BYTE
THE WORLDWIDE COMPUTING AUTHORITY

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Penny-Pinching PCs

from IBM, Compaq, DEC, AST, Dell, and Apple: How They Did It

PLUS

Xerox PARC's Information Theater

Compaq Unveils Network Printers

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d Cons

Apple Macintosh Performa 600

Compaq ProLinea 3/25zs

IBM PS/ValuePoint 325T

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World Radio History

Once upon a time, a band of young rebels known as Gateway 2000 launched a crusade against the tyranny of the PC Titans' bloated prices. Price Wars raged between the Titans and the value-driven upstarts, but the lumbering giants could not match the speed or strength of the rebel attacks.

So the Titans plotted a crafty revenge. They'd cut quality and features, thereby to match the renegades' prices – an evil plan to fool PC buyers and chase the merry Gateway band right out of the forest!

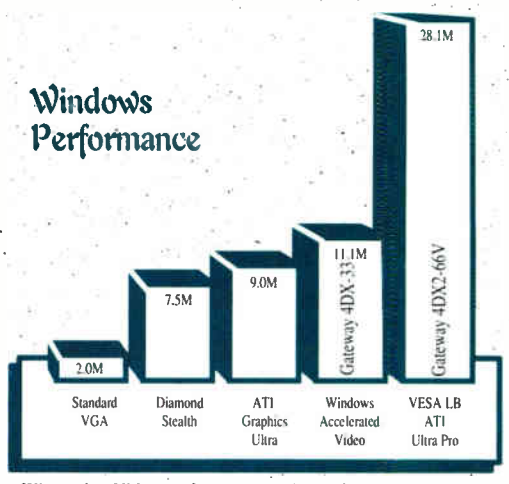
With great fanfare, the Titans charged – only to fall into a clever trap! The woodsmen had crafted powerful new weapons – weapons smarter, better, harder-working and more value-packed than ever.

New Legends Are Born!

The rebels introduced a new product line with faster video, bigger hard drives, local bus and the latest processors. True to form, they boosted performance and lowered prices!

VESA Local Bus Systems

Unlike most proprietary implementations on the market, Gateway's local bus met VESA (Video Electronics Standards Association) compatibility standards. To get optimal performance from the local bus, the woodsmen added ATI's™ new Graphics Ultra Pro video system, with 1MB VRAM. The Ultra Pro is nearly three times faster than the older ATI Graphics Ultra, giving the new rebel systems incredible speed – up to 28 million Winmarks!



Based on Winmarks. Video performance varies with processor speed.

Amazing as 28 million Winmarks is, this benchmark doesn't adequately show local-bus video performance. You just have to see it to believe it!

The wily woodsmen also put the IDE hard drive controller on the local bus for shining disk performance.

Faster Mini Desktop Systems

The renegades made powerful improvements to mini desktop systems, too. On these compact models, they put better, integrated motherboards, faster video, and on 486 models, high-performance local-bus hard drives.

And They Lived Happily Ever After

The Gateway arsenal was further fortified by other valuable features and products (described on the next page). And the people turned against the Titans' trickery and flocked to the banner of value.

Once again, there proved to be one strong and true victor in the Price Wars. Gateway 2000 remains the Champion of the People, and the best value prevails.

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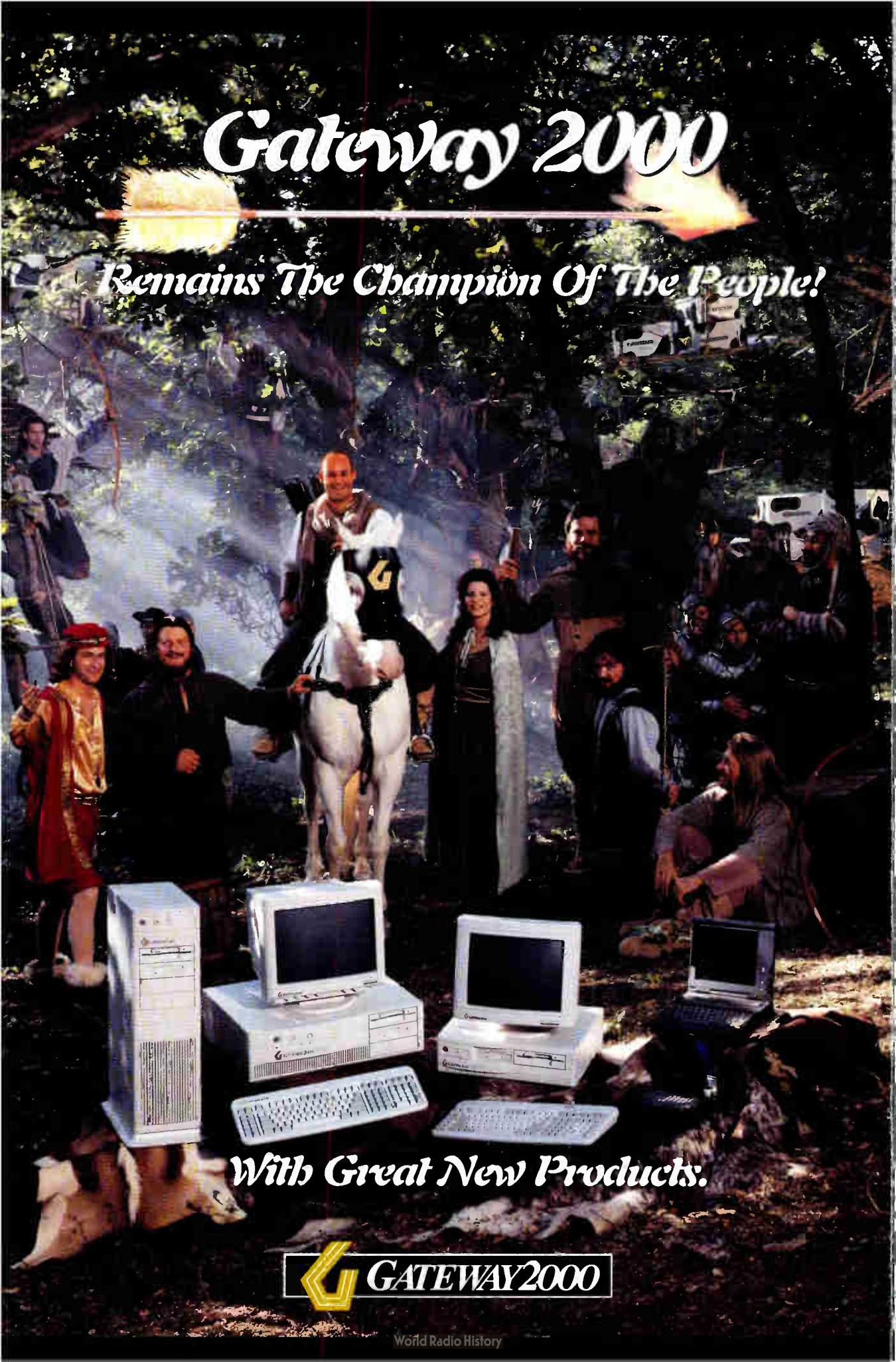

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The PC Titans
Are Conjuring Up
A New Plan
To Catch The
Rebel Leader,
But...

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More Champion Values From Gateway 2000!

Road Warriors

Wherever you journey, our lightweight **Nomad** notebook computers give you desktop performance – in 386SX-25, 486SX-20 and 486DX-25 models.

You get 4MB RAM and 80 or 120MB hard drive, depending on the model; one of the biggest and brightest 10-inch backlit screens in the industry, with 640 x 480 resolution, 64 gray scale, on the LCD; our compact FieldMouse portable pointing device; patented power-management features for over six hours of operation from a single battery – and the Nomad with battery weighs less than six pounds! Plus it's made in the U.S.A.!

The **HandBook**™ is a one-of-a-kind, real PC in miniature form! HandBook owners tell us you can carry it with you everywhere, to do all kinds of work – and it weighs so little, you have to check your briefcase to make sure it's there!

The HandBook weighs just 2.75 pounds and measures about 6 x 9 inches, yet delivers 286-class performance for all your DOS applications. You get a bright, backlit screen; 40MB hard drive; a comfortable 78-key keyboard and up to 4.5 hours of battery life with power management.

Bountiful Software

Every Gateway system includes free software; check our system configurations on the back page of this ad for details. All software is installed at our factory, tested, and ready to run – master diskettes and comprehensive manuals provided.

- NEW! Our Cool Tools for DOS is a utilities software package that comes with all Gateway desktop systems, including: QA Plus™ from DiagSoft™ (for diagnostic hardware testing), Central Point® Anti-Virus, RAM Boost, Defrag and Emergency Disk (for recovering your precious data if you have hard drive problems).

If your system includes "choice of application software," pick one from the following popular applications, all latest versions:

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- Desktop Case (Tower Upgrade)
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- MS-DOS, Windows & Mouse
- Cool Tools for DOS
- Choice of Application Software

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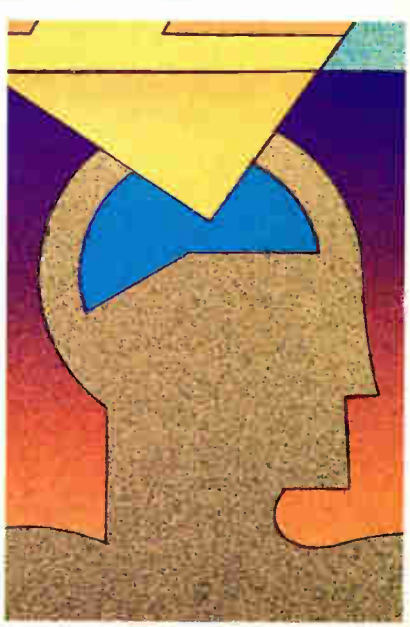

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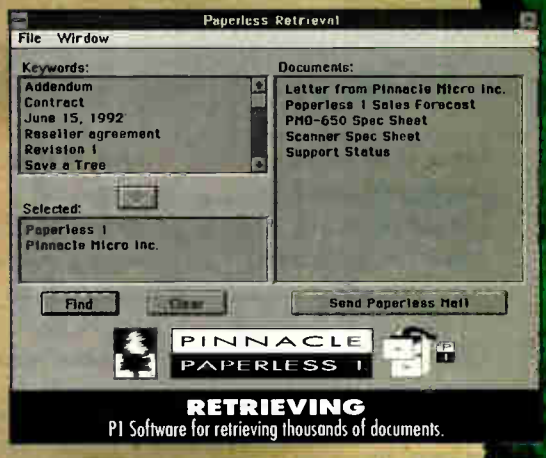

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INSIDE BYTE

BYTE Topic Index

This index helps you find articles that contain information on each of the listed topics. (The topic list changes each month.) Combined with the table of contents (page 4) and the Editorial Index by Company (page 370), you can identify articles by type, subject, title, author, or product discussed.

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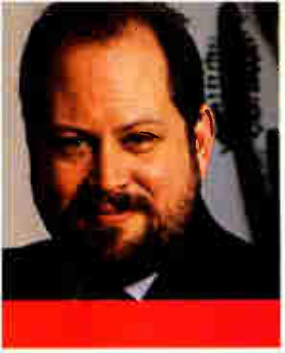


EDITORIAL

DENNIS ALLEN

PCs Will Become More Personal

When we first set out to learn how the major computer makers cut corners to lower prices, we didn't know exactly what we would find. All we knew for sure was that manufacturers must be doing *something* different to lower prices so dramatically. And to be honest, we were cynical enough to think we just might find that corners had been cut so much that the resulting computers would be less than desirable.

The real impact of low-price computers is empowered users

Our cynicism proved to be invalid, but that gives us something else to consider: Given that manufacturers can make low-price computers without necessarily sacrificing quality, what impact will low-price computers have?

Before answering that question, consider the current situation. So far, the price war has yielded 486-based computers with enough memory, disk storage, and adequate graphics to run virtually any major software application satisfactorily at prices that start under $2000. And if you shop around, you can find 386SX-based systems for less than $1000 that are adequate for many applications.

Plus, you can buy those systems not just through mail-order suppliers, but also at department stores. Remember that we're not talking about toy computers; these are high-powered computer systems that you can buy in the same stores where you might purchase a VCR or camcorder. In fact, nowadays you might even pay more for a camcorder than for a computer.

The point is that a lot of high-powered computers are being offered—and sold—through traditional consumer channels. To be sure, some of those sales are for businesses, but often individual consumers are buying single units. To put it another way, the home computer has arrived, and it's not exactly wimpy.

It's too soon to have hard numbers on exactly how many computers are being sold into the home, but it is happening in a big way. The next time you visit the local shopping mall, stop by the computer section of one of the department stores and watch what is happening. You'll see people—sometimes whole families—buying a computer system for their home just as they would buy a new VCR. Even if you don't have time to visit the mall, your friends have probably asked you for advice as to which computer they should buy for their home.

These home-computer users will undoubtedly have new and different needs from current business users. Instead of complex workgroup solutions, their needs are likely to be of a more "personal" nature that a single user experiences. And you can bet that some creative folks are ready and willing to address those needs.

It's even ironic that when most of the computer industry is focused on solving enterprise-wide computing problems with complex operating systems and workgroup software, a new community of users is emerging that will demand that their computers be *more* personal.

The result will be more emphasis on solving a single user's problems, whether it be managing disk files or improving personal productivity. In many ways, this shift will mean a return to the roots of personal computing. In other words, even though network administrators may be taking greater control of PCs, a move is afoot to once again empower users.

As the price war causes the number of individual users to grow, more and more programs and peripheral hardware will be developed to address the specific needs of individual users, and that's good news for business.

Not everything should be networked and shared. There always has been and always will be a need for personal information in every organization. Maybe it's notes, confidential memos, a private phone directory, or background information on client contacts. Or maybe it's a PIM (personal information manager), a utility to automate particular tasks, or a software application peculiar to a particular job.

It all boils down to a matter of empowerment, and it was the concept of empowerment that started the PC revolution over a decade ago. Back then, it was a matter of processing information without being dependent on the company's mainframe. Now, it's a matter of regaining some of the personal control of networked PCs.

Of course, the trend is only emerging, yet it seems clear that something big—something important—is happening. Simply put, many products that will be created for individual users will transcend their home-computer beginnings and benefit networked users in business. And that's the real impact of low-price computers: empowered users.

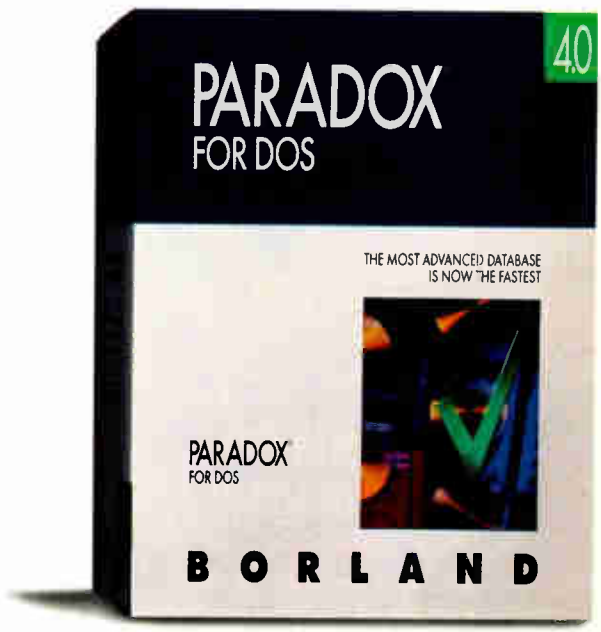
—Dennis Allen
Editor in Chief

World Radio History

DEMAND PERFORMANCE

Introducing Paradox 4.0 for DOS

The most advanced database is now the fastest



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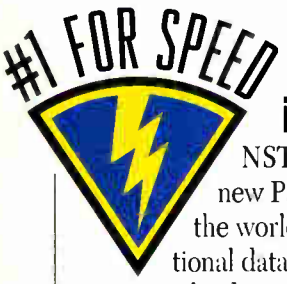


Paradox is fastest

NSTL results prove new Paradox® 4.0 is the world's fastest relational database! Thanks to Borland's new WarpSpeed™ performance, Paradox 4.0 sets the standard in performance for both network and standalone use. For you, this means faster answers to queries, faster memory access and faster multiuser applications.

In fact, Paradox 4.0 gives you unparalleled performance throughout all aspects of database management and application development. As NSTL put it, "Paradox is clearly the best all-around product evaluated." It beats FoxPro hands down.

Software Digest's *NSTL report rates Paradox highest of all databases tested in Overall Power and Performance.*

New Windows-like interface

Our new Windows-like interface makes using Paradox 4.0 more intuitive than any other database. Context-sensitive SpeedBar™ controls give you instant access to your frequently used commands and features. Movable, resizable windows, pull-down menus and mouse support make creating and editing your database simple. And new dialog boxes give you the choices you need in one place, saving time and effort.

The fastest way to get an answer

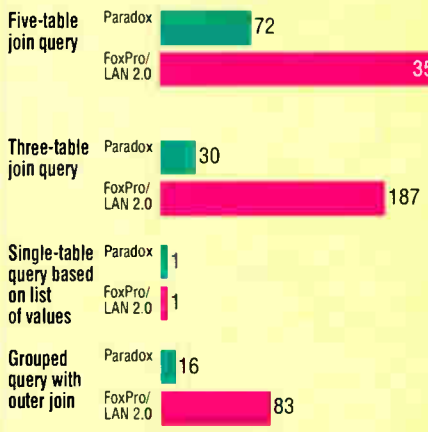
Paradox pioneered Query By Example (QBE), the easiest way to get answers from your database. Now, a built-in query optimizer enhances QBE, automatically finding the fastest path to the answers you're seeking. Plus, multi-table forms and reports make everything from data entry to presentations a snap—all without programming.

WarpSpeed

WarpSpeed stands for Wildly Accelerated Relational Performance. It reflects Borland's commitment to performance, and is also an integral part of our dBASE® and InterBase™ development programs.

NSTL tests confirm Paradox 4.0: Quicker than a Fox

Single-user performance tests
(in seconds)



Multiuser performance tests
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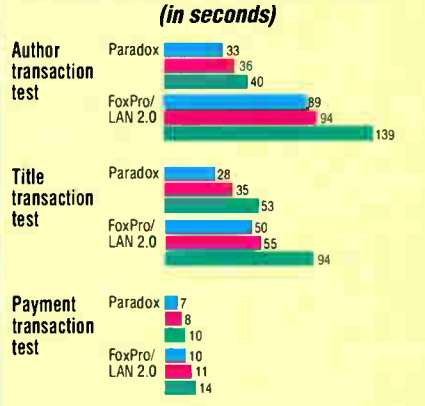


Multiuser Legend:
1 station **3 stations** **8 stations**

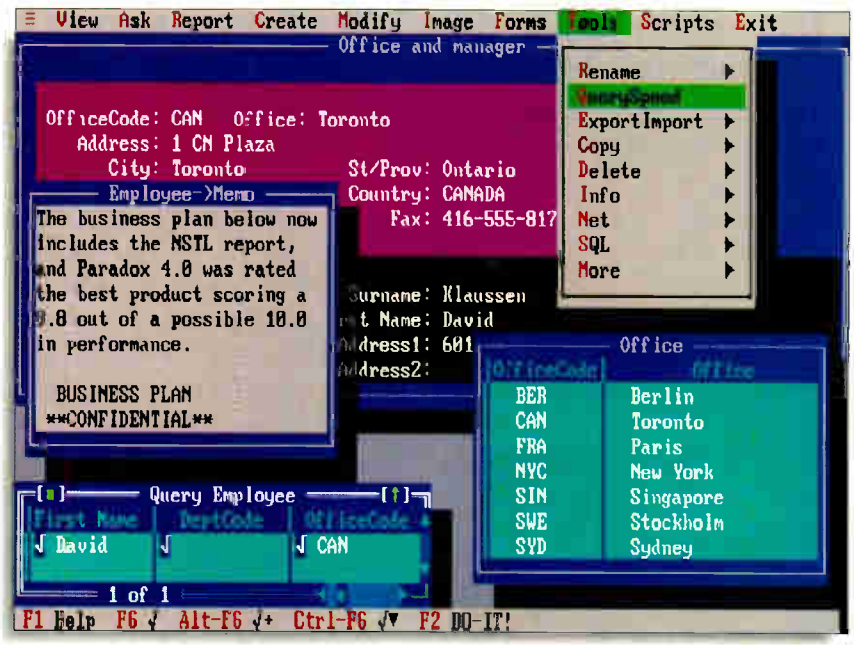
To test the speed of transaction performance, NSTL designed a database for book order entry. Each record contained an author, a title, an ISBN number, a price and inventory information. The database contained 25,000 books and 5,000 authors.

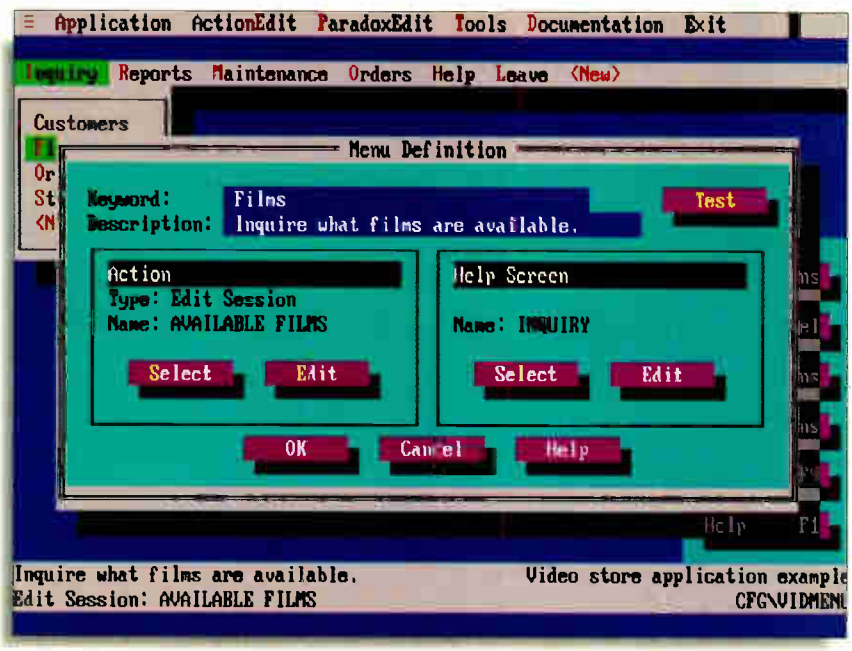
World Radio History

PARADOX

New memo fields

Paradox 4.0 gives you the power to manipulate data you couldn't manage with ordinary databases. With new variable length memo fields, you have the ability to effortlessly manage large amounts of text information throughout your applications. And you can store anything you want in the new binary field—word processor documents, sound, bitmapped graphics, multimedia data—and then manipulate it under program control. Each can hold up to 256Mb of data per field—up to 4 gigabytes per table! There's no easier way to manage large applications.





◄ With the new Applications Workshop, you can build complete applications that include pull-down menus, mouse support, transparent multiuser edit sessions and more. Best of all, it's simple!

Efficient memory management

Paradox 4.0 gives you the best way to manage memory. VROOMM™ with Turbo Drive™ provides more available memory and more efficient memory utilization. So Paradox 4.0 runs on any 286 PC or above. In addition, Paradox 4.0 can run as a DOS application under the Microsoft® Windows operating environment, thanks to complete DPMI support.

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World Radio History

DEMAND

The most award-winning database

Since its introduction, Paradox has won more awards for technical excellence and customer satisfaction than *any* other database. Awards from every major computer magazine and periodical from around the world. In fact, in a recent survey by *Computer-World*, Information Systems professionals ranked Paradox as having the best technology, best documentation, best service and support and best price performance. All of which have made Paradox the favorite of users and developers alike.

BEST TECHNOLOGY
BEST SERVICE/SUPPORT
BEST DOCUMENTATION
BEST PRICE/PERFORMANCE

Faster network performance

Paradox 4.0 is the fastest multiuser network PC database ever. And it's network-ready right out of the box. Multiple users can read, write and modify data simultaneously. You get all this, plus new automatic group lock security that allows multiple users to share data flexibly, providing dramatically increased performance. Just another reason Paradox 4.0 is the best investment for your business.

Transparent access to SQL data

With Paradox SQL Link (sold separately), you can seamlessly access remote SQL data. You can then work with this data using standard Paradox features such as Query By Example. Paradox does all the translation for you.

Paradox SQL Link completely shields you from the intricacies of PC and database server communications. When you specify an SQL table operation, Paradox SQL Link automatically selects the correct communications protocol, opens up

Paradox Developer's Corner

Powerful, procedural language

The Paradox Application Language (PAL™) lets you create sophisticated Paradox applications quickly. PAL procedures allow for private and global variables, array passing and variable scoping. Paradox 4.0 includes more than 90 new commands and functions.

Powerful UI controls

Easily construct your applications with a robust look and feel using the built-in UI controls: non-modal pull-down menus, dialog boxes (with push buttons, check boxes, radio buttons, pick lists, type-in lines and more), pop-up menus, mouse support and multiple overlapping windows.

Event-driven extensions

GetEvent() passes keyboard, mouse and/or system events into your procedures for dispatching. Use dynamic arrays to pass dynamically created data structures to procedures. This greatly increases the modularity and reusability of your code.

Leverage Paradox behavior

Build on Paradox's multiuser support for automatic locking, multi-table forms and referential integrity. Define special error-handling procedures to trap and process error conditions, giving you complete flexibility over users' interaction with your custom application.

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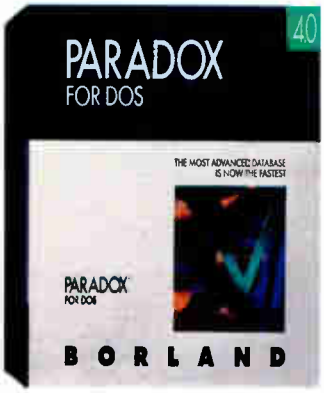

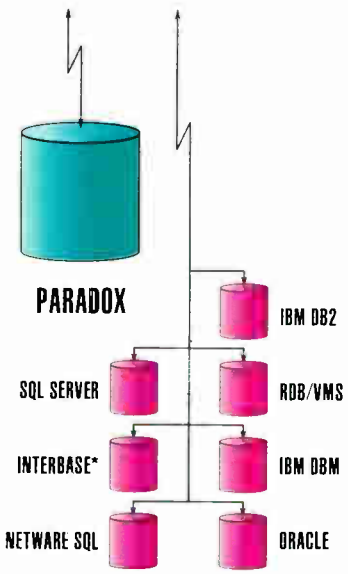

*Paradox SQL Link supports more industry-standard database servers than any other PC database available. (*And the InterBase SQL connection will be available soon.)*

a communication link, relays statements to the database server and presents the results of your query.

By using Paradox SQL Link, you can now enjoy the benefits of SQL databases without the difficulty of mastering the SQL programming language. In addition, Paradox SQL Link operations follow database server security restrictions.

Borland—the database leader

Borland is the acknowledged leader in PC relational databases. More users and developers trust their data to Borland products than any other company. And an integral part of that trust is Paradox.

Paradox 4.0's power to create and manage sophisticated applications, maintain data integrity, handle large quantities of data, perform complex database operations and connect to corporate data is critical to the success of a database management system today. No other PC database meets this challenge like Paradox 4.0—the most advanced database. Best of all, with Paradox 4.0's 60-day, money-back guarantee, you can order risk-free today. So demand the best. Demand Paradox!

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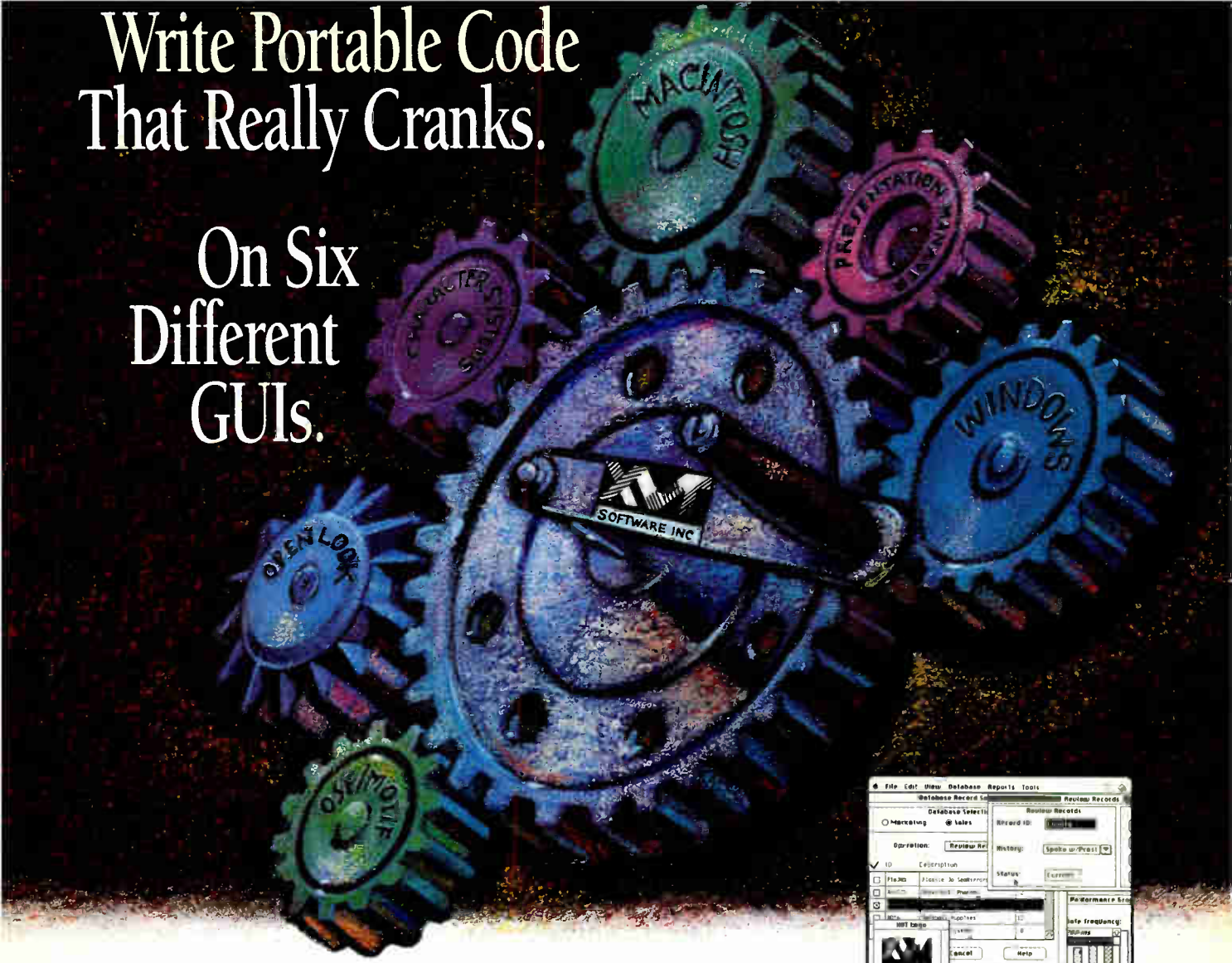
Write Portable Code That Really Cranks.

