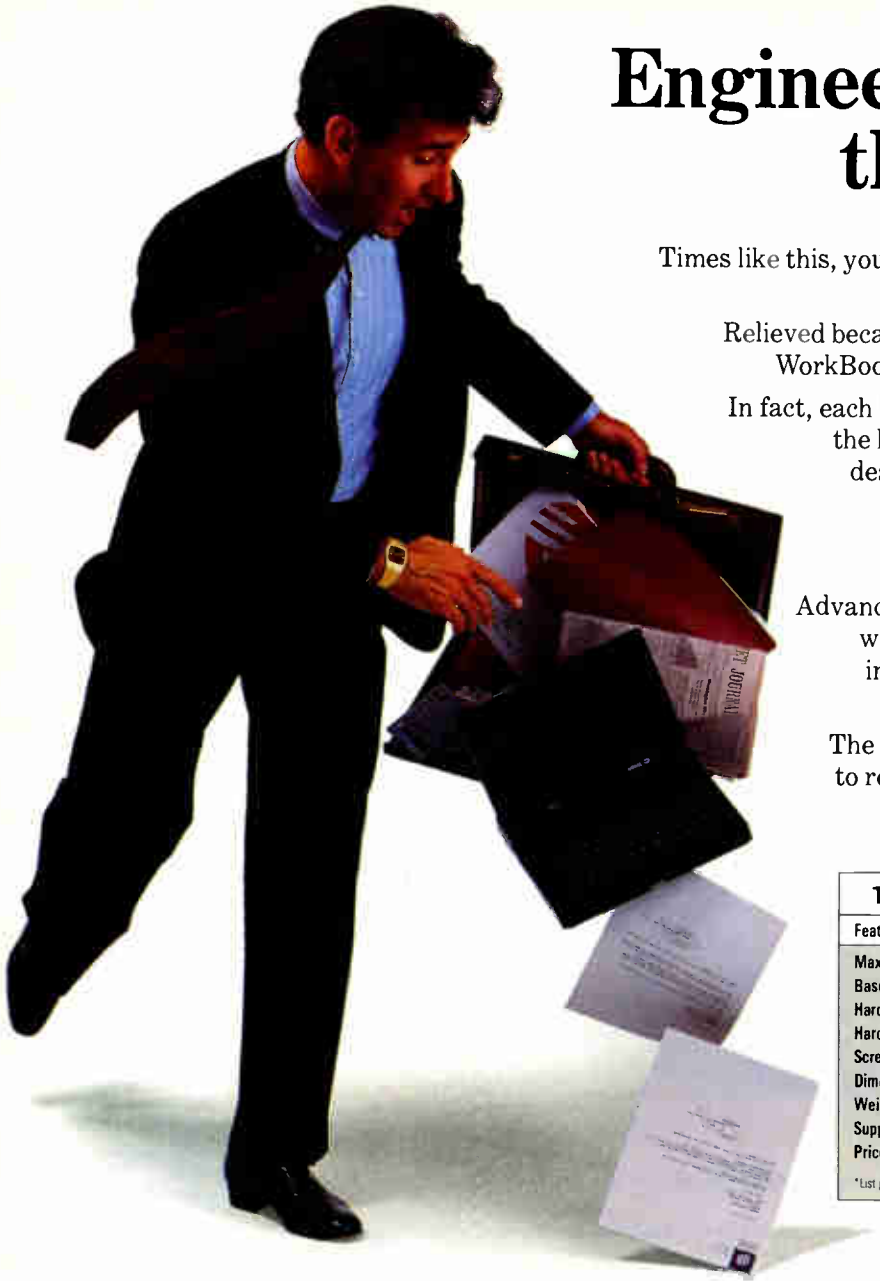

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HARDWARE

Three 40-MHz 386 Systems Set New Price/Performance Standards

ROBERT MITCHELL

What a difference a little competition can make. Since Advanced Micro Devices (AMD) introduced its Am386-40 386DX CPU clone last spring, Intel has responded with a spate of 486SX processors. But the first 486SX systems didn't live up to all the hype (see "A Trio of 486SX Machines," September BYTE). This month, the BYTE Lab tested three Am386-40 systems that challenge 486SX/20 computers on price and performance.

These systems—the Arche Technologies Master 386-40, Club American's Falcon 386/40, and Ares Microdevelopment's 386-40 Sonic—outperformed 486SX/20 and 386/33 systems BYTE has tested. They fell short, however, when compared with fast 486DX/25 systems.

The systems all include an external, direct-mapped write-back CPU cache. The Sonic and the Falcon use a 64-KB cache; the Master uses a 128-KB cache. The Falcon and Master models accept a wide range of processor cards. All three reviewed systems have FCC Class B certification and come with DOS 5.0 and Windows 3.0 installed. None integrates video or basic I/O functions on the motherboard.

I asked each vendor to supply a system with 4 MB of RAM, a 100-MB or larger hard drive, a 1-MB Super VGA card and Super VGA color monitor, and a math coprocessor. (For the exact configuration, see the system configuration table.) I ran BYTE's low-level, DOS-application-level, and Unix benchmark suites on each machine. The benchmark summary results appear on page 323.

The Arche Master 386-40 (left), Club American Falcon 386/40, and Ares 386-40 Sonic. The Master and the Falcon accept processor upgrade modules.

Ares 386-40 Sonic

Ares sells the 386-40 Sonic by mail order and prices it aggressively. The basic configuration includes 4 MB of RAM, a floppy drive, a Quantum 105-MB Intelligent Drive Electronics (IDE) hard drive, a ViewSonic 4 display, a 200-watt power supply, a Microsoft Serial Mouse, DOS 5.0, Windows 3.0, and HyperDisk Speedkit and CheckIt utility programs

BYTE ACTION SUMMARY

■ **WHAT 40-MHZ 386 SYSTEMS ARE**
Systems that use AMD's Am386-40, a fast clone of Intel's 386DX CPU.

■ **LIKES**
Better price and performance than that of 486SX/20 systems.

■ **DISLIKES**
ULSI Math Co. FPU in machines from Ares and Club wouldn't complete Unix benchmarks.

■ **RECOMMENDATIONS**
Arche's Master 386-40 for performance-hungry applications; the Ares 386-40 Sonic for bargain hunters.

■ **PRICE (as tested)**
Arche Master 386-40, $5217;
Ares 386-40 Sonic, $3450;
Club Falcon 386/40, $3474

■ **FOR MORE INFORMATION**

Arche Technologies, Inc.
48502 Kato Rd.
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fax: (510) 683-6754
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fax: (510) 490-2687
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SYSTEM CONFIGURATION AS TESTED

	Arche Master 386-40	Ares 386-40 Sonic	Club Falcon 386/40 Tower
Processor	40-MHz Am386-40; 40-MHz Cyrix FPU	40-MHz Am386-40 CPU; 40-MHz Cyrix FPU	40-MHz Am386-40 CPU; 40-MHz Math Co. FPU
Memory	4 MB of system RAM; 128 KB of CPU cache memory	4 MB of system memory; 64 KB of SRAM processor cache	4 MB of 80-ns SIMM RAM; 64 KB of CPU cache RAM
Mass storage	Arche 2001 IDE controller with 512 KB of cache RAM; Conner 120-MB hard drive; Teac high-density 5¼-inch floppy drive	210-MB Quantum IDE hard drive with 64-KB cache RAM; Teac high-density 5¼-inch and 3½-inch floppy drives	Maxtor 200-MB hard drive; Teac 5¼-inch high-density floppy drive
Display	Diamond SpeedStar Plus Super VGA board with 1 MB of RAM; 14-inch Arche PX-14S Super VGA monitor	Diamond SpeedStar Plus Super VGA board with 1 MB of RAM; 14-inch ViewSonic 5 multifrequency color monitor	Rainbow 4000A Super VGA board with 1 MB of RAM; Club 500A multifrequency color monitor
Keyboard	101-key NMB, IBM Enhanced style	Focus Electronic 101-key, IBM Enhanced style	101-key NMB, IBM Enhanced style
I/O interfaces	Two serial ports; one parallel port; one 8-bit, four 16-bit, and one proprietary 32-bit expansion slots available	Two serial ports; one parallel port; one game port; six 16-bit expansion slots and one 32-bit memory card slot available	Two serial ports; one parallel port; five 16-bit expansion slots available
Other	Windows 3.0; DOS 5.0; serial mouse	DOS 5.0, Windows 3.0, Microsoft Serial Mouse; CheckIt 3.0	DOS 5.0; Windows 3.0; Microsoft Serial Mouse

for $2675. My test system configuration, which included a 210-MB Quantum hard drive with a 64-KB cache, sells for $3450, including shipping. The warranty covers parts and labor for two years.

The 386-40 Sonic is slightly narrower than a full-size system. It has the usual array of status lights up front, along with power, reset, and turbo switches. The loose, clicky keyboard places the backslash key to the right of the right Shift key instead of along the top row. A built-in LCD turns the numeric keypad into a stand-alone calculator, but rapid keystrokes didn't always register in calculator mode.

The Sonic baby motherboard holds an Am386-40 CPU, up to 32 MB of system RAM, and up to 256 KB of cache static RAM. You can expand memory to 64 MB by installing a memory-expansion board in a 32-bit slot ($275). The AMI BIOS has an extensive set of configuration options. Two of the system's eight 16-bit expansion slots hold a DTK Multi I/O board and a Diamond SpeedStar Plus video adapter. The case had space left for one full-height and one half-height 5¼-inch storage device. The ViewSonic 5 noninterlaced color multifrequency monitor included with my test system had the sharpest display in the group. It uses a 0.25-mm dot-pitch Sony Trinitron tube and has a 72-MHz refresh rate.

I didn't experience any compatibility problems with the Ares machine and had no trouble getting through to Ares's technical support, which required a toll call. The technicians quickly resolved my DOS 5.0 upgrade problems but couldn't help me configure Windows to run properly on a NetWare LAN. I had similar experiences with Club and Arche technicians.

Arche Master 386-40

The Master 386 is a desktop system that accepts processors ranging from the 386/25 to the 486/50. The base Master 386-40 system, with 4 MB of RAM, Arche's 128-KB processor cache and 512-KB caching IDE controller, a floppy drive, keyboard, serial mouse, 200-W power supply, DOS 5.0, Windows 3.0, and a two-year on-site service warranty, lists for $3399. My test system has a list price of $5217. Dealer discounts should bring the street price closer to that of the Ares system.

Arche put reset and CPU speed buttons up front with the status LCDs but left the power switch at the rear of the case. Inside, the video and I/O boards filled two expansion slots, leaving one 8-bit slot, four 16-bit slots, and a proprietary 32-bit slot for an optional memory board. You can expand on-board memory to 32 MB. If you've filled all eight sockets with 1-MB SIMMs, you can use Arche's memory board ($405) to add another 16 MB. The system bus runs at 10 or 13 MHz but doesn't have an 8-MHz compatibility speed. As configured, my test system had just one half-height 5¼-inch drive bay available. Overall construction quality was good.

I received a defective analog VGA monitor, which Arche replaced. The PX-14S displays an interlaced image at 1024 by 768 pixels. The display didn't match that of the ViewSonic 5, but Arche does offer a comparable monitor. The NMB keyboard is a bit stiff.

The Windows 3.0 and DOS 5.0 learning guides included with the Master will suit beginners fine but are a poor substitute for reference manuals. If you have any questions, however, Arche offers a toll-free technical-support line.

Falcon 386/40

Club's Falcon series accepts a range of plug-in processor modules, from a 386/25 to a 486/33. Club sent the tower version of the Falcon 386/40 for testing but also offers a desktop version. The base system comes with 4 MB of system RAM, an Am386-40 processor card with a 64-KB CPU cache, a floppy drive, a keyboard, a 250-W power supply, and a one-year warranty for $1775. My test system sells direct for $3474. Club also sells the Falcon through dealers.

The cavernous tower case has a locking access panel on one side and uses two cooling fans. A set of castors and a handle at the back of the case make moving the box easy. A plastic door covers the front-mounted switches, floppy drive, and indicator lights. It wouldn't stay open, and I couldn't remove it. My test machine had five half-height drive bays, two full-height drive bays, and seven 16-bit expansion slots. A 200-MB Maxtor hard drive occupied one half-height drive bay; a Rainbow Super VGA card and a Multi I/O board used two slots.

The Falcon's system board holds up to 64 MB of RAM; the CPU board plugs into a special 32-bit slot. Club uses the

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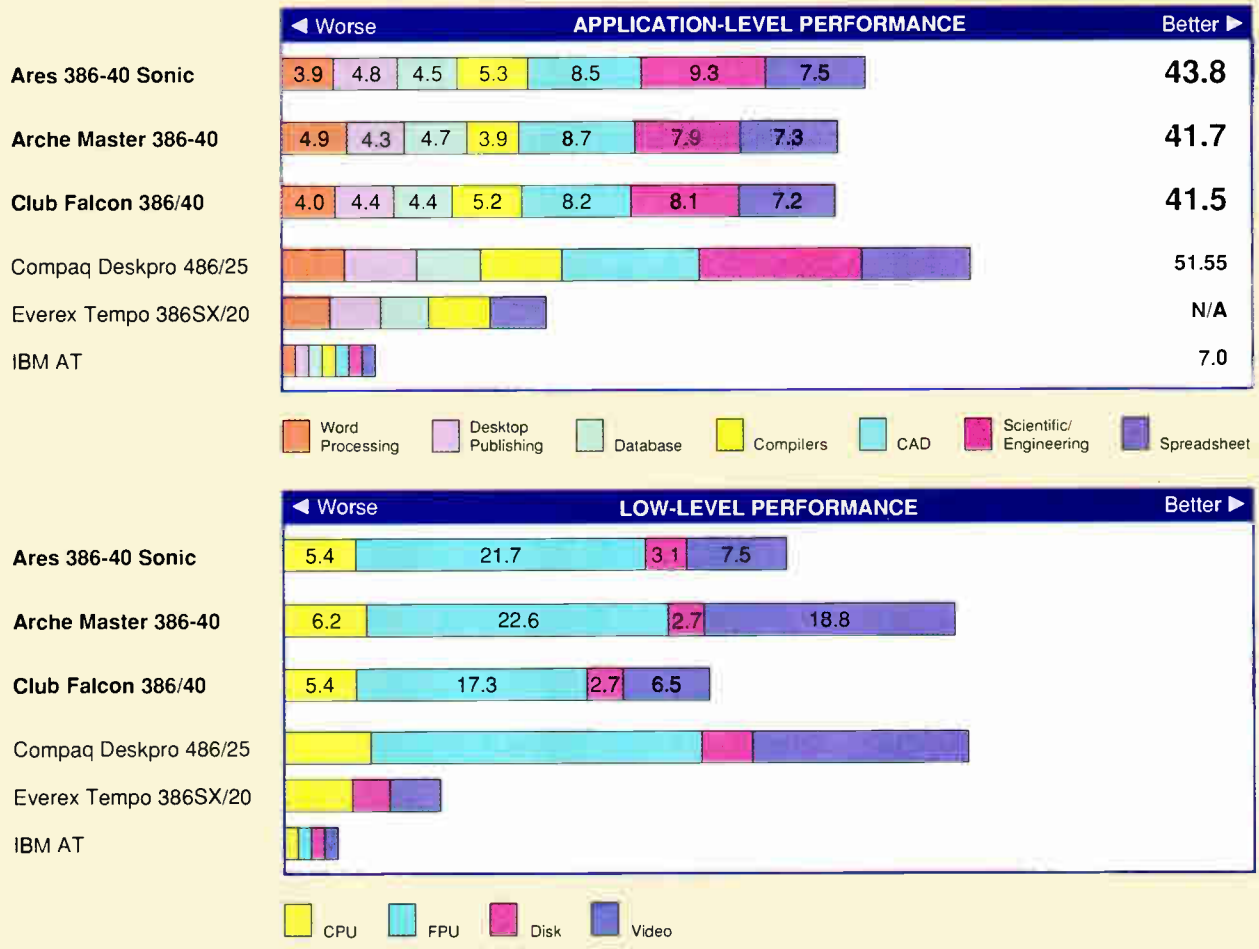
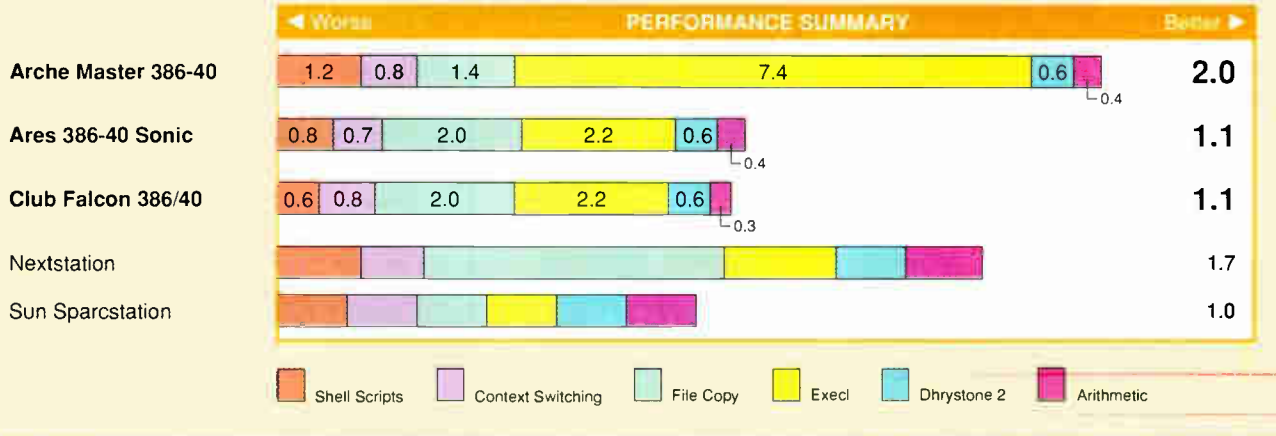
DOS BENCHMARKS



For application and low-level benchmarks, results are indexed and show relative performance; for each individual index, an 8-MHz IBM AT running MS-DOS 3.3 = 1. For all benchmarks, higher numbers indicate better performance.

The BYTE low-level benchmark suite identifies relative performance at the hardware level; the application benchmarks evaluate real-world performance by running a standard test suite using commercially available applications. To obtain a copy of the benchmarks, join the listings area of the byte.bmarks conference on BIX or contact BYTE directly.

UNIX BENCHMARKS



The graph above summarizes the results of BYTE's Unix benchmarks (version 3). We index the results to show relative performance; for all tests, a Sun Sparcstation IPC = 1. We formed the summary index by averaging the cumulative performance results for the individual tests. The tests show relative performance for running a shell script with 8 concurrent scripts running, pipe-based context switching, file copy throughput (in 5 seconds), spawning a process (execl()), the familiar Dhrystone 2 benchmark, and double-precision arithmetic.

BYTE's Unix benchmarks are available on UseNet, from Demolink, and in the listings area on BIX, or on disk. See page 5 for details. Comprehensive results are available by contacting BYTE.

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same extended AMI BIOS found in the Ares machine. The Club 500A multifrequency monitor presents a noninterlaced image at 1024 by 768 pixels. Club does not offer a toll-free number for technical support, but the support technicians seem well trained, and I didn't have to wait long for service.

Test Results

I experienced one compatibility problem during testing: The Ares and Club machines locked up when running BYTE's Unix double-precision and floating-point benchmarks. I tracked the problem to the ULSI Math Co. FPU. ULSI was looking into the problem as we went to press. Ares substituted a Cyrix FasMath FPU, which worked fine. Unlike the Ares system, the Falcon/Math Co. combination successfully ran the Unix benchmarks in multiuser mode. Those results appear in the benchmark graph.

As a group, the 386/40 machines consistently outperformed the 486SX and 386/33 computers BYTE has tested. Of the three machines reviewed here, the Master 386-40 took the lead: Its 6.2 low-level CPU index left the Ares and Club machines in the dust and came close to the Deskpro 486/25L's 6.4 score. The Master was about 30 percent faster than the Everex Tempo 386SX/20, but it couldn't hold its edge in the application benchmarks against the Ares Sonic.

The Master's high video index reflects extremely fast text-mode and scrolling operations but only average graphics-mode times. That didn't help in the application benchmark tests, which run mainly in graphics modes. Also, the Arche caching IDE controller didn't perform substantially better than noncached IDE drives in BYTE's low-level disk benchmarks. The Sonic's Quantum hard drive, with its built-in 64-KB cache, did much better. Arche recommends expanding controller cache RAM beyond 512 KB to improve performance. The board holds up to 4 MB of RAM (16 MB with an optional daughtercard) using 80-nanosecond 256-KB or 1-MB SIMMs.

The Master also took top honors in the Unix benchmarks. Its fast CPU cache paid dividends on the Execl throughput (spawning processes) and the Shell Scripts tests. It didn't do as well on the File Copy test.

Should You Buy One?

All of these machines have a clear price/performance edge over the 486SX/20 systems BYTE has tested. They also did better than some 486DX/25 systems, although the Deskpro 486/33L is clearly faster. I didn't run into any compatibility problems attributable to the Am386-40, although the problems that I experienced with the ULSI FPU gave me pause. The replacement FPUs from Cyrix ran fine, however, and the low price ($270 from Ares) gives the 386-40 an upgrade path that is less expensive than that of the 486SX/487SX.

For straight-out performance, my first choice is the Master 386-40. Its fast CPU architecture should serve both Unix and DOS users well, and a few extra SIMMs in the disk cache should improve its DOS-application benchmark results. For bargain hunters, I recommend the Sonic; it earned top DOS-application scores, uses mostly name-brand components, and has the lowest price in the group. ■

Robert Mitchell is BYTE's senior editor for columns. You can reach him on BIX as "rob_mitchell."

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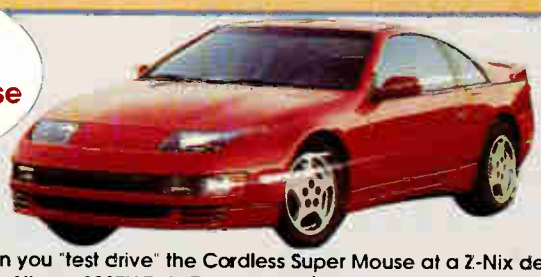

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APPLICATION

Photoshop vs. ColorStudio: Their Battle Reaches New Heights

CAL VORNBERGER

Whether your interests lie with computer illustration, digital color separation, or both, the recent upgrades to Adobe's Photoshop and Letraset's ColorStudio have much to praise. Macintosh-based illustrators will admire the new tools and image-processing features introduced in the upgrades, while desktop color separators will appreciate the real-time CMYK (cyan, magenta, yellow, black) color editing capabilities now in both programs. By combining these features with improved color correction and refined printer support, Photoshop 2.0 and ColorStudio 1.5 give you unparalleled control over the color printing process.

However, both programs have some nagging problems. ColorStudio's interface remains as arcane and difficult to learn as ever. And while Photoshop has caught up to ColorStudio in its ability to rasterize Encapsulated PostScript files, its new vector-based Bézier tool falls short of its competitor's capabilities. But in the end, both upgrades bring a bevy of important new tools and effects to the high end of the color-retouching and image-processing market.

A New Color Separation Era

Real-time CMYK editing and color correction is a great step forward in the quest for high-quality desktop color separations. Prior to these upgrades, if you wanted to retouch or manipulate images for four-color process output, you had to work in an RGB color space and then convert the images to CMYK. Because the Macintosh's 24-bit RGB mode can display more colors than cyan, magenta, yellow, and black inks can reproduce, you had to make educated guesses about how certain colors would print. The ability to separate, color-correct, and retouch an image in a CMYK color space ends this guesswork.

In addition, the programs can now be precisely calibrated to specific output devices and paper stock. The upgraded Photoshop contains a new Preferences menu item that lets you configure the program to match your color monitor to a specific color output device.

Photoshop's improved color-correction tools give greater control over undercolor removal and gray-component replacement for increased control of color separations. The program now supports PostScript Level 2 output devices. Also new is Pantone's Color Matching System and support for Pantone's recommended CMYK equivalents when used in the four-color printing process.

ColorStudio also supports the Pantone color system. Version 1.5 offers a separate program called ColorCalibrator, which lets you create custom printer configuration files and fine-tune color printer output much the way you can with Photoshop's Preferences. ColorStudio includes new drivers for several popular output devices, including dye-sublimation printers and many desktop scanners.

Vector Layers

An important new feature in Photoshop is its ability to rasterize Encapsulated PostScript files created with Adobe Illustrator and other compatible programs. Previous versions could open only a ragged bit-mapped representation of the PostScript file; now Photoshop does an excellent job of creating an antialiased final image at any size or resolution.

With its Shapes Annex, ColorStudio has had this ability for a while, and it is still one of the most innovative features of the program. Supplied with the upgrade, the Shapes Annex lets you draw on a PostScript layer with vector-based drawing tools. This vector-based layer sits on top of a bit-mapped image, and you can turn the Shapes layer on and off at will. You can also import Illustrator and FreeHand files into this layer and convert the finished product into a clean antialiased bit map.

This is a powerful feature, particularly when combined with the mask functions in either program for creating embossed effects. I used the Shapes Annex and mask layer to produce the black-on-white dollar signs in screen 1a. Color-

BYTE ACTION SUMMARY

- **WHAT PHOTOSHOP 2.0 AND COLORSTUDIO 1.5 DO**
  They give Macintosh-based graphics professionals high-end image-processing and color-retouching capabilities.
- **LIKES**
  Real-time CMYK editing and color correction, vector-based drawing tools, and an array of new image-processing tools.
- **DISLIKES**
  ColorStudio suffers from a daunting interface and slowness when performing some tasks. Photoshop's vector-based Bézier tool falls short of the competition.
- **RECOMMENDATIONS**
  Both applications provide impressive image-processing power, but I give Photoshop the edge for its speed and easy-to-use interface.
- **PRICE**
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  ColorStudio 1.5, $995
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Screen 1: *ColorStudio's Shapes Annex created the vector-based dollar signs* **(a)** *in a mask layer. The author then used a ColorStudio texture to create a background* **(b)** *and produced the embossed wallpaper* **(c)** *using ColorStudio's new Relief tool in conjunction with the mask layer.*

Studio's new Relief filter in conjunction with a texture (screen 1b) created the final embossed effect (screen 1c).

But ColorStudio's Shapes Annex suffers from the same flaw that I perceived throughout the program: lack of a consistent, intuitive interface. Moreover, if you attempt a complex vector-based graphic on the PostScript layer (e.g., the dollar signs), ColorStudio will slow to a crawl.

While Photoshop 2.0 introduces a vector-based selection tool that enables you to create defined shapes using Bézier curves, the tool doesn't compare favorably with ColorStudio's fully implemented Shapes Annex. Photoshop's new Bézier tool works like a pen in Adobe Illustrator. You can create paths that you can save as Encapsulated PostScript files and use later as a clipping path to silhouette an image. In addition, with the new `Make Path` command, you can turn a selection shape into an editable path and save it as a PostScript file.

Duotone Support

Photoshop now supports duotones (and tritones and quadratones). A *duotone* is a method to increase the tonal range of a gray-scale image by printing with black and an additional color (see screens 2a and 2b).

You can specify any Pantone or process ink as the second ink color in an image to increase dynamic range. A third and fourth color can also be selected to create tritones and quadratones. While these tools are valuable additions to the desktop designer's toolkit, Photoshop makes it so easy to create duotones that I fear publications may soon be swamped with them.

Imaging and Video Tools

The programs include some interesting new image-processing tools. ColorStudio offers average, high-pass, blur, and color relief filters, among others. The program also lets you create custom effects with the ColorTalk script-language module. Photoshop's new effects include pointilize (for a mosaic look), emboss, crystallize, wind, and radial blur filters.

Both Photoshop and ColorStudio have extensive file-import capabilities. Photoshop supports a wider range of alien file formats, including TARGA, Amiga, and GIFF files, among others. ColorStudio imports TARGA files and Photoshop's native file format. The two programs let you import images scanned on high-resolution scanners (e.g., a Scitex) for manipulation on the Mac. The problem is, the higher the scan resolution, the larger the file size. And while both programs make use of virtual memory schemes, files in the 20-MB to 200-MB range are just too large for a 68030-based machine to handle effectively. Perhaps the 68040-based Macs will make high-resolution desktop retouching and color correction practical.