On Six Different GUIs.



XVT's Portability Toolkit™ is a powerful C development environment that allows you to build a single application, then re-compile to every major GUI without rewriting code. XVT solutions also include an interactive design tool and class library for C++ developers.

- Supports Macintosh, Microsoft Windows (NT in development), OS/2 Presentation Manager, OPEN LOOK, OSF/Motif, and Character Systems
- Native look-and-feel to all target GUIs
- Portability to 26 hardware systems
- Access to the complete functionality of every windowing system
- Easier to use than native development toolkits
- Minimal size and performance overhead
- Shorter development cycles
- No royalties or runtime fees
- Clear documentation and responsive technical support

Now in its third generation, XVT is recognized as the industry leader in portable GUI development solutions and is the base document for the emerging IEEE standard. It is used by world-class software developers like • Novell • HP • AT&T • Digital • Lockheed • Kodak • Grammatik/Reference Software, because it allows them to take their applications to the widest market, quickly and cost-effectively.

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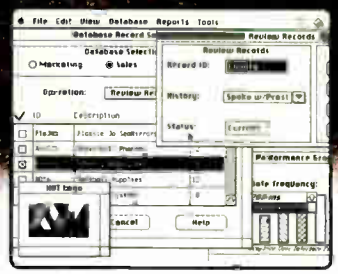
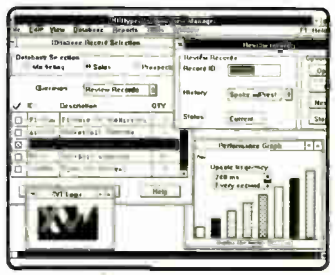


▲ Macintosh



▲ Microsoft Windows

▲ OSF/Motif

Shown above are three of the six GUIs supported by XVT.

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SOME COMPANIES WILLING TO PAY FOR A N IT'S THE ONLY

Design. Engineering. Testing. Service. Support. When you think about it, these are what make one computer better than the next. Which makes it all the more surprising that companies are cutting back in these areas. And, amazingly, some do little but stick their name on at the end of somebody else's assembly line.

It would be like buying a car, looking under the hood, and discovering that it was built by a company you'd never heard of from a place you'd have trouble finding on the map.

It makes you wonder about the kind of company that would do it. Why they would make the decision to put their name on a product over which they maintain little control. And why they would then sell it to their customers.

Obviously, at some point during some meeting in some boardroom, the mandate came down:

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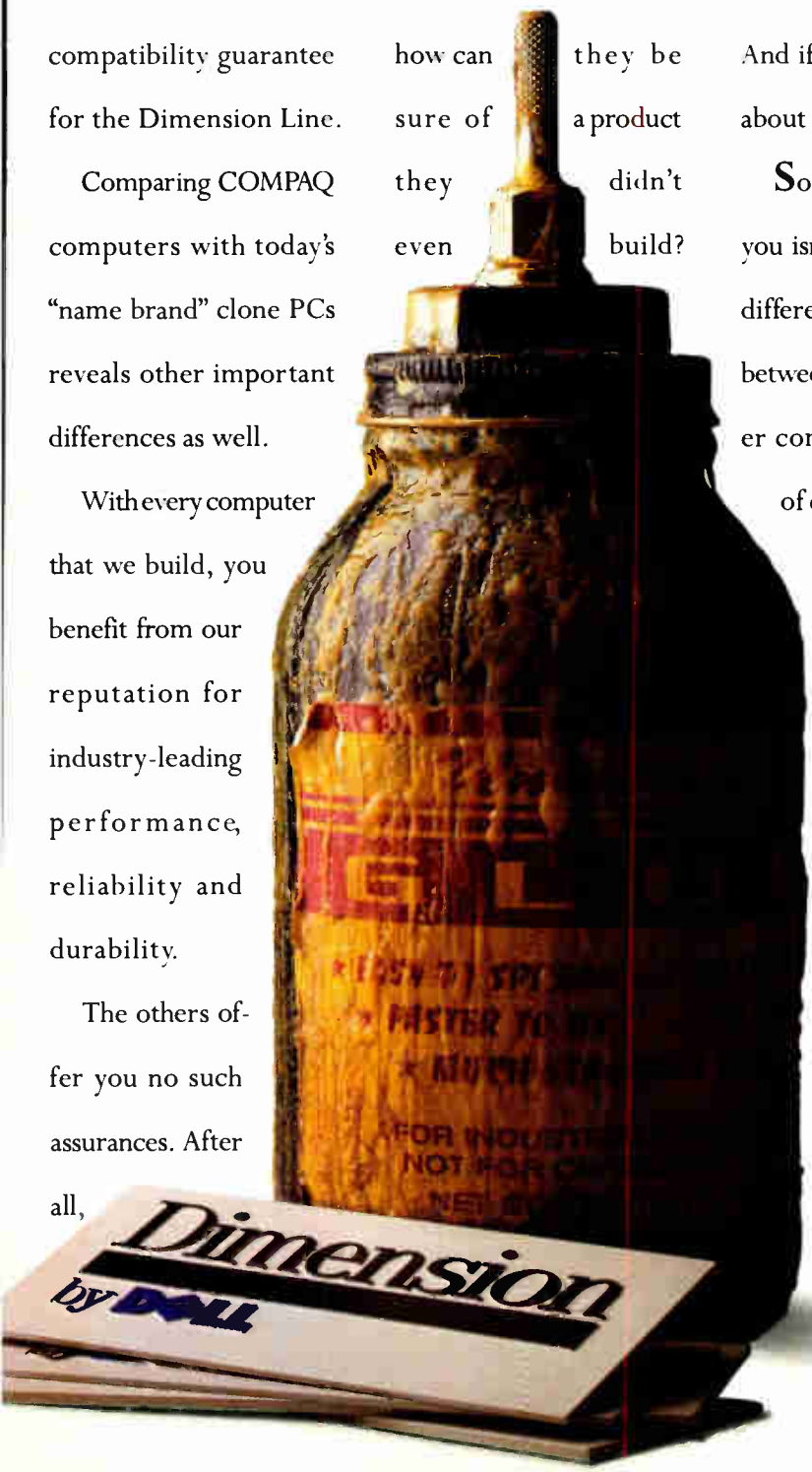

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LETTERS

OS/2 2.0: A Mixed Blessing

OS/2 in Review

I would dispute Jon Udell's claims of problems with IBM's OS/2 2.0 in "OS/2 2.0: A Mixed Blessing" (August). The WPS (Workplace Shell) is a well-designed and well-thought-out replacement for the Presentation Manager. The object-oriented system designed for WPS is far superior to the Windows Program Manager and File Manager, and once you get used to it, it is easy to use.

I have had few problems with WPS crashing. When it has crashed, OS/2 has taken care of the situation by killing it and restoring it immediately. WPS seems to run quite fast with my 40-MHz 386, and I'm happy with its speed.

I deleted Windows and never looked back. Buying OS/2 2.0 is the best decision I've made since buying a 386 system. I think a lot of people will agree, especially after the 32-bit graphics engine and Windows 3.1 enhancements become available this fall.

Timothy D. Jasionowski
Fairfax, VA

Jon Udell's review of OS/2 2.0 missed some important points. To have a stable OS/2 setup, you really need 8 MB of RAM and 40 MB of disk space. Contrast this to IBM's stated minimum of 4 MB of RAM and 30 MB of disk space. Udell would have been better off spending $50 to $60 on 2 MB of RAM for his PS/2 and leaving the HPFS (High Performance File System) cache at 256 KB.

Regarding the disk search test, Udell made no mention of the two-to-three-times speed improvement, for both OS/2 and DOS/Windows programs, that occurs when using the HPFS. Since VDMs can access HPFS partitions under OS/2, there is no reason not to use HPFS.

I beat up heavily on the WPS and have rarely seen it crash. A couple of times I have seen the WPS crash and then restart itself, bringing up all my applications as if nothing had happened. Let's see DOS/Windows try that.

All in all, OS/2 2.0, with all its faults, is the most stable operating system I have ever used. My PC has run many weeks at a time without a reboot. Looking back on my DOS/Windows days, I remember having to reboot often.

John Morris
Sparks, NV

I've used every version of OS/2 since 1.0. For my money, the best one yet was 1.3. And yes, let's be quite clear, the quality of that product is thanks to IBM, not Microsoft. I'd like to be able to say that OS/2 2.0 comes up to the same standard. But along with the WPS, 32-bitness, multiple DOS boxes, and Windows support came problems with ease of use, integration, performance, and stability.

If you follow the OS/2 conferences on BIX, CompuServe, and the Internet, you must have noticed that I'm not alone in my indictment of the WPS. Most power users come to terms with it (myself included), but only after a struggle that IBM shouldn't have required of everyone. The WPS, several readers have reminded me, can rise phoenixlike from its own ashes. Indeed it can, but that's faint praise.

For the record, I tested the shipping version of 2.0 on two machines: a 16-MB Systempro 486/33 (using a file allocation table) and a 6-MB PS/2 Model 70 (using HPFS). File-search performance lagged behind that of Windows 3.1 on both machines by an order of magnitude. A stabler, faster, more intuitive WPS has to be a top priority for the forthcoming point release of 2.0.

Like Unix, OS/2 puts DOS/Windows to shame in many respects. Yet, like Unix, OS/2 hasn't been an easy migration choice for DOS/Windows users. I'd love to be able to install OS/2 on every PC hooked to the network I manage and have those machines keep doing everything they do now—only faster and more reliably. Unfortunately, 2.0 isn't the OS/2 that can pull that stunt off. I'd love to be shown one that can.—Jon Udell

Not for Wimps

For years, I've been reading articles that criticize the weight of laptop and, now, notebook computers. At first the reviewers complained unless a laptop was under 12 pounds, then 10 pounds, then 8 pounds. Now they say a 7-pound notebook is too heavy and advise something in the 5-pound range if you'll be lugging it to the airport.

Who are these wimps? I'm 44 years old, weigh 135 pounds, and carry my 17-pound bag of golf clubs around 18 holes at least twice a week. And these reviewers can't make it to the airplane with 7 pounds and a carry-on bag?

These yuppies. None of your reviewers play golf? I knew it—they ride in a cart.

Ron Crisona
address unknown

The PC Gets Personal

Thank you for your generous comments about the Gateway 2000 Handbook in your July cover story, "The PC Gets More Personal." IQV Corp. designed this product and had it manufactured in Japan. Gateway private-labels it from us. We believe the day is fast approaching when people will be unwilling to carry 6- to 7-pound notebook computers on business trips. Some visionaries are even convinced that weight is so important to travelers that subnotebooks will eventually replace notebooks, just as notebooks replaced laptops.

Thomas F. Dornback
President
IQV Corp.
Wheeling, IL

Thanks for the compliment. Let's hope those visionaries don't meet Ron Crisona on the golf course.—Eds.

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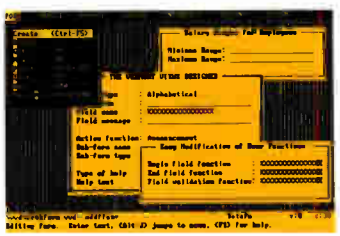

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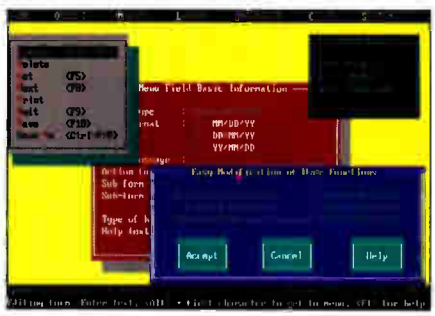

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LETTERS

In "The PC Gets More Personal" the authors state that there is presently no affordable wireless communication technology for the consumer. They mention cellular telephones and packet radio but not second-generation cordless communications (CT2), also known as Telepoint.

This technology, in common use in Europe, is known as "Bi Bop" in France, "Birdie" in Germany, and "Rabbit" in the U.K. It's about to be implemented in Canada in an enhanced form called CT2Plus. This digital technology operates much like a cordless phone (unlike cellular, it does not support roaming). The difference is that the base station can be a public base station connected to a PBX. The handsets are relatively cheap—less than $300—and support about 10 hours of continuous talk time.

While cordless technology doesn't provide true mobile communications in the same way as cellular, it does offer affordable wireless communications in a large number of environments. Since the infrastructure requirements are less than for cellular or packet radio, the implementation of the networks is likely to occur more quickly.

Chris Shepherd
Beeston, U.K.

Unix for Nothing

In response to Ben Smith's First Impression of Mark Williams Co.'s low-cost Unix clone, Coherent ("Coherent Grows Up," August), I'd like to bring to your attention Linux, a free Unix clone written by Linus Torvalds of Finland, with help from hundreds of programmers from all over the world. Linux is a 386-specific, mostly Posix-compliant, SYSV-like Unix clone. It rates favorably in benchmark testing against commercial versions of Unix.

One of the few reservations Smith had about Coherent was its lack of X Window System support. I run X on my Linux machine daily.

Due to the widely varying backgrounds from which Linux's contributors come, the system is blessed with very good hardware support: SCSI, several brands of Super VGA cards, nonstandard serial configurations, and many brands of motherboards. Peripheral drivers are well represented, too. I wrote most of the Logitech bus mouse driver and am working on a CD-ROM driver.

Linux lacks kernel support for TCP/IP. However, a group of programmers is working on that.

Linux is available via anonymous FTP from tsx-11.mit.edu:/pub/linux (U.S.) or nic.funet.fi:/pub/os/linux (Europe). The news group is comp.os.linux; send E-mail to linux-activists-request@niksula.hut.fi to join the mailing list.

David Giller
Los Angeles, CA

MacGuffin Rebuff

Jim Manzi's Stop Bit, "The Productivity MacGuffin" (August), raises interesting questions, but I find his prescription for more LAN hardware unconvincing. A failure to achieve increased productivity through computerization may have little to do with hardware and software choices and does not necessarily say anything about the value of computerization. It more likely reflects inadequacies of management style and practice and the adoption of computerization strategies aimed mainly at bolstering the status quo.

A reasonable alternative is to take a hard look at the assumptions underlying management practice and to establish productivity-related goals regarding such things as manager/worker ratios. Then one is in a position to decide how computers might contribute to solutions.

Mike Connealy
Las Cruces, NM

It is curious to see Jim Manzi concerning himself with the effect of computers on productivity when his company is busy litigating to try and prevent software developers from using commands and keystrokes with which users are already familiar. If he succeeds—and it appears that he has—applications will no longer be able to use the same keystrokes or menus as competing products, and user productivity will inevitably suffer. If Manzi really wants to increase the productivity of white-collar workers, the best thing he can do is get Lotus to drop its ridiculous lawsuits against companies such as Borland.

Mathew
Cambridge, U.K.

A20 Issues

Mark J. Minasi's "Exorcising the A20 Poltergeist" (August) was very educational. I was interested to learn that the A20 handler chip also processes the keyboard. However, the article had one minor error. The 386SX and 386SL processors have 32 address lines, not 24. Otherwise, how could a 386SX go to 386 extended mode in Windows? This requires the CPU to go to virtual mode, which requires access to the full 4-GB address space of the 386/486 family.

The distinction Minasi was thinking of is the number of data lines in the external data bus. The 286, 386SX, and 386SL all have 16-bit external data buses, while the 386DX and 486 have 32-bit buses. Although this error was not significant in the context of the column, I thought readers would be interested in the distinction.

In my opinion, IBM should have left out the A20 gate and written an A20 software handler back in 1983.

Charles Bretana Jr.
Apple Valley, CA

Real Time Goes Amiga

When I read "Real Time Goes Home" (August), I thought Ken Kaplan was describing things to come. I was pleasantly surprised to learn that CD-I was fulfilling the real-time promise. However, there is another entry in the home information appliance market that warrants mention: the CDTV by Commodore Business Machines. CDTV is an Amiga computer with a battery of infrared I/O devices, a CD-ROM drive, and a personal RAM card slot. It is capable of all the actions described in the article.

I hope Commodore will give us the opportunity to make it happen. At a street price of about $700, the CDTV doesn't quite fit Kaplan's $200 scenario, but we all know what time does in these markets. ■

Gordon Cunningham
Sebago Lake, ME

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NEWS

MICROBYTES

IBM Boca Raton Readies OS/2 Enhancements

BOCA RATON, FL—Now that IBM has passed the 1 million sales mark for OS/2 2.0, the company has its hands full keeping the bandwagon rolling at a sufficient clip to ward off the 16-bit Windows threat while attempting to preempt Microsoft's unreleased 32-bit Windows NT. By the end of the year, IBM expects to make several announcements in the areas of OS/2 multimedia, 32-bit graphics, Windows 3.1 support, and pen computing.

IBM's programmers have been improving OS/2 and fixing more than a hundred bugs found in the initial April release of version 2.0. By the end of next month, IBM expects to release a Service Pak that will fix the numerous bugs and enhance the operating system. The nominally priced Service Pak will offer faster DDE and Clipboard links between Windows and OS/2 Presentation Manager applications and between Windows applications when run from OS/2. A 32-bit graphics engine will provide developers with a flat-memory model that should cure problems encountered from the previous 16-bit engine's resource limits. Slowness attributed to 32-bit graphics calls being thunked, or converted, into 16-bit instructions should be alleviated, and seamless Super VGA and XGA support will allow for resizable windows where the original version 2.0 permitted full-screen windows only.

IBM will also provide video drivers for five major players in the video adapter market: Tseng Labs, ATI, Headland, Western Digital, and Trident. According to OS/2 senior programmer/manager Franz Walkow, the Tseng drivers will be included in the Service Pak; the others will follow early next year. A video device-driver kit for other vendors' boards should be available to developers this fall.

IBM will provide support for Microsoft's Windows 3.1 through an "installable feature." In this feature, the company will include most of Windows 3.1 but not games, the Windows macro recorder, the terminal emulator (OS/2 has its own terminal emulator), and certain applets. This feature will improve OS/2's support in several ways. DDE links will be supported across VDMs (virtual DOS machines), although OLE will work only within a single VDM. It will also add extensive online support for Windows, DOS, and OS/2. For example, instructions on creating a custom AUTOEXEC.BAT file for each VDM will be provided. (Previously, individual VDMs could not be customized beyond individual CONFIG.SYS files.) Windows applications will also run non-Windows DOS applications.

This year, IBM hopes to release OS/2 Pen Extensions for desktop pen devices (e.g., digitizing tablets) that are connected to desktop PCs. Support for pen-centric portable PCs like the original ThinkPad will arrive in the first quarter of 1993. Also slated is support for PCMCIA (Personal Computer Memory Card International Association) devices and the Intel-Microsoft Advanced Power Management specification.

Gordon Arbeitman, IBM's senior programmer for OS/2 Pen Extensions, said that the pen extensions will come bundled with an application called TeleSketch, which lets users share and collaboratively edit on a simulated blackboard across a LAN or a remote link. A second application called ImageMail, which lets you embed voice attachments in a pen program's document, began as an internal application and may or may not make it to market.

At the Fall Comdex, IBM plans to demonstrate beta versions of new UltiMotion software, a companion product to the shipping Multimedia Presentation Manager/2. UltiMotion, in combination with MMPM/2 and an IBM M-Audio or other adapters from Creative Labs and MediaVision, provides 8-bit audio, 320- by 240-pixel resolution, and full-motion color video at 24 frames per second. The program's algorithm can compress a 300-MB full-motion video file to a mere 6 MB.

—Ed Perratore

NANOBYTES

Now that LANs have become a reality in business computing, the move toward downsizing (or rightsizing) is gaining momentum, according to a recent **Datapro Information Services Group** (Delran, NJ) study. Of about 1000 respondents, 23 percent of MIS professionals plan to implement within the next 12 months a client-server structure in their organization, which is up from just 8 percent in 1991. One barrier to the successful implementation of a client-server solution, according to Datapro managing analyst Pam Paul, is that client-server applications and other software programs are not available yet for MISes. "There's a lot of pieces that are missing from this whole [client-server] puzzle," Paul said. One of those pieces is network system management, which is why Computer Associates is porting its CA-Unicenter for mainframes to NetWare. □

Softool's president **Leon Presser** says that another software piece

that will be crucial to the client-server puzzle is configuration maintenance and version-control. "As more companies downsize, the change-control problem is multiplying," he said. "If you're going to downsize, change and configuration management is essential where it was not as essential when you were centralized," he said. When companies move to distributed network solutions, Presser explained, someone still needs to be responsible for managing the software that goes out to a population of users. □

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- **Comprehensive toolset** includes debugger, linker, profiler and more
- **DOS extender** support for Rational, Phar Lap and Ergo
- **Run-time compatible with WATCOM FORTRAN 77/386**

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Fox Software, *David Fulton, President:* "FoxPro 2.0 itself is written in WATCOM C, and takes advantage of its many superior features. Optimizing for either speed or compactness is not uncommon, but to accomplish both was quite remarkable."

GO, *Robert Carr, Vice President of Software:* "After looking at the 32-bit Intel 80x86 tools available in the industry, WATCOM C was the best choice. Key factors in our decision were performance, functionality, reliability and technical support."

IBM, *John Soyring, Director of OS/2 Software Developer Programs:* "IBM and WATCOM are working together closely to integrate these compilers with the OS/2 2.0 Programmer's Workbench."

Lotus, *David Reed, Chief Scientist and Vice President, Pen-Based Applications:* "In new product development we're working with WATCOM C because of superior code optimization, responsive support, and timely delivery of technologies important to us like p-code and support for GO Corp's. PenPoint."

Novell, *Nancy Woodward, V.P. and G.M., Development Products:* "We searched the industry for the best 386 C compiler technology to incorporate with our developer toolkits. Our choice was WATCOM."

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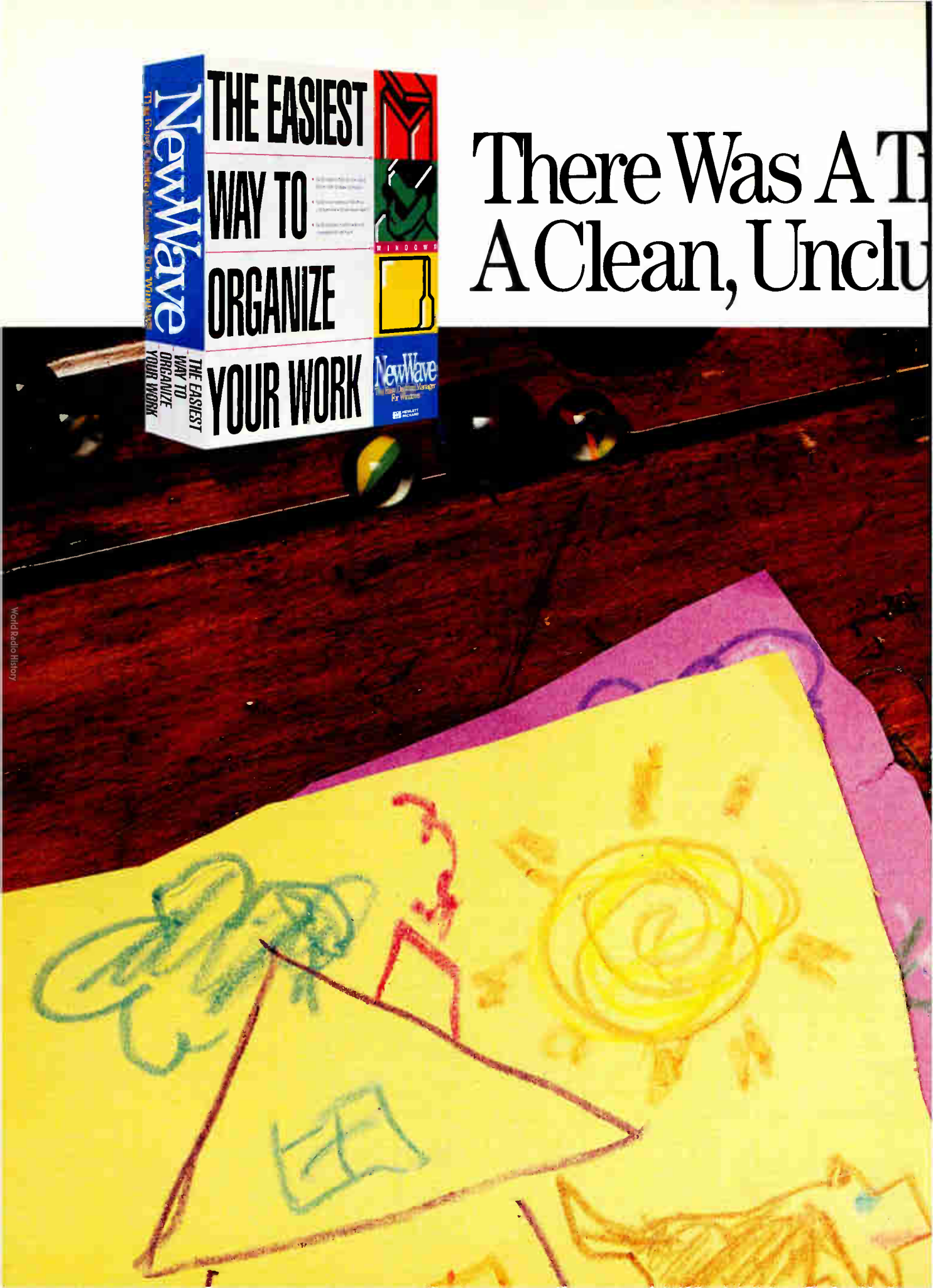

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World Radio History

NEWS

MICROBYTES

Sun Expands Alliance With Russian Computer Scientists

REDWOOD CITY, CA—Sun Microsystems (Mountain View, CA) has hired 33 top Russian computer scientists, including supercomputer designer Boris Babaian, to write compilers and other development tools for Sun Sparcstations. Working under exclusive contracts at three locations in their home country, the Russians will apply their knowledge of multiprocessing architectures to a new generation of Pascal and FORTRAN compilers and optimization tools.

"We think this can be a precedent for other research-and-development-intensive companies," said Scott McNealy, president, CEO, and chairman of Sun Microsystems. Babaian, a longstanding member of the Russian Academy of Sciences, is known as the "Seymour Cray of the Russian computer industry." He was the principal architect of the Elbrus-3 supercomputer, which was reputed to be three times faster than a Cray Y-MP, the fastest U.S. supercomputer. The 16-processor Elbrus-3 uses an architecture known as fine-grain parallelism to achieve its high performance. In the 1970s, Soviet computer designers pioneered multiprocessing architectures to overcome the limitations of their slower processors, and their long experience in writing software for those architectures is what attracted Sun's attention.

Sun first contacted the Russians in 1990. Negotiations were delayed by legal barriers and the deepening political turmoil in the crumbling Soviet Union. In March, Sun formed the Moscow Center of SPARC Technology and contracted with Babaian for basic research. The latest agreement goes far beyond that by integrating the Russians into Sun's U.S.-based development efforts. It's a rare example of a Western company employing Russians to produce high-technology commercial products.

The Moscow team will focus on the Sparcompiler Optimizer, a performance-enhancing tool for SPARC applications. Two other teams in St. Petersburg (formerly Leningrad) and Novosibirsk (Russian Siberia) will work on the Sparcompiler FORTRAN and Sparcompiler Pascal products sold by SunPro (Mountain View, CA), the software development arm of Sun. The projects are scheduled for completion in 12 to 18 months.

Trade restrictions left over from Cold War days made the alliance difficult to cement. Sun will equip the Russians with workstations, but it is forbidden to provide machines more powerful than a Sparcstation 1+. Ironically, if current restrictions are not lifted, the Russians won't be allowed to buy the finished software they help develop, said Jon Kannegaard, SunPro's vice president and general manager.

—Tom R. Halfhill

PCMCIA Standard Faces Incompatibilities

PCMCIA (Personal Computer Memory Card International Association), the standard for credit-card-size devices to hook up with laptop and palmtop computers, is off to a fast, and incompatible, start. At the Fall Comdex, about 50 vendors will be showing computers and peripherals that use the PCMCIA interface. The problem is that a significant number of them won't be able to talk to each other.

PCMCIA got popular too fast. While the physical specification is well established, some critical pieces of the software standard are still missing. Socket services, which interface with the hardware, need to be reworked to meet the changing uses of PCMCIA. The card services layer, which is the layer above the socket services layer, isn't complete yet. In their eagerness to use PCMCIA, manufacturers are working around the missing pieces by hooking into higher levels in various, mostly incompatible, ways.

PCMCIA is being stretched beyond what its designers originally envisioned. PCMCIA was supposed to be for memory cards, but it is becoming the standard for connecting any kind of peripheral to a notebook or palmtop computer. It is compact and power-efficient in a way that alternatives (e.g., the ISA bus) are not.

Because manufacturers are writing their own versions of the missing software, most of their work will probably have to be redone when the standard is made final. PCMCIA thinks the fuss is overblown. Brendan McGuire, executive director of PCMCIA, said he expects some incompatabilities. "That's inevitable" with a new standard, he said. But he added that incompatibilities will be minor and companies have said they will release compatible versions of their software as soon as possible.

—Rick Cook

NANOBYTES

"In our country, all computer industry has stopped due to the economic situation and other circumstances," says **Boris Babaian**, a Russian supercomputer architect

who's working with Sun Microsystems. Babaian explains that thousands of engineers are jobless and that the native computer industry cannot compete with the Western technology now flooding his homeland. □

Recently speaking on the promise of computer-supported collaboration, Intel chairman **Gordon Moore** prophesied that the computer's growing ability to simultaneously manipulate voice and image data will lead to a new era of international productivity and cooperation. Moore predicted that it will soon be possible to carry on a conversation with a personal computer. He said that he was "frankly amazed" that voice-activated menus and command recognition have taken so long to appear in the DOS marketplace. "Most of the people that use computers want to just use them and not have to work with them," he said. □

The advent of low-cost PCs—and razor-thin margins for PC manufacturers—is arguably the story of 1992. Companies such as Compaq have been hard-pressed to keep up with the demand for the low-end machines, and yet, according to **Michael Dell**, president and CEO of Dell Computer, the industry has not responded properly to customer demands. Speaking to an audience of mostly U.S. government workers, Dell said, "You've invested $80 billion in computer products, and it's resulted in a 1 percent increase in productivity." After a pause, he added, "I would hate to be the CEO of a company with those results." □

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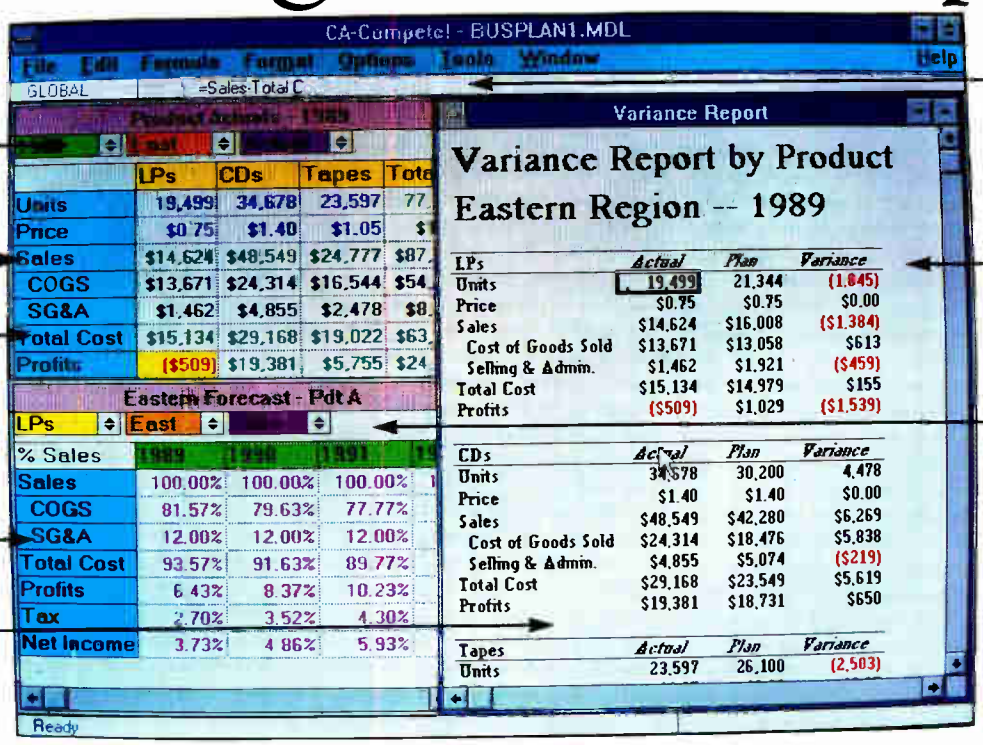

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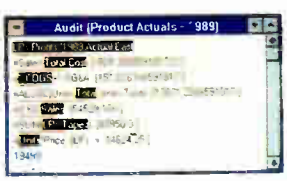

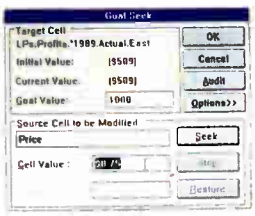

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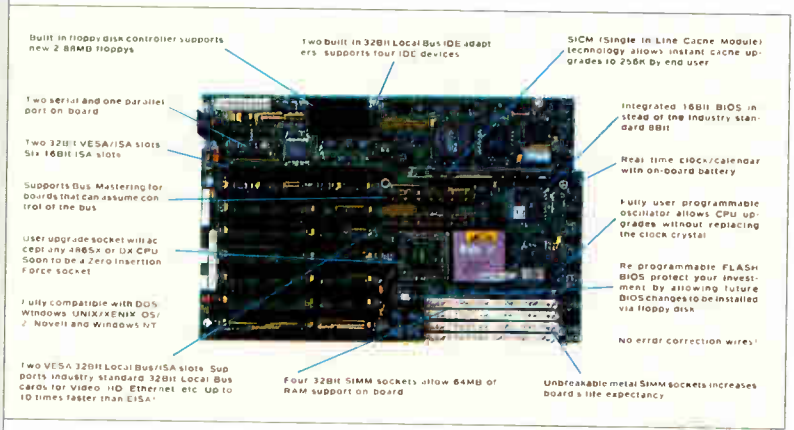

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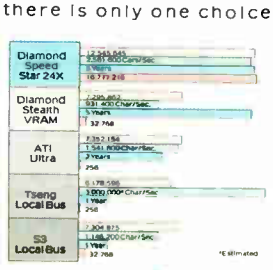

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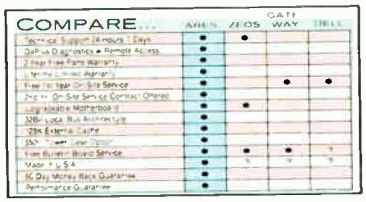

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NEWS

MICROBYTES

Borland vs. Symantec: High-Level Intrigue

Is it a tempest in a teapot or a full-blown industrial espionage? And just how private is E-mail? That's what people are wondering about one of the strangest scandals to erupt in Silicon Valley in years.

On September 1, Eugene Wang surprised his colleagues at Borland International (Scotts Valley, CA) by resigning to join Symantec (Cupertino, CA). As vice president and general manager of the Languages Business Unit, Wang was one of Borland's top executives.

But the real surprise came after Wang resigned. Borland says it "received information" that Wang had leaked company secrets to Symantec. Borland then accessed Wang's corporate MCI Mail account and read all the messages he had sent over the previous five days. According to Borland, at least 10 of those messages were addressed to Symantec CEO Gordon Eubanks and contained secret information about Borland's marketing plans, recruiting prospects, business strategy, and specific strategy regarding Symantec.

Borland called the local police and the district attorney, charging that Wang had stolen trade secrets, a felony in California. Authorities obtained search warrants and raided Wang's home and Eubanks's office and two houses. The 12-page list of seized items included computers, disks, and files. The next day, Borland sued Wang, Eubanks, and Symantec.

How did Borland access Wang's MCI Mail? Borland uses MCI for internal communication and pays for its employees' accounts; therefore, Borland had Wang's password, and the company was able to scan his MCI mailbox. Borland says that this is the first time it has read an employee's E-mail.

Symantec won't comment on specifics but denies any wrongdoing. Symantec also accused Borland of "harrassment tactics" and dismissed the situation as a "tempest in a teapot."

—Tom R. Halfhill

C&T Refocuses on Single-Chip Systems

Chips & Technologies (San Jose, CA) says it will no longer make new clones of discrete Intel-compatible 80x86 processors; instead, it will focus its efforts on single-chip systems for the emerging portable computer market. Spokesperson Gavin Bourne put a positive spin on the company's fourth-quarter financial loss of about $8.8 million, saying C&T is now shipping its Super386 processors and SuperMath coprocessors in volume. C&T will continue to ship its Super386DX processor but has canceled its plans to release the Super38600SX and 05SX processors. "The [SX] parts are here, but clearly, the market has collapsed," he said.

—David Andrews

New RISC Chip to Emulate 486 and 68040

International Meta Systems (Torrance, CA) claims it has a new RISC microprocessor that can emulate an Intel 486 or Motorola 68040 at their full native speeds and at a fraction of their cost. IMS is pitching the CPU for pen computers that need high performance for tasks such as handwriting recognition. It also says the chip could be used in a "chameleon computer" that runs PC and Mac software.

The IMS 3250, slated for mid-1993 production, is a two-chip set with a RISC CPU and an I/O controller. IMS says the 3250 will use 0.7- or 0.8-micron CMOS technology with the equivalent of 400,000 transistors. Clocked at 100 MHz, the CPU reportedly runs at 90 MIPS in native RISC mode.

What sets the 3250 apart from other RISC chips is its programmable microcode. Although many CISC processors implement their instruction sets in microcode, most RISC chips do not. Systems designers can reprogram the 3250's microcode using assembler-like tools. IMS says it has written modules that emulate a 486 at 25 MHz and a 68040 at 30 MHz, including FPU support.

To build a computer that runs both PC and Mac applications, a designer would still have to add the appropriate system software. PC clones are easy to make, but a Mac clone would require either licensed Mac ROM chips or their legal equivalent. One possibility is a Mac "compatibility engine" such as the toolbox emulator from Quorum. IMS says the 3250 will cost just $50 to $60 in production quantities.

—Tom R. Halfhill

NANOBYTES

Home Row (Clackamas, OR, (503) 656-2995), the developer of the **J-Mouse**—an alternative to the traditional mouse for Microsoft Windows—has developed a smoother-functioning version of the device that the company hopes will make the J-Mouse a standard on desktop keyboards. Portable PC manufacturers have already incorporated the J-Mouse into their keyboards so that you don't have to struggle with a klunky trackball. The J-Mouse, which appears as a blue-colored *J* key in the keyboard, does double duty as a regular alphabet key and as the actual pointing device. Sejin America (Sunnyvale, CA, (408) 752-8447) will include the J-Mouse in a new 101-key keyboard. □

Rumors of the demise of **DataPerfect** have been greatly exaggerated, says Russ Dastrup, product manager for the WordPerfect database package. Responding to reports in trade papers and in BYTE's September Microbytes claiming that WordPerfect's new WISE (WordPerfect Information System Environment) strategy could mean the end of DataPerfect, Dastrup said the software "is not dead." To the contrary, he says, WordPerfect's board of directors has "made a recommitment to DataPerfect in both development and marketing." A new release 2.3 is expected to ship at the end of October, while work is under way on "a version beyond 2.3," Dastrup says. □

California would gain as much as $5 billion in reduced fuel costs and increased productivity a year if more workers **commuted electronically**, a study by the California Engineering Foundation says. The biggest obstacles to telecommuting are structural (e.g., the IRS rules on workers' home offices). □

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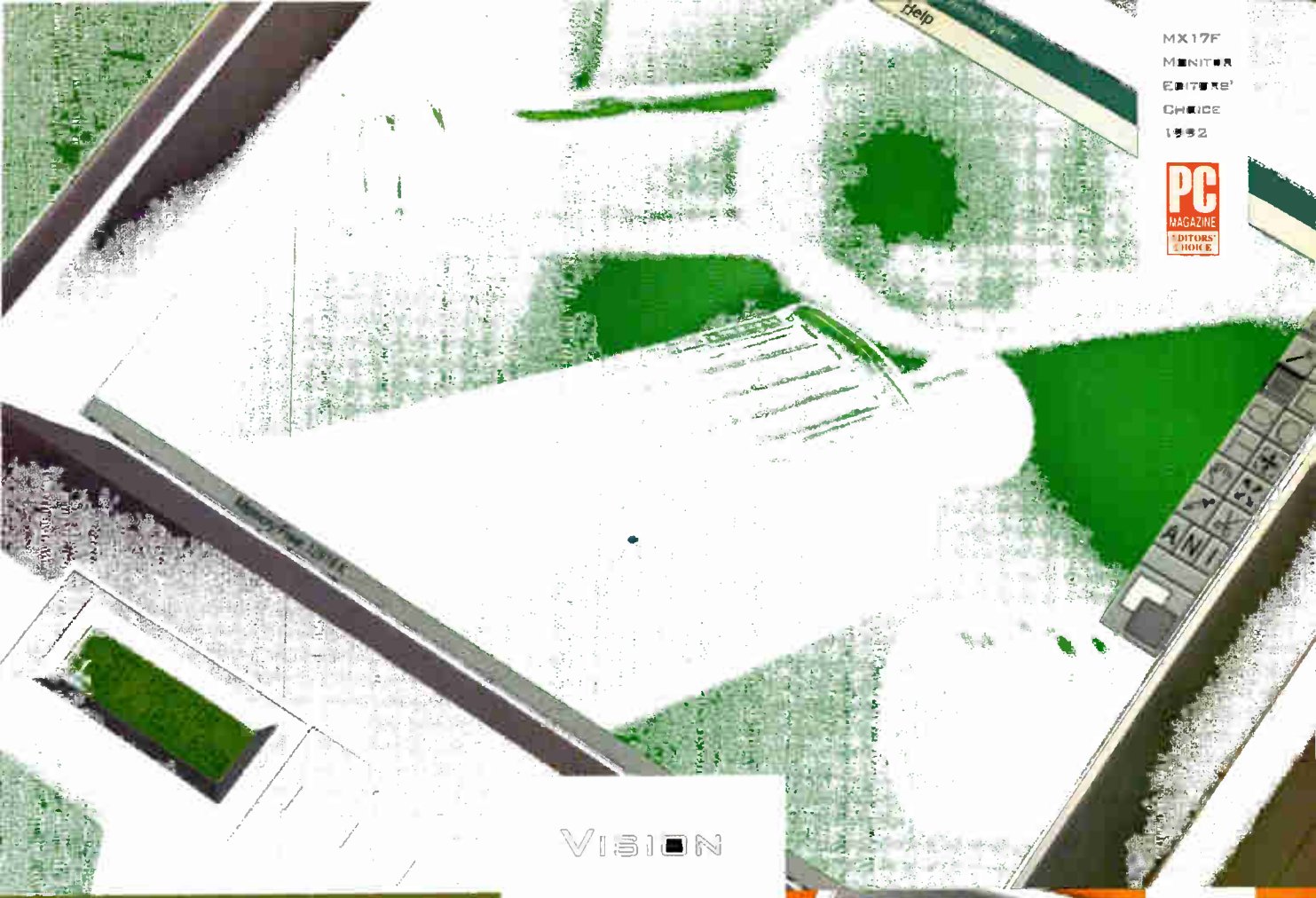

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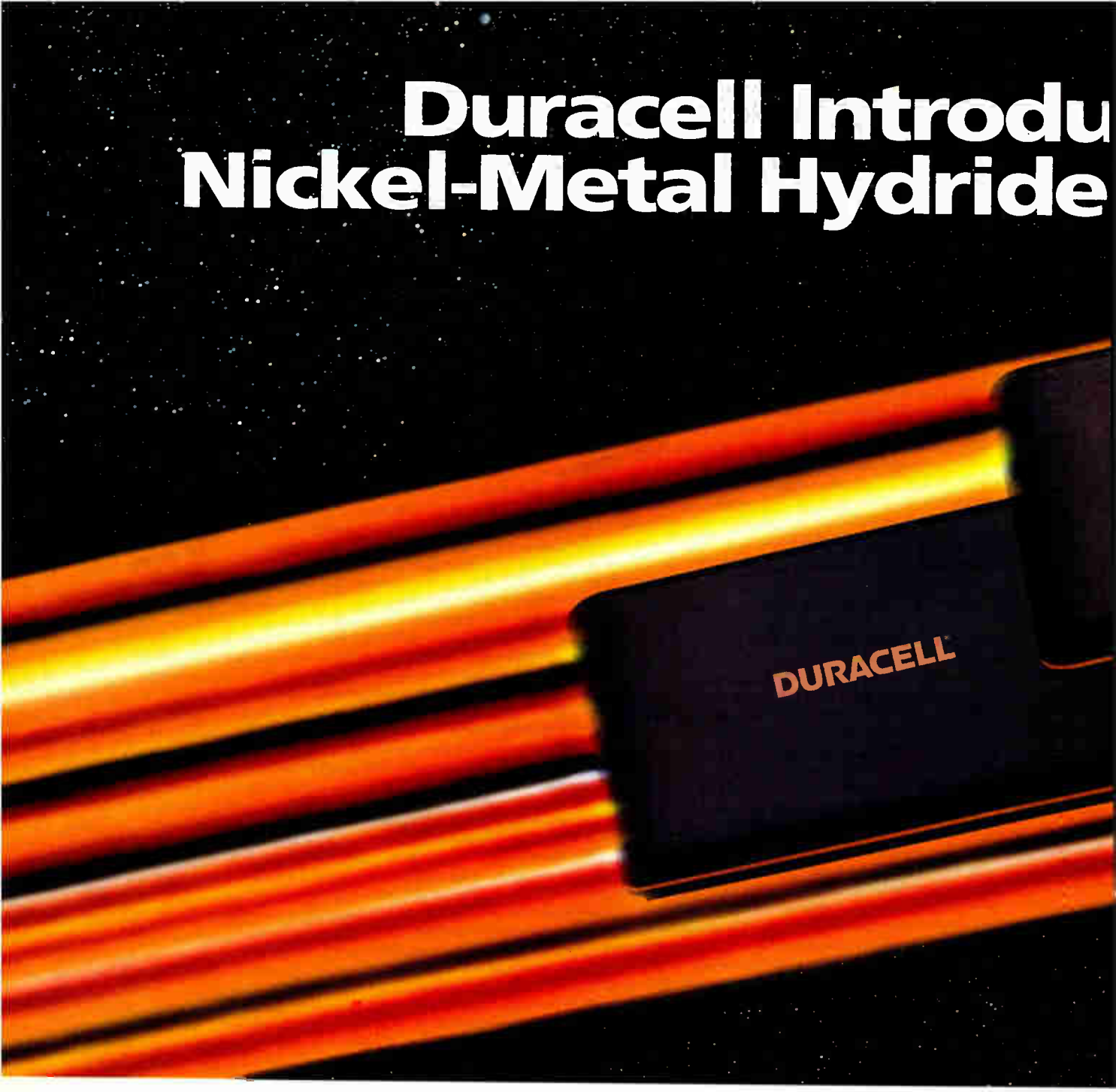

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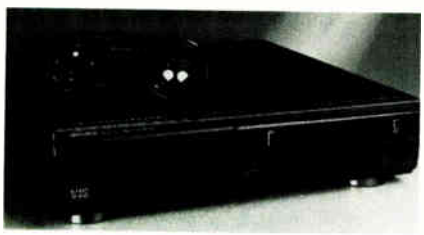
NEWS

MICROBYTES

Tandy Goes After the Interactive Home Market

Tandy has joined companies such as Commodore and Philips in the interactive home-learning, information, and education market. Tandy has announced a new CD-ROM-based digital information delivery system that uses the TV as its display. As part of the announcement, Microsoft said that it is developing a modified ROM version of Windows for Tandy's new VIS (Video Information System) multimedia player that's optimized for viewing on TV. Modular Windows titles feature large 3-D buttons and support a simple point-and-shoot remote-control operation.

Tandy will be competing with Philips's CD-I and Commodore's CDTV formats—neither of which will be compatible with VIS—as well as possible future products from Sega, Nintendo, and NEC. But the alliance with Microsoft enables Tandy to attract potentially thousands of developers to Tandy's VIS format: applications developed for VIS will be easily ported from standard Windows to Modular Windows, both companies said. Mike Grubbs, senior director of Tandy's marketing department, said Windows 3.1 programs won't be able to run on Tandy's or other manufacturers' VIS players without at least some modification to the program's interface and drivers. For example, users interact with CD-ROM Windows applications via the keyboard, and VIS players won't have a keyboard. "But a lot of applications will transfer quite readily," he said. "Adaptations required in the program will be relatively minor."



Tandy's VIS player can play standard audio CDs through the stereo input on a TV or through a stereo amplifier.

Tandy envisions VIS as a technology that will be integrated into products tailored to learning, information, and family entertainment, where programs will let viewers interact with pictures, voice, music, and animation. Grubbs said that because Tandy will license the VIS format to other drive manufacturers, including Zenith Electronics, pricing of VIS players will be left to individual vendors. But Zenith's player will sell for about $700, which is about the same price as a VIS player that Radio Shack will sell.

The VIS player looks like a standard CD audio player (it will play standard audio CDs) but will be more simple to operate, Grubbs said. A typical VIS configuration will use standard TV as its display with stereo sound provided through audio connections to a TV or receiver. VIS players will also have an infrared remote handheld controller, and a Save-It cartridge for saving positions in applications and other user information. Nearly 50 software and content-publishing companies have committed to delivering over 100 VIS titles, which will range from $29.95 to $79.95.

Beginning this fall, VIS products will be sold nationwide by consumer-electronics retailers and department stores, including Tandy's own Radio Shack stores under the Memorex label. VIS products are expected to be available in stores before Christmas.

—David Andrews

PCSes Battle for Bandwidth

PCSes (personal communications services) may be in trouble before they even get off the ground. Despite recent FCC approval, the plan to use high-frequency radio to tie together pocket telephones, personal computers, and other kinds of equipment, is facing powerful opposition in the U.S. Senate because of a squabble over frequency allocations.

Recently, a group of computer industry leaders, including representatives from Apple, went to Washington to testify against a proposal that would effectively block PCSes from the wavelengths the FCC assigned. The FCC chose to assign PCSes to the relatively underused 2-GHz bandwidth. However, *underused* doesn't mean unused. Some corporate communications systems, notably utilities and railroads, use the frequencies. Senator Ernest Hollings (D-SC), chairman of the Senate Commerce Committee, says he will introduce legislation to protect the utilities and railroads if their concerns aren't met. PCS proponents in the communications and computer industries say that Hollings' bill would effectively kill PCSes. ■

—Rick Cook

NANOBYTES

AVI (Audio Video Interleave), otherwise known as Video Windows, Microsoft's device-independent compression technology that's under development, will play a big role in Tandy's VIS format. AVI will let users compress and store video segments on a mass-storage device for later decompression and retrieval. □

The industry shakeup continues to claim victims: Both Momenta and Librex have recently bitten the dust. **Librex**, a notebook-computer venture of Nippon Steel, shut down when its parent company decided—not surprisingly—that the computer business was too far afield from steel. □

Momenta, a pen-computing startup that had received an estimated $40 million in venture funding, fell victim to a depressed economy and a weak market for pen systems. The company's unique *pen-top*, featured on the cover of the November 1991 BYTE, was ahead of its time. Touted as a compromise between traditional notebooks and a pen tablet, it apparently weighed and cost too much in a market that remains skeptical of pen computing. Momenta had no other revenue sources to fall back on; after trying for several months to sell off its technology, the company closed its doors in August. □

Acorn Computers, the U.K.-based computer manufacturer, has announced 10 new systems based around the ARM (Advanced RISC machine) chip set. None of the new machines is PC compatible, although many of them are bundled with a DOS emulator and DR DOS 6.0. Acorn argues that it has created a niche market for low-cost RISC machines that don't have to be PC compatible. Acorn's marketing director, Mike O'Riordan, says "No other manufacturer in the world can currently offer RISC computing for under £500." □

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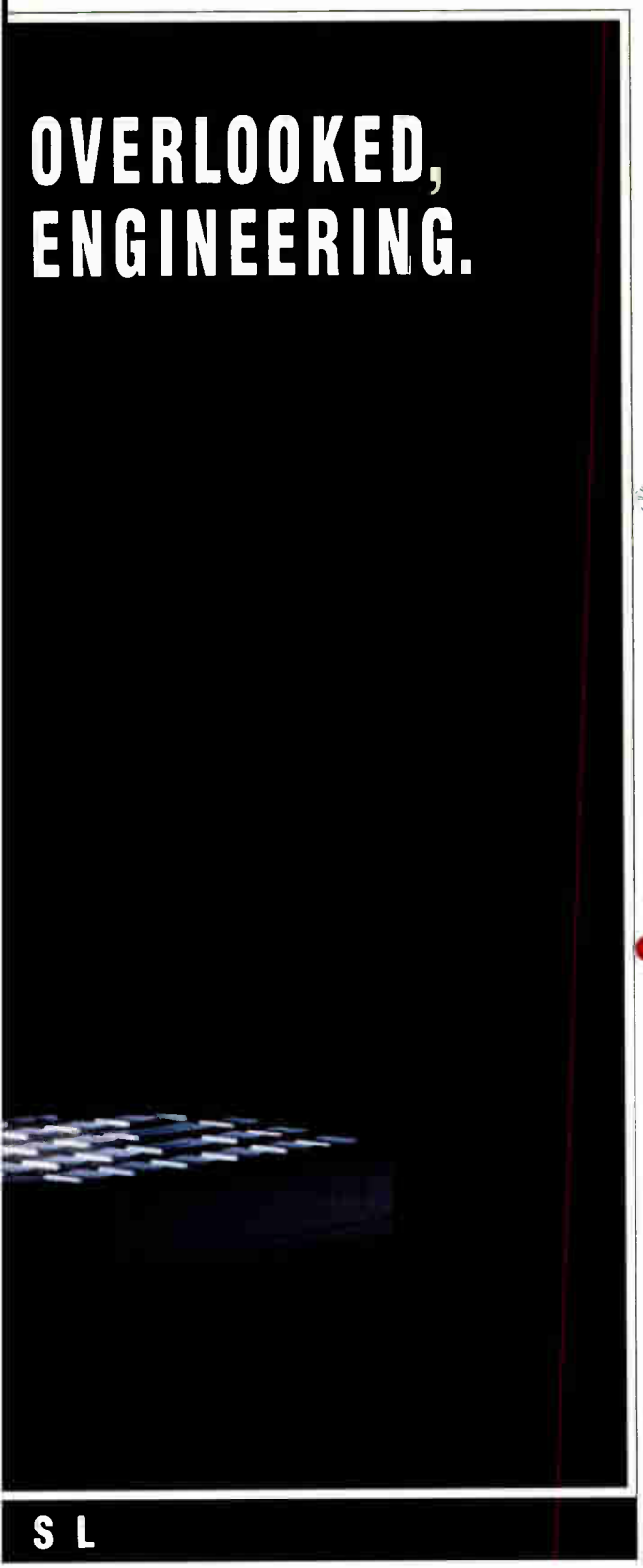
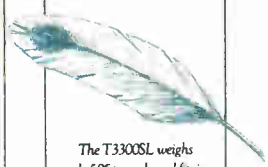


PC MAGAZINE EDITORS' CHOICE
August 1992
Toshiba T3300SL

In PC Magazine's survey of 65 notebooks, guess who received Editors' Choice honors.



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intel inside

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"Business users who need a wide variety of graphics functions shouldn't pass up this package. It is an amazing bargain."

Luisa Simone, PC Magazine, August, 1992

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Jon Honeyball, Windows Magazine UK, August, 1992

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STEPHEN BANKER

THE WORLD'S LARGEST COMPUTER SHOW

SÃO PAULO—Large computer trade shows are often held in relatively small places like Las Vegas, Nevada, or Hannover, Germany, where the event dominates the city's existence during its run. But the biggest show of all, by some measurements, is just another layer of crowding in this mammoth, blocky metropolis of over 22 million inhabitants.

Twenty minutes from São Paulo's gridlocked downtown lies the relatively open space of Anhembi Park. This area contains an imposing trade-show building, a modern conference facility, and, between them, the mortar skeleton of an unfinished hotel. The visitor's glance is almost unwillingly pulled to the aborted structure and its dramatic outline. This, in a few acres, is the promise and despair of Brazil: the surge toward development and, at its center, the hulk of an economy gone mad.

Inflation is Brazil's principal, inescapable fact of life—now back to around 20 percent a month after temporary constraints imposed by the reform government of Fernando Collor de Mello in 1990. Businesses continually take the pulse of the economy in order to hedge the inflation with purchases of dollars, precious metals, or goods. It is an ongoing, counterproductive distraction. During a single week last July, the cruzeiro, Brazil's basic unit of currency, gained 7 percent against the dollar.

It was the week of Fenasoft, a contraction of the Portuguese for "National Software Show." Although Max Gonçalves, the 49-year-old dynamo who started the event in Rio de Janeiro a decade ago, is keeping the name, he insists that hardware has fully caught up with software, both at Fenasoft and in Brazil as a whole.

Banned in Brazil

Starting in 1964, when the country entered a 26-year period of military rule and changed from an agrarian to an industrial economy, walls of protectionism were erected around the computer industry, which the generals considered dangerous and subversive. With the resulting tariffs, software cost Brazilian consumers up to two and a half times what they would have paid in the U.S. In the 1980s, as the developed world latched onto microcomputer power, foreign hardware makers were banned in Brazil, except for a few mainframe and minicomputer producers. One of those, IBM, finally gained access to the microcomputer market in 1991.

In Brazil's banks, law offices, and accounting firms, older generations of computers are treated with respect, even reverence. Often a single central microcomputer is shared by several executives, with lower-level bureaucrats and secretaries still pounding away at typewriters. The 8088-based XT is common in high-profile places and constitutes almost a third of new sales. Hard drives are frequently no more than 10 or 20 MB in size. Monitors are typically CGA. The most common word processor in the country is WordStar, and a significant proportion of the installed base is WordStar for CP/M.

Although XTs are prevalent here, a visiting journalist found himself the center of attention whenever he prepared to take notes on his XT-compatible palmtop. This was the Poqet PC, an 80C88-based computer, whose 9- by 4- by 1-inch dimensions caught the eye of many Brazilians, to whom such miniaturization seemed irresistibly *encanto* (charming) or *engenhoso* (ingenious).

As Brazil's protectionist economy fades away, computer vendors are anxious to show their wares

A Hunger for Technology

Despite a diet of outmoded technology, or perhaps because of it, a hunger for sophisticated products has arisen. In a nation of 150 million citizens, an estimated 1 million computers are in place, perhaps half of them brought in against the rules. The guess is that 80 percent of individual users and 20 percent of corporate users have dealt with smugglers.

The public, deprived of the possibility of shopping, stays abreast by reading. Brazil's major newspapers run regular computer supplements, and there are 17 monthly computer magazines and five semimonthly computer newspapers, all designed to keep readers up-to-date on the latest in cutting-edge, unavailable technology. One is reminded of the movie *Modesty Blaise*, in which a parched Dirk Bogarde crawls through a blazing desert, rasping, "Champagne, champagne...."

The extra excitement this year coincided with long-awaited moves by the democratically elected government, now politically beleaguered, to end trade barriers.

continued

PHOTO: UNIPHOTO / BRUCE MCALLISTER

World Radio History

The bureaucratic hurdle of software registration—and its compulsory and expensive translation, filing of multiple copies, and months of waiting for a ruling—is gone. As for hardware, some of the tariffs have already been reduced and are scheduled to fall to 20 percent by the end of 1994. At that level, Brazilian merchants believe, legitimate products, with their telephone support, documentation, upgrade paths, and so on, have a fighting chance against contraband.

O Estado de São Paulo, the city's leading newspaper, noting that barely 10 percent of the computers in the country are currently networked, predicts that the connectivity market will grow to eight times its present size in two years. And Marcelo Bernstein, editor in chief of *BYTE/Brasil*, while referring to the inflation as "our catastrophe," also calls himself "optimistic" about the computer industry here. He cites estimates that 350,000 new systems will be installed in the next three years. "It's the only way to make economic achievements," he says. "This country understands that there's no way to run any industry without computers."

"The Billion Dollar Show"

No wonder, then, that Fenasoft attracted a multitude that American showgoing veterans would find difficult to imagine. Published estimates ranged as high as 800,000, but Fenasoft president Gonçalves, anticipating incredulity at such numbers, hired a group of young, upright Mormons from Salt Lake City to handle the attendee registration process. This group, Market Lead, had firm figures of 450,000 badges sold at US$5 apiece by show's end; this doesn't count staffers, press, students (who had special badges), and those who may have circulated their cards for a price. That made Fenasoft '92 the world's largest strictly computer show, in terms of attendance. It also drew more than four times the number of the U.S.'s biggest computer show, Fall Comdex.

On the second day, a delegation from Comdex's producers, The Interface Group, including president Sheldon Adelson, arrived from Boston for a look-see. Interface is one of three sponsoring groups for Comdex/Sucesu-São Paulo, which it billed as "South America's Largest Computer Trade Show and Conference," scheduled for a mere 45 days after Fenasoft in the same hall.

What the members of the delegation saw as they made the rounds were some 800 exhibitors in a room of 485,000 square feet, in many respects similar to a large trade show in the U.S. Although the familiar logos of IBM, Compaq, Microsoft, WordPerfect, Lotus, and Borland were in evidence, some of the largest exhibitors—Itautec, Microtec, SID—were domestic hardware manufacturers. Equally large booths represented Brazilian software distributors Compucenter Informática, Brasoft, and Wild West. Most of the hardware groups would return to the Interface show in September.