Photoshop 2.0 gives the nod to video users with two important features. The first is the ability to "de-interlace" a video frame capture. This removes jitters normally encountered when digitizing full-motion video. Second, you can now remap the color palette of an image so that only "video-legal" colors are used. Similar to the problem encountered in printed output, 24-bit RGB mode can create colors that cannot be rendered by the NTSC standard. Letting users remap and image to a video-legal color palette avoids this problem.

The new Photoshop release also has several features for animators. It can convert 8- or 24-bit RGB images into 8-bit indexed color images. You can map these images to a predefined color palette or a palette imported from another program. This feature should endear itself to users of Paracomp's FilmMaker or MacroMind's Director. Another benefit to animators is the PICT Resource module. With this plug-in module, included with the program, you can open PICS animations and import them into Photoshop for individual processing.

Interface Problems

You have to admire ColorStudio's developers for cramming more features into this program than the typical user could ever need. But Letraset should have spent more time developing a simple, intuitive interface that lets you tap into all that power. The new release suffers from the same confusing interface as previous versions. And while the new ColorStudio is significantly quicker than its predecessor, the program is still annoyingly slow with certain tools and commands. When I ran it on a Mac IIci, it was often sluggish with any but the most basic 24-bit-color images.

Photoshop's interface continues to be a major reason why this program has a wide following among designers. While the new Photoshop isn't quite as feature-laden as ColorStudio 1.5, its interface is simple, consistent, and intuitive, making it much easier to learn. All of Photoshop's tools and effects are more immediately accessible than its competitor's, and all perform smoothly without a noticeable lag or delay.

Not much has been done to improve ColorStudio's masking features, which remain one of the program's most arcane concepts. With its single mask layer and obtuse way of implementing masking features, ColorStudio makes you conform to its idea of how masks should be created and used. The whole process is far too modal, employing several tedious and unneeded steps.

By contrast, Photoshop's developers have improved on the mask selection process. You can still have multiple masks

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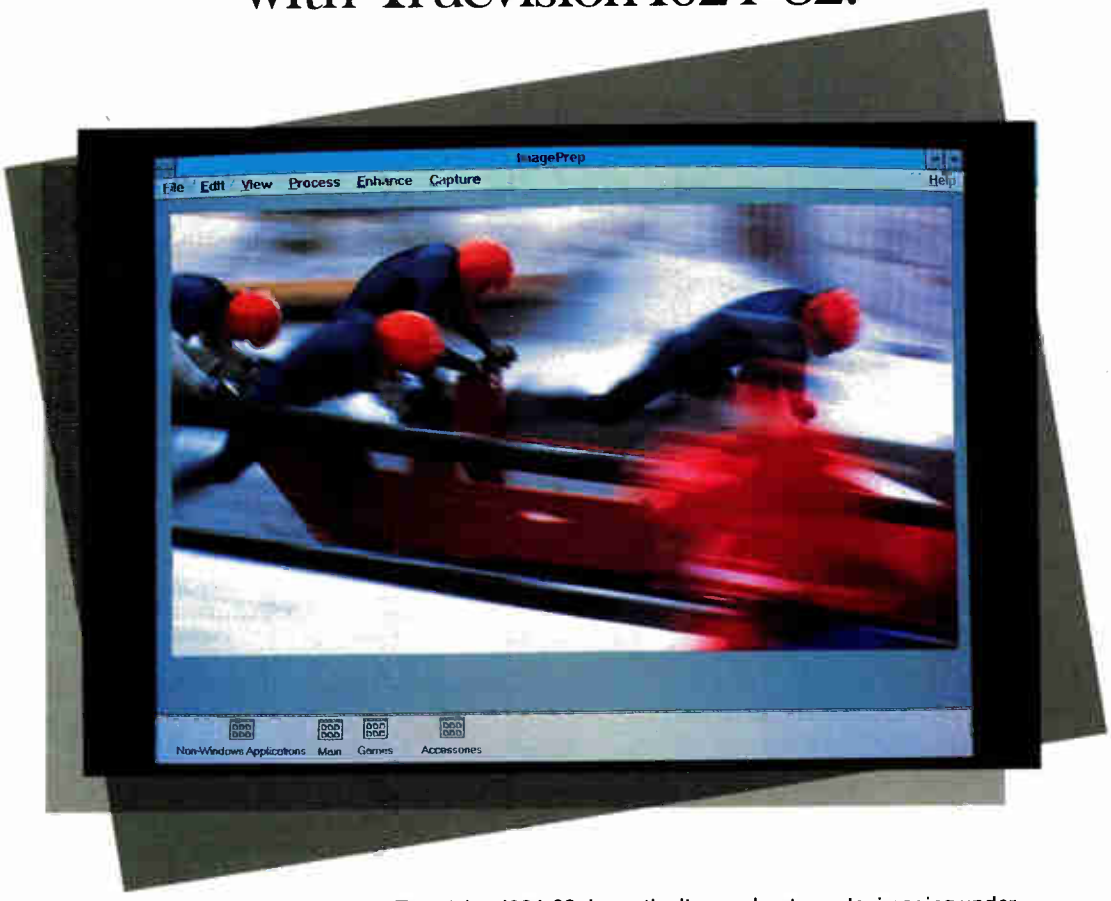

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Screen 2: *Photoshop 2.0's support for duotones can expand the contrast range of gray-scale images* **(a)** *by adding a second color* **(b).**

per image. I find the masking tools in Photoshop one of the program's strongest and most versatile features.

Finally, I encountered an annoying quirk with ColorStudio: its propensity to search the SCSI bus for a device with the most available space to store its temporary files. In my case, it found a WORM (write once, read many times) drive and proceeded to gobble up more than 100 MB of disk space with temporary files. You can control temporary drive parameters, but you must run a separate program to change these defaults. ColorStudio's extensive use of temporary files written to storage devices is part of the reason the program is so slow. Photoshop 2.0 uses the start-up disk as the default temporary file disk. You have the option of choosing another "scratch disk" from the Virtual Memory submenu under the Preferences menu.

System Requirements

Both programs are System 7.0–compatible, although Adobe recommends avoiding Apple's virtual memory scheme. Adobe claims that its own scheme works better, and I have no reason to doubt this. Both Photoshop 2.0 and ColorStudio 1.5 ran very well on a Mac IIci with 20 MB of memory and 32-bit addressing turned on. Both programs support Apple's Publish feature and Balloon help.

Adobe recommends that you run Photoshop 2.0 with at least 4 MB of memory. ColorStudio 1.5 needs at least 5 MB of memory and a Mac with a floating-point processor. Macs without the floating-point chip, notably the LC and the IIsi, can use a special, slower version called ColorStudio NFP. A 24-bit color video card is a must for both programs.

A Clear Winner

ColorStudio could be a very good program if Letraset solved some daunting interface problems and sped up the program. With so much power under the hood, it's like driving a car with an interior as complicated as a Boeing 747 cockpit. If you could figure out how all those knobs and dials and gadgets worked, you could probably make the car go very fast. Photoshop, on the other hand, fools you with its simplicity. At first, you wonder how such a simple, spare-looking interface could ever live up to Adobe's claims. You quickly learn that inside that simple exterior lies an extremely powerful design tool.

The latest versions of these programs are on a par in terms of features and image-processing power. However, Photoshop wins hands down in speed of execution and ease of use. ■

Cal Vornberger is a principal at Tumble Graphics and Animation, a New York design firm that specializes in interactive multimedia presentations. He is also a faculty member of the Pratt Institute in Manhattan, where he teaches computer illustration and multimedia production. You can reach him on BIX as "cvornberger."

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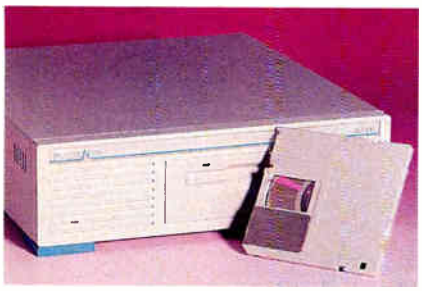
Will 3½-inch Rewritables Reshape the Optical Market?



Pinnacle Micro's REO-130 drive portends well for emerging 3½-inch erasable optical drives.

The onslaught of 3½-inch rewritable-optical (R/O) drives due this month could finally make optical storage a high-volume business. Approximately a dozen vendors, including IBM and Sony, plan to join Pinnacle Micro and Ocean Microsystems, which are already selling drives to creators of large graphics and CAD files and those interested in securing and distributing data.

The BYTE Lab recently had a chance to look at one of the first 3½-inch R/O drives to ship, Pinnacle Micro's REO-130. The well-built external subsystem houses a drive manufactured by Most, the parent company of Nakemichi. Western Digital's 7000-Fasst SCSI adapter ships with the drive, along with Columbia Data Products' setup software. The package sells for $2495, and each 128-MB optical disk costs $129. Aside from the problems we encountered with incorrectly formatted media, installing and running the REO-130 were straightforward. We quickly had an additional 128 MB of storage capacity up and running as if we'd just attached a new SCSI hard drive.

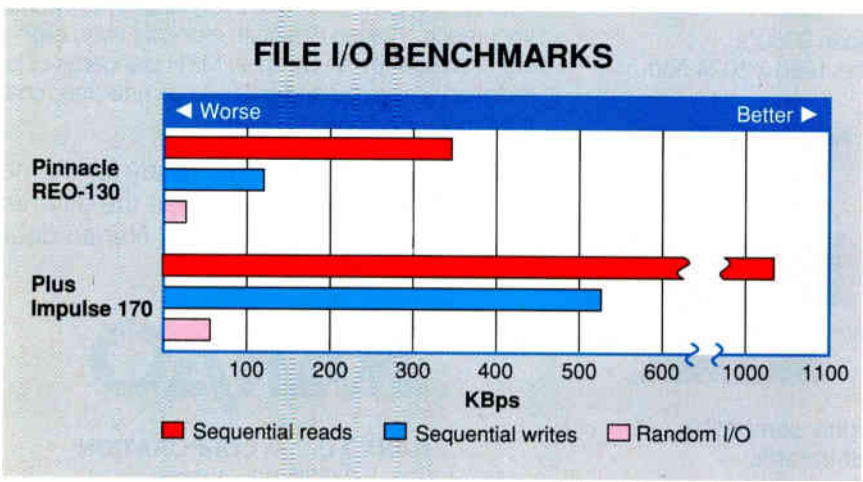
Citing a 30-millisecond access time for the drive, Pinnacle Micro compares the REO-130's performance to that of hard disks. We decided to explore performance further by running the BYTE Lab's SCSI file I/O benchmarks on the REO-130 and Plus Development's Plus Impulse 170-MB SCSI hard drive. Each ran on the same 25-MHz 386 system and SCSI controller. Based on these results (see the figure), the REO-130 posted results respectable for an optical drive, but not within the performance ballpark of its hard-drive cousin.

Pinnacle Micro also sets up the REO-130 to compete in price against removable-storage contenders such as the Syquest 88 and Iomega's Bernoulli 90. The optical drive costs roughly twice as much as the two competing drives, but media costs are lower, so economy of scale is important to the REO-130 price comparisons. For example, the price of roughly 256 MB of storage for the REO-130 is a relatively steep $10.75 per MB, compared to $6.54 and $7.99 for the Bernoulli and Syquest, respectively. But the economic differences flip-flop at higher storage levels: At around 1 gigabyte, the Pinnacle Micro, Bernoulli, and SyQuest drives and media cost $3.44, $3.63, and $4.14 per MB, respectively.

Overall, we rank the REO-130 as an encouraging first look at what may become a ubiquitous class of storage products. The drive performed flawlessly, and we liked the thought of adding a subsequent 128 MB of storage for roughly the cost of a software utility program.

But now is not the time to jump onto the 3½-inch R/O-drive bandwagon. Still unresolved are standards for high-level formatting and rotational speeds that will determine interchangeability of media written by different drives. Currently, Pinnacle Micro supports IBM's standard, while Sony and others plan to support a still-developing ANSI/ISO standard. Also, competition will have an immediate downward effect on prices for drives and media. Sony will price its external drive at $1895 and sell media for $69. The expected flood of competing products could drive street prices for drives and media even lower.

Security concerns or intense curiosity may force some to become early adopters today; the promise of clearer standards and better prices will cause us to wait a few months before we succumb.



The REO-130 posted performance respectable for an optical drive.

PixelPaint Professional 2.0: A Satisfying Sequel

It's hard to improve a program like PixelPaint Professional without just heaping more features onto it. With the new version 2.0, SuperMac Technology has fixed a few faults, built in a few new tricks, and managed to walk that line between added value and elephantiasis.

One complaint with 1.0 was that it couldn't handle 24-bit-color TIFF files. PixelPaint Professional 2.0 can. Reading in a TIFF file will give your hard disk some serious exercise, though, and if the file's big enough, you'll have plenty of time to fix a cup of coffee. The program will save things in Encapsulated PostScript form but can't read EPSF files. There is also a new file format called PixelPaper, which lets you store an image on a textured surface; this essentially simulates materials that traditional artists work on, such as canvas, linen, watercolor board, and rice paper.

The zoom tool also bothered some users of 1.0. You can now zoom in and not be confined to a little window that looks lost on a big screen.

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Mesh warp is another nice new trick. This lets you manipulate an image by bending anchor points on a grid. A new "random path mode" lets you distribute paint by splattering it in a sort of Jackson Pollock mode. You could do similar things with the Speckle Brush in 1.0, but now you can apply the same effect to other tools.

SuperMac has made one change that every other developer of paint programs should follow: Like Time Arts' Oasis package, PixelPaint now works with pressure-sensitive tablets, such as Wacom's or Numonics'. This means you can use a stylus to control tools like pastel, charcoal, and airbrush and have the same flexibility you'd have working with traditional media. Someday, may we all be free of having to paint with a mouse.

Performance is our one big complaint with this program. Some operations banged awfully hard on the hard disk, and response felt a tad slow when we used some tools. Painting at 24 bits will tax any machine, but we were using a Mac II powered by a Radius Rocket—that's a 25-MHz 68040 engine—with 8 MB of RAM. It doesn't get much better than that. For the next release, SuperMac should concentrate on optimizing performance and not worry about adding new features.

This is one deep program. Taken a little further, it would be too deep, with a crowded interface and tools too hard to find, and so complex that you'd have to—eegads!—read the manual. SuperMac continues to build on the fabulous MacPaint concept without losing the simplicity of that original.

$149 DisplayMate Rivals $25,000 Worth of Lab Equipment

When we received the DisplayMate Video Display Utilities from Sonera Technologies, we evaluated the package as a tool for testing monitors in the lab. That put the software product up against a pretty stringent standard. The BYTE Lab uses sophisticated hardware-based test equipment costing over $25,000. While we didn't expect a $149 software package to perform the same as our SuperSpot testing equipment, we found ourselves analyzing the trade-offs.

The DisplayMate software serves several useful purposes. If you have already bought a monitor, it can help you adjust the settings for the best display possible. It can also alert you to possible problems that may require a service technician. DisplayMate's rich set of tests can reveal nearly any problem afflicting your monitor, and the system prompts clearly explain the problem and how to deal with it.

Purchasers of video display equipment will find DisplayMate indispensable. And it's convenient enough to be practical. By carrying a single disk to your dealer, you can quickly and effectively test a broad range of monitors for common pitfalls. The utilities can expose quirks in even the most expensive display systems. We found it especially useful to run two monitors side by side to evaluate subtleties in display quality. DisplayMate belongs in the software arsenal of every volume buyer of monitors.

Most of the DisplayMate tests do not produce quantitative data: Problems with display quality must be detected by the human eye. At first we had a problem with this. But in the end, the software's clever design made us believers. Sonera created test patterns to make the effects you need to see clearly discernible. For instance, the test for screen regulation displays a blinking box framed by a single-line border. A monitor with geometric distortion will cause the outer border to change size as the inner box blinks.

We first tested a monitor that didn't suffer from this problem, so we found ourselves striving to see the smallest possible changes in the border. Once we found a monitor that did have a problem with screen regulation, the evaluation required no guesswork; the border clearly expanded when the inner box blinked. As we tested many monitors around the lab, we discovered a range of display problems. The tests exposed these problems with impressive consistency.

The program also did a good job of testing LCDs for common problems, such as color mapping, ghosting, text scrolling, and persistence. It may not replace our current monitor-testing equipment, but it surely will become a required utility in our testing suite.

And one word about documentation: outstanding. In addition to clear instructions, the manual includes extensive general information about video displays. Ironically, the program is easy enough to use so that you may not need the manual to run the software, but you'll probably keep it handy for reference purposes. ■

—The BYTE Lab

Correction ▲

In "Getting Groups on Schedule" (September BYTE), the cost to license 50 simultaneous users for Synchronize 1.1 was incorrectly stated. The correct cost is $4500. We regret the error. CrossWind Technologies, makers of Synchronize, can be contacted at (408) 335-4988.

Reviewer's Notebook provides new information—including version updates, new test data, long-term usage reports, and reader feedback—on products and product categories.

ITEMS DISCUSSED

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PRINTF PLUS

An extensible template-oriented printing function for C

Every C programmer has come to know and love `printf`. The kind of output that `printf` and its relatives `sprintf` and `fprintf` provide—a string template that indicates places where values should be substituted—is far more concise than outputting each item with a separate function call (as in Modula-2) and is more readable than separating the items by commas (as in BASIC and Pascal).

There's only one problem with `printf`: It's not extensible. There's no way to add to its fixed set of format specifications. For example, you can write

```
printf("The value of %s is %d\n",
       var.name, var.val)
```

if `var.val` is an integer, and similar notation for the data types long, float, double, char, and string. But you can't be so concise if `var.val` does not correspond to one of the few built-in specifications that `printf` allows, in which case you have two choices: First, you can resort to a Modula-2 style of output, writing

```
printf("The value of %s is",
       var.name);
print_var_value(var.val);
printf("\n");
```

That's not very pretty. Second, you can use a more general solution, writing a function `var_value_string` that places a printable representation of the object into a string. If the function takes care of allocating the string, you can write the following:

```
printf("The value of %s is %s\n",
       var.name,
       var_value_string(var.val));
```

But even though this is almost as concise as the original example, it requires a lot of storage to hold the string for large objects, as well as some way of managing that storage. If you `malloc` the string space, you have to free it, which means you can't write the above code—you'd lose the pointer to the newly created string. If you use a fixed-size character array to hold the string, you have the unpleasant problem of guessing the largest size you'll ever need and weighing that against the inevitable waste of space. You also have to use the function carefully, since a second call will overwrite the string from the first call.

Neither of these solutions holds a candle to this idea: Add a new format specification to `printf` (I'll call it `%V`), arrange for it to invoke `print_val_value`, and write the following:

```
printf("The value of %s is %V\n",
       var.name, var.val);
```

ILLUSTRATION: MARK FISHER © 1991

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That's clean, simple and elegant. There's just one problem: You can't do it with `printf`.

But you *can* do it with the function that I'll present in this column: `eprintf`, the extensible `printf`. The `eprintf` function lets you define new format specifications that invoke your print functions when they appear in a format string. You can use single characters, as in the above example, or you can use strings enclosed in angle brackets. For instance, if you have a data structure called `Node`, you could write some code so that this would work:

```
eprintf("Current node:
    %<node>\n",
    cur_node);
```

For uniformity's sake, `eprintf` also lets you enclose single-character specifications in angle brackets.

If you're familiar with C++, you may think that that language has the extensible printing problem solved. In C++, you can overload the output operator << so that it invokes a function of your choice, depending on the type of its right-hand argument. So, in C++, you could write the above `eprintf` line as follows:

```
cout << "Current node: "
    << cur_node << "\n";
```

This solution is definitely an improvement over the earlier two ideas, but it has two problems. First, it's not as concise as the template-oriented style of printing—it's about as bad as the Pascal `write` statement. Second, and more important, it doesn't provide any way to print the same object in different formats.

This capability is one of the great strengths of template-oriented printing. For instance, as every C programmer knows, you can output an integer in decimal, hexadecimal, or octal, depending on whether you use `%d`, `%x`, or `%o`. Furthermore, you can supply arguments to the format specifications to further control the output. The specification `%-10.3s`, for instance, means that the first three characters of a string should be right-justified in a field 10 spaces long.

C++'s type-based output mechanism can't compete with this kind of flexibility. So even when I switch to C++ I'll still be using template-oriented printing.

Using eprintf

Here is the basic functionality `eprintf` provides. First, you can write

```
eprintf(format-string,
    arguments);
```

for any format string that `printf` would accept, and with the same effect. The same goes, of course, for `efprintf` and `esprintf`, analogs of C's other formatted-output functions.

Second, you can write your own printing function, install it on any character or string, and have it called when you use that character or string in a format specification. This is accomplished by a call such as the following:

```
install_eprintf_func("node",
    print_node);
```

where `print_node` is a function you supply. There's no restriction on the length of the string or on the characters it contains, except that it can't be the single

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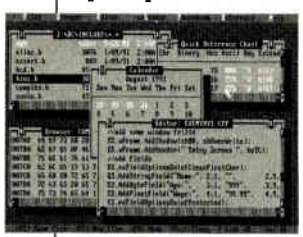

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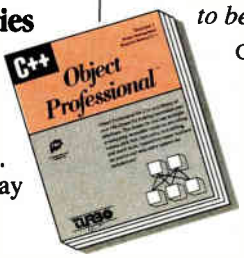

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character < and it can't contain >. However, if you use a single-character string that is a format flag, a digit, a period, or the letter *l*, you must enclose it in angle brackets when you write it in a format string.

The `eprintf` function provides some other capabilities as well. There is `get_eprintf_func`, which returns the function associated with a given string (or NULL if there is none). This is useful for checking to see if you are clobbering an existing association; `install_eprintf_func` doesn't warn you about these. The function `eprintf_abort` prints an error message on the standard error stream and aborts the current invocation of `eprintf`. In addition, there are several functions that are aids to writing your own printing functions.

Before showing you how to write a printing function, I'll explain how C handles functions with a variable number of arguments.

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The stdarg Facility

One of the nicer things that ANSI C has done is to establish a portable way to write functions that take a number of arguments not fixed at compile time. All you need to do to avail yourself of this is include the header file `stdarg.h`. (Most older, non-ANSI implementations provide a similar facility, obtained by including the header `varargs.h`; see your system's manual for details.)

The `stdarg` facility lets you access the arguments of a C function by manipulating a variable of type `va_list`. You first initialize the variable to the function's argument list by invoking the `va_start` macro. Then you can pick off the arguments one by one by calling `va_arg`, which takes a `va_list` and a type, returns the next argument, and, as a side effect, modifies the `va_list` so that subsequent calls to `va_arg` get the following arguments. You can even pass the `va_list` to other functions, which can themselves use `va_arg`. (As you'll see, this ability is crucial to `eprintf`.) Finally, when you're done, you must call `va_end`.

As an example, look at the `eprintf` function itself:

```
int
eprintf(const char *format,...)
{
    va_list args;
    int r;

    va_start(args, format);
    r = do_eprintf(format,
     &args, fput_char, stdout);
    va_end(args);
    return r;
}
```

The function header says that `eprintf` takes at least one argument, the format string, followed by an indeterminate number of other arguments. (Both the `const` and the ... are legal ANSI C.) I've called the `va_list` variable `args`, a convention I follow throughout. I initialize it with `va_start`, which also takes the last explicit argument to the function. Then I pass a pointer to `args` to `do_eprintf`, which does all the real work. (I'll talk about it more later.) I then finish with `va_end`.

Now the overall structure of a call to `eprintf` can be made clear: `do_eprintf` passes the `va_list` around to all the printing functions, and each printing function gobbles up as many arguments as it needs, using `va_arg`. (Woe if too few arguments were passed! But `printf` has the same problem.)

continued

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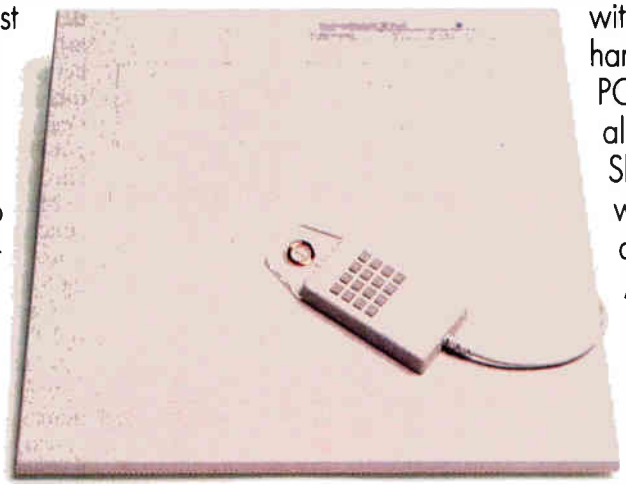

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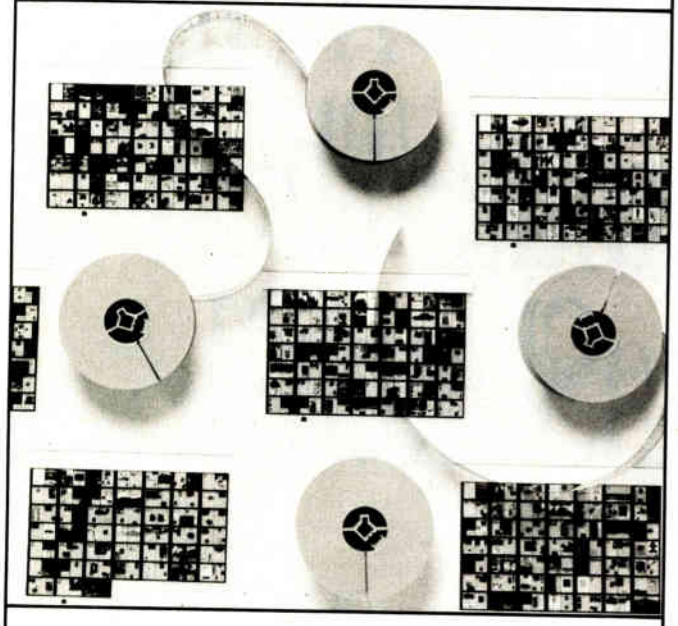

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Writing Printing Functions

Now that you understand `stdarg`, you can look at how to write printing functions. Here's a simple one: I'll use the character "C" to mean "print a single character, capitalized."

```
void
print_cap_char(EprintfInfo
    *info, va_list *args)
{
    char ch =
     (char) va_arg(*args, int);
    putch(islower(ch) ?
     toupper(ch) : ch);
}
```

As you can see, the second argument is a `va_list`, and the first thing that `print_cap_char` does is get its single value from the list using `va_arg`. (Ignore the first argument to `print_cap_char` for now.) You install this as follows:

```
install_eprintf_func("C",
    print_cap_char);
```

The `print_cap_char` function uses the `eprintf` function `putch` to perform character output; `putch` works just like `putchar`, but there's one crucial difference, and it brings up an important point that I've glossed over. Although I keep talking only about `eprintf`, there are actually three printing functions; the other two are `efprintf` and `esprintf`. One sends its output to the standard output file, another sends it to an arbitrary file, and the third sends it to a string.

Must you then write three printing functions instead of just one? No, because `eprintf` and friends set up some global variables to provide a uniform interface to all three output destinations. All the helper functions use this interface, so as long as you confine yourself to `eprintf`'s sanctioned list of helper functions, you can write just a single print function. The lowest-level part of this interface is `putch`, which adds a single character to the appropriate output. Had I used `putchar` instead of `putch` in my definition of `print_cap_char`, the call

```
efprintf(file, "%C", 'x');
```

would have resulted in `X` being printed on the standard output, instead of being written to `file`.