But surely most impressive to the visitors were the teeming attendees, who swarmed in, eight or 10 abreast, almost uninterruptedly. At times, the aisles were almost impassable. And these throngs were not what American show producers sometimes disparagingly refer to as "junk people." Since Brazil does not have U.S.-style distribution channels of computer stores, outlets, or mail-order houses, many attendees were here to buy. Fenasoft is a cash-and-carry show; hardware and software alike are for sale on the spot.

Fenasoft attendees swarmed in 10 abreast almost uninterruptedly.

Some of the paper deals cut on the floor were large-scale. ZIM, a Canadian database management firm with a strong presence in São Paulo, appeared at Gonçalves's office with a case of champagne to toast the signing of a nearly $10 million contract with a Brazilian firm. Taking into account floor transactions, exhibitor fees, advertising revenue, and attendance charges, the business magazine *Visão Econômica* headlined its story "The Billion Dollar Show."

Few New Products

The missing ingredient usually associated with important trade shows was an array of new products. That is presumably because the country's restrictive trade policies have also restricted innovation. As President Collor said shortly after he took office two and a half years ago, "Protectionism leads to incompetence." Many Brazilians wondered why, with such clear-sightedness, he had not moved more quickly to stimulate the talent and energy of his country's domestic computer industry.

There were some signs, however, of what may prove to be fertile ground. A Brazilian company, Fácil Informática, showed a word processor for Windows that seemed to be competitive with Word for Windows 2.0 and even performed rapid on-the-fly formatting in preview mode. But a shipping copy is not available yet, and there is little reason to anticipate an English-language version for export. There are hopes for a database application development system, Joiner 3.0, which Tuxon Software Development of São Paulo intends to introduce in the U.S. One of its claimed features is that it compiles the same code for DOS or Unix.

Deico Electronics, an established California motherboard manufacturer, is making a move both into Brazil and into the systems business. It has committed to building a factory in Florianópolis, the island capital of the southern state of Santa Catarina, to produce hardware for worldwide export. Ingrid Moos, Deico's CEO, recalls a meeting with the governor of Santa Catarina, who told her, "Go to Singapore. Go to Hong Kong. Go to Taiwan. Get the best deal you can and then come to me. I'll beat it." And, she adds, "he did."

Bridging the Computing Gap

To one viewing Brazil from the perspective of an interested and sympathetic visitor, a striking parallel suggests itself between the nation's computer users and its society as a whole. At the top is a healthy high end, familiar with mainframes, minicomputers, and networks, using Unix-based systems and coding in a variety of languages—the elite. At the bottom is that massive, uncountable population of XTs. And in between, there is a void—virtually no 286s, no 386SXes, no middle class.

When that void is filled, computers may actually make a difference to this inflation-wracked country. Simple software can provide immediate solutions to common, time-wasting bothers. For example, restaurant workers who repeatedly copy new prices onto their menus can have a software package do the conversions and the printing for them. And businesspeople who lose hours of their workday reacting to the cruzeiro roller coaster can automate many of their calculations. Perhaps enough time, money, and energy will be saved by such widespread utilizations of computer technology that the hotel in Anhembi Park can, before too long, be finished. ■

Stephen Banker is the Washington-based publisher of Tapes for Readers, *a series of audiocassette interviews with contemporary figures. You can reach him on BIX as "sbanker."*

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Shatter the 640K barrier and build multi-megabyte DOS applications.

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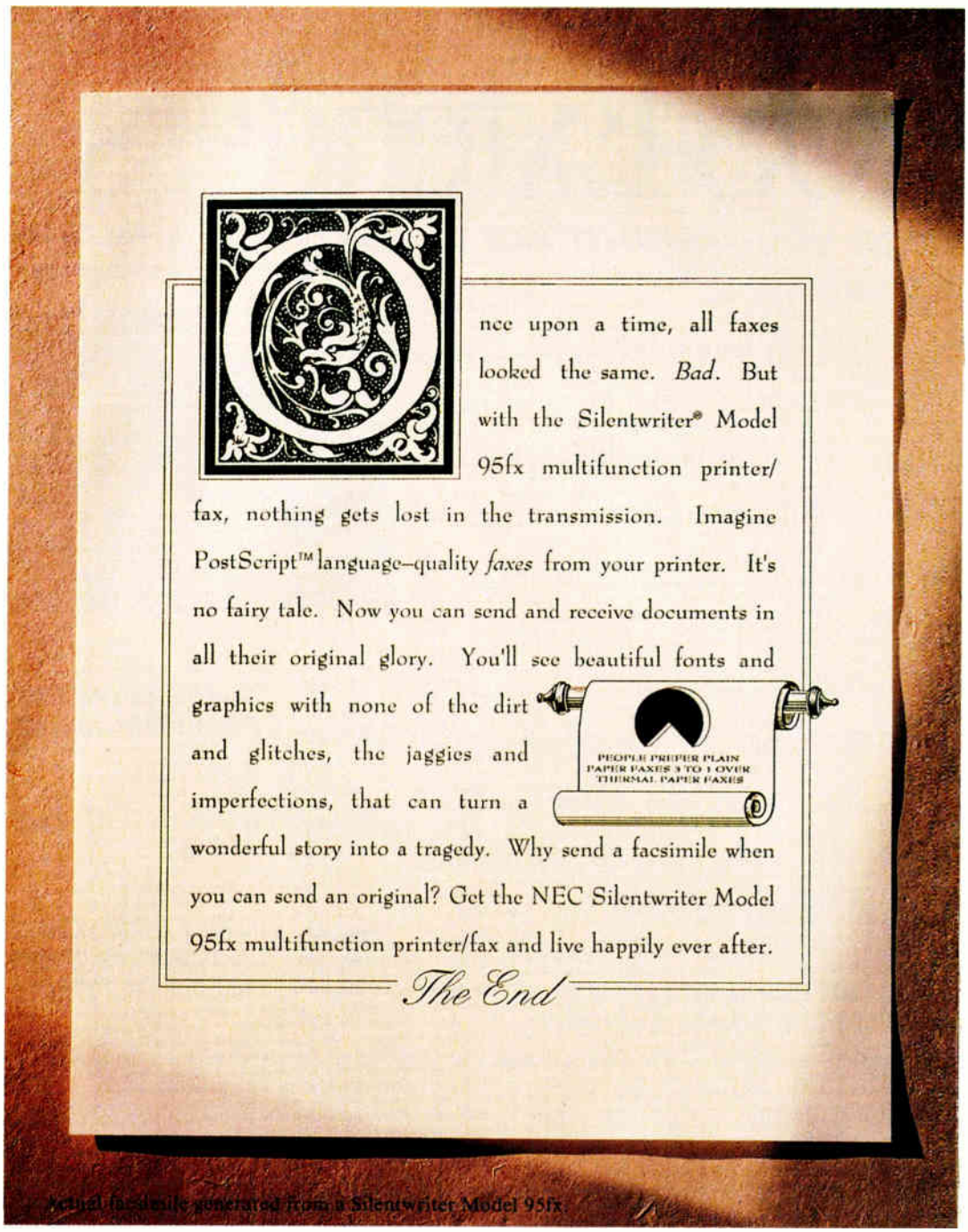

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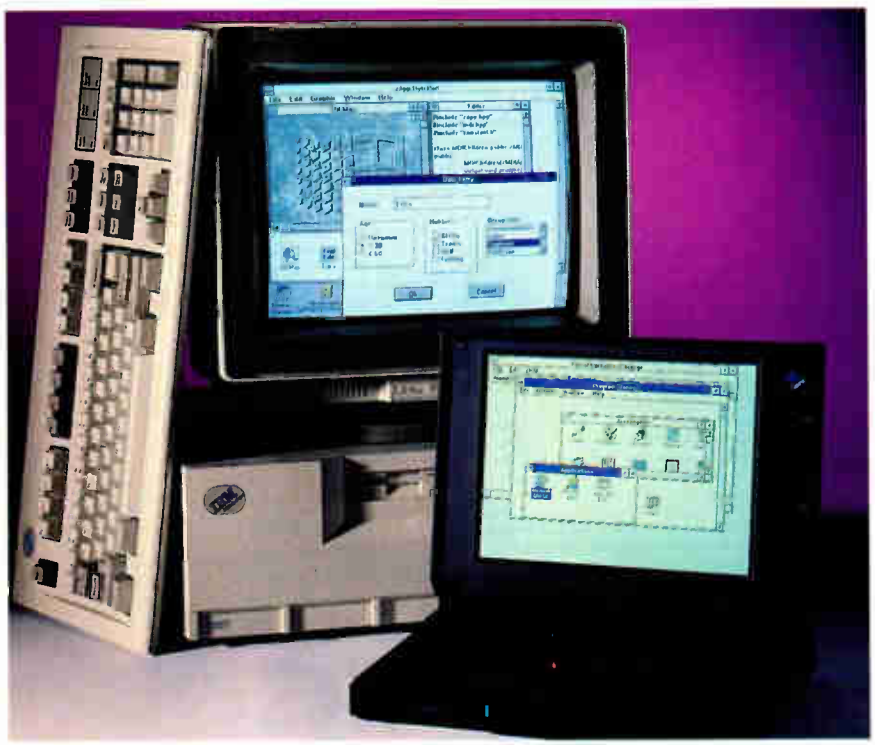
New Systems... New IBM?

ED PERRATORE

Underdog is here, with fresh new lines of desktop and portable PCs built to oppose the dreaded price-busters and make IBM a contender once again

"Great machines, but can't justify the cost." The words may have varied across corporate America, but the sentiments were consistent regarding IBM. The products were good. The technology was cutting-edge. But as the performance and quality of clones improved, pricing became increasingly important. IBM, came the cry, didn't get it.

Now that IBM apparently gets it, you can get an IBM machine for an affordable price. Big Blue's sweeping announcements opened the fall season with a restructuring of the company's existing PS/2 line; the debut of a new clone buster line called PS/ValuePoint; and, at last, the introduction of a formidable notebook line. The new product announcements came roughly a month after IBM's formal reorganization of its Personal Systems line of business into the IBM Personal Computer Co., a separate operating unit. With the new operating company in place, the new lines boast a better chance of evolving with the needs of the market place.



IBM's PS/ValuePoint 325T represents the low end of IBM's new value line of reliable, no-frills desktop PCs. The notebook is the ThinkPad 700C, the flagship model of the new portable line.

The first task IBM faced in developing low-cost desktops was to redefine the PS/2 line, which had ranged everywhere from the 386SX/20-based PS/2 Model 35 to the PS/2 Server 295, the multiprocessing Parallan superserver IBM resells. The new PS/2 theme? Exclusively Micro Channel architecture, XGA-2 graphics on the motherboard, compliance with the latest ISO specifications for the work environment, SCSI, and fat three-year warranties that include on-site service worldwide. PS/2s also sell with OS/2 2.0 preinstalled.

The PS/2 Models 80 and 90 will remain in production, but IBM plans to phase out the Model 70. New in the line are the 486-based PS/2 76 and 77 and the 486SLC2-based PS/2 56 and 57. While all PS/2s are upgradable, the 56 and 57 have an as-yet unannounced upgrade path. Rely on Intel, if not IBM, to clear up that ambiguity.

Break with the Past

As before, the IBM PS/2s will be sold through dealers and system integrators as well as directly to corporate accounts. In addition to these channels, however, Big Blue will market its new, lower-cost PS/ValuePoint line through distributors as well as by mail order. IBM experimented in the mail-order channel with its PS/2 Models 35 and 40, both of which are being phased out. The only channels through which IBM doesn't plan to offer the ValuePoint are retail stores such as Sears and superstores; these remain the realm of the newly revamped PS/1 line.

New for IBM, and expected to encompass at least the PS/ValuePoint line, is the company's intention to advertise estimated street prices (with a footnote that dealer prices may vary) instead of its own suggested retail price. This departure is good news for consumers, provided that the figures quoted are indeed representative of the average. It also reinforces the message that IBM is meeting traditional mail-order PC makers on their own turf.

World Radio History

Under the hood, the three IBM-designed and -manufactured systems that make up the PS/ValuePoint line are easily distinguishable from the PS/2s: Industry-standard—as opposed to industry-leading—is the way IBM describes them. More specifically, the desktop systems are ISA-bus machines with Super VGA graphics, an IDE hard drive, and no external caching. The top-of-the-line model, the 433DX, is a 33-MHz 486 system with 8 MB of SIMM RAM standard (expandable to 32 MB), a 170- or 213-MB hard drive, five drive bays (three of them slim-line) with one 1.44-MB slim-line drive included, and five 16-bit slots, all available since the video and I/O circuitry are integrated on the motherboard. You can upgrade the system with an Intel 486DX/66 processor.

What's notable about this system (and the 486SX/25-based 425SX as well) is that the rumored internal battle over whether a value-line system might sell better bundled with Windows appears to be over. Buy an OS/2–equipped system, after all, and you'll also have virtually all of Windows—perhaps version 3.1 by the time you read this.

The 425SX's standard configuration is 8 MB of RAM (expandable to 32 MB), your choice of an 80-MB or 170-MB hard drive, the same expansion-slot and drive-bay setup as with the 433DX, and upgradability to a 486DX2/25 or 486DX2/66. If you do not need even this level of performance, the PS/ValuePoint 325T offers a 386SLC/25 processor (with an 8-KB internal cache), 2 MB of 70-nanosecond RAM (expandable to 16 MB), and an 80- or 170-MB hard drive. It doesn't come with OS/2 2.0; DOS 5.0 alone is preinstalled. On benchmark tests that we ran on a preproduction 325T, the machine scored midway overall between the Compaq Deskpro 386/25e and the faster Tandon 486/25 on CPU, disk, and video tests.

All ValuePoint systems offer a one-year on-site warranty. IBM claims a 4-hour response time—an improvement over the standard support services that Dell Computer provides for its low-end Dimension line. IBM provides this service through its toll-free HelpWare line, which is staffed around the clock seven days a week.

Overseas, don't expect the PS/ValuePoint line to replace the Ambra clones that IBM's Individual Computer Products International subsidiary is selling on the international market. According to an IBM spokesperson, there is room for both lines, however much market share the new machines may chip away.

TFTs and Jujubes

Over the years, IBM has earned the Rodney Dangerfield no-respect award for its notebooks; an IBM spokesperson even derided one recent offering as "a 12-pound system with an 8-minute battery life." However, the company has finally announced an entire line of respectable machines, called ThinkPad. For the one 386SL/25-based model that so far makes up the low-end 300 series, Big Blue had to swallow its pride and have Zenith Data Systems do the building according to IBM specifications.

No such humility need accompany the three-model 700 series. The product we've known as ThinkPad, the pen-based tablet that runs Go Corp.'s PenPoint operating system, is now ThinkPad Model 700T. The star of the line, the 486SLC/25-based Model 700C, is a 7½-pound Micro Channel–bus model (all 700-series models are considered PS/2s from design to distribution) that uses a 10⅓-inch TFT (thin-film-transistor), active-matrix color VGA display that was developed through IBM's joint venture with Toshiba. Its nickel-metal-hydride battery provides 2 hours of continuous use (with a claimed 4 hours of typical workday use). Dual display is possible for presentations—the screen will even tilt back at a full 180-degree angle to the keyboard so presenters won't have to peer over it at a podium. Both DOS 5.0 and Prodigy software come preinstalled for the price, expected at press time to be about $4000 on the street.

There's more. The standard 4 MB of RAM comes on a module that slides in and out of the PC from the outside for upgrades to the 16-MB maximum. The 120-MB hard drive eases in and out of a slot the same way, and a metal tab protrudes to let you snap on a small padlock.

Another attraction of the 700C and its monochrome equivalent, the Model 700, is what IBM called The Pointing Stick when it first previewed at 1991's fall Comdex. Called TrackPoint II in its shippable form, this cursor navigation device is sandwiched among the centermost keys like a large Jujube candy; it's even reportedly available in five colors (though only one flavor). Essentially, it allows you quick cursor movement, with minimal finger effort, aided by two "mouse" buttons situated on the plastic casing beneath the keyboard's space bar. As an inveterate keyboard user, I found it was an advantage to keep my hands in one place even in a GUI environment.

The Model 700 offers the same processor and RAM configuration but has a 9½-inch monochrome supertwist nematic LCD displaying up to 64 gray scales. The 6½-pound unit's nickel-metal-hydride battery is rated at 3¾ hours of continuous use, with a claimed 7½ hours of typical workday use. The Model 700 comes with your choice of an 80- or 120-MB hard drive, which is easily installable in the same fashion as on the 700C. For either model, a docking station is available as well.

Performance-wise, a preproduction model of the Model 700C fared worse in CPU tests than the four 486-based notebooks BYTE reviewed in the September issue ("486 Notebooks Double as Desktops"), however closely related the 700C's 486SLC CPU is to the Intel 486. Where the system soared above the pack was on our disk tests. And in video testing, only the Toshiba T4400SX outraced it.

IBM is ready to relinquish none of its claim of providing some of the most cutting-edge computing power you can find today. But for those who can't afford that PS/2 technology—or don't need it at every station—at last the company has hit on a formula of lower prices for industry-standard systems that maintain the reliability on which IBM made its name. And if the new, lower-cost systems take away some PS/2 profits, well, Big Blue would rather see the dollars go for a PS/ValuePoint than for a Compaq ProLinea. ■

Ed Perratore is a BYTE news editor based in New York. He can be reached on BIX as "eperratore."

THE FACTS

IBM PS/2 56, 57, 76, and 77
IBM PS/ValuePoint 433DX, 425SX, and 325T
IBM ThinkPad 700C, 700T, 700, and 300
(the prices are unavailable at press time)

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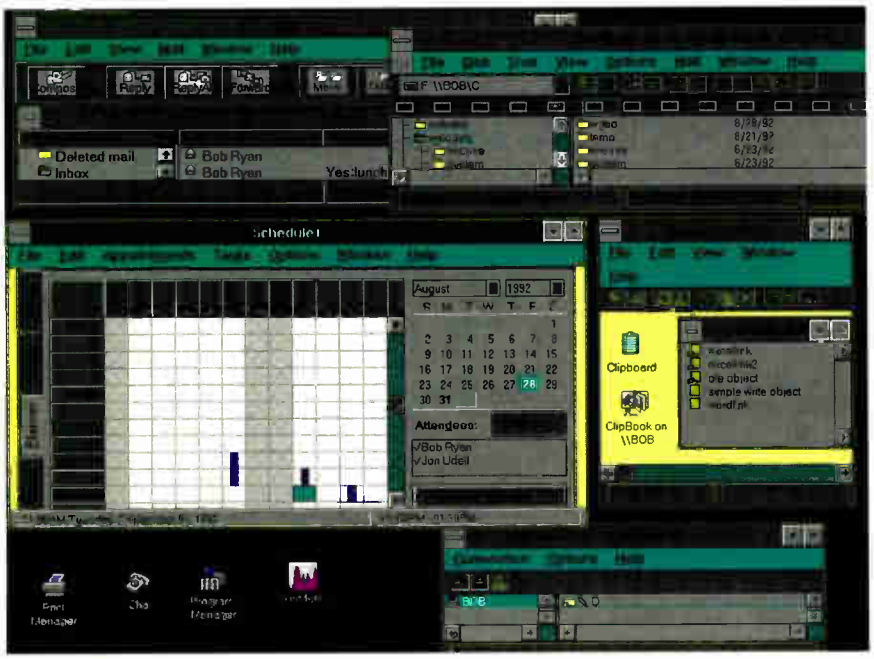
Windows for Workgroups

JON UDELL

Microsoft's collaborative Windows environment offers print and file sharing, plus mail and group scheduling

As the world awaits Windows NT, Windows for Workgroups—Microsoft's newest upgrade—offers an impressive set of network services. They function equally well whether you're sharing information and printers between two PCs or working with multiple machines on existing NetWare or LAN Manager networks. WFW is easy to install and use and includes peer-to-peer file, printer, and Clipboard sharing; mail capabilities; group scheduling; chatting functions; and simple network-monitoring tools.

WFW installed smoothly on two NetWare-connected PCs, automatically detecting the NE2000 adapters in use and adding Microsoft's IPX-over-NDIS protocol alongside WFW's native NetBEUI (NetBIOS Extended User Interface); the TCP/IP alternative isn't supported yet. After rebooting, both machines reconnected to the NetWare drives and printers they'd been using. Since I assigned them the workgroup name published by my Windows NT test machine, the WFW machines could use that machine's shared drives as well as each other's. Given the NT result, it's likely that connecting to a LAN Manager server (one wasn't available) would have been equally painless. Windows lags noticeably when there is heavy access to shared resources, but that's true of all DOS-based peer-to-peer LANs.



Mail and Schedule+ make Windows for Workgroups a real bargain.

WFW will not republish NetWare or other remote drives as shared resources. Microsoft says you can share out a local CD-ROM drive provided that you use MSCDEX 2.21 and specify the /s switch. There's no remote-access solution for pure WFW networks yet; the best you can do now is dial into a LAN Manager network, using its client software instead of WFW's, and then tap into WFW resources visible on that network.

WFW's dual-shell configuration for NetWare isn't as unwieldy as LAN Manager 2.1's. Microsoft has rewritten components that used to compete for conventional memory or UMB (upper memory block) space as Windows virtual device drivers. The redirector and the NetBEUI transport (as well as the server) run in protected mode, so the real-mode memory hit is almost nil. That's great news even in straight WFW or WFW/LAN Manager environments, since Microsoft's real-mode redirector and transport are bulky.

There's one catch. To benefit, you've got to be running Windows in 386 enhanced mode. For DOS-only and standard-mode Windows users, WFW includes a real-mode redirector and NetBEUI (although no server), but they're poor substitutes for their protected-mode cousins. If you use Windows only occasionally, you'll be better off with one of several excellent peer-to-peer networking products for DOS.

You should note, however, that WFW jumps through hoops to make Windows more attractive as a permanent habitat. File Manager and Print Manager gain toolbars that make sharing out resources, as well as attaching to others' shared resources, mostly a point-and-click affair. It's not as slick as the Macintosh's System 7.0, but it's much better than LAN Manager 2.1, and fully graphical at last. If you're sharing resources, you can use NetWatcher to monitor who's connected to your machine and WinMeter to see how much CPU power the server is stealing from your applications.

WFW packs considerable value beyond basic networking. It includes the newly redesigned Microsoft Mail 3.0 client and

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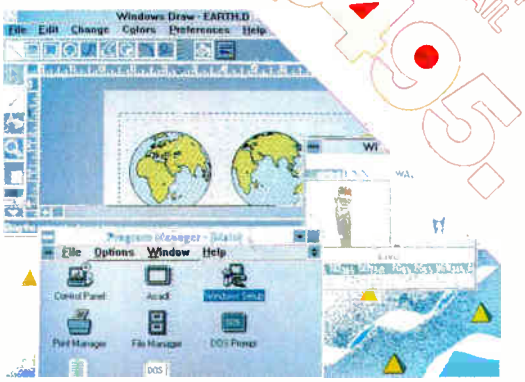

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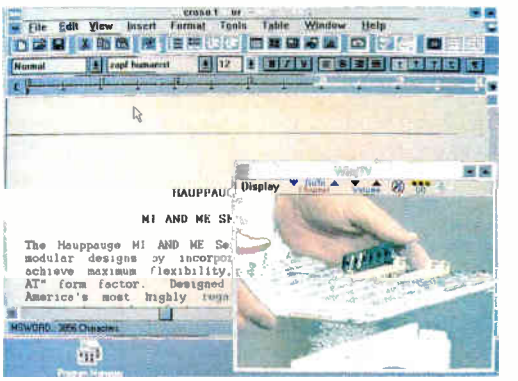

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NEWS

FIRST IMPRESSIONS

the new (to Windows) Schedule+ application (see the screen). Mail uses the MDI (multiple document interface) to create its own miniature desktop for in-box, out-box, and user-created folders. It supports drag-and-drop transfer of messages among folders, and it also handles drops from File Manager by attaching the dropped file to a new message and prompting you for an address. The message editor supports the OLE `Insert Object...` command, so you can embed pictures or voice annotations in messages.

In a stand-alone workgroup, one machine has to own and share out the directory tree that is the "post office," and it must always be available. Alternatively, a workgroup attached to a server-based LAN can locate the post office at the file server, although I had to trick Mail into using NetWare for that purpose. Mail rolls its own directory services; it can't acquire the user databases of NetWare or LAN Manager, nor can it synchronize with WFW's distributed machine-name/password data. So on my NetWare-attached WFW machine, I have to log in three times: to NetWare, to WFW, and to Mail. To send mail to other workgroups or to the outside world, you'll generally need a server edition that can route mail through gateways to foreign destinations.

WFW supplies a scaled-down version of MAPI, Microsoft's messaging API, for Mail's use—and for any other program that wants to exploit it. Schedule+, which integrates tightly with Mail, is the other obvious MAPI client. There's also a File Manager extension that, if named as an add-on in WINFILE.INI, appends a send-file button to File Manager's toolbar.

WFW's generic support for mail-enabled software may change how you work even more than its file-sharing features do. If I *send* you a document via a shared directory, I still have to tell you where I put it, what it represents, and when you can retrieve it. I may also need to configure that shared directory for privacy. If I *mail* you the document, the meta-data ("final version, includes your changes") and the data arrive in your private mailbox.

I can also send you a document, or part of a document, by way of WFW's networked Clipboard. Built around the network DDE toolkit, the WFW Clipboard viewer becomes a "ClipBook viewer"—essentially a Macintosh scrapbook with Publish/Subscribe capability. If I connect to your ClipBook, I can transfer "pages" you've chosen to share onto my Clipboard and then into my applications.

Like MAPI, NetDDE could be an important enabling technology. The Chat program uses it, and other applications will surely follow. Would-be NetDDE developers may rightly wonder, though, how the protocol fits in with RPCs (remote procedure calls), Windows sockets, and a variety of other network IPC (interprocess communications) mechanisms lately advanced by Microsoft.

WFW's most ambitious push into the groupware realm is Schedule+, a personal planner and meeting maker. I can invite you to a meeting by picking your name out of Mail's address book. Schedule+ merges our schedules into my planner and picks the first slot that's mutually available. Then it mails you an invitation form. If you confirm by return mail, the meeting is booked and appears in our planners.

The only hitches are that Mail must be active to keep your schedule up to date and Windows briefly halts when Mail polls for messages. Fortunately, Schedule+ lets you delegate appointment-making to an assistant who can act as your proxy.

This is potent stuff. WFW pushes mail-enabled groupware into the mainstream, raising users' expectations of what their networked software should do. It isn't Lotus Notes for the rest of us yet, but it's a big step in the right direction. ■

Jon Udell is a BYTE senior technical editor at large. He can be reached on BIX as "judell," or on the Internet at judell @bytepb.byte.com.

THE FACTS

Windows for Workgroups
$250 (tentative); upgrade from Windows 3.1, $100 (tentative)

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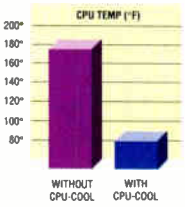

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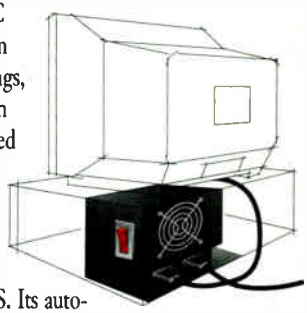

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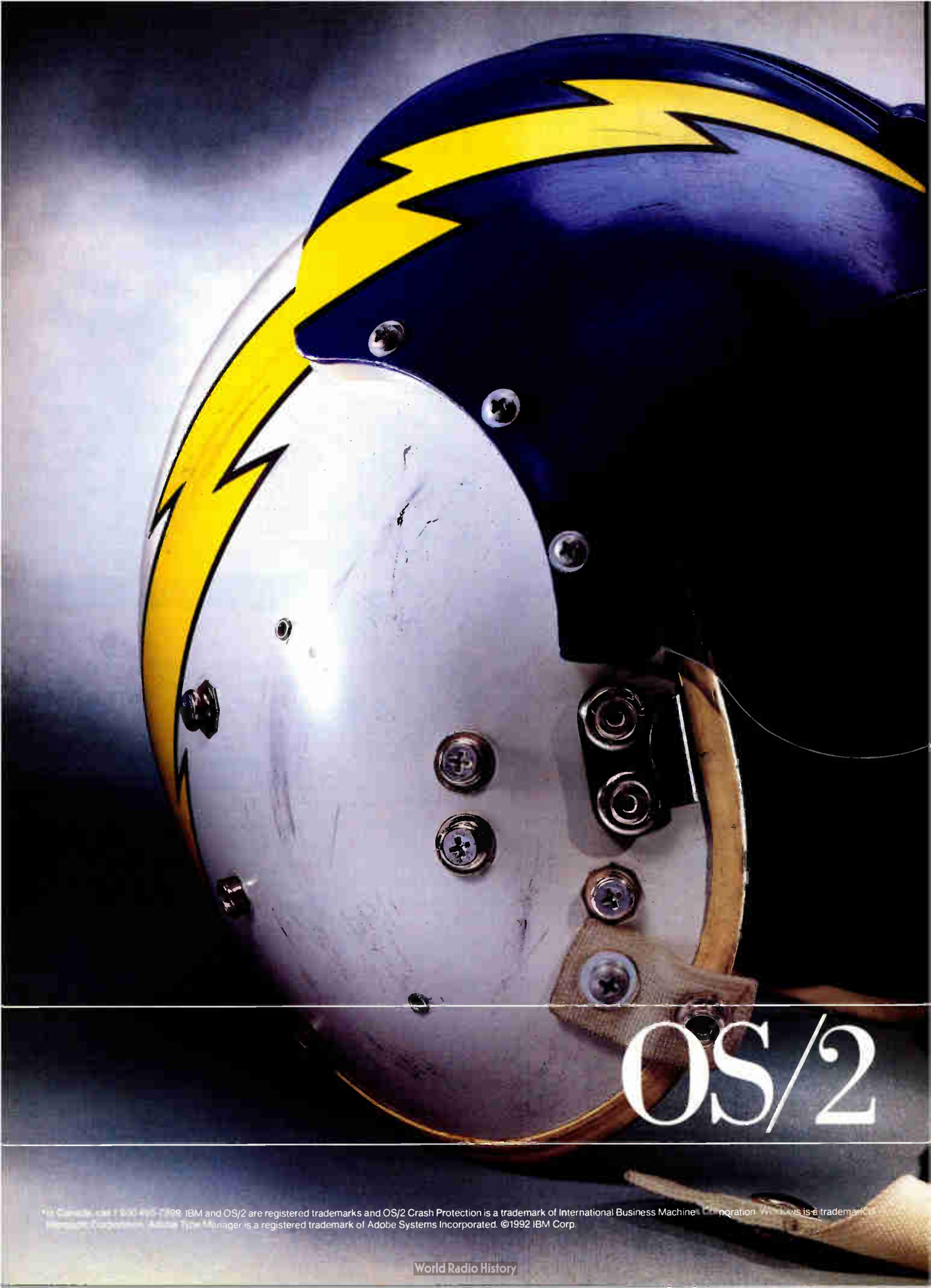

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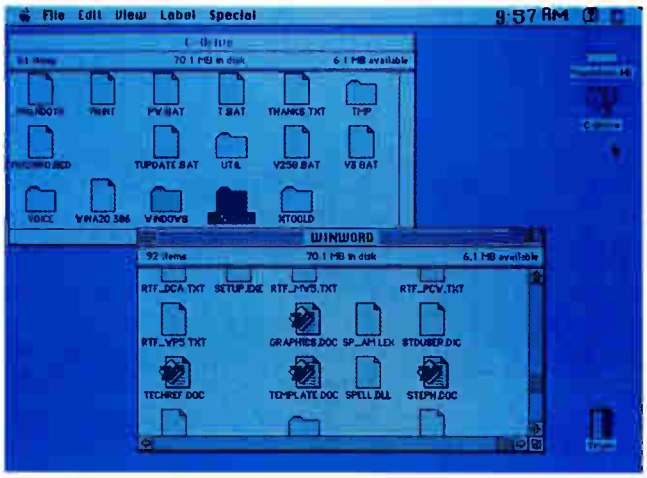
LANtastic Merges PCs and Macs

In this election year, it's not difficult to compare Mac and PC users to the major U.S. political parties. All have their strong (often conflicting) opinions on "platforms" and applications, and getting them to work together is often virtually impossible. Still, in this Age of Connectivity, there's a real need for Mac and PC users to share files, applications, and resources through those ubiquitous LANs.