You may have noticed that I'm telling `va_arg` that the argument I want is an `int`, even though it is in fact a `char`. That's because C automatically performs two conversions during argument passing: It converts `float`s to `double`s,

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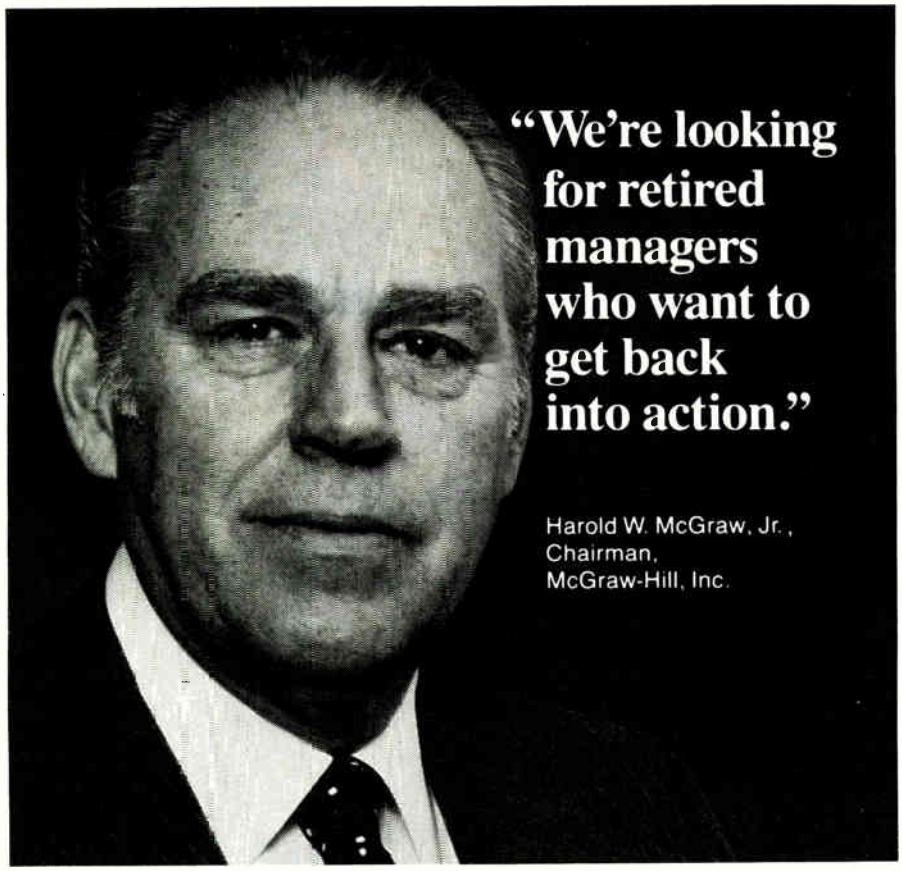

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writing a diagnostic message, of course). I implement this by using C's `setjmp` facility, which allows long-distance jumps between parts of a program. If this is a top-level (i.e., not a recursive) call to `do_eprintf`, it sets up a jump point using `setjmp`. The `eprintf_abort` function jumps back to this point. See my article "Taking Exception to C" (August BYTE) for a discussion of `setjmp`.

Now `do_eprintf` calls `veprintf_internal`. When it returns, the global `count` contains the number of characters that have been output. The `do_eprintf` function restores the saved globals and returns the count. The next stop is the `veprintf_internal` function, but first note that `eprintf_internal` is just a front for `veprintf_internal` that handles a variable number of arguments.

At last, in `veprintf_internal`, some real work is done. The format string is traversed, and any character that is not a percent sign is simply output by calling `putch`. If a percent sign is seen and it isn't followed immediately by another percent, then it must be a format specification. It's turned into an `EprintfInfo` structure by `parse_format_spec`, and then width and precision asterisks are filled in from the argument list. Finally, `veprintf_internal` calls `eprintf_from_info`.

The `eprintf_from_info` function is responsible for finding the function associated with a specification string. It manages references to functions in two ways: If the string is a single character, the function reference is stored in a table indexed by a character; otherwise, the reference is found through a hash table. (I use the simplest possible hash table design, a fixed-size table with linear probing.) If no function can be found, then `eprintf_from_info` writes an error message and aborts; otherwise, it simply invokes the function with the `EprintfInfo` structure and the argument list. The `eprintf_from_info` function is available for your printing functions to use, should you find it helpful.

The last functions I'd like to discuss are those that implement the built-in specifiers. There are two approaches to writing these functions. One is to write them from scratch; if you are lucky enough to have access to the source for your system's `printf`, you can probably use that code with minor modifications.

The other approach is to call `sprintf` with the format string and a buffer, and then write out the buffer using `putch`. That's the approach that I've taken. The advantage is that I don't have to worry about implementing all the functionality

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Listing 2: *The function* print_quoted_string *gets around the ugly problem of printing strings with double quotes with simple* printf.

```
void print_quoted_string(EprintfInfo *info, va_list *args)
{
  char *s;
  int n, len;

  s = va_arg(*args, char*);
  /* compute # of chars of string that will be output */
  len = strlen(s);
  if (info->precision >= 0 && info->precision < len)
    len = info->precision;
  /* compute spaces to use */
  n = info->width - len - 2; /* -2 for quotation marks */
  if (contains_flag('-', info)) { /* left-justify */
     eprintf_internal("\"%.*s\"", info->precision, s);
     while (n-- > 0) putch(' ');
   } else {       /* right-justify */
     while (n-- > 0) putch(' ');
     eprintf_internal("\"%.*s\"", info->precision, s);
   }
}
```

Listing 3: *The* print_int_array *function prints out a one-dimensional array of integers in a mathematical format.*

```
void print_int_array(EprintfInfo *info, va_list *args)
{
  int *a, i;

  a = va_arg(*args, int*);
  putch('{');
  if (info->width > 0) {
    for (i = 0; i < info->width-1; i++)
      eprintf_internal("%d, ", a[i]);
    eprintf_internal("%d", a[info->width-1]);
  }
  putch('}');
}
```

```
printf("The string is \"%s\"
    \n", str);
```

to print out a string with double quotes around it. This is ugly enough that it's worth defining a printing function for it. Assume it's assigned to S. The printing function handles widths, so I can write

```
eprintf("The string is %*S\n",
    n, str);
```

to get str with quotes around it right-justified in a field of width n. Note that this is something you can't write at all with printf; the closest you can come is

```
printf("The string is \"%*s\"
    \n", n, str);
```

which will leave the left quotation mark at the left end of the field instead of just before the first character of the string.

Listing 2 gives the printing function. There's really nothing much new there; the only function in it that I haven't covered yet is contains_flag, which I've provided to simplify a common test. This code handles left justification and precision as well as width; it takes care of justification and width itself and lets %s deal with the precision.

I'll do two more examples before diving into the implementation of eprintf. For the first example, say you had a structure defined as follows:

```
typedef struct {
    char *name;
    int count;
  } Node;
```

A simple printing function for Node might look like this:

```
void
print_node(EprintfInfo *info,
    va_list *args)
{
    Node *n = va_arg(*args,
     Node*);
    eprintf_internal("<%s:%d>",
    n->name, n->count);
}
```

For the second example, I'll print out one-dimensional arrays of integers. I'll use the width field in a nonstandard way, to specify the length of the array. If the variable array contains the three integers 0, 1, and 2, in that order, the call

```
eprintf("%*<IA>", 3, array);
```

will print {0, 1, 2}. The printing function is shown in listing 3.

Implementation

The division of labor for eprintf is a bit complicated. The call hierarchy is illustrated in the figure.

At the top level are the three functions eprintf, efprintf, and esprintf. As you've already seen, these do almost nothing, leaving the real work for do_eprintf. In addition to the format string and argument list, they give do_eprintf a function pointer, which will become the putch function, and either a file or character pointer, which is the output destination.

The actual top-level function is do_eprintf. It begins by ensuring that eprintf is initialized. Then it saves the current global variables putch, stream (the output destination), and count (the count of characters output) in local variables. This is so you can call eprintf recursively. Normally, you won't want to do this—you'll call eprintf_internal instead. Sometimes, however, you may want to use esprintf to help you out, or efprintf to print to a log or write an error message while in the middle of a printing function. By saving and restoring these global variables, do_eprintf ensures that recursive calls won't clobber the existing values.

Next, do_eprintf initializes the globals for this call. The putch and stream functions are initialized from the arguments passed from eprintf, efprintf, and esprintf, and count is set to zero. The stream and count functions are used only by the two putch functions, fput_char (for writing to files) and sput_char (for writing into strings).

The next step has to do with error handling. When an error is encountered during printing, the simplest thing to do is abort the entire printing operation (after

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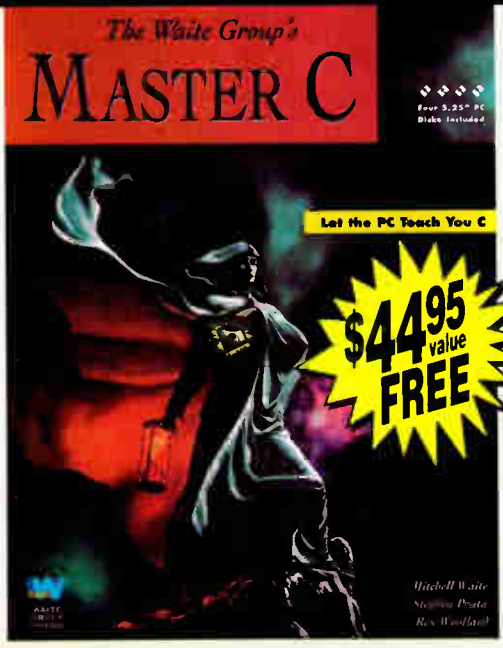

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Listing 1: *The header file,* eprintf.h, *shows the definition of the* EprintfInfo *structure and documents each field.*

```
/* Header file for eprintf. By Jonathan Amsterdam */

#ifndef _eprintf_h
#define _eprintf_h

#include <stdio.h>
#include <stdarg.h>

typedef struct {
    char *start;     /* pointer to just after the '%' */
    int len;         /* length of entire format specifier */
    int n_flags;     /* number of flags-first chars of start */
    int width;       /* width arg (-1 if not present) */
    int precision;   /* precision arg (-1 if not present) */
    char pad_char;   /* padding character (blank or zero) */
    int is_long;     /* true if an 'l' was seen */
    char *spec;      /* pointer to start of char or string */
    int spec_len;    /* length of spec char or string */
  } EprintfInfo;

typedef void (*EprintfFunc)(EprintfInfo* info, va_list *args);

/* top-level functions */
int eprintf(const char *format,...);
int efprintf(FILE *f, const char *format,...);
int esprintf(char *s, const char *format,...);

/* helper printing functions */
void eprintf_internal(char *format, ...);
/* like eprintf, but output to current destination */

void veprintf_internal(char *format, va_list *args);
/* as above, but with a va_list */

void eprintf_from_info(EprintfInfo *info, va_list *args);
/* dispatch to a printing function based on info */

void putstr(char *s);
/* output a string, using putch */

/* utilities */
int contains_flag(char ch, EprintfInfo *info);
/* was the specifier written with the flag ch? */

void eprintf_abort(char *s);
/* write error message, abort eprintf */

char *format_string(char *fmt, char *flags, int width, int precision,
                    char pad_char, int is_long, char *spec);
char *format_string_from_info(char *fmt, EprintfInfo *info);
/* Convert separate items, or an info, into a format string. You supply
   the storage in the first argument, which is filled and returned.
*/

/* associating strings and printing functions */
void install_eprintf_func(char*, EprintfFunc);
EprintfFunc get_eprintf_func(char *s);

void (*putch)();  /* add one character to the current output */

#endif
```

and it converts chars to ints. Go figure.

There's a slightly more complicated printing function that prints out an integer representing a number of cents as an amount of money, with dollar sign and decimal point (but no commas). You might assign this function to the $ character. The code is a bit tricky, because you must avoid using the mod or division operators with negative operands if you want to be portable. Here's the function:

```
void
print_dollars(EprintfInfo*
    info, va_list *args)
{
    int amount = va_arg(*args,
      int);

if (amount >= 0)
     eprintf_internal
     ("$%d.%02d", amount/100,
       amount%100);
else
    eprintf_internal
    ("$-%d.%02d", (-amount)/100,
    (-amount)%100);
}
```

The eprintf_internal function is another helper function. It looks just like a call to eprintf, but it will send its output to the current destination instead of to the standard output.

Now I'll look at that first argument to print_cap_char and print_dollar: As you're aware, a format specification can be considerably more complicated than just a percent sign and a character. The full syntax of what can follow the percent sign is as follows: zero or more flags (the flag characters are +, –, #, and blank), then an optional sequence of digits specifying a width, then an optional precision consisting of a decimal point and a digit sequence, then an optional l to indicate a "long" argument, and, finally, the specification character. Furthermore, instead of a digit string, the width or precision part can be a single asterisk, in which case the next argument is used as the width or precision.

If you want to write a fully general printing function, you'll have to deal with all this complexity. For example, you should do something sensible with %–12$—probably left-justify the output in a 12-space field.

Of course, if you're just writing printing functions for your own use, then feel free to do as little work as you can get away with. But if you do opt for generality, you'll have to deal with those hairy format specifications. At least you won't have to parse them, though; eprintf does that for you, and it also takes care of the width and precision asterisks.

When it parses a format specification, eprintf puts all the pieces in a structure of type EprintfInfo and gives your printing function a pointer to that structure. Listing 1 shows the definition of the structure and documents each field. I've been careful to arrange things so that no string copying needs to be done; all the character pointers are pointers into the original format string, and the length fields tell how long they are.

Now I'll write another printing function that uses some of this information. I often find myself writing something like

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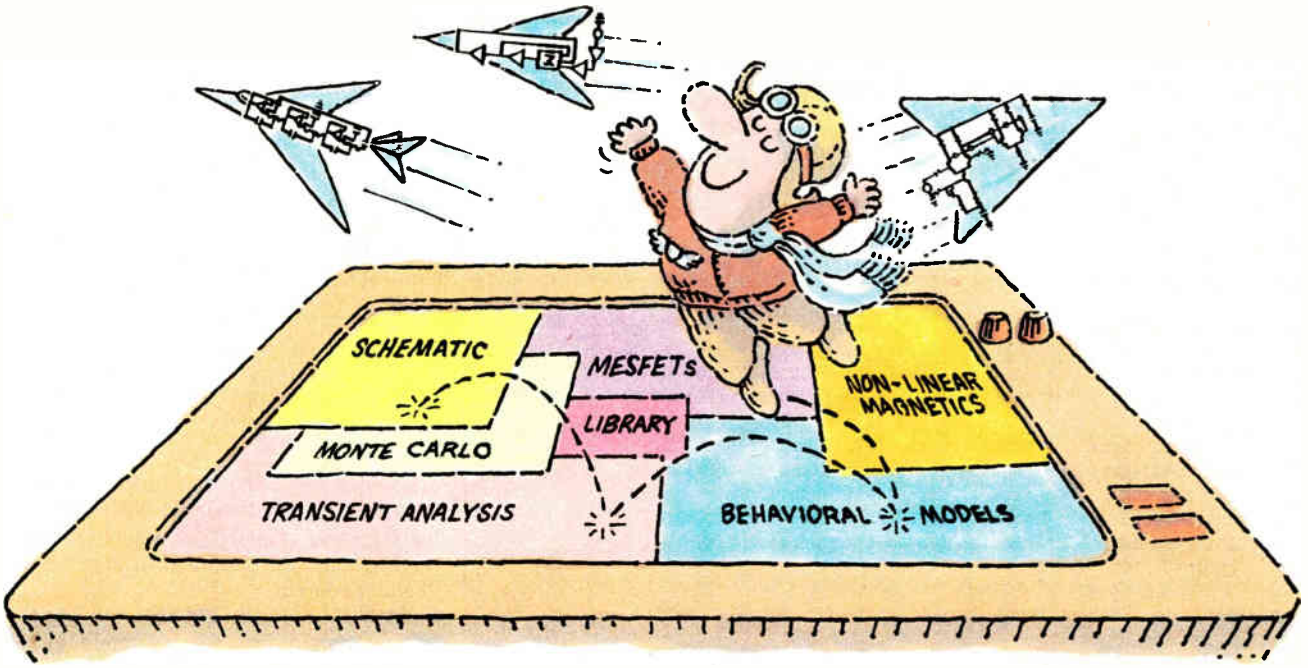

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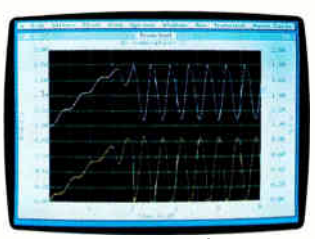

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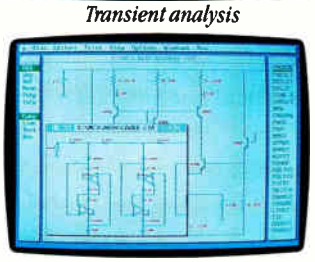

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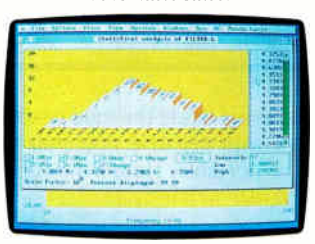

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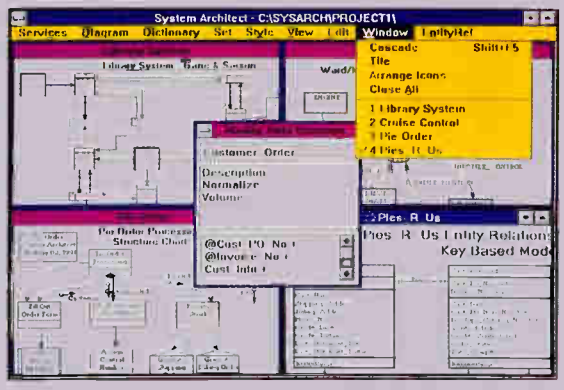

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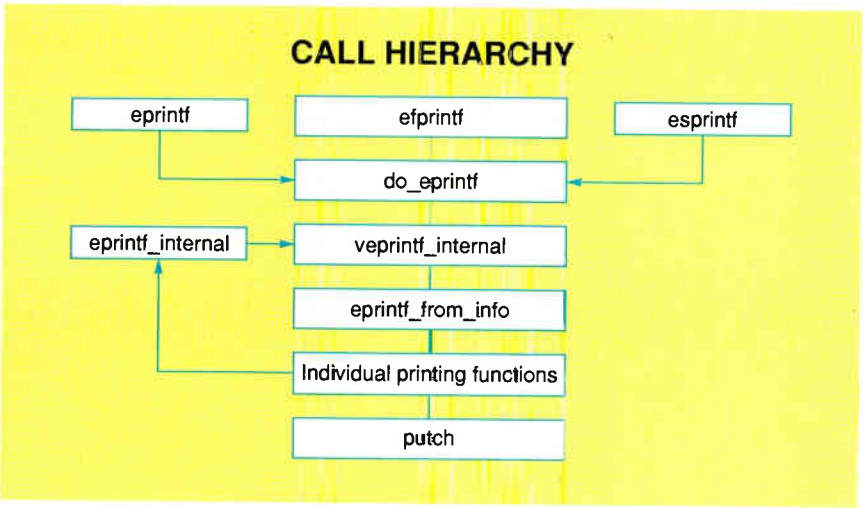

The function call hierarchy of `eprintf`*, the extensible formatted print function.*

of format specifications; the writers of `sprintf` have already done that. The disadvantage is that I have to allocate space for the buffer. I've decided to use a fixed-size 1-KB buffer, which should be more than enough. Still, if someone uses a very long width in a call to `eprintf`, it will fail, whereas `printf` won't (or shouldn't).

The four built-in printing functions include `char_printer`, `int_printer`, `real_printer`, and `string_printer`, and they do what their names indicate. The last three of these use the `format_string_from_info` function, which is the inverse of `parse_format_spec`: It turns an `EprintfInfo` structure back into a string. You can call it in your own printing functions if you want, or you can use its companion, `format_string`, which takes a separate argument for each part of a format specification.

It's Yours

The `eprintf` function is a good example of how a straightforward idea can hide a multitude of subtleties. The most difficult part of the project was getting the call hierarchy of the figure right, so both fully recursive calls and internal calls were possible and easy to express. I dealt with recursion using two mechanisms: explicitly saving and restoring global variables (`putch`, `count`, and `stream`) and passing local variables as arguments (`info`). Keeping `eprintf` efficient, by avoiding string copying, and handling the built-in printing functions elegantly were the two other main challenges.

There are at least two ways to go with this project; I'll leave them as exercises for the interested programmer. The first has to do with efficiency. How much is `eprintf` slowed down by the need to look up multicharacter format specifications in a hash table? Not at all in the case of single-character specifications—they are indexed directly in an array. And my guess is, hardly at all for multicharacter ones, especially if the hash table is sparsely populated. Parsing the format string probably takes as long; anyway, the real bottleneck is the actual character output (except when writing to a string).

The project is to profile `eprintf` to see if the hashing is slow, and if so, to design a better indexing scheme. Most programs install a bunch of printing routines initially, before they print anything, so perhaps you can optimize the hash table by exploiting this fact.

The second extension to `eprintf` is to make it even more extensible. One suggestion is to allow the user to define new flags; another is to allow arbitrary pad characters (currently, only blank and zero are possible). Use your imagination, or take a look at Common Lisp's `format` function. In addition to the features of `printf`, it also supports pluralization, justification, case conversion, conditionals, and iteration constructs with nonlocal exits. ■

Editor's note: *The complete source code of* `eprintf` *is available in electronic format.* *See page 5 for details.*

Jonathan Amsterdam is a graduate student in computer science at MIT and lives in Cambridge, Massachusetts. He can be reached on BIX c/o "editors."

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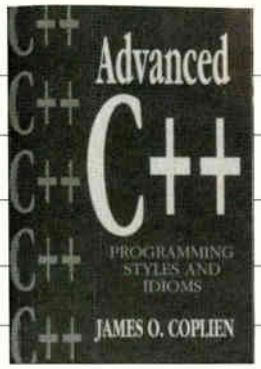

Advanced C++
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James O. Coplien

Written by an expert in C++, *Advanced C++ Programming Styles and Idioms*, looks at the design features of the C++ programming language. Assuming a background in the syntax of C++, Coplien shows how to become an expert C++ programmer by learning the idioms of the language. His approach is organized around the abstractions that C++ supports: abstract data types, combining types in inheritance structures, object-oriented programming, and multiple inheritance. Using small, but rich examples, he shows how these abstractions can be combined to use the language effectively. Experienced programmers will appreciate the comprehensive coverage of the most current release of C++.

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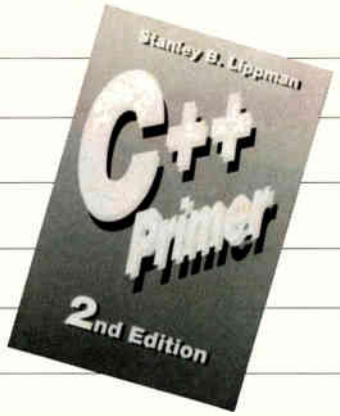

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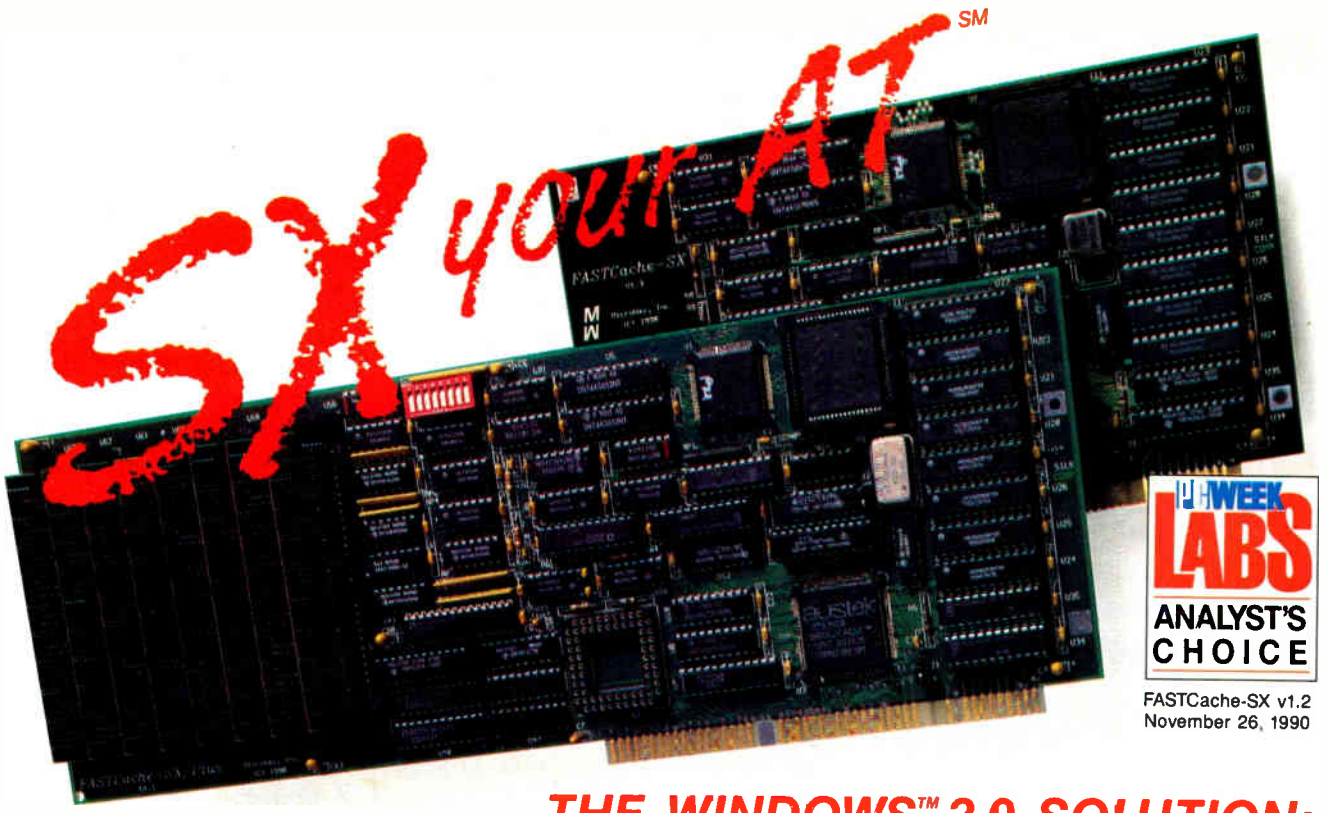

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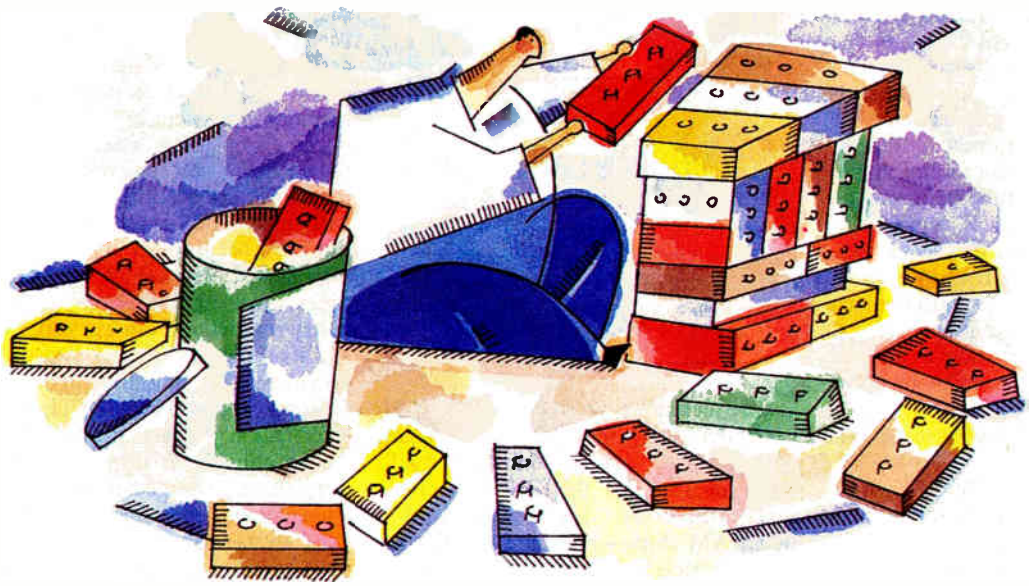
ROGER C. ALFORD

MODULAR-CPU DESIGNS



Weighing the pros and cons of upgradable systems

More and more vendors of high-end systems are jumping on the modular-CPU bandwagon. New converts this year include Zeos International and industry heavyweights IBM and Compaq. Modular-CPU designs allow users to upgrade to a faster processor without replacing the rest of the system and, increasingly, have become a checklist item (especially for corporate buyers).

Modularity, however, doesn't come without a price. Designing a system to support a replaceable CPU board entails significant challenges. The resulting modular system usually costs more than its nonmodular counterpart and may perform less well. Moreover, it now has one more potential point of failure—the CPU-board interface connector. Nevertheless, some newer designs have overcome the performance compromises of earlier systems, and Intel's latest processor announcements bode well for the future of replaceable-CPU systems.

In this installment of Under the Hood, I'll take a look at how a modular-CPU system design compares with the more conventional motherboard design, and I'll highlight the major design concerns and trade-offs involved in implementing such a system. I'll also describe some alternative modular-CPU designs.

A Conventional System Design

The design of a typical high-performance PC system (see figure 1) provides a basis by which to compare modular-CPU designs. The main functional blocks include the microprocessor (or CPU), the chip set, the system clock oscillator, an optional cache-memory subsystem, the main system memory (or DRAM), and the system I/O (e.g., keyboard interface, video interface, drive controllers, and expansion slots). The chip set contains the main system logic, including the interrupt controllers, the DMA controllers, the memory controller, and the bus buffers. It also contains the I/O bus control circuitry and often contains the cache controller. The system oscillator generates a high-speed square-wave clock signal that determines the speed at which the CPU runs.

An important concept in the design of such a system is *synchronization*. The CPU generates various signals during a memory or I/O access (read or write) and requires the rest of the system to operate in sync with these signals. Signals going to the CPU from the system must meet specified setup and hold times. This means they must be present and stable for a defined minimum amount of time (i.e., the setup time) before a particular edge of the processor's clock and must be held stable for some minimum amount of time (i.e., the hold time) after the clock edge; the processor samples the signals at the clock edge. If the setup and hold times are not met, proper CPU operation is not guaranteed. Thus, the CPU and the chip set (which controls the memory and I/O access timing) must operate synchronously,

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using the same clock.

It is also important to understand how a system accesses both main memory and cache memory. High-speed microprocessors, such as 386 and 486 devices, can access memory much faster than conventional DRAM chips can handle. These memory chips essentially store a charge on tiny capacitors—one capacitor for each bit. The bits are organized on the chip as an array of rows and columns. To read a particular bit on a chip, the system circuitry must provide the row address and the column address of the bit, in that order. Then, many nanoseconds later, the memory outputs a bit value representing the charge on the capacitor at the specified row and column addresses. The system must then wait for the chip to get past its precharge time before it can be accessed again. All these steps together result in lengthy DRAM access times.

Further complicating DRAM use, the capacitors on these devices must be periodically refreshed to keep their charge. They can be refreshed a row at a time just by accessing that row. PC-compatible systems generate a special DMA cycle every 15 microseconds that refreshes one row on the DRAM chips.

Even a modern "fast" DRAM with a 60-ns access time requires more than twice that much time to complete a full read or write cycle. The 60-ns access time refers only to how quickly the DRAM can output data from the time it receives a row address and does not count other cycle-to-cycle delays, such as the precharge time, the row-address set-up time, and timing safety margins. In contrast, high-speed 386 and 486 processors can access memory much faster. CPUs operating at 33 MHz can complete a read or write cycle every 60 ns. A 486 with burst transfer mode can go even faster. When the accessed memory (or I/O) location cannot respond with data as quickly as the CPU can accept it, wait states (or idle time) must be added to the CPU cycle to make the CPU wait until the memory can respond as requested.

Static RAM (SRAM) chips do not suffer from these operational anomalies, but they are much more expensive than their DRAM counterparts and are thus prohibitive for the large amounts of memory needed in today's PCs. Fortunately, some methods have been developed to reduce the performance penalty normally incurred when using DRAM chips. Most of these techniques are based on the fact that processors are largely sequential devices that spend most of their time retrieving instructions from memory one word at a time in sequential order.

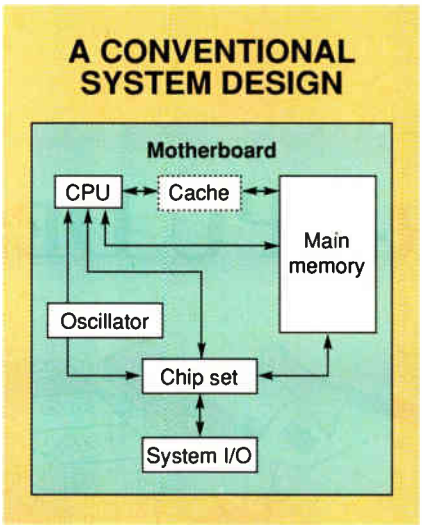

Figure 1: *The motherboard contains the main functional blocks, including the CPU, system oscillator, main memory, cache memory (optional), chip set, and system I/O.*

One technique for enhancing DRAM performance is called *page mode*. Once the system specifies an initial row address (i.e., a page), the DRAM can perform fast accesses—under 20 ns for 60-ns DRAM chips—anywhere within that page by simply specifying the various column addresses. Page-mode accesses get interrupted when the CPU generates a read or write to another page or when a refresh cycle occurs.

Another technique that will reduce the DRAM access penalty is *interleave* operation. In this case, the memory on the motherboard is divided into two or more banks. Each bank operates at the width of the CPU's data path: 32 bits for a 386DX or 486 system and 16 bits for a 286 or 386SX. The pages are arranged so that when the CPU is reading instructions sequentially from memory, successive word accesses come from alternating banks. Thus, while one bank is being accessed, the other bank can be precharging or being refreshed.

For sequential accesses, then, interleave operation effectively eliminates the cycle-to-cycle precharge (and possibly row-address set-up time), allowing the DRAMs to be continually accessed at very close to their rated "access time" speed. Of course, the interleave operation skips a beat whenever there's a non-sequential access such as a program branch or a refresh operation.

To compensate for the relatively slow access time of DRAM chips, most high-performance systems incorporate a cache-memory subsystem consisting of high-speed SRAM (typically 35-ns access time or faster) and a complex controller. When the processor reads a word from main memory, the word also goes into the cache memory, so that the CPU can refetch it with no wait states. Since most programs are largely iterative (i.e., they execute many program loops), once the CPU has made it through the first pass of a loop, the entire loop contents are in the cache memory, allowing subsequent iterations to execute from the cache memory with no main-memory accesses and no wait states.

The 486 has an on-chip 8-KB cache-memory subsystem, although many 486 systems implement a secondary, external cache as well for even better performance. A good cache design will typically enable 85 percent to 95 percent of the CPU accesses to execute with zero wait states. Because of the fast access times involved, the cache-memory circuitry must couple closely with the CPU and its timing to achieve zero-wait-state operation. (See "Caching in on Memory Systems," March 1989 BYTE, for more information on cache operation.)

The chip set is responsible for handling the page mode and interleave operation and for generating wait states to the CPU as needed. The cache controller must coordinate its efforts with both the CPU and the main-memory controller.

Every microprocessor has its own timing specifications and operational features to which a system design must adjust for optimum performance. Some parts have a 16-bit data path (286 and 386SX); others have a 32-bit data path (386DX and 486SX/DX). Some CPUs require a clock that runs at twice the frequency of the actual CPU operation (286 and 386SX/DX); others require a clock that runs at the actual CPU operating frequency (486SX/DX). And some devices have special bus features, such as the 386SX/DX's pipeline and the 486SX/DX's burst-mode transfer capability.

Pipelining enables a CPU to generate the address of the next memory transfer before the current transfer is completed. This can be particularly advantageous in systems that support interleave operation. The 486's burst-mode transfer allows multiple 32-bit words to move quickly from the system to the CPU at a rate of one word per clock cycle.

The design of a conventional system, then, is based on a host of timing factors. The speeds of the main-memory and cache-memory chips must be optimal for the processor and clock frequency in use. Main-memory accesses, including

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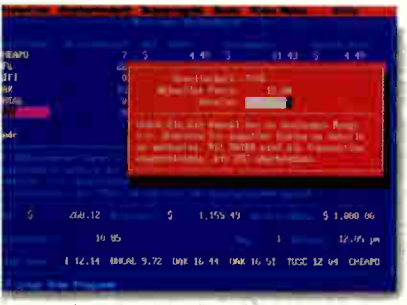

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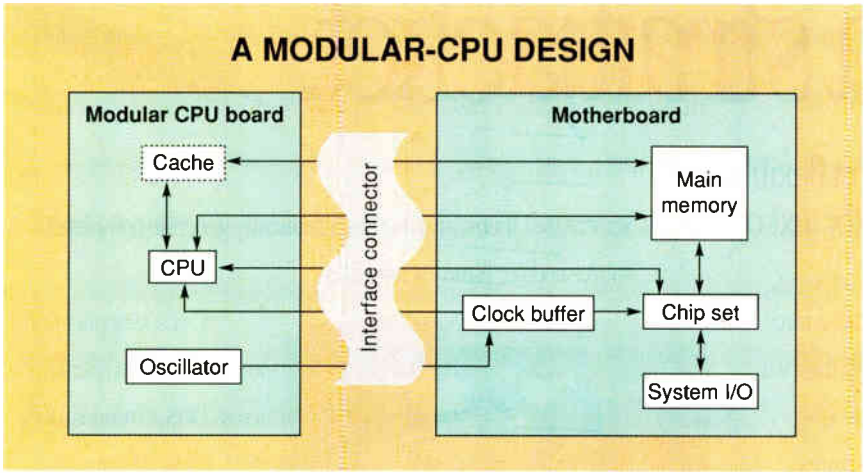

Figure 2: *The CPU, system oscillator, and cache memory have moved from the motherboard to a removable daughterboard. An interface connector links the two boards.*

the number and frequency of wait states, are optimized for best performance (with reasonable economy) based on the timing and bus features of the processor.

Modular-CPU System Design

Figure 2 illustrates the basic design of a modular-CPU system. The processor, system-clock oscillator, and optional cache-memory subsystem migrate from the main system logic board to the replaceable CPU board. Some systems keep the cache on the main system board. Others put the main memory on the replaceable CPU module. This latter approach provides the optimum performance scenario and allows these systems to support processors with different data bus widths, but it is costly and negates much of the benefit of the replaceable CPU-board concept—not having to change other pieces of the system, including the main memory.

The system-clock oscillator must reside on the replaceable CPU board, since its frequency varies from CPU to CPU, but the clock must also drive the chip set to maintain proper timing synchronization. To achieve this without incurring unacceptable clock skew (i.e., clock delays between two different points of the circuit), the clock connects to a special clock buffer on the main logic board, where buffered clock signals are then distributed back to the CPU, the chip set, and elsewhere on the main logic board.

The CPU-board interface connector creates new problems. The addition of a connector in a signal path causes an impedance mismatch that can degrade the signal quality. This problem is particularly pronounced with high-speed signals, like those of the high-performance processors used with these systems. You need a connector that reliably transmits signals between the CPU board and the main system board. Typically, this is a controlled-impedance connector closely matching the impedance of the circuit board traces (and, hopefully, the source impedance of the driving circuits).

For reliability, the connector must also have good-quality, gold-plated contacts, since connectors are a known source of failure or intermittent problems in many systems; this is particularly true where a computer may be subjected to regular shock or vibration conditions. These impedance and reliability concerns led one engineer I interviewed to evaluate nearly 25 different connectors before finding an acceptable one.

Modular-CPU systems must limit the scope of their CPU upgrade repertoire or else suffer performance penalties. For example, early modular-CPU systems supported 286 processors at a particular speed and permitted an upgrade to a 386SX processor at the same speed. Since both processors had a 16-bit data bus and worked at the same clock frequency, the memory interface timing didn't change, and the chip set could handle the slight signal changes between the processors. This generally meant that special processor features, such as the 386SX's pipelining mode, would not be supported. These systems were incapable of supporting 386DX and 486 processors because of the 32-bit-wide data bus (and other timing considerations). Furthermore, the systems were not optimized for one particular processor, so performance was compromised.

Fortunately, the designers of newer modular-CPU systems have the benefit of a peek into the future and some insightful assistance from Intel. These newer 32-bit systems are designed to support the 25-MHz 386DX CPU on the low end and the 66-MHz 486DX on the high end. Of course, the 66-MHz 486 isn't shipping yet, and the 50-MHz part only recently hit the streets, so how can these systems support these faster processors in the future without knowing their timing specifications?

These systems are generally designed to operate at up to 33 MHz (thus, most do not offer a 40-MHz AMD 386DX CPU alternative). Intel has indicated that it will be introducing a 66-MHz 486DX chip that uses a 33-MHz clock and has an internal clock doubler. This lets the CPU (and its internal cache) operate at the faster speed while interfacing to the rest of the system as if it were a 33-MHz chip.

Intel's recent 50-MHz 486DX, however, doesn't offer the same luxury; it requires a real 50-MHz system clock with a clock cycle time of 20 ns (compared to 30 ns for a 33-MHz clock). Intel does, however, offer the chip on a module along with a 256-KB secondary cache that allows the cache-to-system timing to be slower than the 50-MHz CPU timing. The cache controller isolates the processor from the rest of the system. The cache controller acts like the system to the CPU and like a (slower) 486 CPU to the system. A replaceable CPU board could, then, be designed to operate at a 25-MHz or 33-MHz bus speed, allowing it to work with a system designed for 33-MHz CPU bus timing. System vendors may also choose to implement the secondary cache themselves instead of using the Intel module.

Because they try to accommodate so many different processors with varying bus interface timing characteristics, designers of modular-CPU systems can't provide optimum system performance for all supported processors. Typically, these systems don't support the 386's pipeline mode and the 486's burst-mode operations, because they are processor-specific features. These systems therefore lack processor-specific optimization that other systems may incorporate. And while they may do a good job with a 66-MHz 486, thanks to its internal clock doubler and 33-MHz bus timing, they will not run a 50-MHz 486 optimally.

Modular-CPU systems can be designed to operate certain processors (at certain speeds) with near-optimum performance, but as a general rule, systems designed around a particular processor

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running at one speed can be (and generally are) designed to offer higher performance than similar systems that support replaceable CPU boards. In some cases, the performance difference may be very small, while in other cases, the difference will be much more noticeable.

A good cache subsystem can cover a multitude of architectural compromises. If most of the CPU's memory accesses can be retrieved from the cache memory instead of from the main system memory, a slower main-memory interface will have a less noticeable effect on system performance. While some manufacturers choose to put the cache subsystem on the main board (or support the addition of an optional cache module on the main board), the best system optimization can be achieved by placing the cache on the CPU board. This is less of an issue for 25- and 33-MHz systems, but it becomes important with systems using the faster 50-MHz 486.

What Modular-CPU Systems Mean to You

Recent modular-CPU system designs have shown substantial improvements over earlier designs, and you can expect reasonable performance from these systems for CPU speeds at or lower than the speed the systems are optimized for (usually 33 MHz). While it is unlikely that a 50-MHz 486 CPU upgrade for these systems will yield the same performance as that of a system specifically designed around that chip and optimized for its faster bus operation, there's still some benefit in the ability to upgrade to the higher performance. Of course, the planned 1992 introduction of the 66-MHz 486 with its internal clock doubler may be the saving grace for the new modular-CPU systems, since the inherent 33-MHz bus operation of the new chip will give these systems the same level of optimization they now enjoy with the 33-MHz device.

From another perspective, the pace of the PC industry may well justify complete system replacement. Hard drives seem to live a nominal five years—after that, they run on borrowed time. Hard drive interface standards evolve, and both drive and interface performances continue to improve. Hard drive capacities also tend to increase substantially over time. Similarly, video standards are continually in a state of flux, with higher resolutions, more colors, and—important—higher performance being the consistent trend. Floppy drives can show signs of wear over time, including misalignment and mechanical failure, and even the power supply with its rotating fan can tire.

It's also true that the CPU is only one piece of the system performance puzzle. Other system functions, including the hard drive subsystem, the video subsystem, the network interface (if any), and even the ratio of cache RAM to main system memory can all have a substantial impact on the overall performance of the system. The amount these subsystems will affect any one user depends on the user's applications—whether they are CPU intensive, disk intensive, video intensive, or a combination of these. But increasing the speed of a CPU without corresponding enhancements to other critical system functions effectively limits the contribution of the faster CPU.

Regardless of whether or not modular-CPU systems provide optimum performance or economy, they may still be the best choice in some situations, particularly for large organizations that purchase hundreds or thousands of systems.

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I'm giving you something near and dear to my heart this month—plus a little bit more. Over the past several years, my favorite personal programming project has been a communications program. Written in Turbo C, it's a TSR program that occupies approximately 70 KB and performs file transfers in the background. I call it simply COMM.

I developed the software for my own use, but I didn't skimp on the user interface. If you have a mouse, you can use it with COMM. On-line help is available. You can use pull-down menus when you need them, but they disappear out of sight when you don't. You can use the full screen for your communications sessions.

The program features a split-screen chat mode, a phone directory that becomes a pull-down menu, a scroll-back buffer, a capture buffer, and file transfers that operate in the background. You can transfer files with the XMODEM, YMODEM, or Kermit protocols, or you can choose to send or receive ASCII files "as is," with no error checking.

When you load COMM, or when you pick the Load Phone Directory menu option, the program reads a file named COMM.CFG. This configuration file contains settings and parameters that you specify, and it's easily edited with a text editor or ASCII word processor. I've included a sample COMM.CFG file in the program for you.

For a quick start, you can just edit COMM.CFG to show the correct COM port and data rate for your modem, insert a phone directory entry, and fire up COMM.EXE. Then press Alt/Right-Shift to pop up the program. Choose the phone number to dial from the pull-down menu, and you will be on-line in no time at all. You can put COMM.EXE, COMM.CFG, and COMM.HLP into any directory called out by your DOS PATH statement.

I wanted macro keys for the phrases I type most often when I'm on-line, so I programmed them into my communications program. I also wanted to be able to adjust the time-slicing and transfer-protocol time-out settings, so I programmed parameters for them. I wanted and programmed into COMM plenty of other parameters, as well. Among them are screen colors, data rate (110, 150, 300, 600, 1200, 2400, 4800, 9600, 19,200, or 38,400 bps), modem command strings, and COM ports 1 through 4. You set any or all of these with entries in the COMM.CFG file.

I used Turbo C 2.0 and Microsoft Macro Assembler to write COMM. If you like exploring source code to see how a program works, you'll have hours of fun with COMM.C. TSR, mouse, communications, pull-down menu, Kermit, XMODEM, YMODEM, and other capabilities abound in COMM.

Remember back at the beginning of this column, when I mentioned giving you a "little bit more"? To round out this month's Corner, I'm also including a small communications program written in BASIC, suitable for running under BASICA or GWBASIC. Only about 100 lines long, the program nonetheless supports receiving files using the XMODEM file transfer protocol. If you prefer BASIC programming to C programming, this one's for you.

Get connected to other people through a modem and this month's software. You'll make my heart glad. ■

MAC/Tom Thompson

Mug Shots of Your Mac

Suppose your Mac starts acting erratically and bombing at random. The first thing you need to find out is what INITs and cdevs you are running, since these files are either littered all over your System Folder (System 6.0.x) or tucked away in several folders (System 7.0).

Try Mug Shot Lite, a handy little application that generates a "rap sheet" that contains a snapshot of your Mac system. It gives you critical information such as the Mac type, total RAM, and OS version, followed by a list of all the INITs and cdevs and their version numbers.

Just double-click on the beer mug icon and specify either the Clipboard or a file to hold the rap sheet, and Mug Shot Lite does the rest. It helps you find an INIT conflict or determine that the Mac has a real hardware problem. Mug Shot Lite was written by James K. Miles.

UNIX/Ben Smith

Make Your Plans with xcalendar

Despite the fact that all the applications that I have mentioned here have been simple character-based applications, I actually use a Unix workstation that runs the X Window System. The entire source code for X is freely available, but I want to mention one of the not-so-commonly known X utilities, `xcalendar`, because I rely on it as part of my environment.

The X programming example, `xcalendar`, creates a window with a calendar of any month of any year (the default is the current month). By clicking on any day, you can edit or view the events that you have scheduled for that day. The program may seem trivial, but you would be surprised at how useful it is. There are many versions of this program with all sorts of bells and whistles. We provide you with the basic version, which was written by Roman J. Budzianowski, a member of MIT's former Project Athena.

Editor's note: *Software Corner programs are available in a variety of formats. See "Program Listings" on page 5 for details. We solicit your contributions for this column. If you've written a program or utility that you think others might find useful, let us know. We'll pay $50 for any program we use. Write to: Software Corner, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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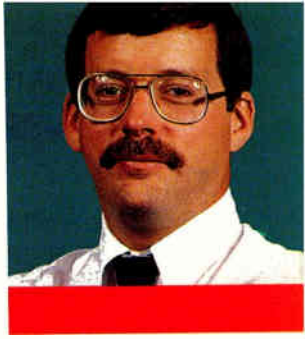

BOB RYAN

ON THE FAST TRACK

Compared with other technologies that make up the modern computing environment, data communications is slow to change and adopt new advances. The telecommunications infrastructure is so large that it inhibits rapid changes to newer and technologically superior solutions. Sometimes, however, a new technology's application is so compelling that it forces rapid and radical change. Such is the case with frame relay and LAN interconnections.

In the past, if you wanted to connect LANs over a wide area, you had two main options: point-to-point connections and packet-switched networks, usually in the form of X.25 public and private data networks. Unfortunately, the former is often prohibitively expensive for all but the largest organizations, and neither option offers sufficient throughput for transparent LAN-to-LAN connections.

Frame relay is an adaptation of a packet-switching technology developed for ISDN. As such, it is usually thought of as a replacement for X.25, although in practice frame relay may be overkill for the types of low-bandwidth applications where X.25 excels. The exciting aspect of frame relay for LAN users and administrators is its ability to connect geographically distant LANs at high transmission speeds and to allocate bandwidth as needed. Frame relay now offers up to 20 percent of Ethernet throughput over public data networks.

Going Faster

X.25 has never been a satisfactory method of interconnecting LANs. The protocol normally limits transmission speeds to the packet assembler/disassembler to either 56,000 or 64,000 bps, and its extensive error checking slows throughput considerably. Trials have shown that frame-relay technology has up to 10 times the throughput of X.25. The only alternative for interconnecting LANs has been to create point-to-point links using bridges, routers, or multiplexers over expensive leased lines at speeds of up to 64,000 bps. Frame relay has changed all that.

Unlike X.25, which was developed when most transmission technologies were analog, frame relay was designed with a digital world in mind. Because digitial transmission is much more reliable than older analog technologies, frame relay requires far less robust error checking than does X.25. It checks packets only where they enter and leave the frame-relay network. X.25 must maintain state information at intermediate locations. Thus, frame-relay networks can assemble, route, and disassemble packets much faster than X.25 networks can.

If you need to interconnect your company's LANs, you need to look at frame-relay services

ILLUSTRATION: JOHN NELSON © 1991

The frame-relay standard does not describe how to switch packets, but it defines how the interface equipment presents them to the frame-relay network. You usually access a frame-relay network using a LAN bridge, router, or T1 multiplexer equipped with a frame-relay interface.

Like X.25, frame relay provides virtual circuits between sites, resulting in less overhead. Unlike X.25, it can also accommodate the bursts of volume that characterize LAN traffic by providing bandwidth on demand. For example, Wiltel (Tulsa, OK) offers local ports (via T1 connections) to its WilPAK frame-relay service at 256,000 and 1,024,000 bps. You reserve up to half the port's bandwith as the minimum available, but you make the entire bandwidth available during bursts of LAN traffic. Thus, a large-file transfer can get more bandwidth than a short E-mail message. Frame relay's ability to handle bursts of traffic and high-speed connections makes it ideal for interconnecting LANs.

Out of the Gate

Given the advantages provided by frame relay as a LAN interconnect method (it's faster than X.25 and faster and less expensive than a private point-to-point network), it's not surprising that LAN administrators want it. What is surprising is how fast vendors are moving to make frame-relay products and services available.

The CCITT first codified frame relay in 1988, and the first public data network to provide frame-relay service was WilTel, which began its WilPAK service in March. According to WilTel's Gil Broyles, the response from customers has been far greater than anticipated. "At trade shows, such as ICA [International Communications Association] in Anaheim, we've had larger crowds at our booth than we've ever had before," he says. One factor behind the initial popularity of the WilPAK service is its flat-rate pricing, which gives customers predictable transmission costs.

continued

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Broyles does not see frame relay as an upward migration path for X.25 users, but as a replacement for private-line networks. As expected, WilPAK's customers are using frame relay primarily for interconnecting LANs. The supercomputer maker Convex Computer (Richardson, TX) has replaced a large number of its dedicated leased lines with the WilPAK service. It now runs a hybrid network that's part public (WilPAK) and part private (leased lines). The dynamic bandwidth offered by frame relay is useful when moving the large files used in supercomputer applications.

Sybase (Emeryville, CA), another WilPAK customer, had a different motivation for going to frame relay. According to John Matthesen, corporate director of telecommunications, the prime motivation was "to make the network bombproof." Prior to moving to WilPAK, the Sybase corporate network consisted of many point-to-point links between satellite offices and the corporate hub. Sybase routed all communications through the hub; a failure in that device would have brought down the entire network. Frame relay provides a mesh-type network that doesn't depend on one site. If one location goes down, the network reroutes the packets so that the other nodes can still communicate.

Frame relay is in its infancy now, but it will be a premier internetworking technology in the 1990s.

WilTel got there first, but it isn't the only company offering public frame-relay services today. CompuServe (Columbus, OH) began its frame-relay service last summer, and Sprint Data Group (Reston, VA) and BT North America (San Jose, CA) are expected to have frame relay in place before the end of the year. MCI Communications (Washington, DC) has announced that it will begin frame-relay service in early 1992.

The availability of frame-relay services depends on the availability of frame-relay equipment for customers and service providers. For example, the WilTel service uses StrataCom's (Campbell, CA) IPX FastPacket T1 multiplexers. StrataCom is a pioneer in providing T1 multiplexers that handle packets, as opposed to switched circuits. MCI, on the other hand, plans to install new software in its existing Northern Telecom (Nashville, TN) equipment to support frame relay.

On the customer side of the equation, many companies are shipping frame-relay bridges and routers that you can use to access public frame-relay services or to construct a private network. The most exciting development in this area is the pairing of a frame-relay interface and a multiprotocol router. For example, Cisco Systems (Menlo Park, CA) has incorporated frame relay into all its routers, including its multiprotocol units. Nick Lippis of Northeast Consulting Resources

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(Boston, MA) sees such products as the forerunners to what he calls internet nodal processors. In a keynote address at Boston University's "Networks of the 90's" conference this past spring, Lippis described his view of the 1990s as the decade of internetworking over multiprotocol backbones, and he also described how INPs would be used to create wide-area links between LANs of different types. A multiprotocol router with a frame-relay interface satisfies most of the requirements of an INP. Other companies that provide customer-premises equipment for frame relay include Proteon (Westborough, MA), Advanced Computer Communications (Santa Barbara, CA), and Vitalink Communications (Fremont, CA).

Beyond Standards

The force behind the proliferation of frame-relay products and services lies in the standards-setting process. Data communications is built on CCITT and ANSI standards, which often take years to develop and implement. Frame relay is no different, and it exists today only in draft standards. Because the internetworking problem is so acute and the standards-setting process is so time consuming, many companies have jumped into the frame-relay market with products based on the draft standards. Such a move can be risky, but most vendors claim that software upgrades will resolve any differences between their equipment and the final standard.