Mac-to-PC connectivity has been available for some time, but for those who wanted to go beyond simple, low-cost solutions (e.g., Traveling Software's LapLink Mac), the cost of truly networking these disparate platforms has been a budget buster. Until now, that is. Leave it to Artisoft to find a solution. The company's powerful yet inexpensive LANtastic network operating system has taken the lion's share of the PC peer-to-peer market. And now, with **LANtastic for Macintosh**, Artisoft has blasted its way into the Mac-to-PC connectivity market with a product that is destined to get Mac and PC users talking again.

Artisoft's product is a unique blend of conventional and unconventional technology. To start off, you will need one or more Macs. On that side of the network, things are simplified immensely by the fact that Macs already have a built-in network; LANtastic for Mac works with all varieties, whether you use the default LocalTalk or opt for adding the faster (and more expensive) EtherTalk or TokenTalk. On the other side, you'll need one or more PCs running LANtastic 4.0.

To tie the two sides of the network together, you'll need a *gateway server*. The heart of LANtastic for Mac is a dedicated PC that sits between your Macs and PCs, acting as the translator between the two worlds. A gateway PC isn't an unusual approach, and with the price of PCs continually falling, it's not an unreasonable expense.

Although the gateway server can be just about any flavor of PC, it's best to choose a system with as hefty a hard drive as you can afford. That's because the gateway server acts as a central repository of files for the network.

A bit of explanation is in order: Because LANtastic for Mac costs orders of magnitude less than other Mac-to-PC solutions, there are, of course, a few compromises. The major one is that, while Macs on the network can read files off both the gateway server and any PC that's set up as a LANtastic server, PCs can't read files directly off Macs. PCs can, however, read Mac files stored on the gateway server. Therefore, if you want to do lots of file sharing, a large hard drive on the gateway server can pay dividends.

The major work of setting up LANtastic is in setting up the gateway server. I used a 386SX-based system with a 380-MB hard drive. I installed a standard LANtastic AE-3 Ethernet card and software, configuring it as a server on my small LAN of four PCs. The next step was to install the Farallon LocalTalk card (included with LANtastic for Mac) into the gateway server and connect it to my Mac IIsi using the supplied PhoneNet cables.

I then installed the LANtastic for Mac software on the gateway server; this is where user accounts and resources are configured. Like any network, this one requires a bit of planning. One important part of the process is *file extension mapping*, enabling Macs to display PC files as icons on the Desktop. Most common applications and data-file types come with default icons, but you can also set up new ones.

I also set up the printer resources. One thing to note: Although PCs can't directly access files off Macs on the network, any Mac or PC can access any printer connected to any computer on either side of the gateway server.

Over on the Mac side, all I had to do was make sure the AppleShare icon was installed in the Extensions folder of my Mac (running System 7.0). There is LAN Mac Manager software that lets you administer the gateway server from the Mac side, but it's optional.

Setting up LANtastic for Mac is actually less complicated than it sounds. Once up and running, it works flawlessly and transparently. It's particularly useful in this era of Mac and PC applications with compatible file formats. I was able to work with Microsoft Word and Excel, Aldus PageMaker, and Claris FileMaker files from both the Mac and PC sides, with the compatible data file sitting on the gateway server.

LANtastic for Mac has extensive configurable security. Besides password log-in (with optional expiration) to the server, file and directory access can be controlled, and there's an audit trail for all users.

With a price that can't be beat, LANtastic for Macintosh is an easy-to-set-up and easy-to-use solution for anyone who wants Macs and PCs to communicate on equal terms. If only politicians could do the same.

—Stan Miastkowski

THE FACTS

LANtastic for Macintosh
with LocalTalk card for PC server, $799; software only, $599

System requirements:
Any Mac with System 6.0 or higher, AppleShare Phase 2 workstation software, LocalTalk network, or EtherTalk or TokenTalk network adapter. Gateway server: PC with hard drive. LANtastic 4.0 or higher. LANtastic-compatible network adapter card, and AppleTalk adapter card (LocalTalk card included). PC servers: PC running LANtastic 4.0 or higher.

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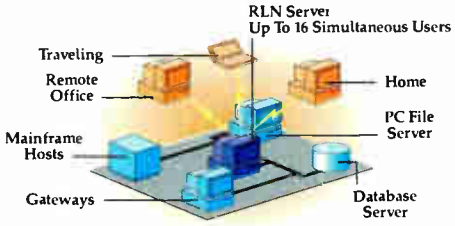

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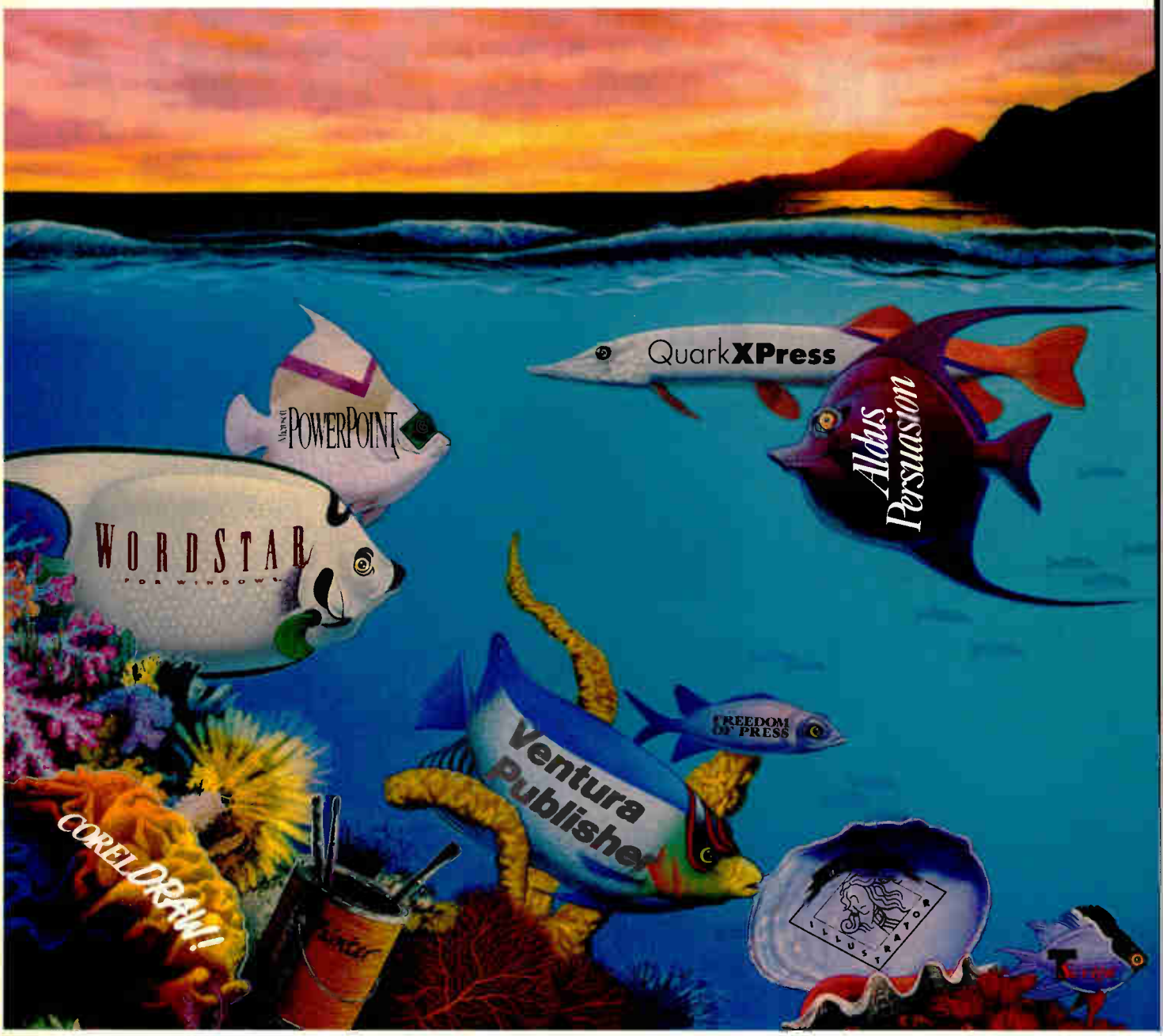

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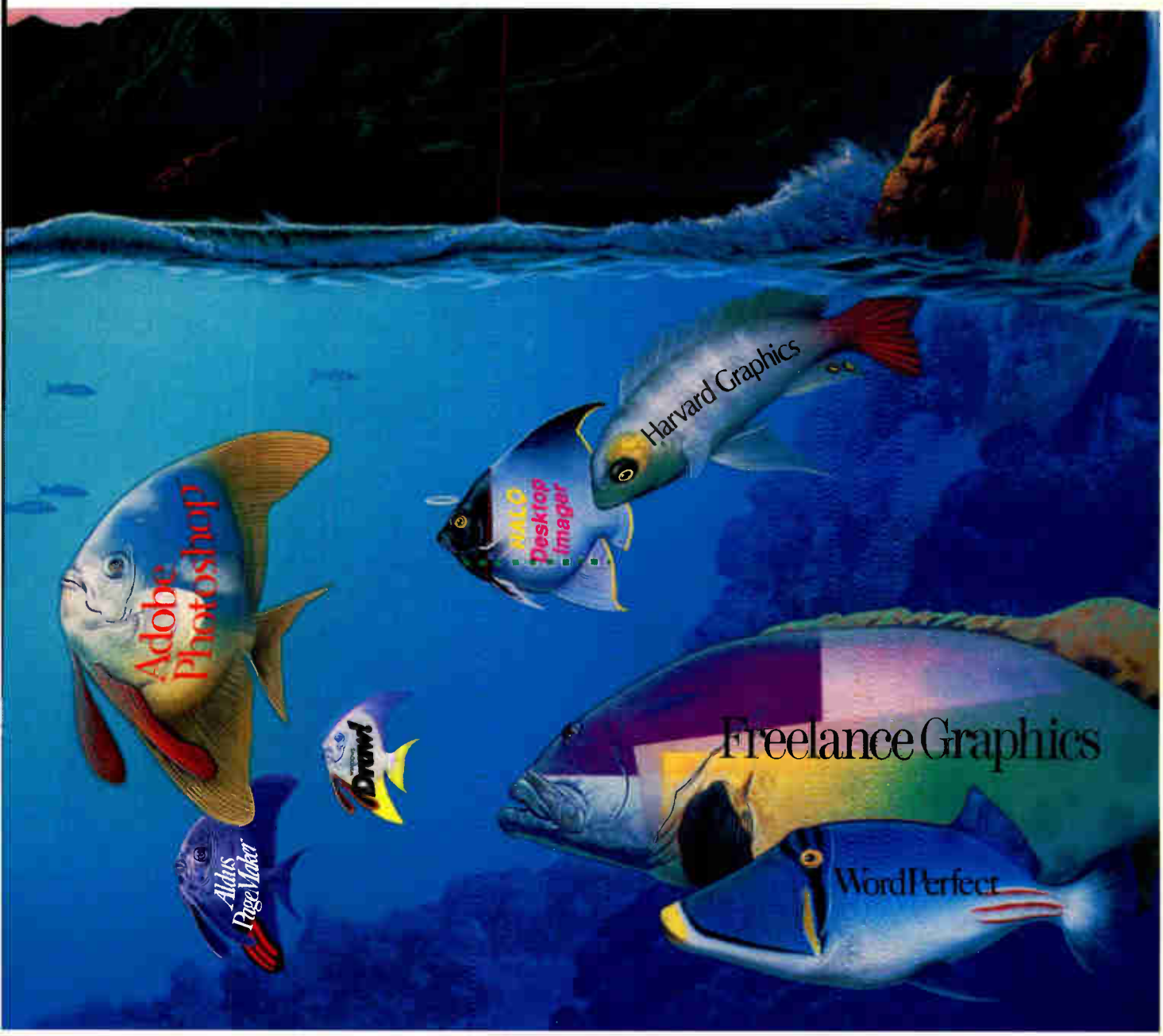

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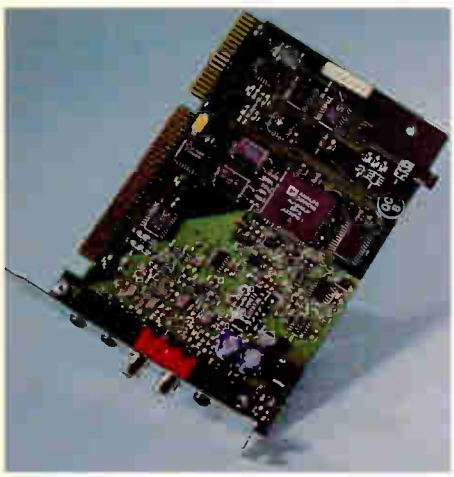
Microsoft Windows Sound System



Microsoft, which legitimized the "serious" business use of PC sound boards with its release of Windows 3.1 and the Multimedia Extensions, has now decided to carve itself a slice of the sound-board pie. The Microsoft **Windows Sound System** is a windy name for a small and sparsely populated board (see the photo). On the surface, compared to other sound boards, this one seems to come up short by virtue of the things it *doesn't* do: You'll find no CD-ROM controller, no Sound Blaster or AdLib compatibility, no external MIDI port, and no big bundle of standard software. But the Windows Sound System is a moderately priced board bundled with unique, useful software tools.

Of all the sound boards I've looked at, this one is the easiest to install. A single jumper on the board let me select a port address. When I fired up the Windows-based setup program from the installation floppy disk, a dialog box popped up to tell me that the board's interrupt had been reconfigured automatically because of a conflict. That's how I like things to work.

Once the board is in, making the back-panel connections is a breeze. In keeping with Microsoft's current icon madness, the ports on the back of the board are labeled with symbols. It has ⅛-inch stereo jacks for a microphone (included), headphones (also included), and line input (for external devices like tape recorders). The headphone jack doubles as a line or speaker output, and Microsoft adds twin RCA line-output jacks for direct connection to speakers or to some devices' line input. Once the board is installed, everything about it is software-controlled.

The flagship application bundled with the board is called Quick Recorder. The name is a little deceptive; this is actually a capable sound editor that doubles as an OLE server. Quick Recorder employs an interface trick I haven't seen from Microsoft before: normal and expanded interface views. In normal view, only the minimum required controls and feedback are presented in a compact window. You can record, play, load, and save sound files, but you can't edit them. Expanded view brings up a more complex interface, with

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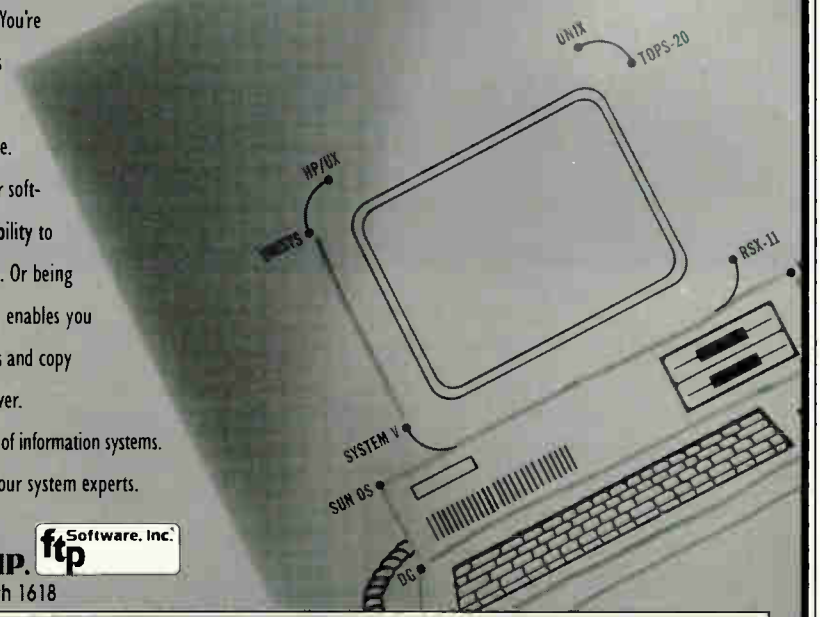

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full editing and effects capabilities.

The digital audio section of the Windows Sound System records and plays digital audio files at a maximum rate of 44.1 kHz in 16-bit stereo. Unique is the availability of a 4-bit compressed format in addition to the 8- and 16-bit formats. The compressed format can be used even at the 44.1-kHz rate to reduce space requirements to the equivalent of those for 22-kHz audio. I found no significant difference between 4-bit compressed and 8-bit uncompressed audio digitized at the same rate.

The Sound System board sounds wonderful, and in my tests it recorded and produced clean, undistorted audio at the 44.1-kHz rate in 4-, 8-, and 16-bit resolutions. The lower rates were less impressive, as you'd expect, but passable.

Even though there are no external MIDI connections, the Windows Sound System includes a Yamaha OPL3 four-operator FM synthesizer. FM is the most prevalent synthesizer in audio boards, but it's a bit of a mismatch here: With the board capable of reproducing such high-quality digital audio, I wonder why Microsoft chose such a cheap-sounding synthesizer chip (most of Microsoft's competitors made the same mistake). Don't expect great-sounding music from this board.

The Windows Sound System includes a voice-recognition module. A Windows application sits in the background and listens to the microphone, waiting for voice commands. Each command set links command words and phrases with Windows keystroke macros. The idea is that you can run your computer, to a degree, by talking to it. Want to find out how much memory you have available? Just say "about Program Manager" into the microphone, and up it pops.

Everything is user-customizable, but a standard configuration is included that supposedly recognizes a limited number of commands without requiring training for a particular user's voice. The prerelease version I used required training before it would do *anything*, but after I learned to use the same inflection every time I spoke, it worked some of the time. Perhaps this will improve in the shipping version.

Overall, I give the Windows Sound System high marks. Its ease of installation, excellent software, and superb digital audio quality make it a worthwhile, though late, entry in the Windows sound-card race.

—Tom Yager

THE FACTS

Windows Sound System
(price unavailable at press time)

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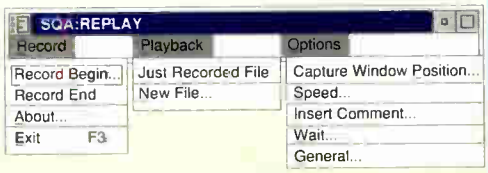

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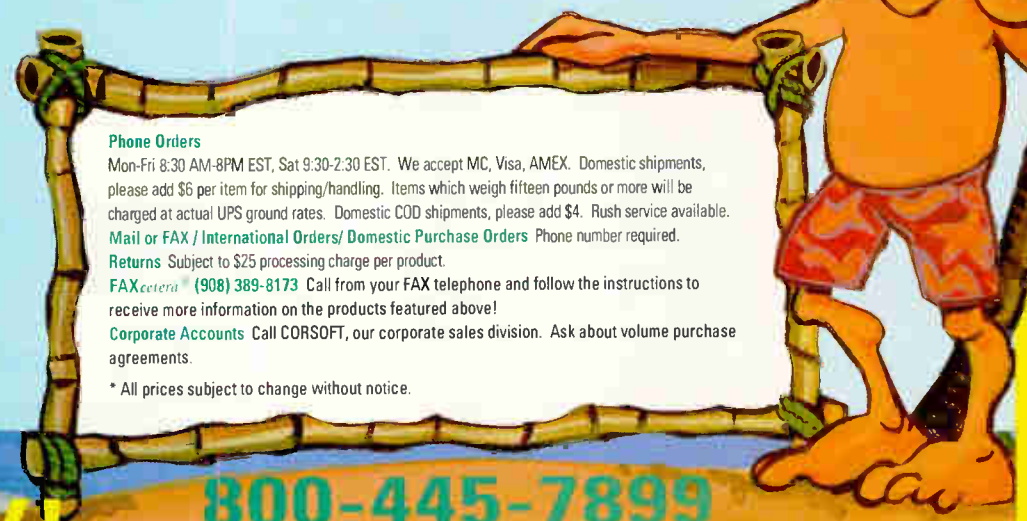

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World Radio History

Infolio Offers Mobile Workers the Power of the Pen

While pen computer system vendors struggle to find a common thread in an embryonic market, PI Systems has struck out on a narrower path. One of the first things you notice when using PI's $1895 **Infolio** is that it doesn't look much like a traditional computer. Rather than designing a notebook-style computer, PI started from scratch and built a deceptively simple yet effective electronic-clipboard type of tablet specifically for data collection tasks for mobile users. Using the Infolio is intuitive and requires little or no knowledge of computing, and nearly everyone I showed my test model to had a tough time letting go of it.

Infolio deviates from the pen-computing norm in its use of the Motorola 32-bit 16-MHz MC68331, which is more often encountered as an embedded microcontroller. Infolio also runs on PI's own internally developed object-oriented operating system, PICOS, which the company says will link to other platforms in 1993.

One reason PI selected the 68331 was that it's a fully static part, allowing dynamic adjustment from 0 Hz (in Infolio's low-power stop mode) to 16 MHz. The 9.4- by 11.2- by 1.2-inch clipboard, which weighs 2.9 pounds (3.4 pounds with a battery pack of 8 AA nickel-cadmium or alkaline batteries), also has no floppy or hard drives; its use of solid-state storage rather than rotating media greatly contributes to low power consumption and brisk performance.

Of its three PCMCIA drive slots, Infolio uses the first for a 2-MB SRAM (static RAM) card containing its operating-system software; the other two slots are for storing additional data or programs. Infolio's microkernel uses only about 200 KB of memory; the entire system software requires 1 MB of memory. The clipboard also sports a Sharp reflective LCD with VGA-level 640- by 480-pixel resolution, and it uses an awake/sleep mode as well as an automatic shutdown mode, prolonging battery life up to a claimed 12 hours.

On powering up Infolio, I was greeted by a list of graphical menus representing forms-based vertical applications that mobile users typically would fill out in the course of their jobs. An example is PI's series of patient-care forms that hospitals would use to track patient billing records or treatment schedules.

My developer's edition of Infolio included a clipboard environment that had several extra utility programs (e.g., a calculator, address book, and memory usage monitor) organized in an electronic file-folder format. At the discretion of developers, most Infolio users will probably not see those features, but they will be able to take advantage of PI's character-recognition system, which allows users to "train" the system to recognize their own printing, and its ability to capture cursive handwriting through electronic ink. PI will also sell a software developer's kit, called the ProformaSDK, that includes a graphical object-oriented applications development tool with an integrated database for developing applications for Infolio using Microsoft Windows–based PCs.

PI hopes to avoid the pitfalls encountered by highly touted but more horizontal pen-system companies. Given the 2-year-old start-up's narrow focus, PI just may be able to capitalize on early growth in pen systems long enough to stick around until the market takes off in earnest later in the decade.

—Patrick Waurzyniak

THE FACTS

Infolio
$1895; ProformaSDK, $1095

PI Systems Corp.
10300 Southwest Greenburg Rd.,
Suite 500
Portland, OR 97223
(503) 293-9585
fax: (503) 293-9590
Circle 1075 on Inquiry Card.

A Move Toward the Paperless Office

Okidata has coined the term *Desktop Document Processing* to describe **DOC.IT**, a printer, fax, scanner, and copier all in one. Okidata has tied all the parts and pieces of the everyday office into a neat package that features a well-integrated Windows application for controlling the hardware.

At the heart of DOC.IT is a dedicated add-in board with an Intel 960 RISC processor and 4 MB of its own RAM. The board takes the processing needs of document processing away from your system's CPU. It also communicates with the DOC.IT external hardware through a high-speed port. Because the board uses an interrupt, a base I/O port, and a base memory address, configuring it is difficult. I recommend leaving this to your dealer.

The software, DOC.IT Manager, integrates all the individual abilities of the hardware and software through a command bar with 14 icons. It works with all your Windows applications and lets you print, copy, fax, or import scanned images.

One key feature is that each module works independently. But you still have to have the add-in board installed and running before you can use any features. The independent

World Radio History

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Ballys MultiMedia Showcase Booth #B910

Circle 227 on Inquiry Card.

World Radio History

functioning of the modules answers the question I always have about all-in-one hardware: What happens when one part or function breaks? With DOC.IT Manager, system functions operate independently. Another feature that makes this peripheral practical is a control panel that lets you make a copy or send a fax while the system is running other applications.

As for quality, it appears that Okidata hasn't cut corners here, either. The printer, copier, scanner, and fax functions operate at resolutions of 300 dots per inch and above. (DOC.IT is available in two models, with 300- or 400-dpi printer resolution.) The fax is CCITT Group 3, and the 8-page-per-minute printer has standard emulations such as PostScript-compatible TrueType and PCL 5.

You use DOC.IT by accessing pull-down menus on the DOC.IT Manager interface. When I wanted to scan an image, for example, I just selected the type of image, resolution, intensity, and page size from the menu. I also had the choice of line art, number of gray levels, and halftones. The scanned image was stored in TIFF format, and I had the choice of compressed, decompressed, and 200, 300, or 400 dpi. The scanner operates at 10 ppm and offers a 64-level gray scale.

The fax function works equally well, and I realized that the fax and scan functions would do the most toward freeing my office of multitudes of paper. Fax features include broadcast, delayed transmission, phone book with group lists, logs, and polling. The document-fed scanner can also be pulled out to be a hand scanner, for books and things that won't fit through the sheet feeder. One key feature that won't be available for a while is character recognition, which I consider essential for turning scanned paper into workable data.

I found DOC.IT a bit of a novelty, but only because it offers so many functions in a relatively small package. It measures 8.5 by 17.5 by 22.5 inches and weighs just 36 pounds. I can imagine a device like this becoming an indispensable part of a busy office environment, but the market may be a hard one to crack. After all, most offices already have a laser printer, scanner, copy machine, and fax. But for those users with individual document management needs, DOC.IT might suit them all.

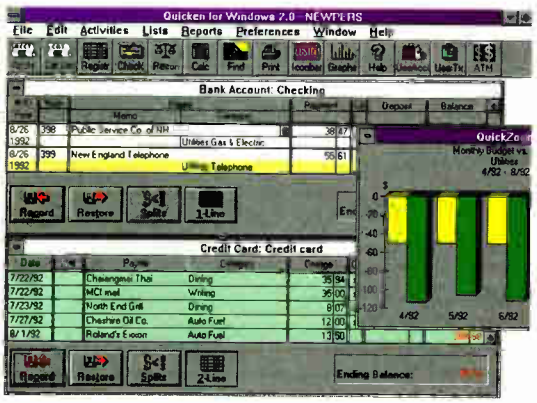
—Anne Fischer Lent

THE FACTS

DOC.IT
DOC.IT 3000 (300 dpi), $3999;
DOC.IT 4000 (400 dpi), $4999

Okidata
532 Fellowship Rd.
Mount Laurel, NJ 08054
(609) 235-2600
fax: (609) 778-4184
Circle 1076 on Inquiry Card.

Personal Accounting: Quicken 2.0 for Windows



One of Quicken's strengths has always been its flexibility, and the beta of Intuit's new **Quicken 2.0 for Windows** that I looked at continues to demonstrate that trait. For example, the icon bar along the top of the screen (which automates standard actions) now lets you display icons, text, both, or neither. You can hide any buttons that you don't use, and you can add icons to automate transactions that you do often, open accounts that you use frequently, and implement a dozen other functions.

In the checkbook register–like transaction windows, you can now choose between two- or one-line entries. When you fill in the payee and category, new drop-down boxes let you choose names from a memorized list, and you can have those boxes appear automatically or by clicking a button—or choose not to have them appear at all.

Like the previous version, Quicken 2.0 for Windows has excellent standard and customizable reports, and now you can change, memorize, or print those reports using a series of buttons right on top of the report. This is handier and more intuitive than having to traverse a bunch of menus.

New features include the ability to create customizable graphs of income and expense, budgets, net worth, and investments. Another new feature (and one that I found to be particularly useful) is QuickZoom, which lets you double-click on any data in a graph and get more details. One optional new service is IntelliCharge, which lets you reconcile your credit card statement automatically, by modem or on disk.

If the thought of setting up a budget scares you, you will like Quicken's new AutoCreate Budget option, which uses your existing data to build a budget for you. The program also has a financial planning toolkit to help you plan for loans, retirement, college, and so on. In several places, a new feature called Qcards pops up to help you when you undertake a new task—it is a bit like the Mac's Balloon Help.

If you already use Quicken, you'll love this new version. If you don't use Quicken, you may want to give this intuitive financial program a look.

—Kenneth M. Sheldon

THE FACTS

Quicken 2.0 for Windows
$69.95; upgrade for owners of previous versions, $29.95

System requirements:
Windows 3.0 or higher; 2 MB of RAM.

Intuit, Inc.
155 Linfield Ave.
Menlo Park, CA 94026
(415) 322-0573
Circle 1077 on Inquiry Card.

World Radio History

Once Again, CA-SuperCalc's Numbers Crunched 'Em.

VARBUSINESS
Spreadsheet Report Card 1992

	Average Score	Access Tech.	Computer Assoc's	Lotus	Microsoft
PRODUCT FEATURES					
Ease of use	7.01	6.70	7.00	6.81	7.52
Memory requirement	6.40	6.82	6.89	5.71	6.16
Ease of programming	6.48	6.33	6.58	6.32	6.69
Ability to manipulate data	7.35	7.60	7.29	7.00	7.52
Sorting capabilities	6.90	7.67	6.64	6.58	6.73
Provision for software security	5.65	5.87	5.67	5.32	5.75
Report writing capabilities	6.14	5.57	6.28	5.89	6.82
Ease of use of interface	6.82	6.75	6.70	6.18	7.63
Software integration capabilities	6.84	6.94	6.82	6.32	7.31
Ease of data retrieval	7.41	7.56	7.52	7.10	7.44
Satisfaction with product profitability	6.21	6.47	6.44	6.05	5.89
Overall quality of product	7.48	7.28	7.72	7.18	7.78
Product features average	6.73	6.80	6.80	6.37	6.94
SUPPORT FEATURES					
Provision for customer support	5.66	5.06	6.97	5.47	6.02
Charges for training time	6.17	4.38	5.95	5.05	8.29
Provision for technical support	6.76	5.20	6.60	5.40	5.85
Provision for marketing support	6.65	5.00	6.40	6.43	5.75
Documentation & product information	6.85	6.25	7.27	6.77	7.13
Frequency of updates & revisions	5.99	6.06	5.96	5.84	5.10
Support features average	5.88	5.33	6.52	5.66	6.02
OVERALL AVERAGE	6.45	6.31	5.71	6.13	6.63

VARBUSINESS
March, 1992

This year's spreadsheet shootout is over. And like last year, the big winner is CA-SuperCalc.®

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World Radio History

A True-Color Combination

I'm a tough customer when it comes to evaluating 17-inch color monitors. After all, I have an NEC 5FG on my desk. Lately, though, I've been using the **Optiquest 4000D** hooked to a **HiColor Turbo F/X** video adapter from International Computers. And I like what I've been seeing.

The Optiquest 4000D has all the amenities you look for in a large-screen monitor. It's noninterlaced and supports the new VESA (Video Electronics Standards Association) standard for refresh rates (72 Hz), resulting in a crisp, flicker-free display. The flat-screen design, coupled with an etched surface, reduces glare; the antistatic coating reduces distortions caused by stray magnetic fields. Radiation emissions fall within the Swedish MPR II standards.

The 4000D's image quality is good: The monitor displayed sharp images and bright colors. I ran the full suite of DisplayMate video tests from Sonera Technologies, and the 4000D showed no serious image defects. But I've been spoiled: The Optiquest monitor is no match for the NEC 5FG when it comes to image quality. It's hard to put a price on quality, but for my money, I'd need to save at least $300 to turn away from the 5FG.

Given the high cost of large-screen monitors, the surprisingly low cost of high-resolution video adapters is downright ironic. The Turbo F/X from International Computers delivers 1280- by 1024-pixel resolution and up to 16 million colors for only $159. The card uses the same Tseng Labs AT4000 chip that many other vendors ship with their video cards, but the Turbo F/X seems to pump some additional power out of the chip. With only 1 MB of video RAM, you can run at 1280- by 1024-pixel resolution with 16 colors, or you can enjoy 32,000 colors in 800- by 600-pixel resolution. Few cards can get those kinds of specifications from a single megabyte.

The card also performs well as a low-cost solution. On Texas Instruments' WinTach benchmarks, the adapter performed significantly better than the AT4000 sample listed by the program. If you want an inexpensive way to move up to true-color Windows, the Turbo F/X can get you there.

—Stanford Diehl

THE FACTS

Optiquest 4000D
$1495

Optiquest, Inc.
9830 Alburtis Ave.
Santa Fe Springs, CA 90670
(310) 948-1185
fax: (310) 949-2231
Circle 1078 on Inquiry Card.

HiColor Turbo F/X
$159

International Computers
12021 West Bluemound Rd.
Wauwatosa, WI 53226
(800) 992-9000
(414) 764-9000
Circle 1079 on Inquiry Card.

Virtually Universal Text-Processing Possibilities

LONDON—**Ways for Windows** is a powerful system for automating Windows text-processing applications. A background program that filters all keyboard input to Windows, Ways can substitute words into the input stream in many ways. Its free-form, associative database engine uses fast word-similarity and cluster-analysis algorithms invented by its author, the Swiss mathematician Hannes Keller, which lets Ways analyze each word you type in real time (typically 0.1 second after you press the space bar). This allows Ways to do on-line spelling correction, abbreviation expansion, macro recording and playback, word-for-word foreign-language translation, thesaurus lookup, and much more. I saw Ways used to do a word-for-word English-to-German translation.

Ways takes about 10 MB of disk space. When running, it displays a long, thin window from whose Files menu you can load new dictionaries and then browse through them manually. When you click on the Online box, Ways performs as-you-type spelling correction or translation using the current dictionary. Click on the Learn box, and Ways adds unfamiliar words to the dictionary as you type. Keller's correction algorithms are adaptive, so the spelling rules improve as a dictionary grows. When you click on the AutoType box, you activate Ways' dynamically created abbreviation dictionary. Thus, if I type the word *transputer*, whenever I type *tr*, *transputer* will be offered in the AutoType box.

Ways' thesaurus is pretty remarkable, too. It contains the usual lists of synonyms, but it also lets you attach a database record, a note, or an external text file to any item, or even run another Windows program.

All these facilities are available within *any* Windows program that accepts text input (e.g., the Notepad or Cardfile) and even on the entry line of file dialog boxes. Keller tells me he's scheduled to demonstrate Ways to Microsoft executives, so this elegant software might find its way into a future version of Windows. ■

—Dick Pountain

THE FACTS

Ways for Windows
about $200 (about 258 Swiss francs)

System requirements:
An IBM PC compatible with Microsoft Windows and 10 MB of free disk space.

Witch Systems AG.
Binzmuhlestrasse 45
CH-8050 Zurich
Switzerland
41-1-311-6595
fax: 41-1-311-6540
Circle 1160 on Inquiry Card.

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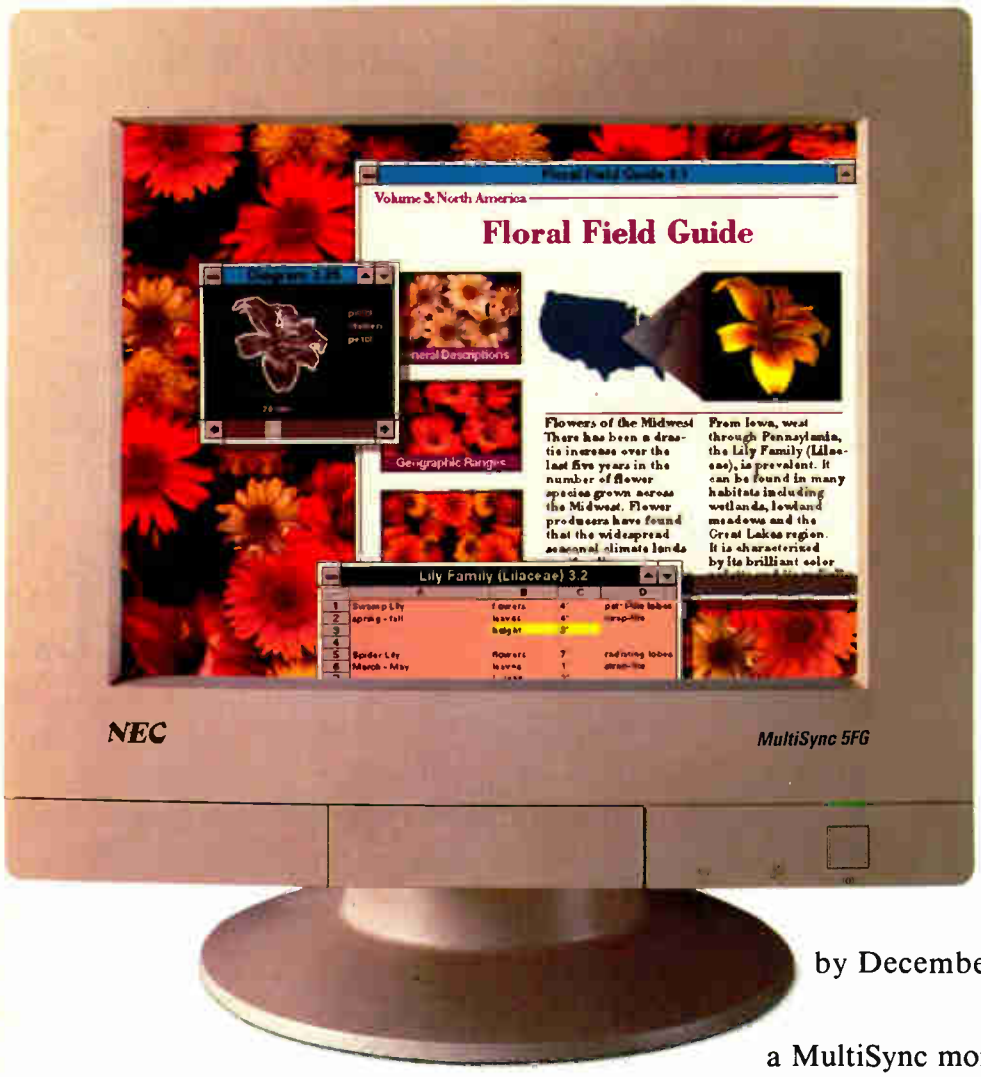

➡ And now if you buy a MultiSync 4FG or 5FG by December 31, 1992, we'll give you a MultiSync monitor lens. Free. ($79 value for the 4FG/$119 value for the 5FG.) The

MVP
MultiSync 5FG monitor

MacWORLD PRODUCT OF THE YEAR 1992
MultiSync 4FG monitor

MultiSync 4FG monitor
MacUser Magazine

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World Radio History

monitor lens provides the perfect balance of contrast and brightness for use in poor ambient lighting conditions such as near windows and under bright fluorescent lighting. It features high-quality OCLI HEA® glass, it integrates perfectly with our cabinet design, and its anti-static coating prevents dust attraction.

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World Radio History

Adjustable Notebook Viewing

With a tilt-and-swivel screen that seems to float above the keyboard, the Zeos Freestyle/SL Notebook provides a range of viewing angles. The 9½-inch-diagonal digitally controlled monochrome VGA LCD has a resolution of 640 by 480 pixels. The 386SL system can support a simultaneous display on an external color VGA monitor.

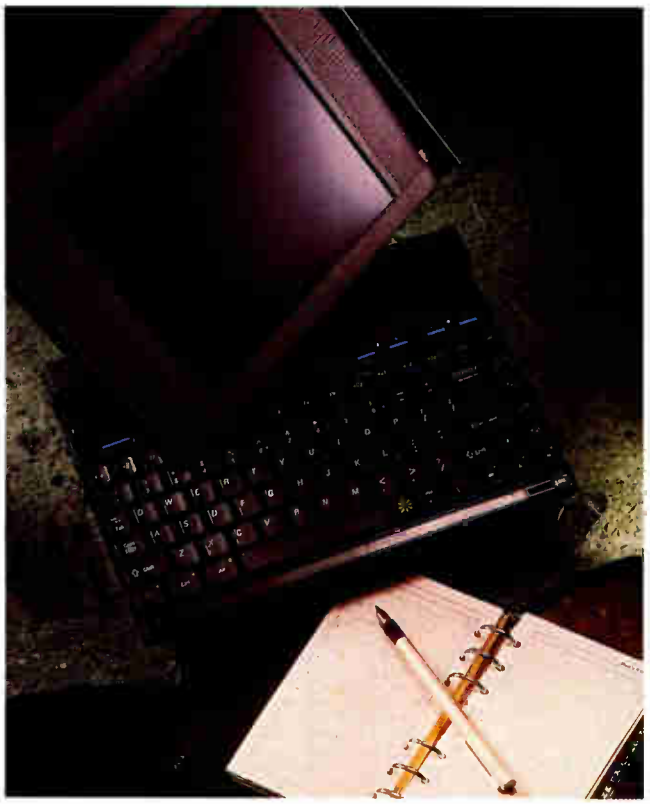
The 5½-pound notebook comes with 2 MB of RAM (expandable to 20 MB), a 1.44-MB floppy drive, and a 64-KB internal processor cache. Its power management system lets you extend the battery's normal 3 to 4 hours of operating time by several hours.

Other features are a built-in pointing key with left- and right-handed three-button mouse controls, flash ROM, and support for BIOS and video shadowing.

Price: Starts at $1895.

Contact: Zeos International, Ltd., 530 Fifth Ave. NW, St. Paul, MN 55112, (800) 423-5891 or (612) 633-4591; fax (612) 633-1325.

Circle 1272 on Inquiry Card.



The Freestyle/SL Notebook's screen is held in place by a pivoting mechanism.

An Assistant for the Office

A complete integrated image- and document-preparation system, the mid-size tower Assistant is the basic model of Tangent's Image/Document Pro Series. The 25-MHz 486SX system features 8 MB of RAM, a 64-KB cache, a 240-MB IDE hard drive, and an internal 120-MB mini-cartridge tape backup unit.

Additional features are a Tangent graphics accelerator, a 15-inch flat square color monitor with 1024- by 768-pixel resolution, a Hewlett-Packard ScanJet IIc 24-bit color scanner, and a Logitech Mouseman. Software includes OmniPage Direct, Adobe Type Manager and Type Align, ImagePals Enhancer/Album/Capture, DOS 5.0, and Windows 3.1. The system comes with page-layout, word processing, and precision artwork software.

Price: $7995.

Contact: Tangent Computer, Inc., 197 Airport Blvd., Burlingame, CA 94010, (800) 466-3300 or (415) 342-9388; fax (415) 342-9380.

Circle 1271 on Inquiry Card.

Tangent's Assistant.

66 MHz on a 486

The ITS 486DX-2 uses Intel's 486 processor chip running at 66 MHz and has a 256-KB write-back cache. The system includes 4 MB of RAM (expandable to 32 MB), an AMI BIOS, 1.2- and 1.44-MB floppy drives, and a 105-MB IDE hard drive with a 2-MB caching controller (expandable to 16 MB).

Interfaces on the ITS 486DX-2 include two serial ports, one parallel port, and a mouse port. The system has nine expansion slots. Graphics features include Super VGA capability and an S3 graphics accelerator with a maximum resolution of 1280 by 1024 pixels and 32,768 colors, plus a 14-inch Super VGA color monitor. The system comes with DOS 5.0 (or, optionally, OS/2) and Windows 3.1.

Price: About $3798 (£1999).

Contact: Mainstream Computers Ltd., Chipping Manor, Wotton-under-Edge, Gloucestershire GL12 7AD, U.K., 44-453-844742; fax 44-453-844743.

Circle 1273 on Inquiry Card.

Choose Your Configuration

The Aurum GoldnoteS25 486SX notebook's removable hard drive configuration provides customizable storage capacity of 80 or 130 MB. Each 6-ounce drive has a seek time of 14.52 ms. Standard features are 4 MB of RAM (expandable to 16 MB), an 80-MB hard drive, a 1.44-MB floppy drive, two serial ports, a parallel port, and an IBM-compatible Award BIOS with advanced power management support. The nonglare backlit VGA LCD has a resolution of 640 by 480 pixels. DOS 5.0, Windows 3.1, and a carrying case are standard.

Price: $1999; 80-MB hard drive, $399; 130-MB hard drive, $499.

Contact: Aurum Computer Corp., 5 Pond Park Rd., Hingham, MA 02043, (617) 749-5092; fax (617) 749-5188.

Circle 1274 on Inquiry Card.

World Radio History

A Solar Panel for PowerBooks

A lightweight panel incorporating impact-resistant solar cells, SolarPower gives PowerBook users an alternative to reliance on the notebook's batteries. The panel attaches to the top of the PowerBook screen via a removable hinge, letting you swing the panel into position when you want to use it. Graphical software aids guide you to the correct positioning for maximum solar power. Optional cabling lets you also operate the unit at a distance from the PowerBook.
Price: $189.
Contact: Microtech International, Inc., 158 Commerce St., East Haven, CT 06512, (800) 626-4276 or (203) 468-6223; fax (203) 467-1856.
Circle 1276 on Inquiry Card.

SolarPower lets you rely on the sun to extend battery life or recharge batteries in your PowerBook.

It's All in the Speed of the Spin

By doubling their spinning speed, Texel America gives two half-height CD-ROM drives an average access time of 265 ms, a sustained data transfer rate of 300 Kbps, and a 64-KB buffer. The internal DM-3024 and the external DM-5024 support applications such as 3-D modeling, animation, and full-motion video.

Compliant with the SCSI-2 command set, the drives are compatible with most SCSI host adapters and support the CD-ROM XA standard, which permits interleaving of audio. The DM-3024 has a 50-pin SCSI bus connector; its DIP switches let you set SCSI ID and termination. The DM-5024 has two shielded SCSI Centronics connectors that let you daisy-chain up to seven devices to a SCSI adapter. You set SCSI ID and termination via external switches. The DM-5024 also has an auto-switching power supply. Both units feature a volume control and a stereo headphone minijack.
Price: DM-3024, $499; DM-5024, $599.
Contact: Texel America, Inc., 1080C East Duane Ave., Sunnyvale, CA 94086, (800) 886-3935 or (408) 736-1374; fax (408) 736-1378.
Circle 1277 on Inquiry Card.

Reading Tool for the Blind

A stand-alone reading machine for the blind, the An Open Book Deluxe Edition is based on a 33-MHz 386 platform with 4 MB of RAM and an 80-MB hard drive. The unit comes with a DECtalk PC synthesizer to provide voice output and includes a keyboard and monitor. Also available is a Standard Edition, as well as An Open Book software for installation in existing computer systems.
Price: Deluxe Edition, $5995; Standard Edition, $4995; software, $995.
Contact: Arkenstone, Inc., 1185 Bordeaux Dr., Suite D, Sunnyvale, CA 94089, (800) 444-4443; fax (408) 745-6739.
Circle 1279 on Inquiry Card.

Portable Printer

A replaceable lead-acid battery pack provides the power for the SP-401B handheld printer. Able to print up to 7000 lines of text between battery charges, the printer features 40-column thermal printer technology, a 7-KB data buffer, and bidirectional RS-232 and RS-485 interfaces. The under-5-pound unit stamps each printout with the date and time and has an enclosed paper supply.
Price: $496.
Contact: Syntest Corp., 40 Locke Dr., Marlborough, MA 01752, (508) 481-7827; fax (508) 481-5769.
Circle 1280 on Inquiry Card.

Handwritten Input

With the SummaScribe desktop graphics tablet and Microsoft Windows for Pen Computing, you can enter data and edit documents in handwritten form. The tablet, which has an active area of 6 by 9 inches with a two-button penlike stylus, works with desktop, laptop, and notebook PCs. It has drivers for AutoCAD, Windows, and Windows for Pen Computing.
Price: About $568 (£299).
Contact: Summagraphics, Ltd., 140 Cromwell Rd., London SW7 4HA, U.K., 44-71-244-7733; fax 44-71-244-8584.
Circle 1281 on Inquiry Card.

Keyboard Intelligence

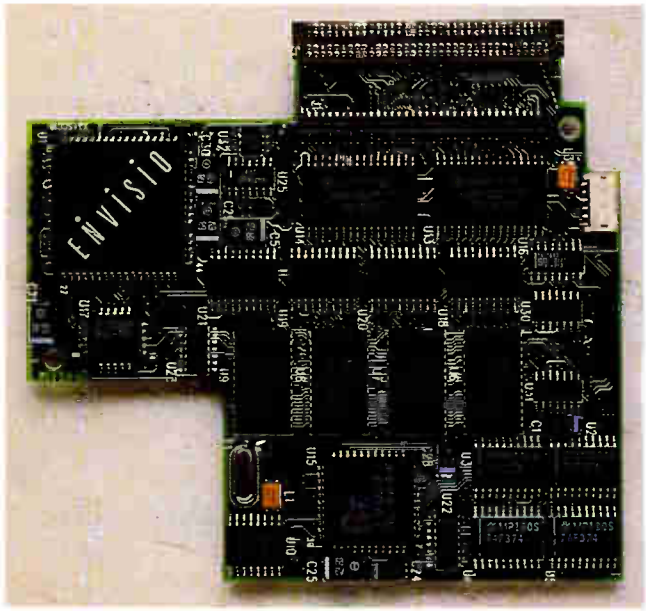
The MaxiPro II fully programmable keyboard for PCs and IBM PS/2s automatically senses the system it is connected to. Compatible with any software, the keyboard has its own nonvolatile internal memory. You can remap each of the 124 keys and program keys for special functions (e.g., diagonal cursor movement). The Macro Keys feature lets you program any key as a macro for complicated command lines, multilayered menus, or lengthy, often-used text; onboard memory holds up to 1800 characters.
Price: $125.
Contact: Maxi Switch, Inc., 2901 East Elvira Rd., Tucson, AZ 85706, (602) 294-5450; fax (602) 294-6890.
Circle 1278 on Inquiry Card.

World Radio History

Display Color from Your PowerBook

A 16-bit graphics card for the PowerBook 140 and 170, the ColorBook 16 provides over 32,000 colors on projection devices and on displays as large as 16 inches. The board delivers 8-bit color on 19- and 21-inch displays.

The ColorBook 16's pass-through memory port accepts an Apple 2-MB memory upgrade. PSRAM (pseudostatic RAM) on the board is available in 2-, 4-, and 6-MB configurations. The QuickTime-compatible board fits in the PowerBook's expansion slot.
Price: Starts at $1295.
Contact: Envisio, Inc., 510 First Ave. N, Suite 303, Minneapolis, MN 55403, (612) 339-1008; fax (612) 339-1369.
Circle 1282 on Inquiry Card.



The ColorBook 16 operates in QuickTime's native 16-bit depth to optimize the software's performance.

Miniature Controller

The Little PLC, a low-cost, compact, C-programmable logic controller, features eight optically isolated inputs, eight relay driver outputs, a built-in switching power supply, and RS-485 serial communications. You program the 4- by 3-inch PC-compatible board using Z-World's Dynamic C software, which can handle 20,000 C statements. As the programs are compiled, they download to the Little PLC via the serial port.
Price: $195.
Contact: Z-World Engineering, 1724 Picasso Ave., Davis, CA 95616, (916) 757-3737; fax (916) 753-5141.
Circle 1284 on Inquiry Card.

The Little PLC miniature controller has an expansion bus for peripheral devices.

A Planet Connection

With the Planet ISDN card, you can connect your Mac to British Telecom's ISDN 2 network. The card supports both of the digital network's channels, providing simultaneous high-speed data and voice communications.

The Planet ISDN comes with Telephone Manager software and an Apple standard Communications Toolbox driver, which allows up to eight applications to share one Planet ISDN card. Using the subaddressing features of ISDN 2, the card automatically routes incoming calls to the correct application.
Price: About $2280 (£1200).
Contact: Mac Connect, 25 Low Friar St., Newcastle Upon Tyne NE1 5UE, U.K., 44-91-230-5596; fax 44-91-261-5746.
Circle 1283 on Inquiry Card.

Remote Graphics Display

The Video Line Driver add-in board lets you display your graphics on a monitor more than 900 feet from your computer through standard 75-ohm coaxial cable. The board amplifies the VGA signal and prevents it from breaking up prior to reaching its destination. The Video Line Driver is compatible with VGA and Super VGA adapters and Windows accelerators.
Price: $369.
Contact: STB Systems, Inc., 1651 North Glenville, Suite 210, Richardson, TX 75081, (214) 234-8750.
Circle 1285 on Inquiry Card.

True-Color Controllers

The D24 BitBlaster uses a Cirrus Logic CL-GD5422 controller with 1 MB of RAM to provide 24-bit true color. Display drivers on the board include those for Windows 3.1 and AutoCAD. A companion board, the V24 BitBlaster, uses S3's 86C924 graphics controller with 1 MB of VRAM and an AT&T 24-bit RAMDAC.
Price: D24 BitBlaster, $99; V24 BitBlaster, $199.
Contact: Edge Technology, Inc., 915 East Karcher Rd., Nampa, ID 83687, (208) 465-3434; fax (208) 465-3424.
Circle 1286 on Inquiry Card.

Single-Slot Expansion

Windows-, multimedia-, and network-compatible, the One Slot board provides four serial and three parallel ports. The board fits in a single ISA or EISA expansion slot and supports laser and dot-matrix printers, mice, plotters, modems, and bar code readers.

The EIA-232 serial ports include full-duplex communications capability. You can disable the serial ports as well as the bidirectional Centronics ports via switch selection.
Price: $349.
Contact: Star Gate Technologies, Inc., 29300 Aurora Rd., Solon, OH 44139, (800) 782-7428 or (216) 349-1860; fax (216) 349-2056.
Circle 1287 on Inquiry Card.

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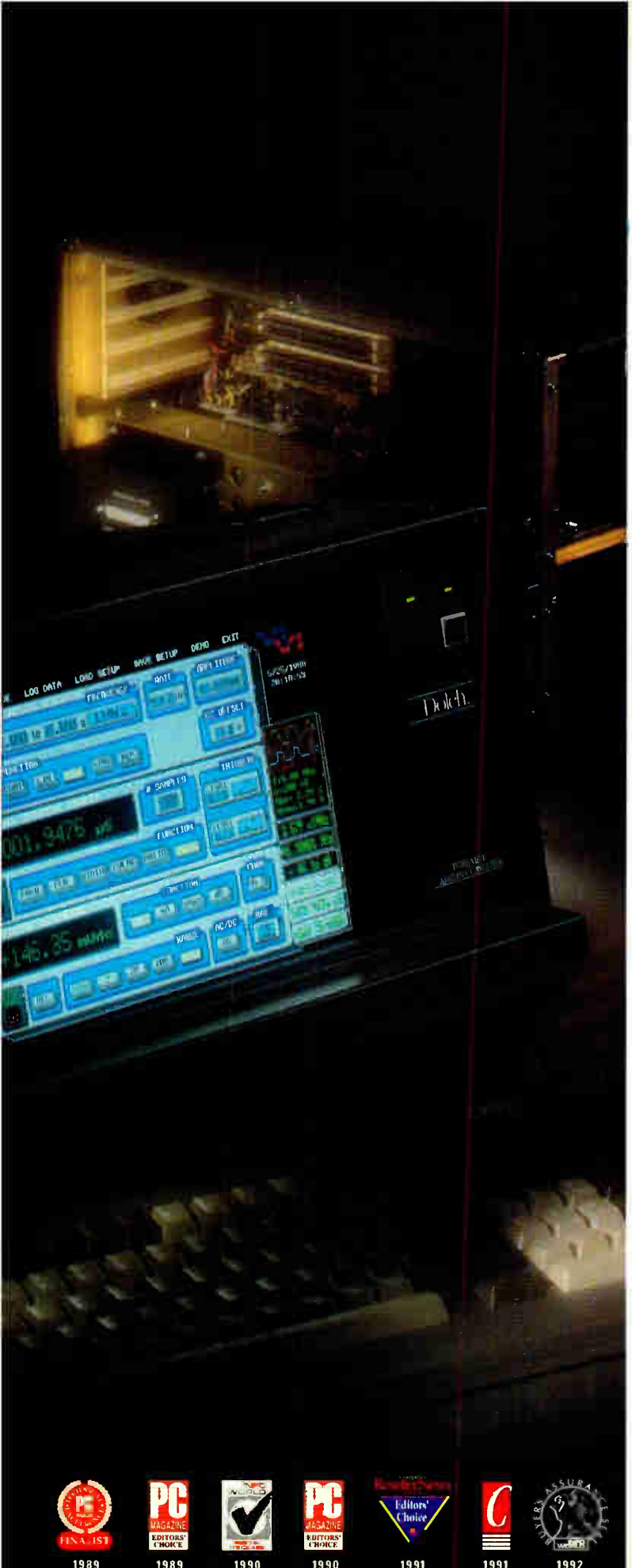

Try stuffing these into a laptop.

Laptops have their place, but for mission-critical applications requiring serious expansion, workstation power, CRT-quality screens or toolbox ruggedness, get a P.A.C.™ (Portable Add-In Computer). ■ **MASSIVE EXPANSION.** Nobody gives you more expansion possibilities than Dolch. In an 18 pound package a Dolch P.A.C. has room for up to five full-size EISA/ISA add-in cards. You can add up to 32 MB RAM, 1 GB HDD, and any combination of drives, CD-ROM, removable HD, streaming tape, and more. ■ **EXTREME POWER.** Dolch P.A.C. systems have been rated "the fastest portables on the market" since 1987, and have won more Editor's Choice awards than any other product in its category. *Computer Reseller News* calls the 486-50E "a dream machine . . . one of the most powerful PCs of any kind." P.A.C. systems are based on 386SX and DX, and 486 CPUs up to 50MHz, delivering as much as 22 MIPs. ■ **DAZZLING DISPLAYS.** "Breathtaking . . . Dolch's heart-stopping TFT Color Display produces vibrant colors and sharp images virtually on par with those seen on desktop VGA monitors," reports *PC Computing*. ■ **MIL RUGGEDNESS.** Every P.A.C. is as tough as it is powerful. Certified under MIL Std. 810C Dolch provides true mission critical reliability. ". . . it simply outclasses its competitors and it is sturdy and solid . . ." says *PC Magazine*. ■ **GET THE FULL STORY.** Call **1.800.995.7581**. In Canada 1.800.561.4527.

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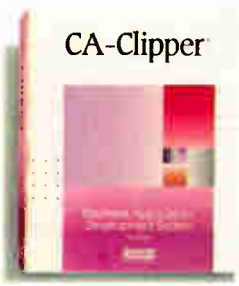
For Xba Roads Le

It's been a very difficult and confusing couple of years for Xbase developers. Filled with uncertainty and doubt about the future. At times, some questioned whether Xbase even had a future.



But those days are over.

With the resources, experience and support of the world's leading database company behind it, and with the combined technological wealth of CA-Clipper, CA-dBFast™ and Computer Associates, the future of Xbase has never looked brighter.

Millions Of Clipper, dBASE, Fox And CA-dBFast Developers Head For The Next Generation Xbase System.

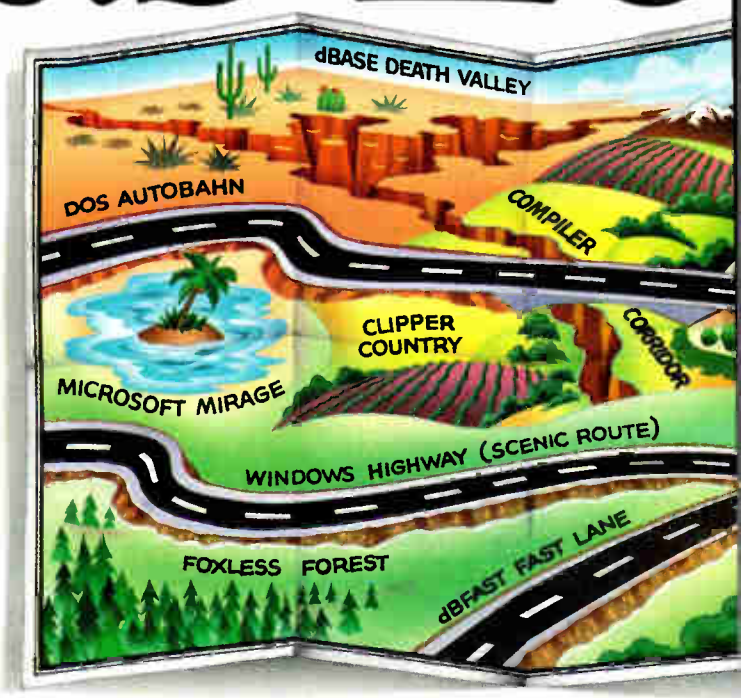
To build the Xbase system of the future, we've added CA's visual tool and client-server technology to Nantucket's next generation Xbase project.