A trickier problem with the standards-setting process is that it often takes too long to address problems of immediate concern. With frame relay, the current CCITT/ANSI standard doesn't adequately address issues such as multicasting and congestion control. Rather than waiting for the standards-setting bodies to get around to these issues, four vendors—DEC (Maynard, MA), Northern Telecom, Cisco Systems, and StrataCom—got together last year to agree on how to handle them. The result was the Local Management Interface, a standard that details how frame-relay equipment from the four companies will handle internetworking, such as congestion control. By agreeing to implement the LMI extensions, the companies had two goals in mind: to get frame relay into customers' hands as fast as possible and to avoid equipment incompatibilities that would stifle the market.

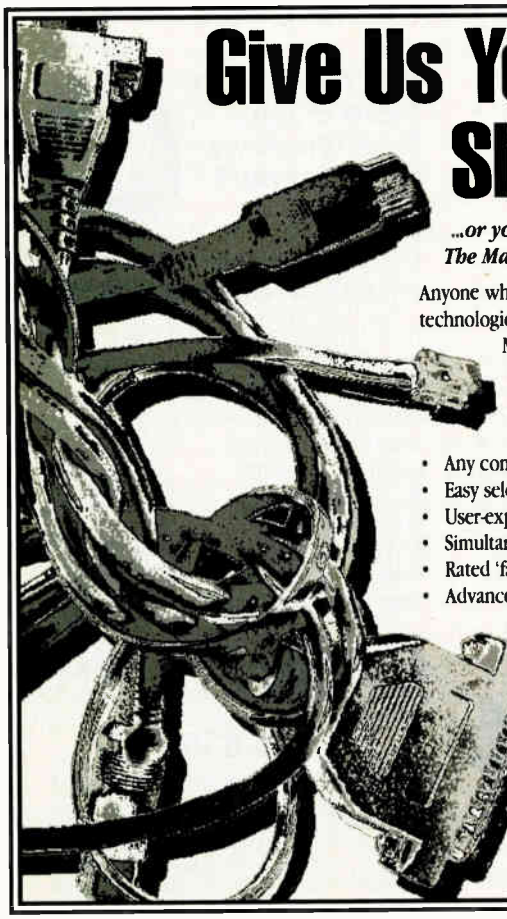
Today, a more formal group known as the Frame Relay Forum coordinates the "extra-standards" activities of participating vendors, and it hopes to provide a communications pathway between vendors and customers. Its members include dozens of frame-relay service and product suppliers.

Framing the Future

Frame relay is in its infancy now, but it will be a premier internetworking technology in the 1990s. Plans are already under way to boost its speed and performance. StrataCom has announced modules for its IPX multiplexers that support T3 links. This is especially significant to those public networks that use StrataCom equipment, such as WilPAK and CompuServe.

Public and private frame-relay services are the first practical alternative to point-to-point bridges and X.25 networks for interconnecting LANs. If your company needs to build bridges between its "islands of connectivity," you should be looking at frame relay.■

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



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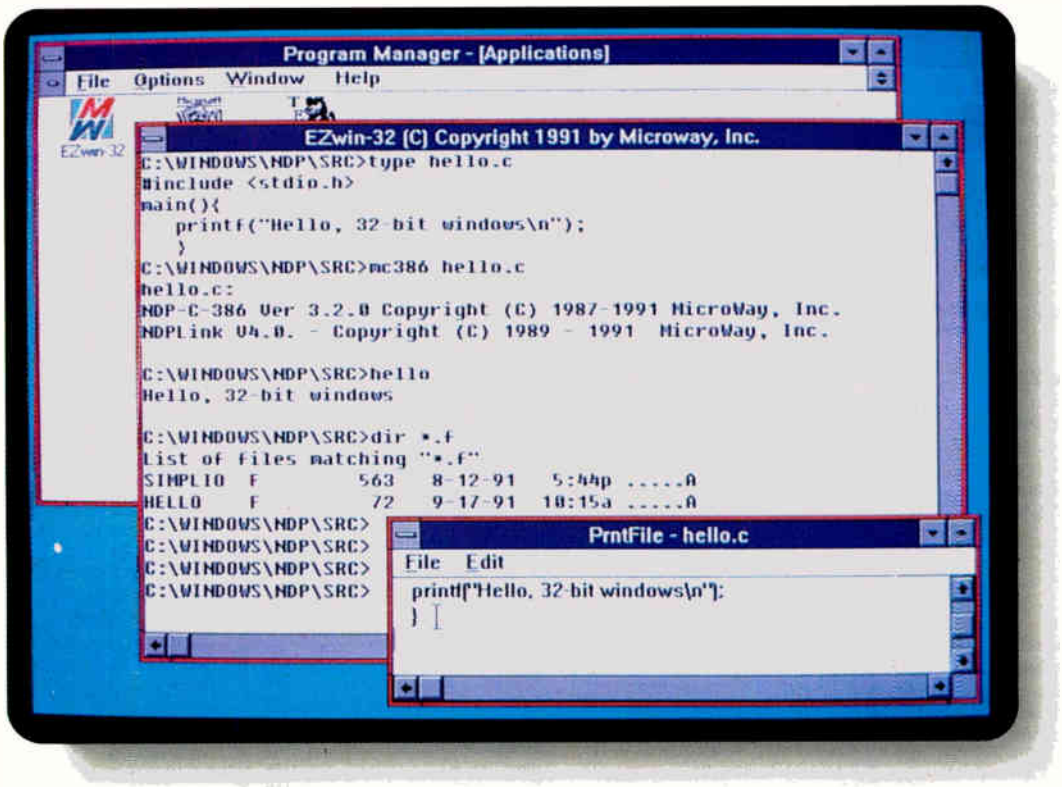

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MARTIN HELLER

SETTING UP SHOP

I want to write a Windows program. What do I need to get started?" People ask me this question at least three times a week. The answer, of course, depends as much on who you are and what you know as it does on what you have. But I'll try to steer you in the right direction as far as what I think you should have. You'll need reference materials, an editor, a compiler and linker, a way to make resources (e.g., dialog boxes, bit maps, icons, cursors, and strings), a resource compiler, a debugger, and (maybe) a help compiler.

For reference materials, you'll need to have a reference to the Windows application programming interface. I got mine bundled with Microsoft Windows Software Development Kit, but you might also get one bundled with a compiler. Otherwise, you should be able to find the *Microsoft Windows Software Development Kit Reference—vol. 1* at your local software store or technical book store (see reference 1).

You'll need at least one more book: Charles Petzold's *Programming Windows* (see reference 2). You'll find more good little sample programs here than anywhere else; with over 900 pages, it's really the bible for Windows programming. Three other introductory Windows programming books rate a look (see references 3, 4, and 5). Authors Peter Norton and Paul Yao provide good explanations of theory and practice; Alan Southerton offers nice library functions; and Jeffrey Richter covers material that the others miss.

And finally, there is a book that picks up where Petzold leaves off: It's (ahem) my own *Advanced Windows Programming* (see reference 6). If you can stand reading my columns, you will love my book—but be sure that you get the disks as well, because there was too much code to print in the book. This reference will show you how to build from a toy program (such as the Petzold examples show) to a real-world program.

Windows Programmer's Editors

Once you know how to go about writing a Windows program, you'll need a way to get it into a computer. Until recently, I did this using a DOS-based editor—usually Solution Systems' Brief or Mansfield Software Group's KEdit or, on rare occasions, Microsoft PWB (which comes with Microsoft C Professional Development System). Then I started collecting Windows programming editors and found half a dozen of them. Although none is ideal, they all do the job. MEWIN—a port of MicroEmacs—has the stellar virtue that it's free, and you can download it from BIX. But MicroEmacs doesn't get along well with my fingers. Bradford Business Systems' SpeedEdit works the same on about a dozen different systems and has a nice global change facility that works across multiple files. Emerging Technology Consultants' Edix/GS does many things well, including capturing program output into buffers. I found it a little clunky to drive from the Windows menus and a little arcane to control from the keyboard. I found Cognetic Systems' CodePad to be simple and serviceable but maybe a little overpriced compared with the competition. Wilson WindowWare's WinEdit has quite a few spiffy features, including an appealing tool bar and a rather respectable scrolling speed.

Tools of the trade for Windows programmers

Actually, for all the good points of all those editors, the one I kept coming back to was Upper Deck Systems' Upper Deck Editor. Peter Graves has been sending me beta copies of this on BIX, and it's growing up rather nicely. Every time I ask for a feature, he adds it (he does the same thing for all the beta testers). I'm not sure why I like it—it doesn't have all the fancy stuff of some of the other editors, and it's not blindingly fast—but it has the right feel and the sort of attention to detail that gives you confidence in a program. And it works for me.

Compiler Options

Language packages these days are more than compilers—they usually include editors, debuggers, sample source, and maybe a profiler along with several versions of the compiler for different environments. I installed a new beta version of Microsoft Quick C for Windows (QC/Win) this morning—it took 12 MB on my hard drive for the options I chose. Remember when you could keep your C compiler and editor on a 360-KB disk?

The language vendors tend to get into features wars. You can ignore most of the features they talk about. For compilers, you need to care about the following four things:

—How solid is the compiler?

—How good is the compiled code with

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all optimization turned on?

—How fast is the compile-link step with all optimization turned off?

—How easy is it to find bugs using the compiler diagnostics and the debugger?

The other points (e.g., the quality of the editor supplied with the package) turn out to be pretty minor, because you can always supply your own substitute. On the other hand, good integration can save you a lot of time. QC/Win is a case in point. Although its editor is not the most powerful in the world, it integrates tightly with its compiler and debugger. Everything flows together, and you don't have to think about what step you're on. Add in the syntax coloring, and you'll find yourself using the built-in QC/Win editor a lot.

Borland International's C++ for Windows and Turbo Pascal for Windows compilers are blindingly fast, but the code quality isn't as good as what you get from an optimizing compiler. Some people say that that doesn't really matter because the improved cycle time helps you to produce better source code and because Borland's library routines are tightly written. Well, good algorithms will beat good code generation any day, so there's something in that. On the other hand, good algorithms *plus* good code generation and good libraries always wins.

Microsoft C has both quick-compile and optimization options; you can use one for development and the other for production. Zortech gives you only an optimizing compiler, but it handles both C++ and C and lets you control its optimizations individually. QC/Win doesn't do any optimization, and it doesn't compile quite as fast as Borland's C, but it's an inexpensive one-box development environment with good overall integration, and it runs entirely on the Windows desktop.

You don't necessarily need a true compiler. Microsoft Visual Basic isn't really one—it's a threaded interpreter, like Forth, with a visual front end. It's also extremely interactive and easy to use once you get the hang of it. I built a little doodling program in VB in about 5 minutes. Building the same program using a program generator and C took me 20 minutes. The 5 minutes for VB included looking up a bunch of things with the on-line help facility; the 20 minutes for C was mostly mechanics and typos—I already knew exactly what I wanted to do and didn't have to look up anything. At the same time, there's a lot of things I know how to do

COMPANY INFORMATION

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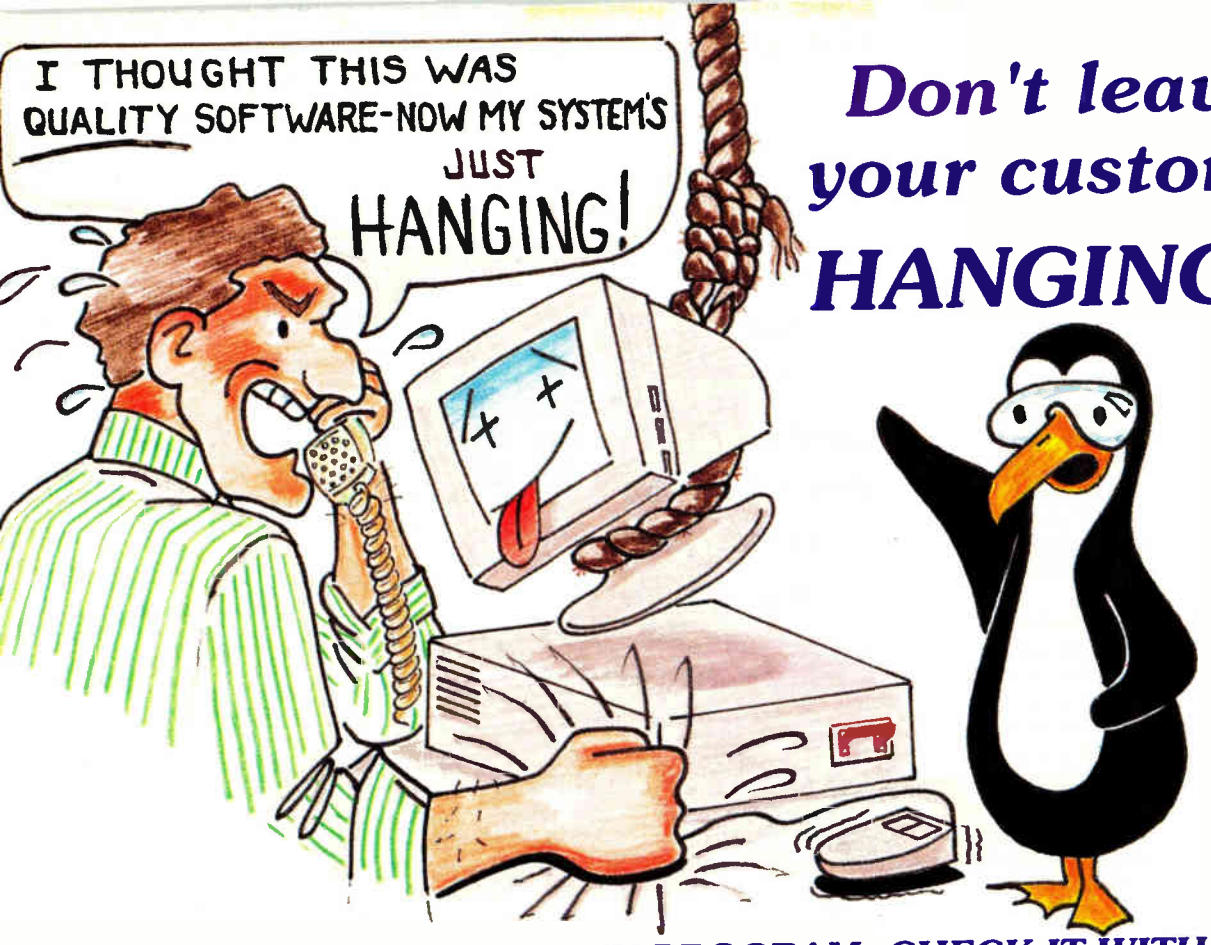

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in C that I can't seem to do at all using pure VB. I'd have to put the C routines into dynamic link libraries and call them from VB if I wanted to build a sophisticated VB application.

Within Technologies' Realizer, another BASIC implementation for Windows, is a little more traditional than VB. If you've been programming in BASIC for a while, Realizer will seem pretty familiar—but if you're evil-minded like me, you'll miss the goto statement. VB makes you do things event by event; Realizer lets you put a whole program together the way you would under DOS.

I talked about Digitalk's Smalltalk V and MDBS's Object/1 in August in the context of writing for multiple-target environments. I feel pretty much the same way about them as I do about Windows programming environments: They are good development environments, but the final executables are sort of tubby to sell commercially. I feel much the same about Actor, even though the Whitewater Resource Toolkit (which is an Actor program) has its adherents. I find it "infuriatingly excellent," to borrow a phrase from Jerry Pournelle.

Good algorithms plus good code generation and good libraries always wins.

If you pick C++ as your language, which right now means picking Borland or Zortech for your compiler, you'll need class libraries. Turbo Pascal for Windows already comes with class libraries for DOS and Windows. I understand Borland is working on the equivalents for C++ for Windows, which should ship soon. And when Microsoft finally ships its C++, it'll supposedly have class libraries for DOS, Windows, and OS/2.

I have been looking at a bunch of C++ class libraries for Windows, and Tier, Win++, and C++/Views are the ones that are available commercially. I told you a little bit about C++/Views in August, and I'll tell you more about all three next time. I will also tell you about a public domain class library that's being developed by members of the ibm.windows conference on BIX.

Hardware Time

Before I sign off, I want to mention a couple of hardware issues. The first has to do with communications. The chip your computer uses to talk to serial ports is called a universal asynchronous receiver/transmitter. Older versions of this chip, like the 8250, interrupt the computer for every character received, which is quite a stress on an environment like Windows. It's awfully hard to get a 9600-bps download going in the background under Windows with one of these older chips. You have to raise the communications priority with a SYSTEM.INI setting or raise the task priority in a PIF file.

continued

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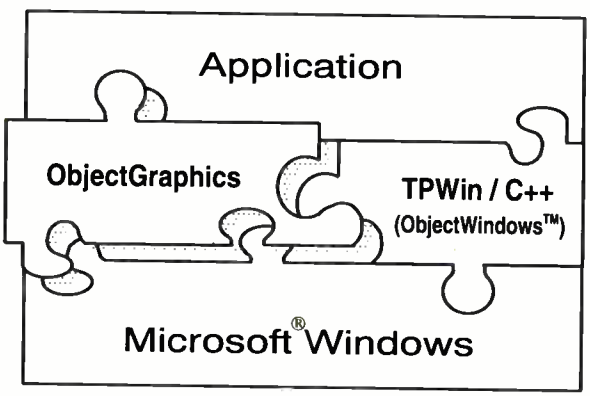

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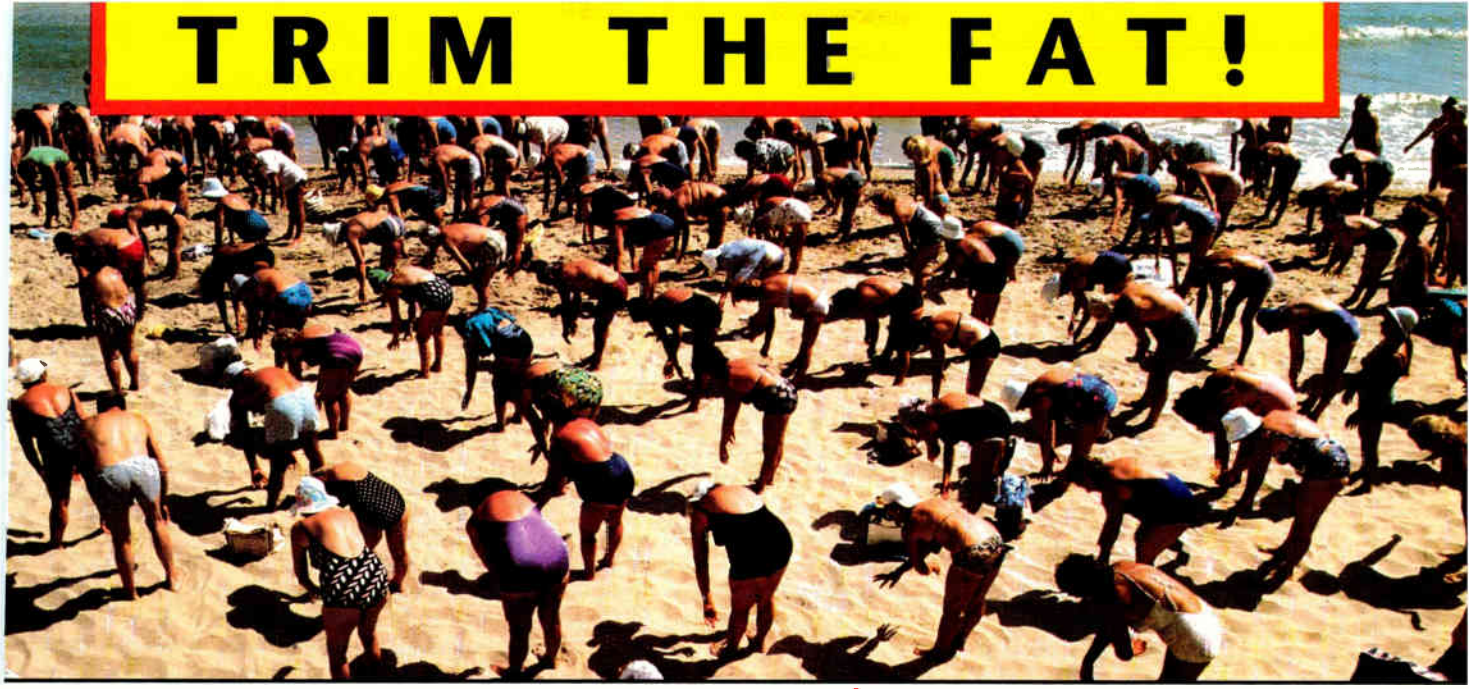

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Newer chips, specifically the NS16550A, have a first-in/first-out buffer so that the chip can get several characters before interrupting the computer. Open the FIFO buffer, and your serial data rates can go up by a factor of 10. Unfortunately, the COM driver in Windows 3.0 does not recognize the FIFO buffer, and it will crash if you happen to open it before you start Windows.

Windows 3.1 will probably fix this problem, but there's a way you can overcome it now. A little company called Bio-Engineering Research Laboratories has a replacement COM driver, called TurboCom, that fully supports the NS16550A. You want 115,000-bps transfers? It's possible to have them with the right hardware/software combination. And they'll work in the background.

The other issue is displays. I mentioned a while back that I longed for 24-bit color under Windows. I don't quite have that, but I do have 15-bit color, and it looks wonderful! Diamond Computer Systems' SpeedStar VGA+ Hi-Color board isn't the only 15-bit color Super VGA board on the market, but it works well, and the price is right: only $299. For closer to $500, the company tells me you can have 15-bit color *and* a graphics accelerator that speeds up screen operations by an order of magnitude. And it tells me 24-bit color at about the same prices is just around the corner. I can't wait. I can't wait for my screen to refresh now, and I can't wait to see how fast it'll run with the accelerator. ■

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6. Heller, Martin. *Advanced Windows Programming.* New York: John Wiley & Sons, Inc., 1991.

Martin Heller develops software and writes about computers, despite a Ph.D. in Physics and despite having worked, literally, as a rocket scientist. His book Advanced Windows Programming *will be published this fall.*

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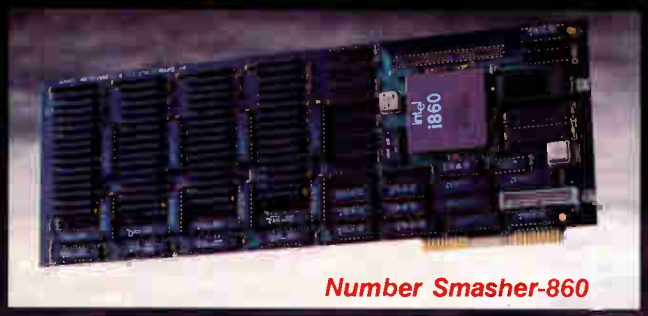

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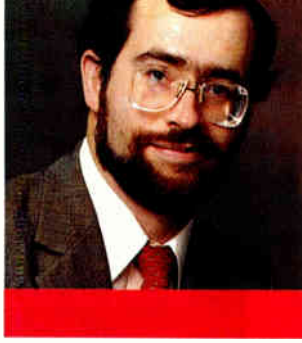


DAVID FIEDLER

PCs TO WORKSTATIONS

The trend is now complete: You can use PCs as Unix workstations. I have been evaluating a Compaq Deskpro 386/33L (with 12 MB of RAM and 320 MB of hard disk space) running The Santa Cruz Operation's SCO Open Desktop 1.1 for a while. I have never seen a personal computer of the quality of this Compaq machine. The only computers built like this that I can remember were at multimillion-dollar mainframe and minicomputer installations. This is a solid machine, one very much up to the challenge of being used as a Unix workstation.

The main topic at hand is Open Desktop, which is supposed to turn your PC *into* a Unix workstation. But can one software product do this? And is it a new and improved Unix, or just another good idea that fails in practice?

ODing on ODT

Open Desktop is an operating system based on SCO Unix System V release 3.2 for 386 and 486 computers. It's basically set up for single-user operation. This makes sense, given its workstation orientation. (Open Desktop can be upgraded to being used as a Unix server.)

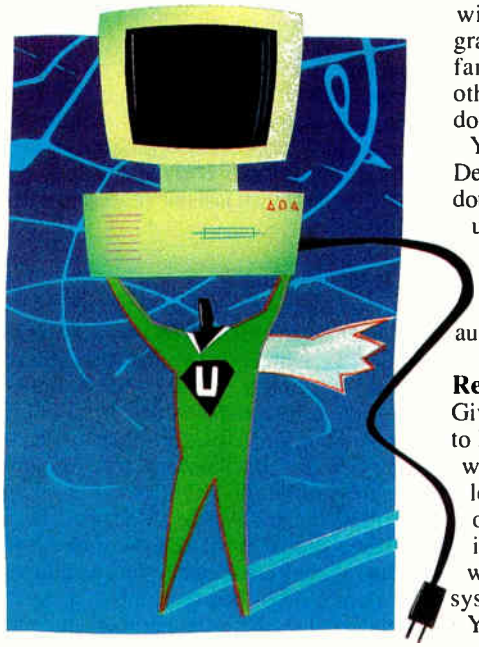
All the parts of Open Desktop are labeled with the ODT rubric. There's ODT-OS (basically, Unix itself), ODT-DOS (the Locus Merge tools that let you run multiple DOS sessions under Unix), ODT-Data (the Ingres DBMS with Structured Query Language), ODT-View (the GUI), and ODT-Net, which lets you tie into other computers on your company's network.

These last two are complex enough on their own to require some explanation. Open Desktop has three parts to its ODT-View GUI. The standard X Window System is the basis for the entire GUI environment, but because bare X is not enough, SCO also includes the OSF/Motif window manager. Motif window manager sits on top of X and lets you change the size, priority, and appearance of your windows, as well as giving them that three-dimensional Motif look and feel.

Finally, another X client (application program) called Desktop Manager (based on the X Desktop package from IXI) adds to this functionality by giving you an icon-based interface. Desktop Manager allows you to copy, move, execute, print, and delete files by simply moving your mouse. X, Motif window manager, and Desktop Manager are integrated more or less invisibly, so all you have to do is log in, pick up your mouse, and start pointing and clicking.

There is ODT-Net, which gives you all that good Unix network stuff: TCP/IP, `telnet`, `ftp`, `nfs`, and even SLIP. Open Desktop LAN Manager lets you work similarly between computers connected with Xenix-NET, OS/2 LAN Manager, MS-Net, or IBM PC Network. All this is integrated into Open Desktop at basic levels, so your applications and services (e.g., ODT-Data) can use networking as transparently as you can.

Open Desktop claims to make a Unix workstation out of a 386 PC



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Open Desktop is a lot of software for a list price of $1295, and it's clear why SCO has been basing so much of its strategy on Open Desktop.

Use and Abuse

The Open Desktop system has seemed quite robust in use here in my small publishing office. While I can't always reliably switch between multiscreens on my own SCO Unix system while running DOS (this is partly a hardware limitation), Open Desktop has no problem switching multiscreens, even from a graphics-based DOS application to an X session to a regular Unix shell.

Right now, I'm editing this article in one window on the screen, while a clock, graphics demonstration program, and the famous cursor-following "eyes" run in other windows, with no apparent slowdown of any of these programs.

You can invoke the editor using the Desktop Manager in many ways. You can double-click on the edit icon, which brings up your previously defined editor, `vi` in my case. You can also choose the shell and call up `vi` from there. Or you can double-click on a file icon and `vi` will automatically be invoked with that file.

Read the Fine Manuals

Given all this, there is one important thing to keep in mind: This is a *big* system. As with any workstation, you will need at least 100 MB of disk space and 6 MB of RAM just to run the basic system (not including applications software), but you will also have to configure it and play system administrator.

You'll find that the Open Desktop user's

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manual has many details that are usually left to the system administrator, because this is essentially a single-user Unix system. And because Open Desktop has so many features and services that are interconnected, you have to read the release notes very carefully; adding or removing packages in the wrong order can cause major problems.

But installing it in the normal manner is not the least bit tricky. The ability to use the tape drive made it a snap. I deliberately didn't read the manual when it came to the GUI, just to see how intuitive it really was. While I had no problems figuring out how to get things done, reading the manual in detail, later, showed me quite a few hints that helped me do things faster.

The new SCO manuals are written distinctly better than others I've seen, including some of SCO's older ones. Examples, hints, and suggestions are everywhere. Somehow, I suppose I wish that Open Desktop wasn't such a complex product, because although it's easy to show someone how to use a running Open Desktop system, it can be quite a handful to set up. Although the user's manual attempts to give an overview, it is also the basic manual for the entire system, and at 500 pages, it is not exactly a "quick-start" guide. I think that many potential Open Desktop users would be happy to see a smaller manual that gives a brief tour of all the facilities, or even a canned "demonstration" account that would do the same.

The 250-page installation manual is detailed and comprehensive. It explains over 100 separate steps of system installation (not all of these will be needed on all systems). If you have the manuals I've mentioned, the included on-line manual pages, and the Administrator's Guide, you have enough basic information to set up and use Open Desktop. But some people will feel uncomfortable without the mammoth seven-volume optional documentation set, which unfortunately costs $275 extra. My suggestion is to get just one of these per department or floor.

Is It Really Real?

The ultimate question, though, was whether Open Desktop feels like a workstation. I can honestly say that when you're sitting in front of the ODT-View graphics screen, it would be difficult to tell if you're at a Sun, DEC, or other workstation. I can say that those machines are noticeably, although slightly, faster when scrolling in their Desktop Managers, but I believe that they also have dedicated graphics controllers rather than a relatively "dumb" VGA board.

It's just that on most other workstations, you can't just press a couple of function keys and come up with a new console, on which you can run your current DOS programs with the hardware environment they expect. The biggest difference is that you can make your current 386 or 486 machine into a real workstation by adding Open Desktop, rather than making it obsolete by adding lots more money for a separate piece of equipment. I suspect that in the current economic climate, many people are going to explore SCO's concept of a workstation.

Epilogue

The sole problem I've noted with the Compaq hardware I received is that its VGA monitor wasn't quite stable. I was able to obtain an AX1448M Impression Plus monitor from Amax Engineering. This monitor has been solid as a rock and is noninterlaced even at 1024- by 768-pixel resolution. The result is a monitor that's easy to look at, even with the relatively small characters that appear on a 14-inch display running X, in poor light with bad eyes.■

David Fiedler is editor and publisher of the Unix newsletters Unique *and* Root, *coauthor of* Unix System Administration, *and a Unix consultant. He can be reached on BIX as "fiedler."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458

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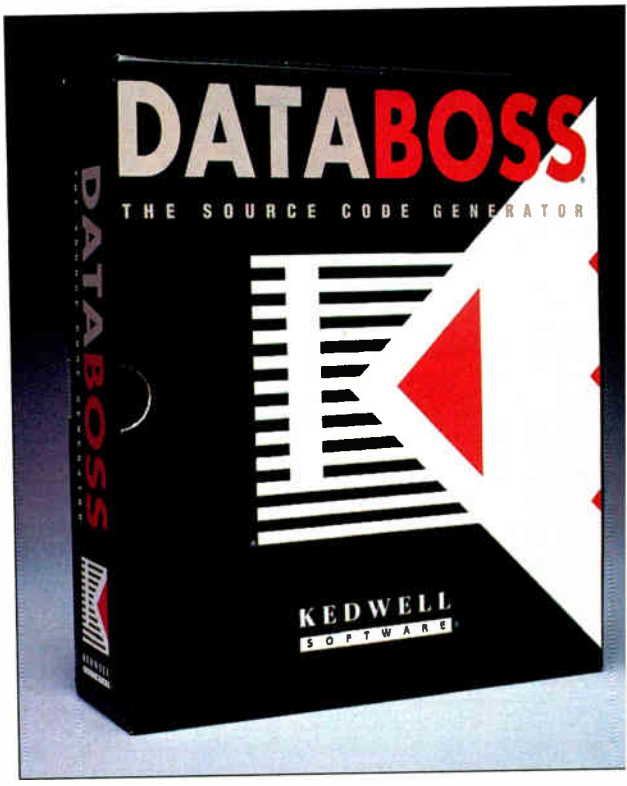

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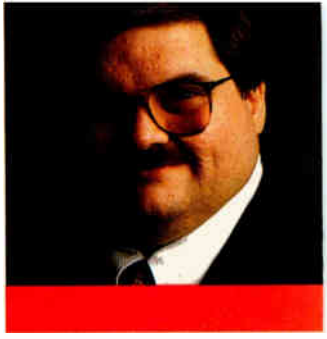

DON CRABB

DEALING WITH SYSTEM ERRORS

Sorry, a system error has occurred. ID=1. Restart. Resume." The good news about System 7.0 is that you probably won't see this dialogue again, but the bad news is that you'll see a new one: "The application 'unknown' has unexpectedly quit, because an error of Type 1 occurred. OK?" This Type 1 error, or bus error, can occur for so many memory-related reasons that you could live inside the machine as an electron and not be sure of the exact cause.

It's true that System 7.0 does a much better job than System 6.0.x does of preventing system errors from crashing your machine outright or from hanging things so that keyboard and mouse input is ignored. However, instead of worrying about your machine dying, you have to worry about applications hanging, crashing, and otherwise going bump in the night. After months of working with System 7.0, it's pretty clear to me that its overall tolerance for slightly goofy memory conditions or infringement on heap space or any of several other minor violations to the memory map due to misbehaving applications is far less than System 6.0.x's. A day doesn't go by when I don't get a Type 1 error. They've become as regular as clockwork, and they almost always occur under conditions that caused no problems with System 6.0.x.

Why don't I just abandon System 7.0 and go back to 6.0.x, at least until Apple gets its act together on these errors? Believe me, I've thought about it. But I'd be giving up too much at this point to go back. Once you've used the Publish/Subscribe feature in System 7.0, it's tough going back to a static cut and paste. As a result, I've become a master of grinning and bearing it, all the while restarting dead applications with aplomb, but this has started to get on my nerves. Since it's pretty clear that Apple won't have a System 7.0.1 out anytime soon to fix these difficulties, I started casting about for some strategies to help ameliorate the problem.

The first thing I found was that the order in which you open your applications has a lot to do with how soon they give you a Type 1 error. Well-behaved applications (typically those that are System 7.0–savvy) don't care in which order they are added to your Application menu (the little icon in the upper right corner of your screen). But applications that the Compatibility Checker may have flagged as "mostly compatible" or that the vendor has told you are System 7.0–compatible (meaning the applications haven't been rewritten to take advantage of all the 7.0 goodies) are sensitive to what contiguous hunk of memory you give them.

I have found that when you start cramming applications into your Application menu, you must first launch Nisus 3.06, MacDraw II 1.1, AppleLink 6.0.2, and FileMaker Pro 1.1. If you need to run more than one of these babies at the same time, I can almost guarantee that you will either get a Type 1 error or the application will mysteriously hang at some point. When you get the former, you really have only one choice—restarting the application. When you get the latter, you can try to get back to the Finder, either by pressing the Interrupt switch (not the Restart switch!) and typing G Finder into the ROM-resident monitor box, or by pressing the Command-Option keys while you hold down the Escape key. The Process Manager then forces the offending application to quit. As soon as you get back to the Finder, you should restart, so that all the wonky memory gets flushed clean.

Even with System 7.0, you need some help in avoiding and fixing problems.

ILLUSTRATION: JOHN NELSON © 1991

Wall Off System Errors with Crash Barrier

Fortunately, though, I've found something a little more effective in my battle against Type 1 errors, unexplainable crashes, and hangs under System 7.0. It's a new utility called Crash Barrier that is published by Casady & Greene—a company most noted for its clever Macintosh games. Believe me, though, Crash Barrier is no game. I've been working with it as a beta version for some time and just got the released version. If not a lifesaver, Crash Barrier sure beats running System 7.0 without a debugger as a safety net.

The way the thing works is simple. Crash Barrier installs as a Control Panel and gets loaded at system start-up. You can customize its error-detection and fix-up modes so that everyone from Mac novices to Mac pros get just the level of control they want. Crash Barrier tries to live up to its name. It attempts to intercept application and system errors that would otherwise blow you back to the Finder or force a restart (see the screen shot). But Crash Barrier does more than that, which is one of the reasons I have it running on

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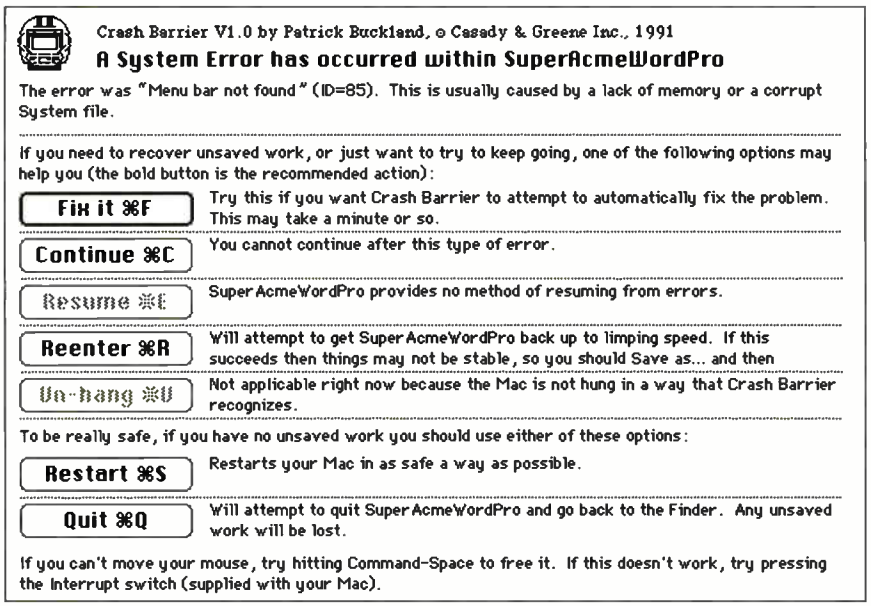

Crash Barrier's recovery window lets you attempt a "soft landing" after an application has crashed.

all my Macs. It prevents system errors from happening by detecting low-system-memory conditions (which often occur if, like me, you have lots of extensions and Control Panels operating) and fixing them. Crash Barrier also allows you to alter the size of system memory so that you'll always have at least 20 percent free in the system heap.

Crash Barrier assumes—as any system utility that purports to save you from yourself should—that bad things will happen to your Mac with regularity; thus, it includes one of the most convenient auto-save functions I've ever used. It works with any application, but if there are some you don't want it to work with (or you want to alter its auto-saving rules), you can specify them from the menu. I use Nisus as my daily word processor, and it already has a good built-in auto-save function. Since I didn't want Crash Barrier interfering with that function, I put Nisus on Crash Barrier's auto-save rules list. When Nisus is active, Crash Barrier won't save its files.

Of course, Crash Barrier is not a license to act stupidly when it comes to your Mac. If you have many questionable extensions installed or if you've used ResEdit to customize some things, you will likely crash often. System 7.0 is a complicated piece of software, and the more you modify it to your idea of the perfect computing environment, the more you change what Apple's engineers took four years to figure out. I'm not suggesting that you back away from using lots of extensions or from tweaking things with ResEdit, but I am suggesting that these kinds of modifications be left in the hands of the most experienced Mac users. If you own a business or manage a department in a company where the Mac is the corporate personal computer, you'll be doing yourself and your staff a big favor if you set some hard and fast rules about which third-party extensions and Control Panels you should install, as well as keeping ResEdit away from all but the experts.

And if you want to help protect yourself and your Mac users as much as possible, you should get Crash Barrier onto all the systems now. It's not a panacea, but it's no worthless sugar pill, either. If you use it along with some system common sense, you'll come much closer to the crash-free Macs we all dream about.

Tip of the Month

If you got used to opening and closing a lot of applications under previous versions of the MultiFinder to keep from exhausting memory, you need to break that habit under System 7.0. Although System 7.0 does improve the way memory is allocated and managed over System 6.0.x, it's still a long way from preemptive multitasking and the dynamic memory map that Apple will have to go to eventually. Even though MultiFinder is now built into the Mac OS, if you are in the habit of opening and closing applications, you will fragment the memory map. Soon, you'll end up with memory so littered with objects that you won't be able to launch anything.

The solution is simple: If you expect to use an application during your current Mac session, open it and leave it open. If your Desktop gets too crowded (e.g., I manage to fill up both the 21- and 13-inch screens that I use each day with application clutter), judicious use of the Hide command (in the Applications menu) will clean up the clutter without closing the application. Although this isn't as clever a solution to recovering screen real estate as the Iconify commands you get with the X Window System under Unix, it works OK, and it reduces your urge to quit applications and fragment memory.

With RAM SIMMs dropping in price to below $40 per megabyte, now is a good time to consider that memory upgrade you've been putting off. Cram as much RAM into your Mac as it can hold, and if you still need some additional space to run all your open applications, consider turning on virtual memory if your Macintosh hardware supports it. Even though System 7.0 doesn't run as fast when part of it gets paged to your hard disk under virtual memory, it's still better than opening and closing applications willy-nilly and thinking that you are saving memory when all you are really doing is making things worse. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. Don is also a contributing editor for BYTE. He can be contacted on BIX as "decrabb."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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University of California, Santa Cruz
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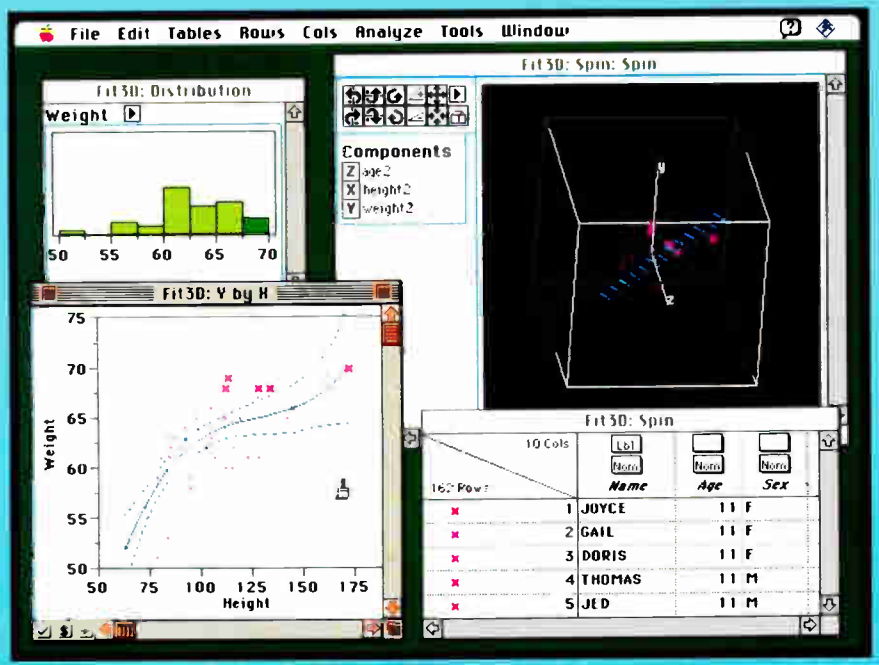

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Snapshot Power

During Fall Comdex, a product was announced that would automatically save the operating environment of an IBM PC or compatible whenever a power outage occurred. The company, Powercard, claimed to have patented the solution. However, I haven't heard any more about this product. Is it available?

Sergio A. Pinto
São Paulo, Brazil

Powercard is alive and well. The Powercard IPS (Internal Power System) is an internal 8-bit card for PCs combined with an external battery. The IPS card has power connections so that it is in-line between the power supply and the hard drive and motherboard. The external battery plugs into the back of the IPS card.

If a power failure occurs, the IPS will sense the voltage drop. The battery will take over supplying power. The IPS card's program, located in a ROM chip, operates at the BIOS level. It takes a "snapshot" of the operating environment and saves that information to a file. The battery will maintain the computer for up to 15 seconds, which is long enough to save the snapshot to a file on the hard disk.

Upon rebooting, the IPS card software displays a message asking if you want to return the system to exactly where it was when the power was cut.

The list price of the card is $299, and it is available from Powercard Supply, 12231 Southwest 129th Court, Miami, FL 33186, (800) 637-2797 or (305) 251-5855; fax (305) 251-2334.—S. W.

PIMs for the Mac

The personal information manager category seems to have lots of products for the PC (e.g., Lotus Agenda and IBM Current), but I've seen nothing in this category for the Macintosh. Are any vendors working on PIM products for the Mac?

J. Paul Holbrook
Ann Arbor, MI

Largely because of the programs you mention, the PIM category is more clearly defined on the PC platform than it is on the Mac. Mac applications have handled many of the components of personal information management for some time. The trend on the Mac side, however, is toward smaller, modular applications that handle specific chores (e.g., alarm clock, calendar, and address book) instead of an all-encompassing application that bundles everything under one umbrella. Many of these smaller applications ship in the form of desk accessories on the Macintosh.

Some recent entrants may fill that gap. Central Point Software (15220 Northwest Greenbrier Pkwy., Suite 200, Beaverton, OR 97006, (800) 888-8199) is now shipping PC Tools for the Mac, and DayMaker from Pastel Development Corp. (81 Franklin St., Suite 3B, New York, NY 10013, (212) 431-3421) also integrates many of the functions of a full-featured PIM. Still, you may want to build the functions you need from a set of specialized products.

Some address-book applications include QuickDex from Casady and Greene, Inc. (22734 Portola Dr., Salinas, CA 93908, (800) 359-4920), Address Book Plus from Power Up! Software Corp. (2929 Campus Dr., P.O. Box 7600, San Mateo, CA 94403, (800) 851-2917), Dynodex from Portfolio Systems (21 East Market St., Rhinebeck, NY 12572, (914) 876-7744), Intouch from Advanced Software, Inc. (1095 East Duane Ave., Suite 103, Sunnyvale, CA 94086, (800) 346-5392), TouchBase from After Hours Software (5636 Van Nuys Blvd., Suite B, Van Nuys, CA 91401, (818) 780-2220), and C-A-T III from Chang Labs, Inc. (3350 Scott Blvd., Building 25, Santa Clara, CA 95054, (408) 727-8096).

Calendar and appointment-scheduling software includes Smart Alarms from Jam Software USA (P.O. Box 1345, Point Reyes Station, CA 94956, (415) 663-1041), Alarming Events from CE Software, Inc. (1801 Industrial Cir., P.O. Box 65580, West Des Moines, IA 50265, (800) 523-7638), Rendezvous Plus 3.0 from PMC Telesystems (P.O. Box 5127, Vancouver, BC, Canada V6B 4A9, (604) 255-9949), and Planisoft from ASD Software, Inc. (4650 Arrow Hwy., Suite E-6, Montclair, CA 91763, (714) 624-2594).

As you can see, the PIM category is very broadly defined. Your best bet is to ditch the whole concept of a single category, decide what applications you need, and buy the products that best suit those needs.—S. D.

Double Your DOS

I recently purchased the Microsoft MS-DOS 5.0 update. Because some of my programs are not fully compatible with the new DOS, I would like to have both the new version and the older DOS 3.21 on my hard disk with the ability to boot in whichever DOS is required.

At present I have DOS 5.0 installed on a 1.2-MB floppy disk. This holds all the DOS 5.0 files I really need. Its AUTOEXEC.BAT and CONFIG.SYS files call for non-DOS 5.0 files (e.g., Intel AboveBoard and CD-ROM driver files) from my hard disk.

I want to place all the DOS 3.21 files in one directory, and the DOS 5.0 files in a separate directory. Whichever DOS is in use would also be in the root directory. There would then be a couple of .BAT files to change from 3.21 to 5.0 and vice versa.

Do you have any ideas on what I could do that would allow me to use both versions of DOS from the hard disk?

L. D. Thomas
Georgetown, DE

The first thing you should do is set up a version table under DOS 5.0. This may allow all your programs to run under DOS 5.0. The version table tells a program that it is running under a different version of DOS, even though it is actually running under DOS 5.0. To load the version table, you must add the command `DEVICE=[drive:][path]setver.exe` *to your CONFIG.SYS file. You then*

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use the SETVER command to add new entries to the table. For example, to tell program A that it is running under DOS 3.21, you would enter the command `SETVER programA 3.21`. *See your DOS 5.0 manual for details.*

I know of no way to use batch files to load different versions of DOS. You must do a warm boot to properly initialize the operating system. My suggestion is to install 5.0 on your hard disk and format a floppy disk with 3.21 on it. Use FORMAT's /S switch to transfer the system. When you need to load 3.21, stick in the floppy disk and reboot. The AUTOEXEC.BAT and CONFIG.SYS files on your floppy disk could then call device drivers and other programs from a DOS 3.21 directory on your hard disk.—S. D.

Oil's Well That Ends Well

When my computer wouldn't boot from the hard drive, I discovered that my Miniscribe Model 3085 drive would not spin up without my cycling the power three or four times.

When I looked at the Miniscribe, I found a hole in the center of the circuit board that revealed the disk shaft and bearing. I applied one drop of three-in-one household oil carefully to the bearing and blotted the excess away.

I've had perfect boots ever since. How often should I oil my hard drive? What about the other bearing under the cover?

Kent R. Rieske
Boulder, CO

I'm glad your drive's working, but according to the technical folks at Maxtor (who now own Miniscribe), your fix had nothing to do with it. The bearing is completely sealed so that nothing can get in or out of the drive. During normal operation over the drive's life, the bearing grinds itself down. Very small metal particles could migrate out of the bearing if it wasn't completely sealed.

So what happened? Most likely, your drive suffers from the ever-popular "stiction," which most drives succumb to after five to 10 years. The lubricant on the platter surfaces moves to the outside of the platter by centrifugal force and creates a sticky blob on the outside of the disk. When the head settles there, it can stick hard enough to keep the drive from spinning. Each time you cycle the power it moves just a bit, and eventually it starts spinning normally. It's also possible that the drive motor has a dead spot in the windings and that, coincidentally, it happened to rest there when you turned off the drive.

It's likely that all you did was physically shake the drive when you removed it. Often the mere act of shaking a stuck drive will make it work again. Finally, there is no top bearing under the cover, and you should never open the drive cover. The drive is tightly sealed against dust. If you open the cover, airborne particles will surely ruin what's left of your Miniscribe.—H. E.

The "Write" Protection

I was very interested in "The IDE Hard Disk Drive Interface" (March). If I understand Intelligent Drive Electronics correctly, a single controller is linked to a single drive. The controller should know exactly where the partition table and the boot sector are.

Now suppose that the controller had a switch (or a jumper) on the card that you could activate. With the switch on, all the write operations would be accepted by the controller, and it would perform them anywhere on the disk. The disk would be unlocked. With the switch in the other position, the controller would only accept write operations outside the areas of the partition table and the boot sector. These two zones would now be protected. The controller could also refuse any low- or high-level formats.

You would unlock your disk only during installation or when you want to modify its configuration. The rest of the time the disk would be locked. With a controller like this, no boot-sector or partition-table virus could settle on the disk. The disk would also be protected against badly written software and user errors.

This kind of security device would only require a switch and a bit of software in the controller. It also seems like this kind of device could be put in any controller. Do you know if controllers like these are now being built?

Yann Bahuon
Noumea, New Guinea

What you're proposing is certainly possible, but I don't think anyone is building IDE controllers with that capability. Adding the switch to an existing IDE drive would be nearly impossible; however, it could be done on an MFM or RLL drive with an extra circuit board.

I wonder if what you suggest would really slow down the spread of a virus on your computer. I suspect that most viruses will either infect program files or simply do damage to the directory. Also, a good antiviral software package should be able to stop any writes to the boot sector.—H. E.

Key Caps on the Move

I answered a letter in July ("Who Moved My Key Caps?") concerning keyboard layouts. Thanks to a flood of mail, I've got a few more bits of information.

One possible explanation of Christopher Sholes's QWERTY layout is that typewriter salespersons needed to show how fast their typewriters were. Of course, they couldn't type, so they arranged the keys so that the letters for the word *typewriter* were all on one row. That sounds as plausible as anything.

Another reader suggests that the anti-key-fouling arrangement of the QWERTY typewriter makes sense, and it also explains why French keyboards are so different—the adjacent letter pairs are different, and a different anti-jamming sequence is needed.