This new system will provide a fully object-oriented Xbase language, native code compiler, an IDE (Integrated Development Environment) and both DBF-style and client-server database support.

It will support Windows, Windows NT, OS/2 and UNIX. The complete product will be demonstrated at Fall Comdex and available for beta testing in the fourth quarter of 1992.

Two Easy Ways To Get There: Go GUI Today With CA-dBFast Or Go The DOS Route With OOP Via Clipper. Your Choice.

There are two migration paths to this ultimate Xbase system: The OOP (Object-Oriented Programming) path of CA-Clipper and the GUI (Graphical User Interface) path of CA-dBFast with Windows support.



Both paths will provide immediate benefits and will protect and leverage the substantial investments you've made in Xbase.

Attention All dBASE IV Developers: Your CA-Clipper/Compiler Kit Has Arrived.

After four years, the compiler kit you've been waiting

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se All ad To CA.

for has arrived. Introducing new CA-Clipper/Compiler Kit For dBASE IV. The easiest, quickest way in the world to compile a dBASE IV application.

All it takes is three easy steps. And in just minutes, you can turn most dBASE IV programs into faster running, higher performance programs.

The new CA-Clipper/Compiler Kit For dBASE IV provides compatibility and database interoperability with most dBASE IV applications. The Kit is implemented using the open architecture of CA-Clipper, including the preprocessor, the Extend System and the RDDs.

Secure Your Future When You Team Up With The World's Leading Database Software Company.

Much more than a PC software company, CA is the world's leading database software company. CA software is used in over 70 countries around the world by more than 10 million users including over 90% of the Fortune 500.

From mainframe to midrange to microcomputers, CA database software runs on more platforms, more operating systems, and handles more mission-critical applications than any other software in the world.

CA90s
CA's Computing Architecture For The 90s.

For Information On CA-Clipper, CA-dBFast And A Statement Of Direction: Call 1-800 CALL CAI.

To get the complete story on The Future of Xbase, call for this special 30-page statement of direction.

It contains an Executive Summary as well as an in-depth discussion of Xbase in the 90s, CA's Open and Client-Server Architectures, Integrated Development Environment, Xbase migration plans and end-user tools.

Free Demo Disk

The Future of Xbase
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And find out why the future of Xbase will lead you right to CA.

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Software superior by design.

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Create a New Ion Field

Now you can neutralize all positive ion radiation from your computer screen by reversing the positive ion field to a negative field of up to 100 square feet. The mouse-size Perfect-Aire 100 attaches to the top of your monitor with Velcro and plugs into a standard 110-V outlet. By eliminating electrostatic radiation, the unit not only cleans up the air around you and your computer, but also protects your monitor from static electricity discharge.
Price: $139.95.
Contact: Planmar Marketing, Inc., P.O. Box 13826, Research Triangle Park, NC 27709, (919) 383-3818; fax (919) 383-2871.
Circle 1288 on Inquiry Card.

PC Remote Control

A 26-button hand-held infrared transmitter, the Mind Path SR50 attaches to your computer's serial port. The transmitter lets you control any DOS or Windows program from up to 50 feet away.

Looking much like a remote control for your TV, the Mind Path SR50 can be reconfigured for any application via a menu-driven program. Each button on the unit works as a single keyboard key or a sequence of keys, and you can encode security keys into the buttons. The unit has full CRC-16 error checking built in. The fiberglass-reinforced plastic case is water and dust resistant.
Price: $495.
Contact: Mind Path Technologies, 12700 Park Central Dr., Suite 1807, Dallas, TX 75251, (214) 233-9296; fax (214) 233-9308.
Circle 1289 on Inquiry Card.

The Perfect-Aire 100 neutralizes positive radiation from the screen, top, and sides of your monitor.

Phone from Your Keyboard

Integrated Technology's PC-compatible 101-key CompuPhone keyboard is integrated with a single-line phone circuit and equipped with an interface for a headset, eliminating the need for a separate phone when you're telecommunicating. You use the numeric keypad for dialing; auto-dialing software is included.
Price: $299.
Contact: Integrated Technology, Inc., 76 South Orange Ave., South Orange, NJ 07079, (201) 907-0200; fax (201) 762-7234.
Circle 1290 on Inquiry Card.

Precise Power

The Onguard Universal Precision Regulators from Clary use a modular approach to power protection. Providing precision line regulation, the units protect your workstation via a ride-through capability based on a proprietary capacitor design. This capability protects your computer against momentary disturbances such as sags, spikes, surges, noise, and voltage/frequency deviations. You can expand protection with options such as a battery backup and a dedicated-input DC-to-AC inverter.
Price: Starts at $890.
Contact: Clary Corp., 1960 South Walker Ave., Monrovia, CA 91016, (818) 359-4486; fax (818) 305-0254.
Circle 1291 on Inquiry Card.

Trap Your Mouse

The Mousetrap enables you to use your mouse from your lap rather than just from your desktop. A fully adjustable keyboard-mounted side tray for your mouse, trackball, or other input device, the Mousetrap quickly clamps onto most keyboards for right- or left-handed use.
Price: $21.95.
Contact: Armchair General, P.O. Box 2211, Twin Falls, ID 83303, (208) 733-7538.
Circle 1292 on Inquiry Card.

Trackballs for Everyone

The Spaceball 2003 provides an intuitive way to rotate and move 3-D objects on IBM, Sun, Silicon Graphics, and DEC workstations. You can manipulate screen objects about the *x*, *y*, and *z* axes simultaneously with just a touch. Increasing pressure on the ball increases the speed of an object's rotation.

Price: $1595.
Contact: Digitizer Products Group, Calcomp, Inc., 14555 North 82nd St., Scottsdale, AZ 85260, (602) 948-6540.
Circle 1293 on Inquiry Card.

Featuring a swiveling two-button control for right- and left-handed use, the SuperTrak is Microsoft compatible. The unit fits in your hand or attaches to the side of your notebook or laptop. If you bump the trackball, its breakaway design prevents damage to it or your computer. Models are available for PCs and PS/2s.

Price: $99.
Contact: Z-Nix Co., Inc., 211 Erie St., Pomona, CA 91768, (714) 629-8050; fax (714) 629-4792.
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4 out of 5 Lotus 1-2-3 users prefer Quattro Pro for DOS

An independent study proves it!

When Lotus 1-2-3 users compared Quattro® Pro 4.0 and 1-2-3 side-by-side, they made a startling discovery. Four out of five found they preferred Quattro Pro from Borland over Lotus 1-2-3. They said Quattro Pro is easier to use than 1-2-3. They said it is richer in features and functionality than 1-2-3. In fact, 94 percent said they would be more productive with Quattro Pro 4.0 than 1-2-3!

The tests were conducted by Usability Sciences Corporation, a highly regarded independent testing lab used by major software publishers, including Lotus. The 1-2-3 users evaluated both products in 20 major categories, including analytical power, speed, graphics, ease of learning, printing, macros, and more. In *every* category, 1-2-3 users preferred Quattro Pro. With Quattro Pro, you simply get your work done faster.

Source: Usability Sciences Corporation, May–July 1992

Switching is easy

Stepping up to Quattro Pro is fast, simple, and painless. Your 1-2-3 files and publishing styles move effortlessly into Quattro Pro. You can even run your 1-2-3 macros.

The Usability Sciences study provides overwhelming proof that when 1-2-3 users just like you try Quattro Pro, they want to switch. Try Quattro Pro today and make your own comparison. If you don't prefer it, return it. We'll give you your money back.

60-DAY GUARANTEE MONEY-BACK

See your dealer today or call

1-800-331-0877, ext. 5751

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Software Craftsmanship

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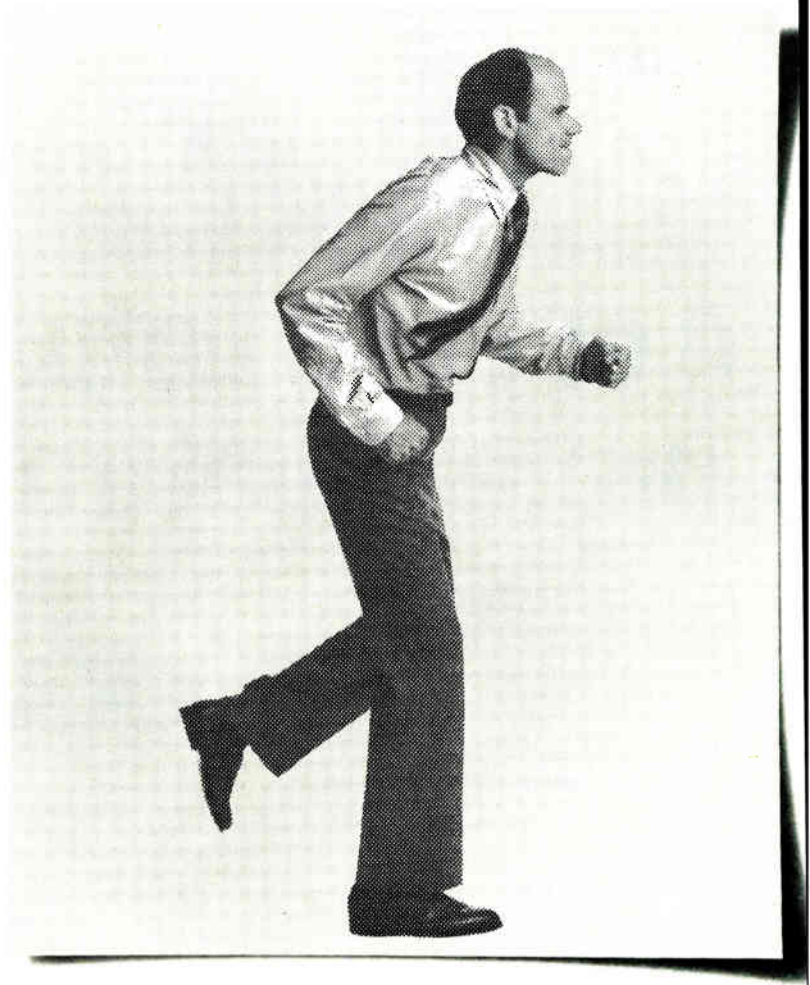
IBM LaserPrinters: The Windows. And

Most laser printers slow to a walk under Windows.



Announcing a Windows™ driver designed to leave other printers in the dust: the new IBM® 4029 Print Accelerator for Windows.

It's now standard equipment on IBM LaserPrinter Models 5E, 6, 6P, 10, 10P, and 10L, at no extra cost. And it delivers supercharged printing speeds with Windows—for more of the productivity and convenience that Windows is all about.

*If you already own a LaserPrinter 5E, 6, 6P, 10, 10P, or 10L, call 1 800 358-5835 for your free driver upgrade.**

Now complex graphics and multiple fonts print with surprising speed. You can use both Type 1 and TrueType™ fonts. And you get the crisp, 300 dpi output and superb

Application	HP® LaserJet® III with standard Windows driver	IBM LaserPrinter 10 with Print Accelerator for Windows	Speed Increase
Harvard Graphics®	1566 seconds	633 seconds	147%
Aldus® PageMaker®	85 seconds	52 seconds	62%
CorelDRAW™	126 seconds	96 seconds	31%

Independent NSTL testing, using complex text-and-graphics documents.

*Free upgrade available through 10/18/92. Print Accelerator requires a PC with 386 SX processor or higher and 4MB of RAM. IBM is a registered trademark of International Business Machines Corporation in the U.S. and/or other countries and is used under license. HP and LaserJet are registered trademarks of Hewlett-Packard Company. Harvard Graphics is a registered trademark of

I B M L A S E R P R I N T

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difference between power Windows.

With the new Print Accelerator for Windows, IBM LaserPrinters keep you comfortably ahead.

paper handling IBM LaserPrinters are famous for.

IBM LaserPrinters come to you from Lexmark International, an independent worldwide company, formerly a division of IBM, that develops, manufactures, and markets IBM personal printers, IBM typewriters, related supplies, and keyboards.

Up to 150% faster Windows printing, on the LaserPrinter 5E, 6, 6P, 10, 10P, and 10L.

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And see something truly unique: a laser printer that can fly through Windows. And look great doing it.

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E R S. P A G E S A H E A D.

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Video Stars on the LAN

Based on a real-time Unix operating system, StarWorks software turns your 486 EISA computer into a video application server that can simultaneously support as many as 20 PCs running DOS or Windows and Macs. The software's Media Transport Protocol enables each user to access the same video file at different starting times.

Initially, StarWorks supports 10Base-2 and 10Base-T Ethernet and provides video networking services for up to a total network bandwidth of 25 Mbps. The software is compatible with digital video systems such as DVI, QuickTime, and AVI. It also supports MPEG and JPEG systems.

Price: Starts at $9950.

Contact: Starlight Networks, Inc., 444 Castro St., Suite 301, Mountain View, CA 94041, (415) 967-2774; fax (415) 967-0686.

Circle 1295 on Inquiry Card.

StarWorks software turns a 486 EISA server into a video application server.

Put Your Mac on the Network

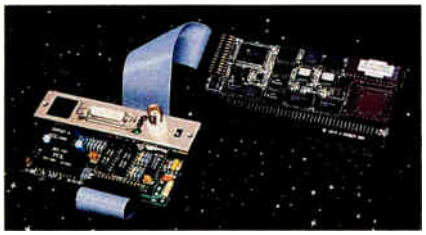
Built for Mac IIsi and SE/30 computers, the MacNet-SE-470 is a combination IIsi and SE-30 Ethernet card. With RJ-45, AUI, and BNC connectors, the card is IEEE 802.3 compliant and uses CSMA/CD packet passing with a transfer rate of 10 Mbps.

A second card, the MacNet-LC-480, is a 10Base-2/T card that works with the Mac LC. Like the MacNet-SE-470, the MacNet-LC-480 is IEEE 802.3 compliant and provides a 10-Mbps transfer rate in its CSMA/CD packet passing.

Price: $299 each.

Contact: MacNet, 2199 Zanker Rd., San Jose, CA 95131, (408) 954-8888; fax (408) 954-8866.

Circle 1298 on Inquiry Card.



The MacNet-SE-470.

Automatic Backup and Retrieval

You can automatically back up and retrieve up to 50 GB of data on NetWare networks with the Fast 5000 AutoLoader package from Palindrome. The hardware and software system combines robotic automation of tape loading and rotation with full management of data migrated from network to tape.

The Fast 5000 AutoLoader hardware provides unattended backups, automated server and volume restoration, and an automated disaster recovery system. The software, Palindrome's The Network Archivist, can track files and file histories through its relational databases, facilitating totally unattended tape rotations for backups. TNA knows where every version of every file is located on tape. You can also send backup and restore commands by E-mail.

Price: Fast 5000 AutoLoader, about $21,850 (£11,500); TNA, starts at about $1510 (£795).

Contact: Palindrome (U.K.), Ltd., 2 Burlington Court, Burlington Rd., Slough, Berkshire SL1 2JS, U.K., 44-753-810751; fax 44-753-810624.

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Network Utility

SoftNet Utilities lets Hewlett-Packard 9000 Series 7xx, IBM RISC System/6000, and SPARC-based workstations and servers act as nondedicated NetWare-compatible servers. The package includes terminal-emulation software that allows PC workstations to use the IPX protocol to remotely log onto Unix hosts.

Price: Starts at $1295 for a 16-user license.

Contact: Puzzle Systems Corp., 16360 Monterey Rd., Suite 250, Morgan Hill, CA 95037, (408) 779-9909.

Circle 1297 on Inquiry Card.

Remote Ethernet Link for Apple

GatorLink, a dedicated ARA (AppleTalk Remote Access) server that fully supports the ARAP (AppleTalk Remote Access Protocol), permits up to three remote PowerBooks or Macs to simultaneously dial into an Ethernet network. The units can directly access file servers, E-mail, and printers as if they were local nodes on the network.

Other features include enhanced access control in the form of zone lists that let network administrators select which AppleTalk zones will be visible to dial-in users, emergency quick-disconnect capability on each port, and scalable configuration and administration. A Motorola 68302 CPU handles all serial I/O duties, leaving the MC68000 core free to process basic ARA services. GatorLink also supports token-based, randomly changing user-authentication codes, as well as static user names and passwords.

Price: $1899.

Contact: Cayman Systems, Inc., 26 Landsdowne St., Cambridge, MA 02139, (617) 494-1999.

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INTROD

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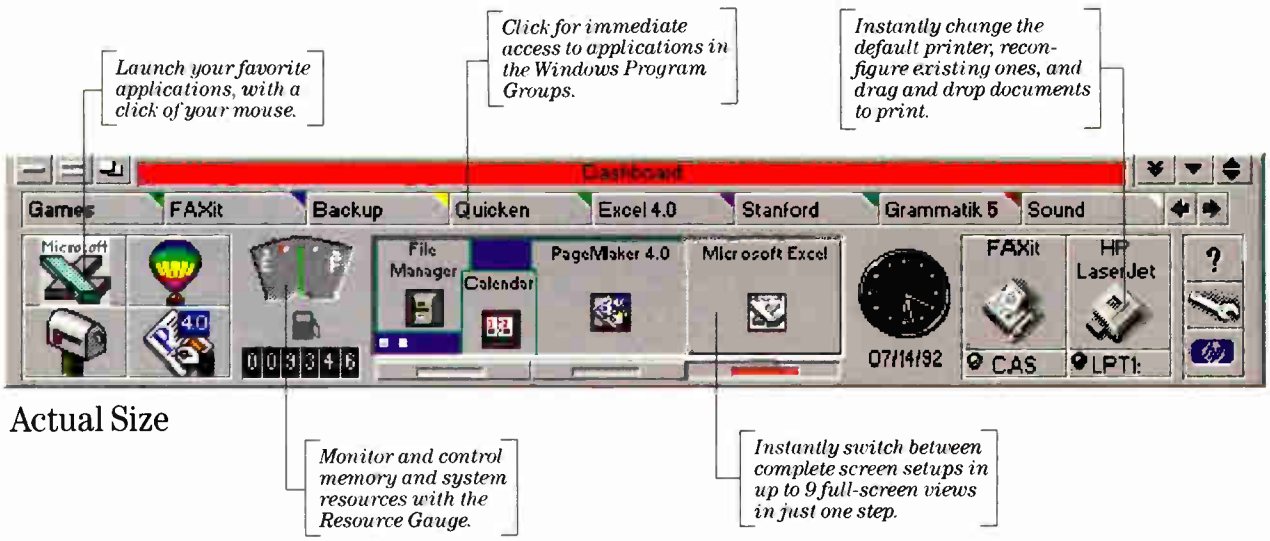

Actual Size

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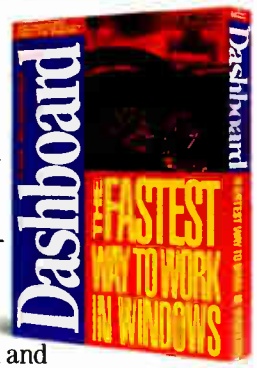
Mention the word "fast," and Windows users get a wild look in their eyes. Why? Because they have a need. A need for speed. Well, here's a little something that satisfies those cravings: Introducing Dashboard.™ The fastest way to work in Windows.™

Dashboard is the convenient push-button utility panel that makes quick work of complicated operations in Microsoft Windows.® Zip into your favorite applications with a click. Switch between different full-screen views of applications in one step. Instantly change the printer default, or drag and drop documents to print... never has so much speed and convenience been packed into so little screen and disk space. Everything, even a clock with alarms, and a "fuel" gauge to monitor your memory usage, is instantly accessible. Whenever you feel the urge.



So the next time you get that uncontrollable craving, you'll know what to do. Grab hold of the world's fastest push-button utility panel, Dashboard For Windows. And get all the speed you need.

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A Fax Modem to Travel With

The Traveler 9600-/4800-bps portable send/receive fax modem works in the background on your notebook computer, letting you continue to work in your application. With the Traveler, you can view, rotate, or print the faxes you want and delete the faxes you don't want without printing them.

The Traveler includes a 2400-bps data modem with V.42bis and MNP 5 data compression and V.42 and MNP 2 through 4 error correction. The unit operates via battery or AC power and is available in a standard DOS version, a Windows version, and as the MacTraveler for use with Macs.

Price: $199.

Contact: Best Data Products, Inc., 9304 Deering Ave., Chatsworth, CA 91311, (818) 773-9600; fax (818) 773-9619.

Circle 1300 on Inquiry Card.

Two Mac FDDI Adapters

The F6069 Desktop Network Interface card from Cabletron Systems provides a direct connection of Mac II and Quadra computers to 100-Mbps FDDI (Fiber Distributed Data Interface) networks. The processing for on-board protocol and management is via a Motorola 68ec020 processor. The adapter uses Motorola's FDDI chip set as well as EEPROM chips. The company's LanView Diagnostic System provides link and activity information. The adapter supports FDDI Station Management 6.2 and is compatible with System 6.x and 7.x and Unix 3.x operating systems.

Price: $2995.

Contact: Cabletron Systems, Inc., 35 Industrial Way, Rochester, NH 03867, (603) 332-9400.

Circle 1301 on Inquiry Card.

The pocket-size Traveler fax modem has auto-answer and auto-dial, as well as time-scheduled transmission. The unit is also a 2400-/1200-/300-bps asynchronous data modem.

Codenoll Technology's CodeNet-9550, -9553, and -9750 NuBus/FDDI adapters also let you directly attach Mac and Quadra systems to a 100-Mbps FDDI network, as well as to an SDDI (shielded-twisted-pair FDDI) network. The adapters all have an on-board Motorola 68020 processor and fit in any Mac or Quadra NuBus-90 slot. They automatically use the enhanced data transfer capabilities of the NuBus-90 system. On-board diagnostics run on initialization or on user demand, and an on-board LED verifies the operational status of the adapter or indicates diagnostic failure.

Price: CodeNet-9550 Single Attached Station adapter, $3995; CodeNet-9553 Dual Attached Station adapter, $4995; CodeNet-9750 SDDI NuBus adapter, $3495.

Contact: Codenoll Technology Corp., 1086 North Broadway, Yonkers, NY 10701, (914) 965-6300; fax (914) 965-9811.

Circle 1302 on Inquiry Card.

A Windows Network Manager

An SNMP network manager for Windows, SNMPc 3.0 uses AI techniques to simplify manipulating MIB objects. You can perform any function with a single button click after you've selected a structured data object. You can also define custom menu options that execute any command sequence.

Additional features of SNMPc include multilevel graphical map representation, automatic node discovery and map creation, real-time statistic graphs or lists, and event action filters. SNMPc exports data to a printer or disk files or through DDE and supports Windows TCP/IP products.

Price: $495.

Contact: Castle Rock Computing, Inc., 20863 Stevens Creek Blvd., Suite 530, Cupertino, CA 95014, (408) 366-6540; fax (408) 252-2379.

Circle 1303 on Inquiry Card.

Carry Your Network Adapter with You

A portable network adapter that attaches to your laptop's parallel port, the TPair-PNA/QL comes with all the hardware and software needed to connect to a 10Base-T network. An integrated auxiliary parallel port on the adapter provides continued local printing capability.

With TPair-PNA/QL you can interact with different protocol environments as if they were attached to local drives. In Windows, you click on a button to simultaneously access data on different servers running such operating systems as LAN Manager, NetWare, NetBIOS, and Vines. An SNMP agent provides support for MIB I, II, and 179.

Price: $468.

Contact: Intellicom, Inc., 20415 Nordhoff St., Chatsworth, CA 91311, (818) 407-3900; fax (818) 882-2404.

Circle 1304 on Inquiry Card.

Fax Server Upgrade

The self-contained FaxPress 3.0 LAN fax server lets you do your faxing from your desktop while on the network. Fully integrated with NetWare, FaxPress gives you the choice of getting your faxes on a network printer, on a FaxPress-connected printer, or in your mailbox.

New capabilities in the software include auto-routing, support for Printer Control Language 5, and support for translation to languages other than English. A link to Novell Bindery lets you become a fax server user while on the LAN. Customized user preferences let you define a personal set of defaults. A dual-line version lets you send and receive faxes simultaneously.

Price: Single-line, $3495; dual-line, $4395.

Contact: Castelle, 3255-3 Scott Blvd., Santa Clara, CA 95054, (408) 496-0474; fax (408) 496-0502.

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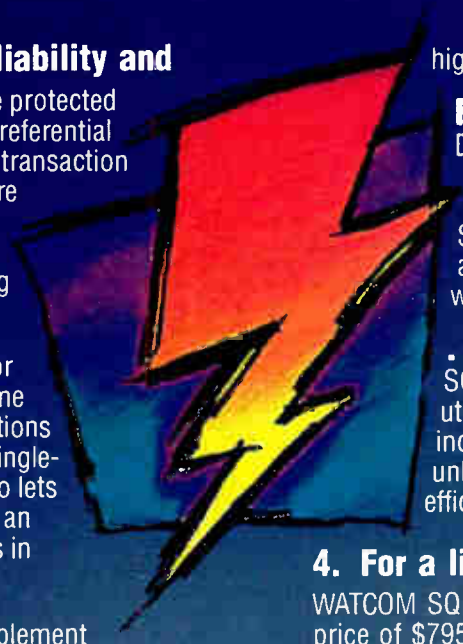
WATCOM SQL

PC-based Client/Server SQL Tools

Four Good Reasons to get your copy right away:

1. True Client/Server for reliability and performance Your databases are protected from corruption by features such as referential and entity integrity, as well as true transaction processing. Client/server architecture and our 32-bit database server software help deliver increased performance for applications running on your PC LANs.



2. Royalty-free run-time For just $99 you get royalty-free run-time support. It lets you distribute applications for standalone PCs and include our single-user run-time database server. It also lets you distribute your applications on an unlimited number of client machines in network environments.

3. Scalability Whether you implement applications using the ACME front-end or write them in C or C++, they can be designed to run without change in environments ranging from standalone 640K single-user PCs to large networks running our high-performance multi-user database server.

From entry level PCs... You can use DOS PCs with just 640K memory as database server machines for small networks. For single-user standalone environments, the SQL database server together with an application can run on DOS PCs equipped with a minimum of 640K memory.

...to high end servers. The WATCOM SQL database server automatically adapts to utilize the available memory on your system for increased performance. The 32-bit version unleashes the power of 386/486 PC's to efficiently serve many clients in large networks.

4. For a limited time it's yours for just $395

WATCOM SQL Developer's Edition has a suggested retail price of $795 but for a limited time you can get it at the introductory price of only $395. Even better, as a registered user of the Developer's Edition you'll be able to get a copy of the 6-user Network Server Edition for only $99 (Suggested retail price: $795).

Developer's Edition

Complete Client/Server Development Tools Package Including Standalone Single-user SQL Database Engine

The Developer's Edition allows you to develop and deploy single-user standalone applications, and to develop applications for use with the WATCOM SQL Network Server Edition. You get the **ACME (Application Creation Made Easy)** front-end application development system. It combines visual forms design with simple event-driven programming to allow rapid prototyping and development of client applications without C programming. The Developer's Edition also includes IBM SAA standard embedded SQL support for C/C++ application development with WATCOM, Microsoft and Borland compilers.

Package components include: Single-user standalone database server (both 16 and 32-bit versions) • Interactive SQL • ACME front-end application development system • Embedded SQL/C preprocessor • SQL libraries for use with WATCOM C, WATCOM C/386, Microsoft C/C++, and Borland C/C++.

System Requirements:
Hardware: IBM PC compatible with hard disk, 640K minimum memory
Software: DOS, Windows DOS box, or OS/2 DOS box

Special Introductory Offer: $395 (Suggested retail price: $795)

Special offers available to registered users: (details inside package)
- **Royalty-free run-time support:** $99
- **6-user Network Server Edition:** $99 (Suggested retail price: $795)

Network Server Edition

High-performance Multi-user SQL Database Server for PC LANs

The Network Server Edition provides client/server support for multiple concurrent users in a local area network environment. The WATCOM SQL database server supports ANSI standard SQL and provides advanced capabilities, including bi-directional scrollable updatable cursors, referential integrity, row-level locking and symmetric multiprocessing of requests. WATCOM SQL also gives you comprehensive security capabilities, data encryption and data compression. Compatible programming interfaces let you implement applications that run without change using either the standalone single-user database or the Network Server Edition.

Package components include: Multi-user network database server (both 16 and 32-bit versions) • Interactive SQL • Network requestor and request manager.

Client System Requirements:
Hardware: IBM PC compatibles, 640K minimum memory
Software: DOS, Windows DOS box, or OS/2 DOS box

Database Server System Requirements:
Hardware: IBM PC compatible with hard disk, 640K minimum memory
Software: DOS

Network Requirements: NetBIOS or Novell Netware (IPX)

Suggested Retail Price: 6-user version: $795
Unlimited version: $1,595

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

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The Leader in Development Tools

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CAD for Windows doesn't have to hurt ...

We at Intergraph believe in Windows™. It's a great tool for integration. That's why we're a bit skeptical about the Windows products some CAD companies are offering.

You see, we know it's a Windows world. We don't see why we should make you pay for the ability to run CAD with Windows. Or ask you to accept a major lag in performance as the price of running Windows.

So we bring you MicroStation Nexus. It offers our Windows Connection and other new links to freedom in how you use CAD – right within MicroStation. And it's free.

No hassles. No limitations.

Nexus is your best choice for running CAD with Windows. What do we mean by best? For one thing, it's fast. And if you've used AutoCAD's extension for Windows, you know the hassles of waiting.

MicroStation Nexus is more than just dialog boxes tacked on top of a DOS interface – it's a complete graphical environment under Windows. And it brings a world of possibilities: cut and paste rendered 3D images into proposals . . . graphics into technical illustrations . . . a scanned logo into your drawing.

Take advantage of powerful object linking. Link text in a drawing and keep it always up to date. Link audio and place a message for your colleagues. Better yet, really tap MicroStation's power, and drive graphics from a spreadsheet.

With Nexus, MicroStation also gives you freedom that other Windows CAD software simply cannot. Like running in dual-screen mode. Enjoy the real estate of a full screen for design and another for running your other Windows applications.

Have a look at the Windows solution that brings true integration. MicroStation for Windows. You can open a world of possibilities . . . without opening your checkbook.