Finally, I received a copy of a fascinating article from the *Journal of Information Processing* (vol. 2, no. 4, 1980) covering the history of typewriters and the difficulty of using a Japanese keyboard. The authors suggest that Sholes did in fact design his typewriter to put frequent letter pairs on opposite sides of the mechanism to avoid jamming. In the process, he coincidentally arranged the keys in such a way so as to make typing difficult.—H. E. ■

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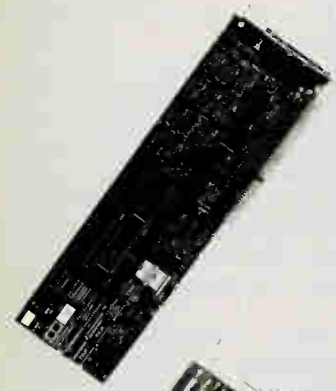

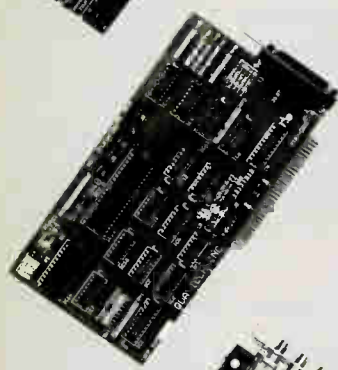

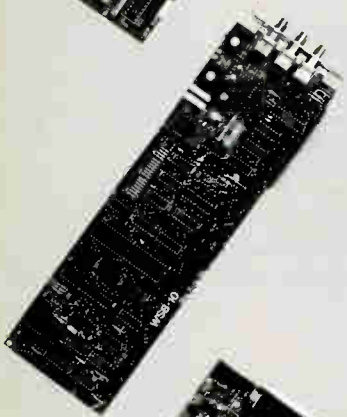

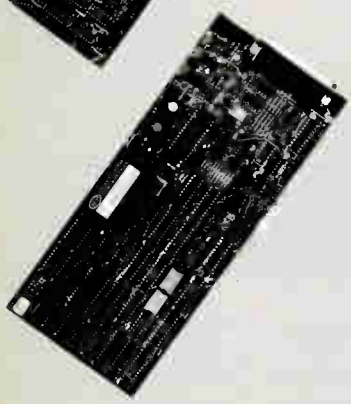

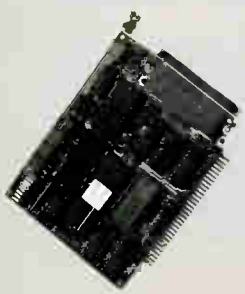

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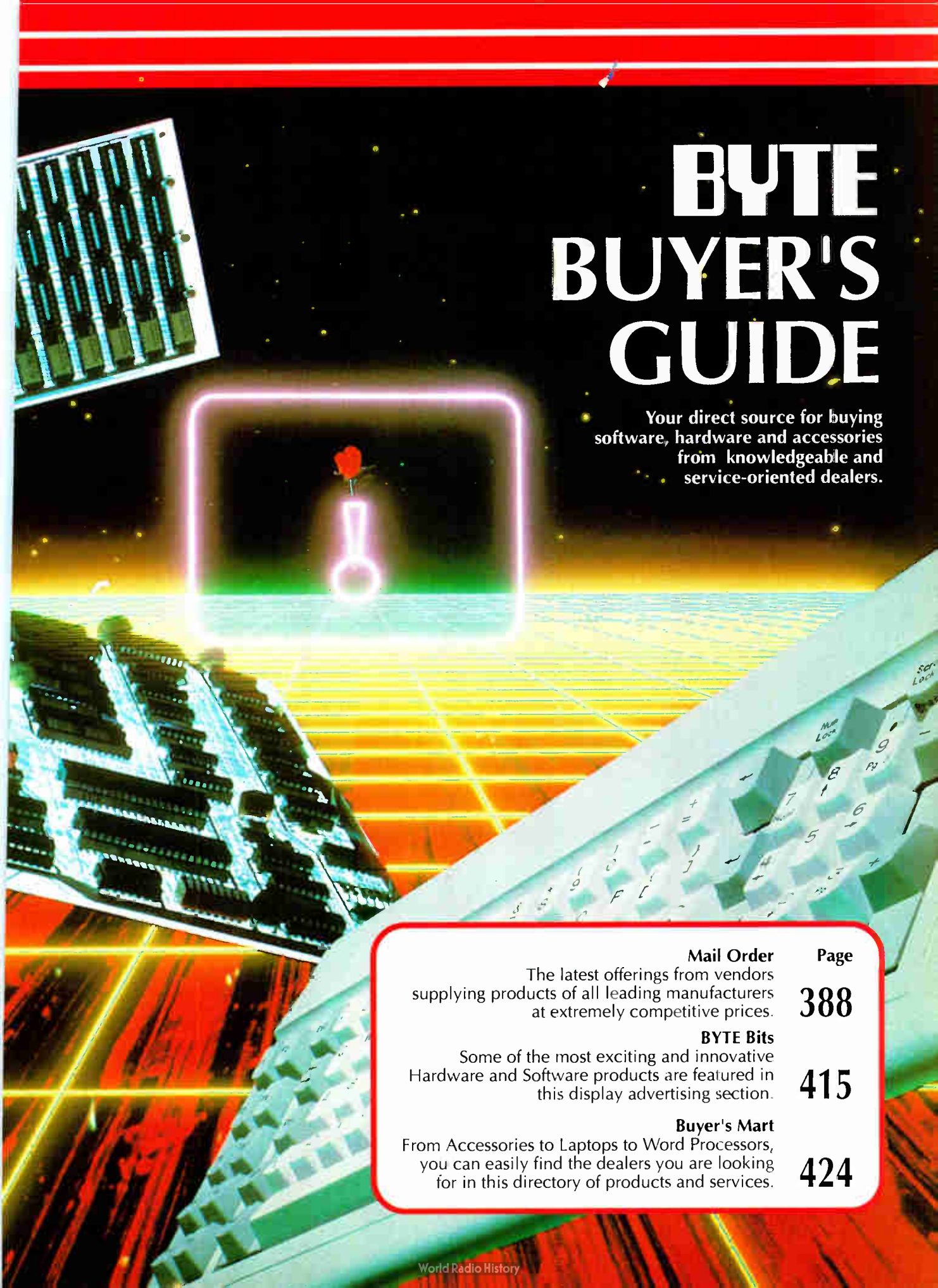

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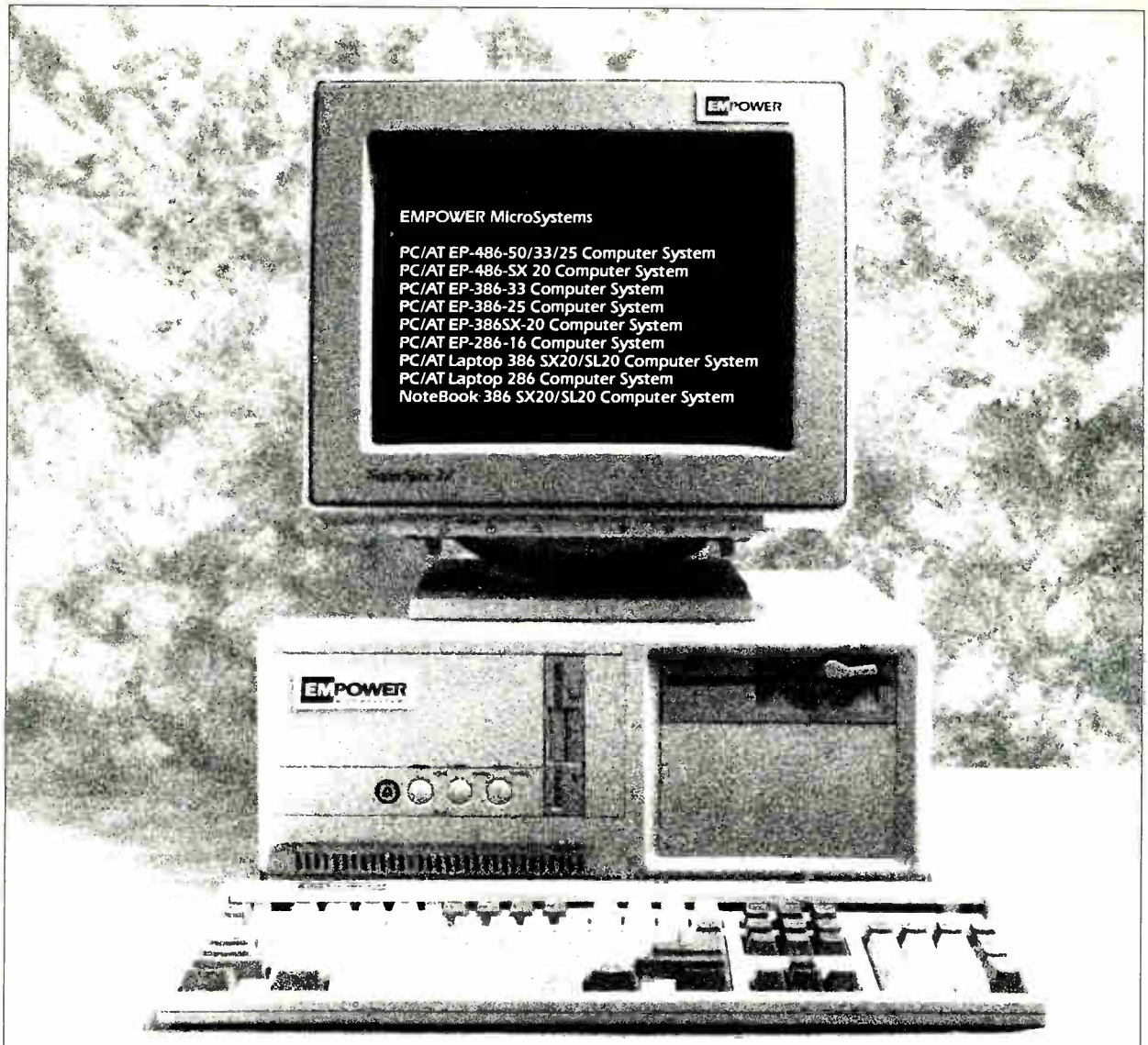

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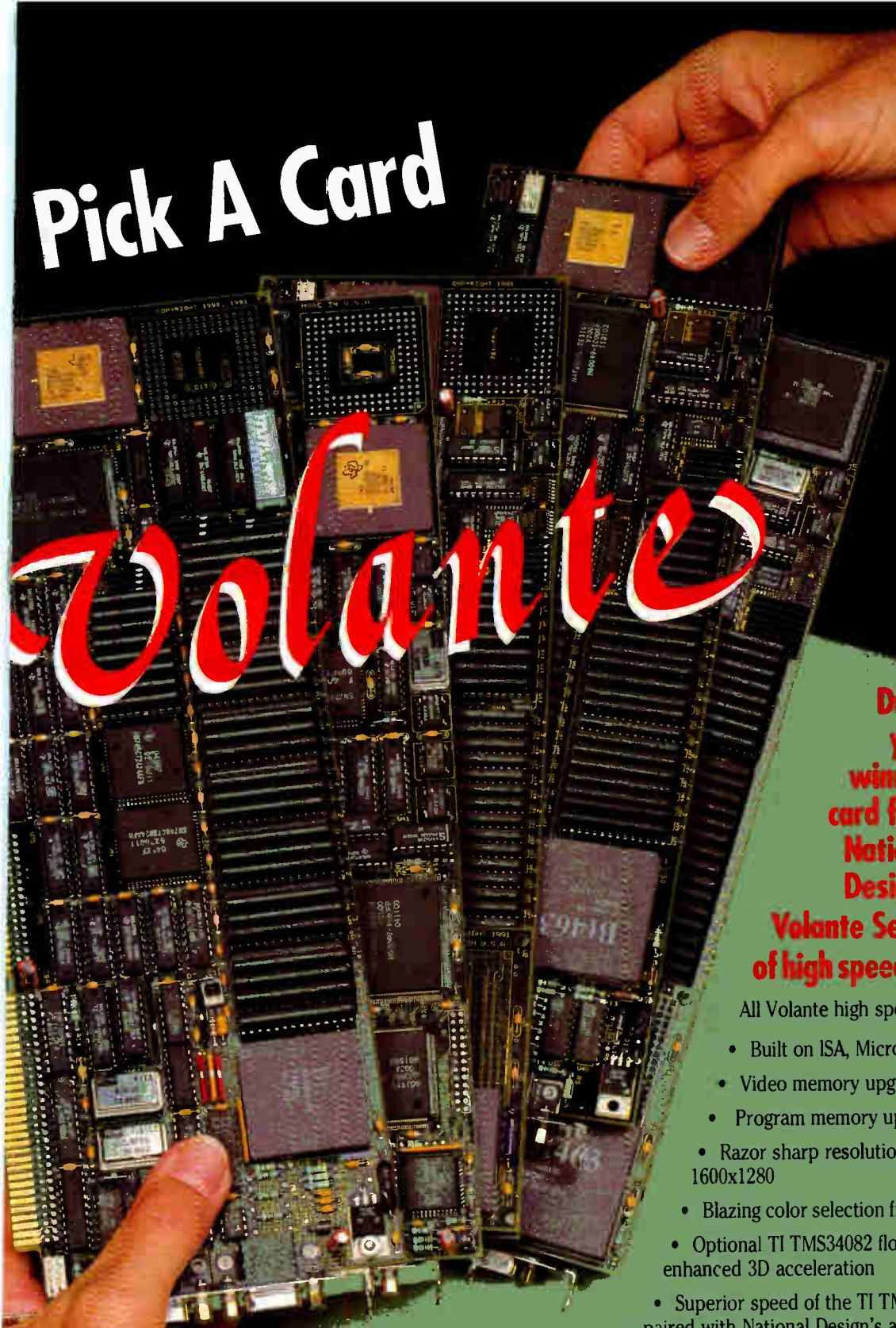

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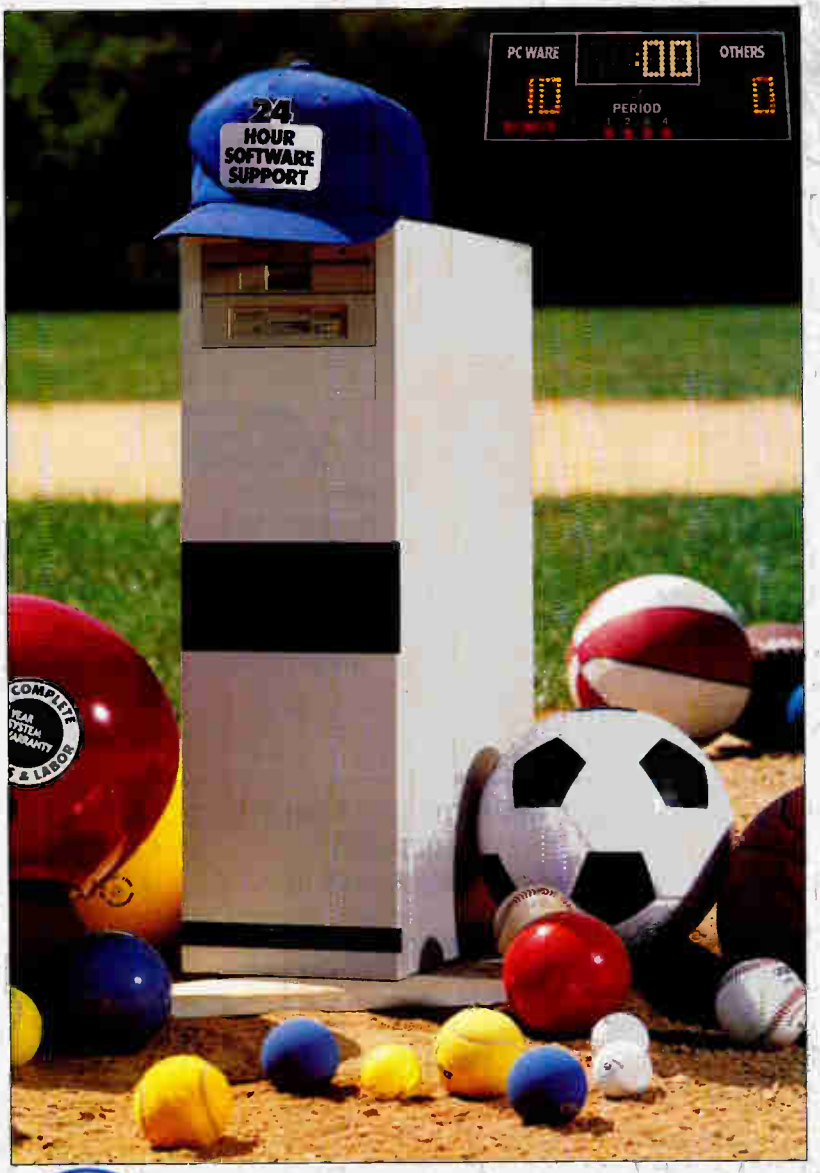

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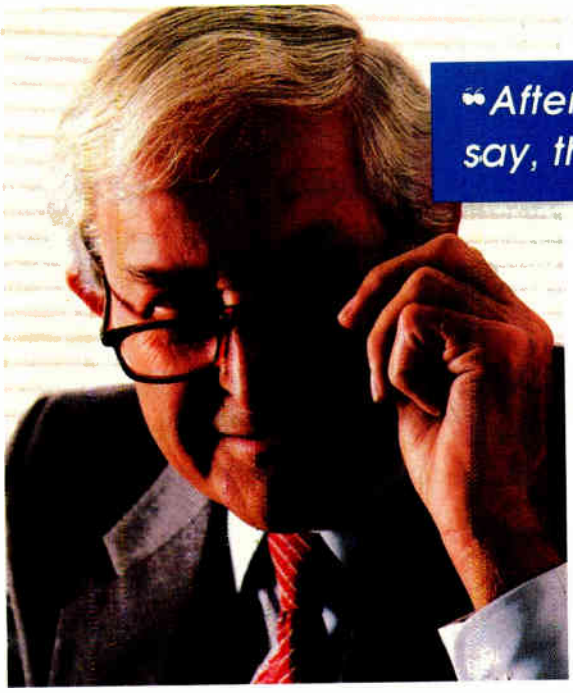

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LQ 850	330 cps, 88 nlq	435
LQ 950	330 cps, 88 nlq	434
LQ 1010	225 cps, 75 nlq	364
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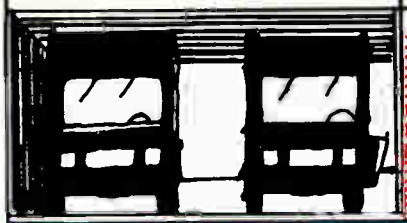

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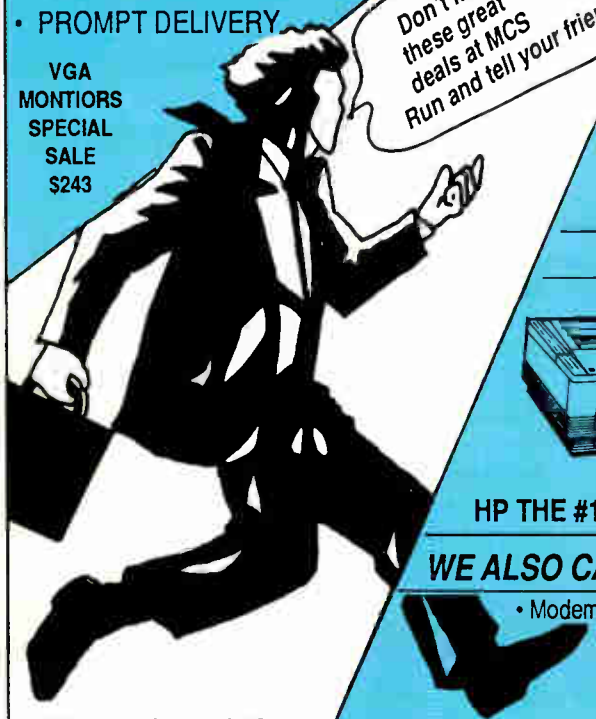

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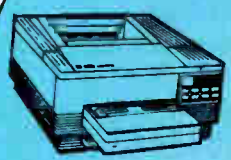

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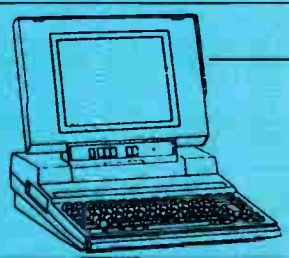

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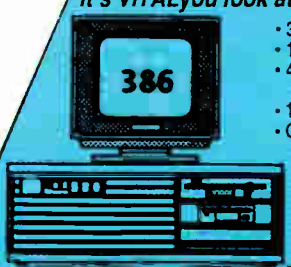

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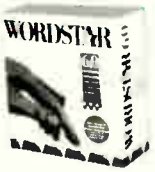

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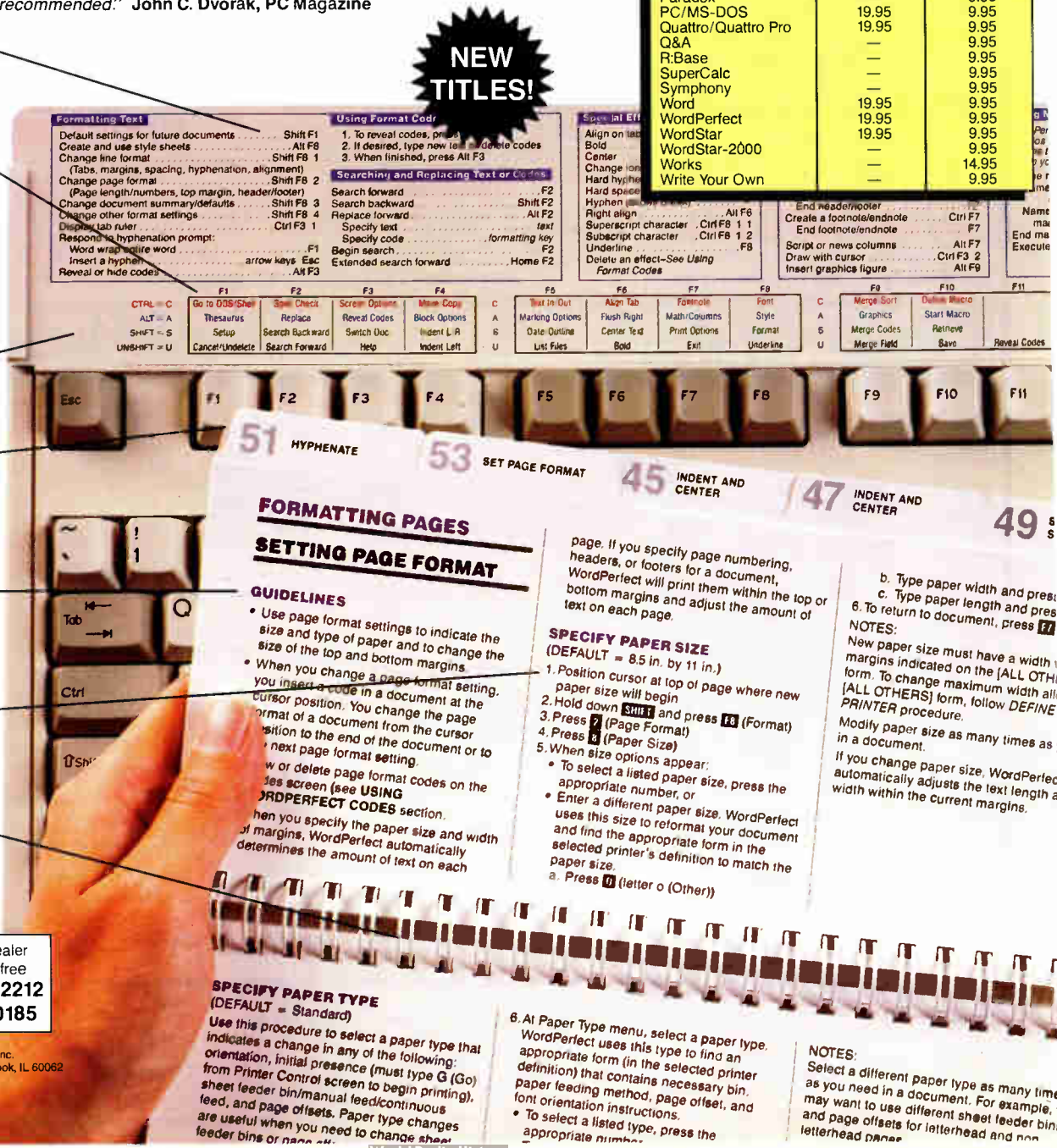

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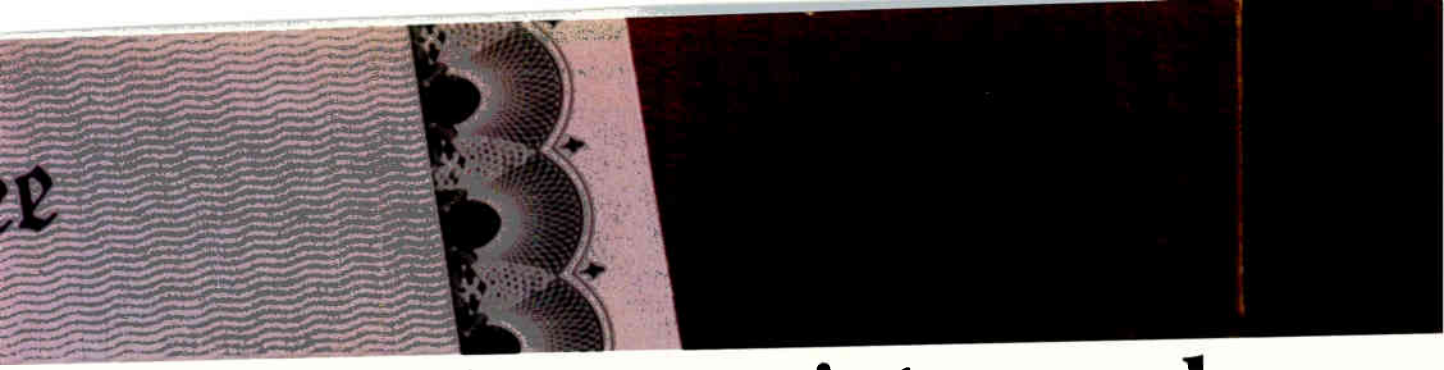

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CodeBase 4	295	269
CodeBase++	295	269
Comet Multiport	169	169
Comm Tools for Clipper	299	269
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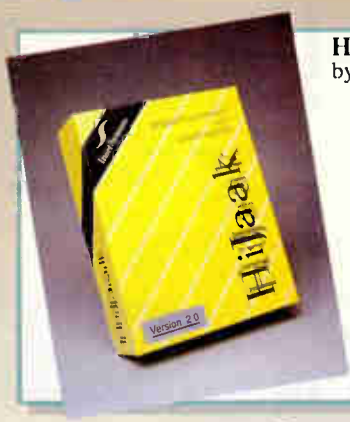

HiJaak Release 2.0
by Inset Systems Inc.

HiJaak 2.0 is a graphics conversion and capture utility that translates more than 36 graphics file formats. HiJaak provides batch conversion capability from the DOS command line or from the user interface. Supported formats include GEM, PICT I&II, CGM, HPGL, PIC, DXF, PCX, MAC, TIF, and support for more than 16 group 3 fax devices. A 5K pop-up provides capture function of text screens, graphics screens, and laser printer output.

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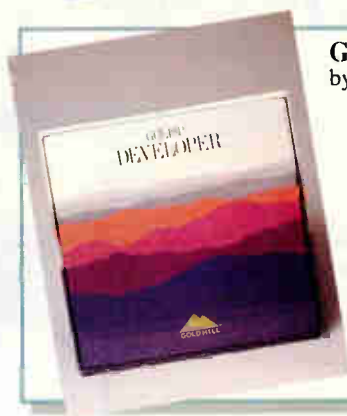

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Gold Hill, Inc., the recognized leader in LISP technology, offers the fastest, smallest, most integrated PC-based environment available for prototyping, developing and delivering advanced applications...NOW, fully integrated with Windows 3.0. Includes complete support for Common LISP, Interpreter and Compiler supporting full lexical and dynamic scoping, FFI (Foreign Function Interface) allowing complete integration of LISP into C applications, interactive Debugger, GMACS Editor, On-Line-Help system and Documentation. Runtime facilities available.

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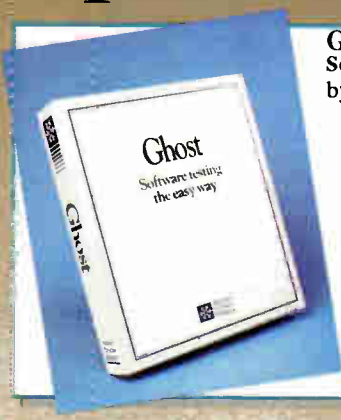

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Software Testing the Easy Way.
by Vermont Creative Software

Ghost is an indispensable tool for automatic testing of *all* software. You can create complete test scripts and run them each time a change is introduced to your program. Ghost compares screen shots from your test before and after changes. You also get reports of all changes, quickly identifying bugs! Ghost needs no extra hardware and only 16K of memory.

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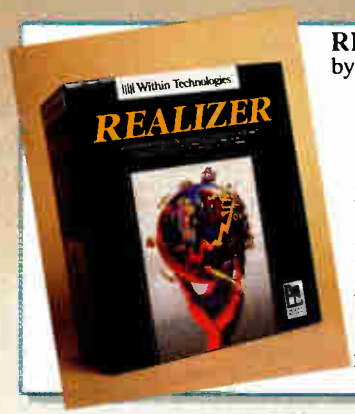

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REALIZER™ is the Complete Application Development Environment for Windows. REALIZER™ combines a structured superset of BASIC extended to access Windows object resources with Programmable Application Tools™, such as charts, spreadsheets, forms, animation, and a command scheduler. The integrated debugger, visual form designer, support for DDE, DLLs, and serial communications, and unlimited, royalty-free run-time make REALIZER™ the Windows development solution.

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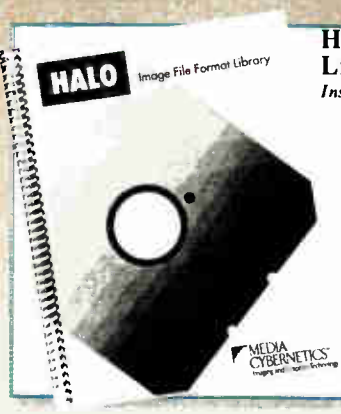
FastFaxts 5022-001



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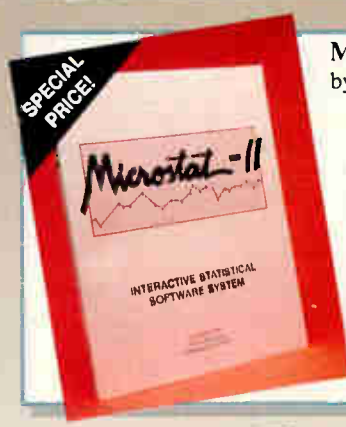

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Microstat-II make statistical analysis easy. Just use your mouse or keyboard to select the menu option you want; there is no command language to learn. Whether you need simple descriptive statistics or advanced multivariate analysis, Microstat-II's superior speed and accuracy will save you time and money. A perfect solution to your statistical needs at a bargain price.

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LIST: $199 **PS** Price: $179
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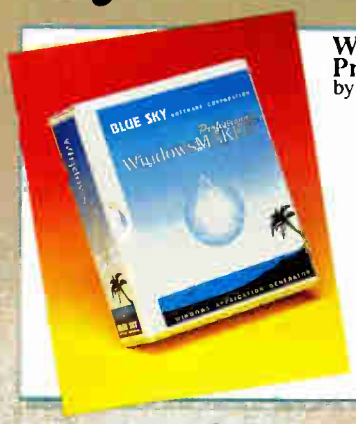

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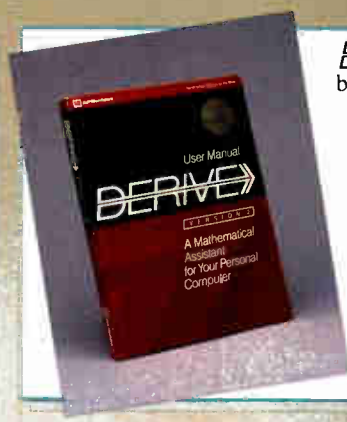

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by Soft Warehouse

Derive, A Mathematical Assistant is a menu-driven symbolic math system. It gives problem solvers the freedom to explore different approaches as it eliminates the drudgery and mistakes of hand calculations. As easy to use as a pocket calculator, Derive does symbolic & numerical equation solving, exact & approximate arithmetic to thousands of digits, calculus, trigonometry, and matrices. Contains a full range of elementary functions and a number of statistical and financial functions. Derive plots expressions in 2D & 3D. This new revised and expanded version also provides programmability.

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Quattro Pro 3.0
LIST: $495 **PS** Price: $395
FastFaxts 777-069

Quattro Pro LANPack
LIST: $395 **PS** Price: $329
FastFaxts 777-135

DETAILS

Effective July 1, 1991, anyone who purchases Quattro Pro or Paradox will be guaranteed a Passport upgrade price to the next version. The Passport pricing is as follows:

- Quattro Pro 3.0, Quattro Pro LAN 3.0, and Quattro Pro 3.0 Competitive Upgrade will get a Passport upgrade for $49.95.*
- Paradox 3.5, and Paradox 3.5 Competitive Upgrade will get a Passport upgrade for $139.95.*

Both of these Passports represent a significant savings off the list price of the next release. If you are not interested in Windows, the Passport can also be used for the next DOS release of Quattro Pro and Paradox.

* Price given in U.S. dollars.

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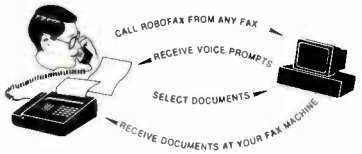

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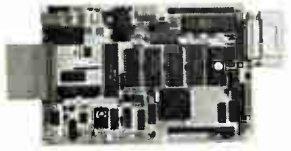

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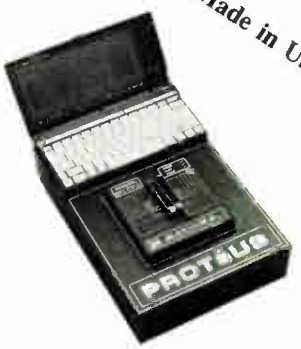

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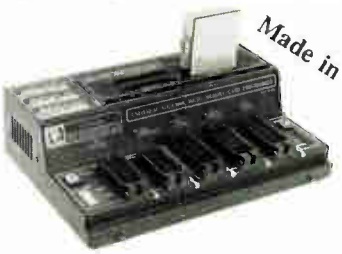

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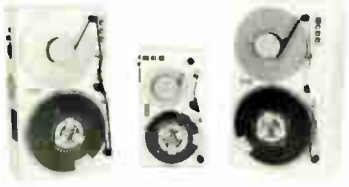

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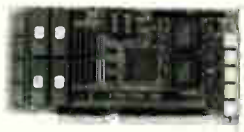

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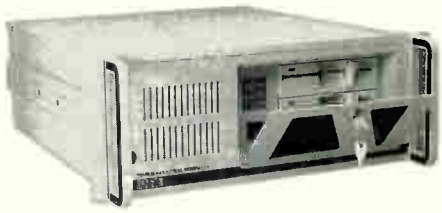

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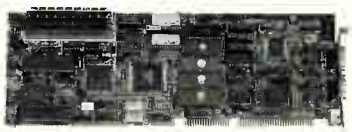

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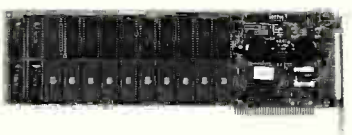

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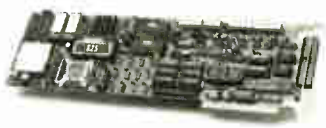

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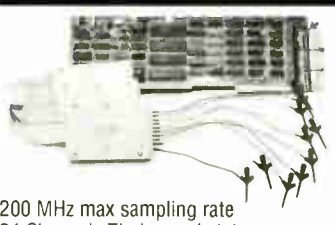

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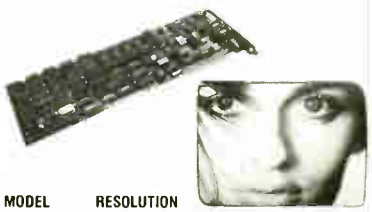

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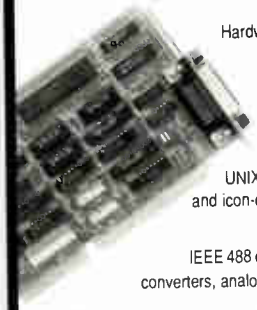

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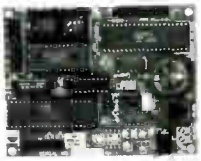

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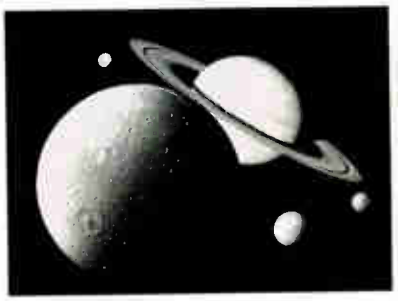

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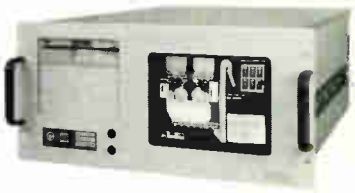

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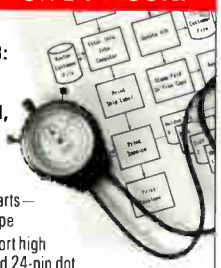

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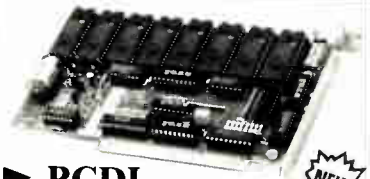

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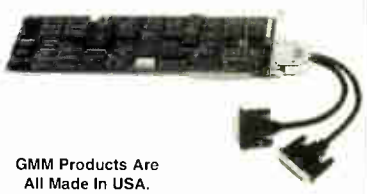

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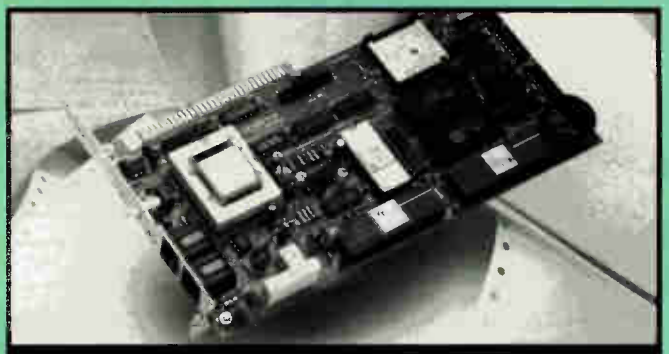

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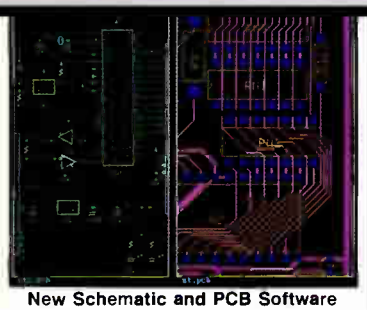

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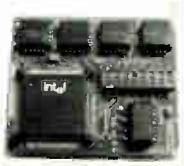

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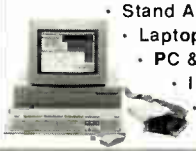

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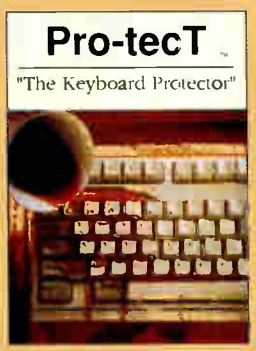

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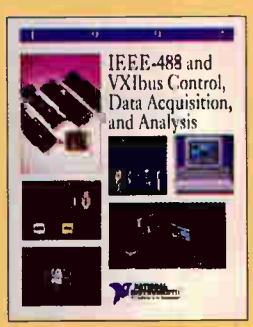

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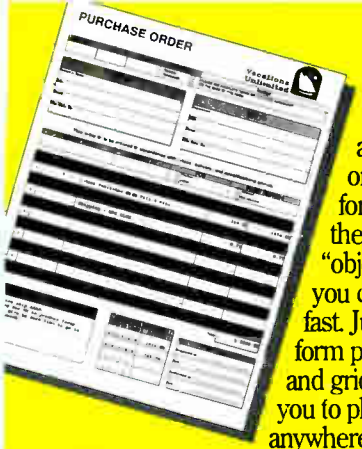

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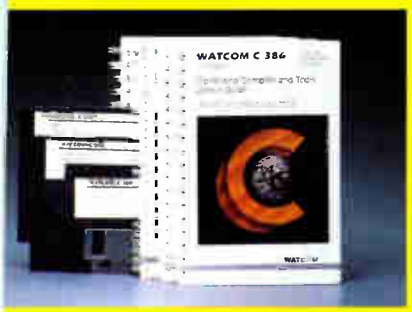

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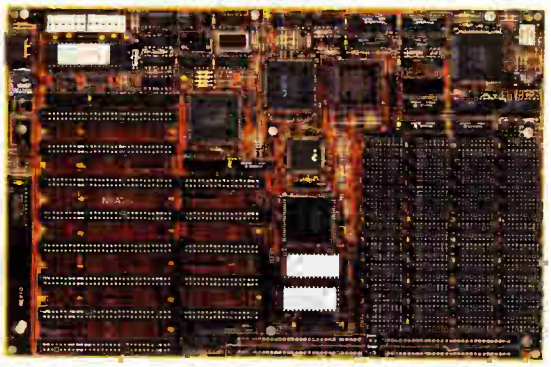

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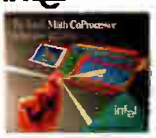

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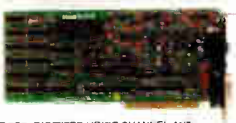

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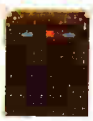

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IDE	3-1/2"	ST-1201A	177MB	15MS	$699
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MFM	3-1/2"	ST-125	21.4MB	28MS	$229
MFM	3-1/2"	ST-138-1	32.1MB	28MS	$259
MFM	5-1/4"	ST-251-1	42.8MB	28MS	$249
MFM	5-1/4"	ST-4096	80.2MB	28MS	$569
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RLL	3-1/2"	ST-138R	32.7MB	28MS	$249
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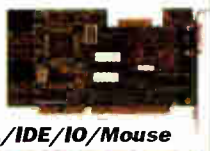

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DATARASE II

Derick's

HIGH-TECH SPOTLIGHT

The JDR FrontPanel was designed to aid both the hardware developer, and programmer. While their aims are slightly different, the methods they use to check their designs are quite similar.

As an example of how the FrontPanel might be used, consider this problem. A new serial device with its own device driver has been installed into the computer. It should generate an interrupt whenever data comes in, read the data from the port, and store the data in memory. But, it doesn't work!

One approach might be to set the FrontPanel switches to cause a non-maskable interrupt whenever the I/O port address associated with the device is read or written. Debug software could then be invoked which would track the program flow to see what happened to the incoming data.

Now suppose we traced the bug to bad data being read from the I/O port. We might hook a loop back plug to the serial device and begin sending and receiving data. If we set the FrontPanel switchesto cause a Sync signal whenever we wrote to the data out port, we could use an oscilloscope to track the data out to the plug and back in.

Trapping an address is very easy. Just set the address switches to the specific address in question, and run the program. If the Run/Stop switch is in the Stop position and the address is exercised the Match LED will light with the current data and address displayed on the board. Further qualifiers can cause it to stop on Reads, Writes, specific Data, DMA channel operation, and external events.

As a software development tool, it can provide information on port usage, memory loop usage, and as an entry point to single stepping and stop on address requirements.

Derick Moore, Director of Engineering

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2732	4096x8	450ns	24	25V	3.95
2732A	4096x8	250ns	24	21V	3.95
2732A-2	4096x8	200ns	24	21V	4.95
2764	8192x8	450ns	28	12.5V	3.95
2764-250	8192x8	250ns	28	12.5V	3.95
2764-200	8192x8	200ns	28	12.5V	4.49
27C64	8192x8	250ns	28	12.5V	3.95
27128	16384x8	250ns	28	12.5V	3.95
27128A-200	16384x8	200ns	28	12.5V	4.95
27256	32768x8	250ns	28	12.5V	4.95
27256-200	32768x8	200ns	28	12.5V	5.95
27C256	32768x8	250ns	28	12.5V	5.95
27512	65536x8	250ns	28	12.5V	5.95
27C512	65536x8	250ns	28	12.5V	6.95
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PART #	SIZE	# PINS	SPEED	CMOS	LOW POWER	PRICE
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HM6116LP-3	2048 x 8	24	150ns	Y	Y	3.25
HM6116LP-2	2048 x 8	24	120ns	Y	Y	3.95
HM6264LP-15	8192 x 8	28	150ns	Y	Y	3.95
HM6264LP-12	8192 x 8	28	120ns	Y	Y	4.95
HM6264LP-10	8192 x 8	28	100ns	Y	Y	5.95
HM43256LP-15	32768 x 8	28	150ns	Y	Y	4.95
HM43256LP-12	32768 x 8	28	120ns	Y	Y	5.95
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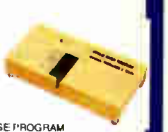

- PROGRAMS 24-32 PIN EPROMS, CMOS EPROMS & EEPROMS, 16K TO 1024K
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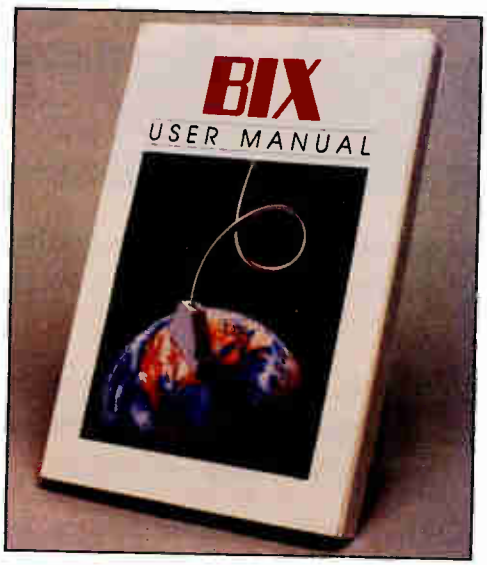

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PRINT QUEUE

HUGH KENNER

Scientists and Simulations

Computers let us see imaginary wonders—including what might have happened if they'd been invented sooner

But a year since *Computers, Pattern, Chaos and Beauty*, and—whoosh, whoosh—here's Clifford Pickover yet again, with a lavishly illustrated new collection called *Computers and the Imagination: Visual Adventures Beyond the Edge*.

Our man seemingly never sits still. "A few years ago, while walking through a Connecticut woodlot, I became curious about the variety of spiderweb structures in the forest. Some webs were vertical, others horizontal, some large, some quite small. To understand which of these webs might be most effective in catching insects, Dr. Gary Login and I designed unusual artificial webs." They used Plexiglas plus a sticky substance called Tanglefoot. And you, "You can design your own computer-generated webs, as described in the 'Stop and Think' section." Well, maybe.

You learn that in the world's scientific journals, from 1986 to 1990, articles with *spider* or *spiders* in the title averaged 170 per year; also that "if all mankind were to disappear, the world would regenerate back to the rich state of equilibrium that existed 10,000 years ago," whereas "if insects were to vanish, the environment would collapse into chaos." So taking up spider simulation lets you in on something *important*.

Alas, the Stop and Think section of this particular chapter offers minimal (nigh useless) help in designing a program, although it does detail the trajectory equation for an insect jumping up at a known angle with known velocity from a rock of a known height.

This five-page chapter, one of the book's 60-odd, shows Pickover at his most maddening: lore scattered in all directions; a primary reference to a journal—*Carolina Tips*—that your library has likely never heard of; and as for the program we're to think of writing, to simulate prey colliding with a web—well, one major omission is that we're told next to nothing about the all-important movements of such bugs as end up in spiderwebs, save for those whose unlikely habit is jumping, Wheee!, at 10 meters per second off 20-meter-high rocks. (Hey, I thought spiders caught flies, and flies just flew?)

But that chapter is an unfair sample? Well, find a fair sample, in a book that defies normative benchmarks. An early page quotes John Steinbeck: "The design of a book is the pattern of reality controlled and shaped by the mind of the writer. This is completely understood about poetry or fiction, but is too seldom realized about a book of facts." One pleasure chez Pickover is his knack for surfacing with pearls like that.

Then there's the leaning tower of books; starting with a book on the edge of the table, can we stagger a stack of books so that the top book will be far out into the room? Yes, we can. Assuming identical book sizes, five books will permit the top one to clear the table. "For an overhang of 3 book lengths, you need 227 books! For 10 books, you need 272,400,600 books."

And so on, while the harmonic series involved keeps diverging very slowly; 1.5×10^{44} books will be needed to carry us 50 book-lengths out, some grasshopper's hiccup all the while threatening to topple the pile. A sphere the diameter of Pluto's orbit would be filled 180 times over by that many books (a fact I owe to BIX and Bill Nicholls). So computer simulation is the only way to go, and adding a small random number to each book's center of mass will afford a running check on sturdiness. The pseudocode in this chapter is easy to retailor. It can change your notions of what's intuitive.

Or try this right now. Draw a big enclosing rectangle. Inside it, draw, left to right, three small boxes, A, B, C, each snug against the bottom edge, where nothing can pass beneath them. Up above, draw, left to right, three small boxes, C, B, A, of which only B is snug against the top edge, where nothing can pass above it; C and A float free. Now draw three lines, A to A, B to B, C to C, no line touching either another line or the enclosing frame.

Pickover tried that on "450 scientists," of whom 20 percent said it was impossible. The rest solved it in from zip up to 6 minutes; their ages ranged from 20 to 60 years, and an interesting graph ties the slowest times to some of the youngest subjects.

Other queries Pickover has tried on scientists fill out a whole section of the book. Suppose Harvard is mysteriously presented, in 1900, with an IBM PS/2, plus a power source good for exactly one year, plus operating manuals and FORTRAN manuals. After the power source dies, scientists are still free to investigate the hardware. "Question: what would be the effect on the world in the 1900s, and on the world today?"

One response: "New religions could get started and congregants would start praying and looking for the next gift." Another: "Scientists learn to type."

More interesting: some zero-impact statements, such as "Almost no effect on science. The tasks we accomplish with computers today are the cumulative product of over 100 years of developing ideas." Pickover chose his 1900 neatly: One way to get a fix on 1991. ■

Computers and the Imagination: Visual Adventures Beyond the Edge, Clifford Pickover, St. Martin's Press, 1991, $29.95, ISBN 0-312-06131-5.

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. He writes for publications ranging from the New York Times *to* Art & Antiques. *His recent books include* Mazes *and* Historical Fictions. *He can be contacted on BIX as "hkenner."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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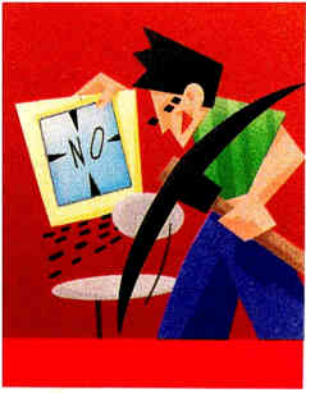

STOP BIT

DICK FLEMING

THINK ABOUT THE UNTHINKABLE

It's easy to become caught up in the excitement of the computer revolution, dreaming of cyberpunk capabilities just around the corner. It's also easy to let our excitement distract us from the more mundane—but often vital—duties of everyday life. A recent experience brought this observation into sharp focus for me.

A few months ago, I received the sad news that an acquaintance of mine had passed away rather suddenly. When I called to express my condolences, the family asked if I could please stop by as soon as possible.

Some suggestions for compiling a disaster recovery notebook

When I arrived the next day, I found them in a state of confusion. Still in shock over their recent loss, they found that much of their financial information was stored in a computer. But no one in the family knew how to access this data.

Their attorney was asking questions about investments so that he could probate the will. Bills had begun to arrive. The family was obviously embarrassed about needing help and worried about having an outsider gain knowledge about their personal finances. Nonetheless, they had to get at the information stored in the computer, and I was the only person they knew who could help. I promised to do what I could.

I'll spare you most of the details. It's enough to say that it took me all weekend to print a few summary reports. Lacking even the passwords and log-on ID, I was forced to play hacker and break into the machine before I could begin retrieving information. Gaining entry, I lacked the most rudimentary idea of what was where on the hard disk. There was obviously some form of subdirectory structure, but it certainly didn't mean much to me, and the filenames looked bizarre.

My lack of familiarity with most of the software packages on the system didn't help matters. Fortunately, the master password used in the financial database had been penciled into a manual; otherwise, I would still be working on getting the data. I realized that my family could be put into a similar predicament.

Managers of mainframe systems have learned to think about the unthinkable and plan ahead. They have a disaster recovery manual stored in a secure place. This manual contains the basic information necessary to resume operations should an emergency occur. I decided to put together a disaster recovery notebook for my PC environment. Here are some suggestions to help you compile one of your own:

- Keep the writing simple and avoid technical jargon.
- Assess the degree of risk associated with the data on your systems. Items of extreme sensitivity (e.g., the password to your automated checking account) are best stored in a safe-deposit box. Less critical data (e.g., log-on IDs and passwords) can be written directly into the notebook.
- Add a page that lists technical-support telephone numbers for each component of your hardware and software. If you purchased your equipment through a local computer store, its phone number should be included. If you have a trusted friend who is familiar with computers, add his or her name and telephone number to the list.
- Write out your directory structure and explain your naming conventions for file systems that you consider critical. This might be as simple as printing a list of all the files currently on the computer and annotating it.
- If your backup procedure is simple, describe how it is done and strongly suggest that a backup be performed before anything else is touched on the system. Explain where backup disks and additional documentation can be found.
- Describe how to log on and access and print the information you consider critical.
- Write down the steps that should be taken to secure your system; for example, turn off the computer or disable the modem to prevent unauthorized access.
- Review the information in the book with your family or a trusted friend. Make sure they understand what the book contains, where it can be found, and how they can use it.

Take the time to "think about the unthinkable" and put together a disaster recovery notebook. Someone may be grateful that you did. ■

Dick Fleming is a member of the AT&T Bell Labs technical staff. He works on communications and systems programming at the Holmdel, New Jersey, facility. He can be reached on BIX c/o "editors."

Stop Bit is a forum for informed opinion on personal computing topics. The opinions expressed are those of the author and not necessarily those of BYTE. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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1. Which products are you most interested in?
   - ☐ 286-based systems
   - ☐ i386™SX-based systems
   - ☐ i386-based systems
   - ☐ i486™SX-based systems
   - ☐ i486-based systems
   - ☐ UNIX® based systems
   - ☐ Laptops/Notebooks
   - ☐ Other: _____

2. Are you interested in computer products for:
   ☐ Home ☐ Business ☐ Resale

3. If for resale, please identify your primary customers:
   ☐ General Business ☐ Government ☐ Education ☐ Medical

4. How many PCs does your company plan to purchase in the next twelve months?

Quantity	Timeframe	Quantity	Timeframe
_____	Less than 1 month	_____	6-12 months
_____	1-3 months	_____	More than 12 months
_____	3-6 months		

5. What do you plan to use computer products for?

_____

_____

_____

6. How many PCs do you have installed now at your company?

_____

7. Are you interested in leasing? ☐ Yes ☐ No

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*Performance Enhancements: Within the first megabyte of memory, 384 KB (450SE, 433SE, 420SE, 450DE, 433DE, and 420DE), 128 KB (320SX, 316SX, and 320LT) and 96 KB (433P, 333D, 325D, 333P, 325P and 320N) of memory is reserved for use by the system to enhance performance. Can be optionally disabled on all except 320LT. All prices and specifications are subject to change without notice. Dell cannot be responsible for errors in typography or photography. **Payment based on 36-month, open-end lease. ◇ Leasing arranged by Leasing Group, Inc. In Canada and Mexico, configurations and prices may vary. Dell and Dell System are registered trademarks, UltraScan is a trademark and TechFax is a service mark of Dell Computer Corporation. 1991 J.D. Power and Associates' Computer End User Satisfaction Study. Phase I. Office Based Small to Medium Sized Businesses™. Responses from Business End Users at 1,784 business sites. Small to Medium Sized Businesses were based on office sites with between 1 and 499 employees. Best Personal Computer in Office Based End User Satisfaction in Small to Medium Sized Businesses. J.D. Power and Associates is a service mark of J.D. Power and Associates. ☆Contains an Intel® i386™ or Intel i486™ microprocessor. Intel is a registered trademark and i386, i486 and the Intel Inside Logo are trademarks of Intel Corporation. Other trademarks and trade names are used to identify the entities claiming the marks and names or their products. Dell Computer Corporation disclaims any proprietary interest in trademarks and trade names other than its own. Service provided by third party servicer. On-site service may not be available in certain remote locations. Shipping, handling and applicable sales tax not included in the price. For information on and a copy of Dell's 30-day Total Satisfaction Guarantee, limited warranty, and third party service contract, please write to Dell USA Corporation, 9505 Arboretum Boulevard, Austin, Texas 78759-7299, ATTN: Warranty. ©1991 Dell Computer Corporation. All rights reserved.

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Most computer companies give you reductions on slow moving computers. At Dell, we give you reductions on award-winning ones.

After our 320N notebook won *PC Magazine's* Editors' Choice, we dropped its price by $900.

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PC MAGAZINE EDITORS' CHOICE 5-1-91

"Dell keeps getting it right."

"Everything about this computer... inspires confidence."

Engineered to tackle the most demanding tasks, the Dell® 320N is an i386™ SX system that runs at 20 MHz.

While it delivers a lot of power, it sure doesn't use much. In a *PC Magazine Labs* test, our notebook led the 20 MHz field in battery life, with over 3 hours of power.

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And the fact that Dell was ranked "best" in J.D. Power and Associates Customer Satisfaction Index for PCs in Small to Medium Sized Businesses.℠

So call Dell today. And ask for our $2,499 computer. At this price we're practically dropping it in your lap.

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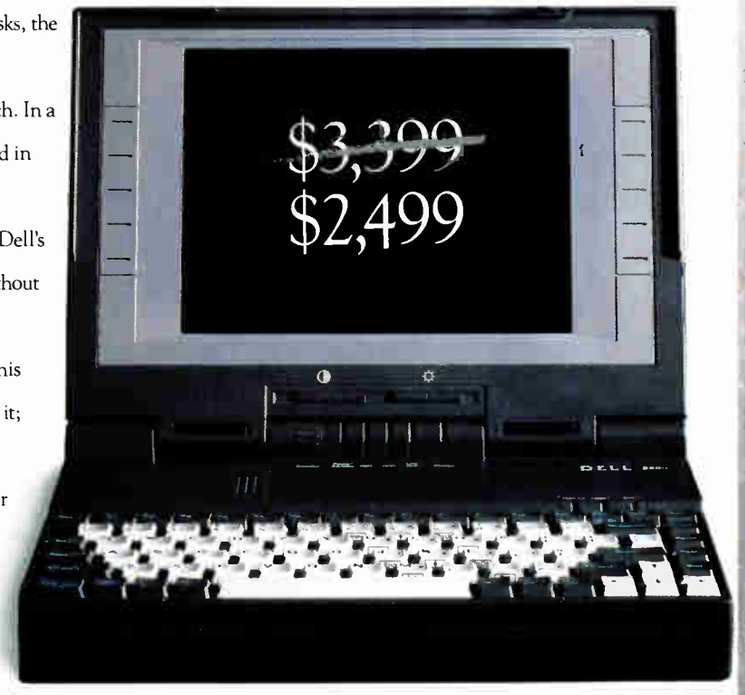

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