MicroStation
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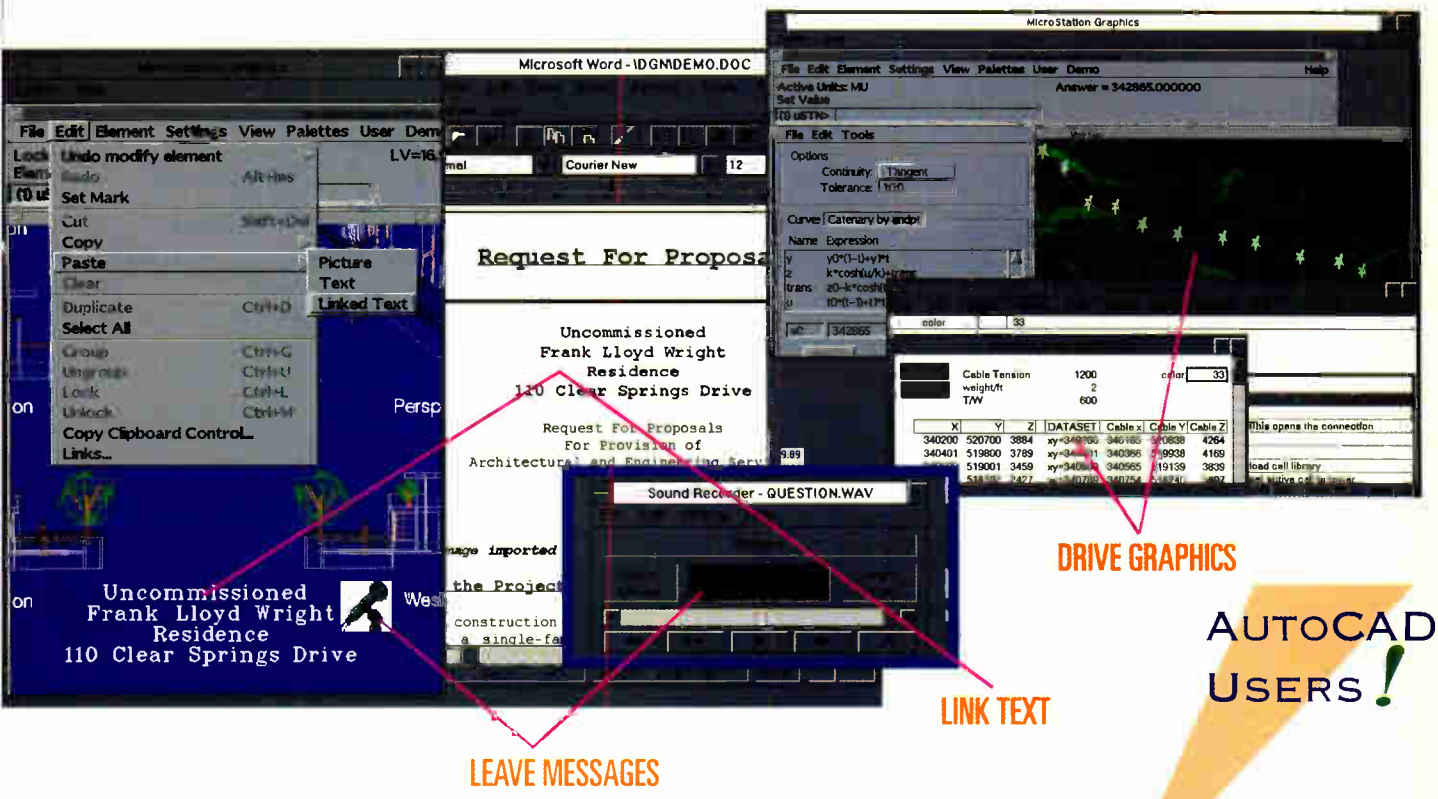

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MicroStation's list price is $3,450. But now through December 31, you can get MicroStation and MicroStation Nexus – with full Windows capabilities – for only $500!

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MicroStation Nexus lets you take your AutoCAD drawing files directly into MicroStation. It also gives you a flythrough animator and tools to configure the desktop. To help you get up to speed fast, with this offer you'll also receive the book, *MicroStation for AutoCAD Users*, by Frank Conforti and Ralph Grabowski.

MicroStation runs on PCs, Apple Macintoshes, Sun SPARCstations, HP Apollo Series 700 workstations, and Intergraph workstations.

To trade up or learn more about MicroStation, call 800-345-4856 for the name of an Intergraph Solution Center reseller in your area. **Offer good in U.S. only.*

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Design Large Industrial Projects

Interactive Software Engineering designed ISE Eiffel 3, its object-oriented programming environment, for large industrial projects. The Unix-based software is available in components, so you purchase only the tools and libraries you need.The components are EiffelBench, EiffelVision, EiffelBuild, EiffelStore, and EiffelBase.

EiffelBench consists of the Eiffel compiler and object-oriented tools that let you debug, browse, edit, and cross-develop self-contained C packages and external language interfaces for languages like C. EiffelVision, a high-level GUI library with standard interface toolkits (Motif and OpenLook), lets you write applications in Eiffel for windowing environments without having to learn the details of the GUI toolkits and their C interfaces.

The EiffelBuild application builder generates the GUI and the links to the semantic actions and produces clear, bug-free, and maintainable Eiffel code. EiffelStore is the class library for interfacing with relational and object-oriented DBMSes. The module deals with high-level persistency and the storage and retrieval of networks of objects into and from databases using SQL (Structured Query Language). EiffelBase contains Eiffel libraries, which provide hundreds of reusable components.

Price: EiffelBench, $995; additional tool sets and libraries, $295 to $1995.
Contact: Interactive Software Engineering, Inc., 270 Storke Rd., Suite 7, Goleta, CA 93117, (805) 685-1006; fax (805) 685-6869.
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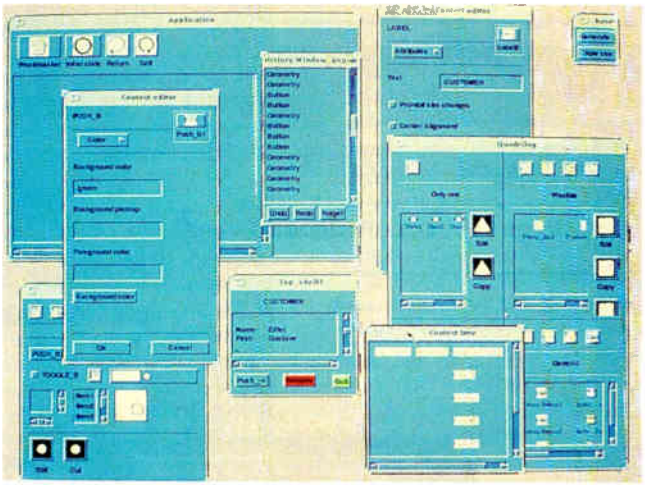

ISE Eiffel 3, an object-oriented programming environment for industrial projects, combines the Eiffel language with advanced, user-friendly programming tools.

Generate C++ Code

If you are a Windows developer who uses KnowledgePro for Windows, now you can generate C++ code with the KPWin++ Windows Development Tool. The C++ code-generation facility lets you prototype applications using KPWin's (or Revelation Technologies' OpenInsight's) interactive design tools and underlying language. KPWin++ works with all the expert systems, hypertext, multimedia, list-handling, and file-handling capabilities of the KPWin language.

The package can read code written in the KPWin or OpenInsight environment and generate ANSI-standard compilable C++ code. Using the Microsoft C/C++ 7.0 compiler, you can amend the generated C++ code, link to third-party libraries, and then compile to create a high-performance executable file.

Price: $895.
Contact: Knowledge Garden, Inc., 12-8 Technology Dr., Setauket, NY 11733, (516) 246-5400; fax (516) 246-5452.
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Build Your Own Pen Applications

Personal Pen Pal, a development environment for pen computers, helps you quickly build pencentric applications or modify the provided applications templates for your own use. Using menu- and graphics-driven selections, you can design forms, define records and databases, program actions, specify communications and print operations, and test and run applications within a single environment. A syntax builder in the menu system virtually eliminates syntax errors and the need to remember names and symbols.

Personal Pen Pal runs under DOS or Windows on PCs with a 286 or higher CPU, a VGA monitor, and a Microsoft-compatible mouse.

Price: $395.
Contact: Pen Pal Associates, Inc., 4970 El Camino Real, Suite 200, Los Altos, CA 94022, (415) 903-3850; fax (415) 961-0995.
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3-D Graphics Toolkit with PHIGS+ and PEX

Liant Software says that its FIGt package is the first 3-D graphics toolkit to combine object-oriented programming with PHIGS+ and PEX (PHIGS Extension to the X Window System). The package lets you write 2-D and 3-D graphics applications with standard PHIGS+ APIs and run the software unchanged across systems from PCs to supercomputers.

FIGt provides a library of preprogrammed objects that contain information on generating and manipulating a given graphics object. It also provides features such as color management, viewing, lighting, shading, and structure ID management. The library can use PHIGS APIs to drive the PEX protocol, and it supports PEXlib, so you can develop distributed graphics applications with a higher-level programming interface than PEXlib alone can provide.

FIGt works with most PHIGS APIs (e.g., those from Sun Microsystems, DEC, Hewlett-Packard, and IBM), as well as with the company's Figaro+.

Price: $1245 to $2245.
Contact: Liant Software Corp., 959 Concord St., Framingham, MA 01701, (508) 872-8700; fax (508) 626-2221.
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Raima Database Manager was the database of choice in the [illegible] World Open. The competition featured in [illegible] built with Windows development [illegible] and two of the finalists [illegible] *Raima Database Manager* to solve their critical application [illegible]

[illegible] developers like [illegible] Raima [illegible]

[illegible] immaculate [illegible] DOS, Windows [illegible]

1-800-DB-RAIMA Also available for DOS, OS/2, and UNIX

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Now Available: dBMAN V for COHERENT

Attention dBASE Users:

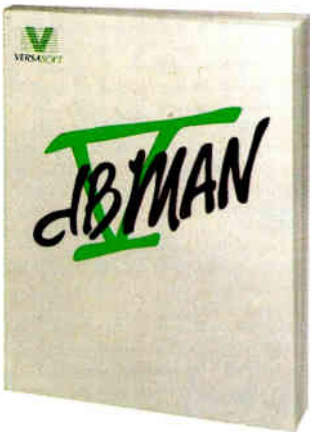
Can you run on UNIX* for only $99.95??

Yes! Now you can with dBMAN V. An exceptional offer. An exceptional program.

dBMAN V is the most cost effective, portable dBASE compatible relational database management system on the market.

Now Available for COHERENT 4.0

dBMAN now runs under the world's best selling UNIX clone, COHERENT. With dBMAN and COHERENT, you can create powerful, multiuser XBASE solutions at a fraction of what you pay now.



Complete with Report Writer

dBMAN V includes a built-in, fully relational "band" style report writer with an easy-to-use "visual" interface. Create simple columnar reports or elaborate multi-line reports quickly without programming.

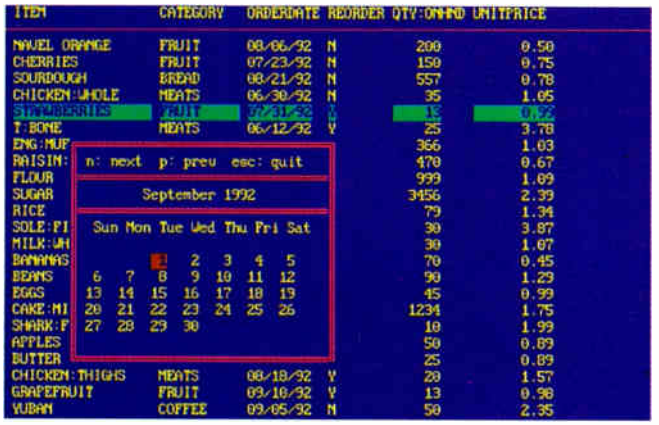
Cost Effective

Pay less for dBMAN V.. less than other dBASE products and much less than major RDBMS. Unlike other dBASE products, dBMAN V is licensed for an unlimited number of users. This all adds up to a significant savings for users, and a cost effective edge for developers.

Portability

dBMAN V let's you take your dBASE application and data, developed and created on one platform, and run them on another, in color, and without modification. Port to over 100 plus platforms and run right away. Platforms include: MS DOS, LAN, UNIX, Xenix, AIX, Sun, HP, COHERENT, mainframe and more.

For end users, the time and money invested in applications is not lost when new platforms are added. For developers, software investments are protected and development efforts are leveraged to market your applications on other UNIX platforms.



The Most Productive Application Development System

dBMAN V 's advanced design tools will enable you to build better applications faster. dBMAN V is based on the dBASE language with more than 300 language extensions. Features such as multiple procedure file, browse engine, push/pop windows, menus, nested GETs and more..., makes dBMAN V the most productive application development language in its class. **Circle 215 on Inquiry Card.**

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dBMAN V Sun SPARC	$ 595.00
dBMAN V IBM AIX, RS/6000	$ 895.00

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VersaSoft has been producting high quality xBASE tools since 1983. We stand behind dBMAN V with a full **30 day money back guarantee** and great product support. Order dBMAN today at 408-723-9044.

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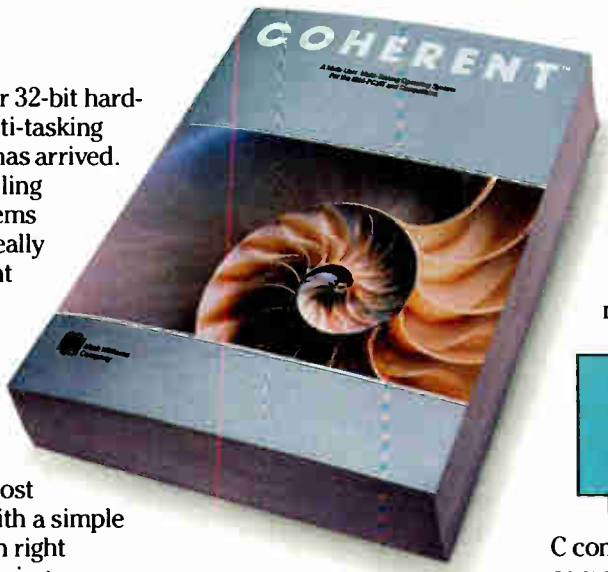
The World's Best Selling UNIX Clone Just Got Better.

Now with full 32-bit implementation!

If you want to ignite your 32-bit hardware with the multi-user, multi-tasking power of UNIX, Coherent 4.0 has arrived. And if you're operating or selling small business network systems with dozens of users, that's really good news. Because Coherent 4.0 is what you want in UNIX at a price that's hard to believe.



Run UNIX applications today!

Coherent is now binary compatible with UNIX. Most UNIX PC applications port with a simple recompile and many now run right out of the box. The list is growing everyday, so call for details.

Yes, It's For Real!

How can it be? First of all, Coherent was independently developed by the Mark Williams Company, so you don't pay for UNIX licensing fees. You don't pay any mark-up or reseller costs either. Coherent is only sold directly to you.

Coherent.™ Still $99.95.

six disk installation is a breeze compared to their 25. You'll also learn it faster and increase overall performance. All because Coherent is smaller, faster... and better.

Small, But So Complete.

Make no mistake, Coherent is a wholly professional development system. You get a complete C compiler, assembler and over 200 UNIX commands including full sets of functions for development, administration, maintenance and text processing.

Coherent also comes with UUCP capabilities that connect you to a world-wide network of free software, news and millions of UNIX users. And it's all clearly documented in Coherent's highly praised 1200 page manual.

"Coherent comes so fully qualified as a UNIX clone, you find yourself thinking, 'I can't believe it's not UNIX!'"–Sean Fulton, UNIX Today!

"...(Coherent) may be the best thing that has happened to UNIX yet."–William Zachmann, PC Week

In fact, over 40,000 copies of Coherent have already been sold. And, like the ones we quote here, virtually every critic who's reviewed Coherent has raved about it.

	MWC COHERENT Version 4.0	SCO UNIX/386 Version 3.2V2
No. of Manuals	1	14
No. of Disks	6	25
Kernel Size	100 K	375 K
Install Time	40 min.	3-4 hours
Suggested Disk Space	10 meg	60 meg
Min. Memory Required	1 meg	2-4 meg
Performance*	85.7	31.3
Price	$99.95	$2590

*Byte C Compiler Benchmark: Compiles per minute on 25 MHZ 486.

So Much Less, Yet So Much More.

As a virtual clone of UNIX, Coherent embraces the original UNIX philosophy: Small is beautiful. Small price, yes. But there's more, much more, to Coherent than its amazing price.

Requiring only 10 megabytes of disk space, Coherent can reside with DOS. So you can keep all your DOS applications and move up to Coherent. And it runs with as little as 1 MB of memory versus 4 MB for other UNIX versions.

The World's Only Plug And Play UNIX Clone.

You'll have Coherent up and running with a fraction of the time and effort it takes for other UNIX versions. Our

Experienced, Supported, Guaranteed.

Mark Williams Company has been developing professional programming tools since 1976. Our commitment to our products and users is unsurpassed. Users applaud our popular BBS and the widely acclaimed telephone support they get free from Coherent developers.

Still, we're not asking you to take a chance on Coherent. We've made it foolproof to see for yourself–with a 60-day money-back, no hassles guarantee. So pick up that phone and order Coherent now. And the best way to UNIX will be on its way to you!

800-MARK WMS

(800-627-5967 or 708-291-6700, FAX: 708-291-6750)

60-DAY MONEY BACK GUARANTEE!

Mark Williams Company
60 Revere Drive, Northbrook, IL 60062

Coherent is a trademark of Mark Williams Company. UNIX is a trademark of USL.

Distributors: Australia (07) 266-2270, Chile (02) 2235538, Czechoslovakia 632-62877, Denmark 42-88-72-49, Finland 41-871-201, France (1) 46-72-80-74, Germany (0511) 53-72-95/(030) 313-7015, Norway 211-0950, Sweden (0) 660-192-90, UK (091) 4276430.

World Radio History

Staff Scheduling on the PC

Designed to automate the staff-scheduling process on a PC, the Universal Staff Scheduler takes into account employee availability, shift lengths, staff task abilities, and the employee's desired hours to help you figure out the right worker for the right job at the right time. You can determine employee availability by the quarter-hour, as well as schedule part-time employees.

The Universal Staff Scheduler provides an Employee Maintenance File where you store historical data (e.g., availability, birthdays, and vacations) and an Employee Exceptions File where you store unusual scheduling requests (e.g., National Guard duty). The package can handle up to 150 user-definable jobs or tasks and provides on-screen calculations of the actual labor cost and its percent of sales. In addition, the Universal Staff Scheduler can generate scheduling and analysis reports, monitor potential child labor law conflicts, and build a business history as a database.

Price: $495.
Contact: Atlas Business Solutions, 3330 Fiechtner Dr. SW, Fargo, ND 58106, (701) 235-5226; fax (701) 280-0842.
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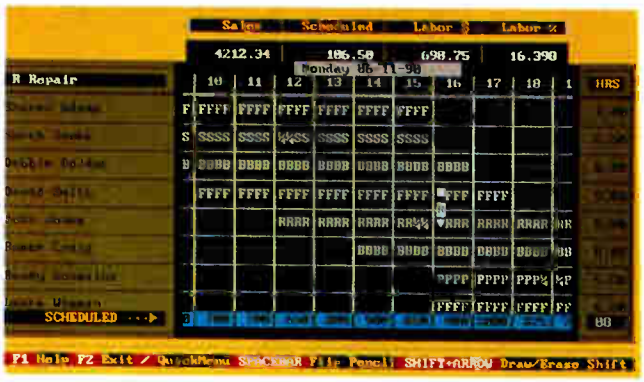
Use Your Sales Force Efficiently

Market-Base helps you build, maintain, and use databases of sales leads and customers to keep your sales force efficient. The package offers flexible look-up fields, a multilevel security system, an alarm system, call planning and reporting, quotation management, lead tracking, analysis of sales-area performance, a built-in word processor, and analysis of promotional campaign effectiveness, market segmentation, and competitors.

For sales project planning, the Multiple Future Actions feature lets you attach to each contact an unlimited number of actions to be taken to alert you to each stage of the customer's purchasing decision process. With the Field Label Tailor feature, you can modify data fields and determine which customer information to keep. The Action View option lets you access contact records in date order of action required. You work directly from a To Do list, noting the results of each event and setting the next action date. Market-Base also lets you separate prospective and actual customers, moving companies from one data area to another.

Market-Base is available for single-user PCs, for a multiuser network, or in distributed mode for field sales staff on portable PCs.
Price: Entry-level system starts at about $1130 (£595).
Contact: Kensington Marketing Systems, 6/51 Drayton Gardens, Kensington, London SW10 9RX, U.K., phone and fax 44-71-373-5746.
Circle 1312 on Inquiry Card.



The Universal Staff Scheduler solves your staff-scheduling problems and creates an information base that lets you track your performance history.

Manage Personnel on the Mac

OrgChart Express for the Macintosh integrates two areas of personnel management: the display of a reporting structure and the administration of employee and job-related information. By connecting tiles (i.e., graphical boxes) containing personal and job-related data, you can visually define reporting structures while maintaining the integrity of the tile data.

You specify data fields as tied to either the personal or position information as represented by the tiles. This lets you move employees to different positions while leaving previous job-related data intact. For special projects, you can assign multiple positions to one person and still maintain the integrity of his or her personal data.

OrgChart Express also includes searching and sorting by any data field, importing and exporting text data, displaying functions with numerous name formats and tile and line styles, and color and gray-scale support.
Price: $279.
Contact: Kaetron Software Corp., 12777 Jones Rd., Suite 445, Houston, TX 77070, (713) 890-3434; fax: (713) 890-6767.
Circle 1314 on Inquiry Card.

Data 2.0 Helps You Make Decisions

TreeAge Software has added financial and mathematical functions, annotation, TrueType font control, and exporting of graph data to spreadsheets and trees to Data 2.0, the System 7.0 version of its graphical decision-analysis software for the Mac. Version 2.0 also includes Apple events, Publish/Subscribe for spreadsheets and word processors, print preview, and improved tree display, manipulation, calculation, and printing.

You can use Data 2.0 for strategic and tactical decision making, risk assessment, determining settlement values in complex litigation, and medical triage. The package provides two mechanisms for drawing the decision tree: You can generate a tree, including branch names and numeric probabilities, by converting a hierarchical outline that you type in Data or import from a word processing or outline program, or you can construct a tree on-screen by adding branches or by copying a subtree at decision or chance nodes that you have selected.
Price: $495.
Contact: TreeAge Software, Inc., 1 Post Office Sq., 23rd Floor, Boston, MA 02109, (617) 426-5819; fax (617) 338-2880.
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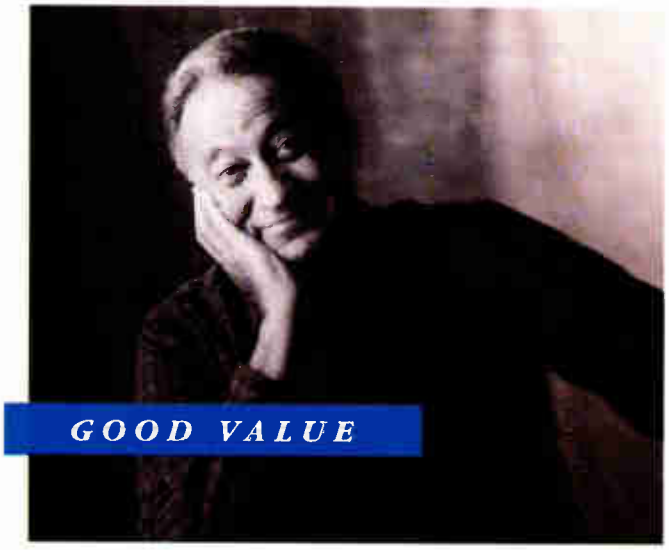
"Sure, I remember my first one..."

World Radio History

"Now I Know Better."

"My first one? Slow going, I gotta admit. *At 2,400 bps, it took forever. But the DataPort 14.4/Fax Modem knows amazing techniques and gets my data speeding up to 57,600 bps."*



"It was a cheap thrill. *And that impulsiveness really cost me. Now I know better. The DataPort 14.4/Fax Modem saves my company real money; I'm a believer."*

The DataPort™ 14.4/Fax Modem

Introducing the powerful, robust V.32bis DataPort 14.4/Fax Modem. It pays for itself by significantly reducing your phone costs—and features fax capability, too! Designed by AT&T Bell Laboratories and AT&T Paradyne, it's tested and proven to be compatible with virtually all modems, all speeds, and all standards. Solidly-built, solidly-backed by AT&T with a lifetime warranty, plus toll-free support. The all-in-one DataPort 14.4/Fax Modem satisfies your needs for both fax and modem. It:

- Sends/receives text, data, and images
- Links PCs to PCs, fax machines, and mainframes
- Connects remote offices and homes to corporate headquarters, and
- Transfers data files; exchanges images with fax machines; accesses E-mail, bulletin boards, information services.

For PCs and Macintosh®. Five models to meet your exact price/performance and feature/function needs: the DataPort 14.4/Fax Modem and DataPort 9.6/Fax Modem, in standalone and PC-internal card models; and the DataPort 14.4 Modem standalone.

AMAZINGLY FAST

You'll love its performance. The V.32bis DataPort 14.4/Fax Modem can deliver an effective throughput of up to 57,600 bps. That's 4 times faster than lesser 14,400 bps modems and 24 times faster than 2,400 bps modems.

It's all in the technique. Its exclusive *Optical phone Line Interface (OLI),* pat. pending, enables the DataPort 14.4/Fax Modem to accurately isolate usable data, even on extremely weak "real world" phone lines!

THRILLING, AND PAYS FOR ITSELF

The high-speed DataPort 14.4/Fax Modem dramatically reduces your phone line costs. In fact, if you currently use a 2,400 bps modem for just 2 hours a week on long distance calls, the DataPort 14.4/Fax Modem can save you enough in long distance bills to pay for itself in less than 5 months. After that, the cost-savings become money in your pocket!

The DataPort 14.4/Fax Modem is a good value in other ways, too. It comes with FREE, powerful yet friendly QuickLink II™ communications fax software.

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*"**It's essential to talk to everyone.** I tried connecting my first modem to old friends and new ports of call. It couldn't talk to them. It was embarrassing."*

*"**My first modem was so undependable,** which explains the short warranty! The modem didn't last, neither did the manufacturer. Is lifetime commitment too much to ask for?"*

And you only use—and pay for—one phone line for both fax and modem functions. Plus your productivity improves—so figure in your time-savings, too! For example, there's no more waiting for your screen to refresh. And the DataPort 14.4/Fax Modem:

- Comes ready to use, easy to operate
- Saves time waiting in line to send faxes
- Allows you to send presentation-quality faxes, and
- Receives faxes even if you've been working on your PC!

SHAKES HANDS ALL AROUND

Compatible with the industry's widest range of modems, the DataPort 14.4/Fax Modem automatically senses and adjusts to the line speed of other modems. It connects to older, slower modems—even 300 bps die-hards. Plus, it's compatible to standard Group 3 (2,400-9,600 bps) fax machines and Class 1 fax/modems.

No one surpasses the DataPort 14.4/Fax Modem for compatibility.

PROVEN RELIABLE

AT&T agrees: lifetime commitment is not too much to expect. The DataPort 14.4/Fax Modem is so reliable, we back it with a lifetime warranty. Moreover, AT&T is on call, toll-free, to help you with superior service and support. We'll always be here for you.

READY TO GET SERIOUS?

It's a terrific value that pays for itself. Highly-compatible. And its performance is breath-taking! For a lasting relationship, connect with the DataPort 14.4/Fax Modem.

Proudly made by AT&T Paradyne in the U.S.A.

For more information on the DataPort 14.4/Fax Modem, DataPort 9.6/Fax Modem, and DataPort 14.4 Modem—or the name of the dealer nearest you—call us at 1 800 554-4996 ext. 25.

SOLIDLY-BUILT, SOLIDLY-BACKED BY AT&T.

AT&T

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World Radio History

Automate Data-Analysis Tasks

The latest version of Axum, a technical graphics and data analysis package for the PC, provides batch-processing features that you use to automate repetitive graphical and data-analysis tasks. Axum 2.0 also offers automatic axis scaling and intelligent tick-placement methods that help you create publication-quality graphs.

With version 2.0's advances in 2-D, 3-D, and contour plotting, you can plot 3-D mesh-surface plots of any size, draw 3-D grids on any plane at any position, draw reference lines anywhere on a graph, and use color shading for 3-D surfaces and splines. You also get additional curve-fitting plot types; labeled scatter plots; PostScript fonts; support for TIFF, Color PostScript, and HPGL2; and the ability to use matrix data for grouped bar charts, grouped box plots, and 3-D.

Axum 2.0's data editor lets you sort multiple columns of data of any size, perform block operations, evaluate arbitrary functions, and sort on unlimited-size data sets. Axum 2.0 automatically uses EMS, XMS, and the high-memory area.

Price: $495.

Contact: TriMetrix, Inc., 444 Northeast Ravenna Blvd., Suite 210, Seattle, WA 98115, (206) 527-1801; fax (206) 522-9159.

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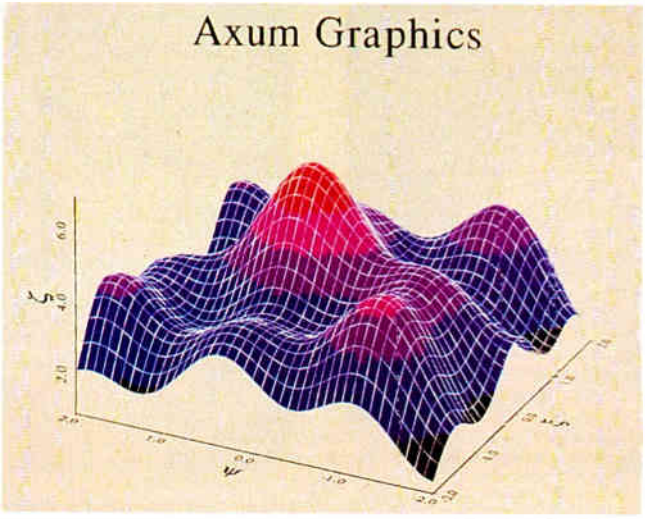

Scientists and engineers can have Axum 2.0 automatically load new data and update a set of graphs on a regular basis.

Scientific Data Analysis and Visualization

IDL for Windows provides a single distributed environment that lets scientists and engineers share programs, data, and computing resources transparently. You can use the package for applications such as physics, astronomy, image and signal processing, remote-sensing medical imaging, and financial analysis.

The Windows version includes all the capabilities of the workstation versions. Features include IDL/Widgets, a GUI toolkit for building custom applications interfaces; 2-D plotting; 3-D visualization; IDL/maps, which lets you create sophisticated mapping and remote-sensing applications; IDL/gridding, which lets you fit irregularly gridded data to a regular grid for use with IDL's plotting and visualization capabilities; and IDL/statistics, a library of statistical routines for data analysis.

IDL for Windows also provides routines for 10 mapping projections with inverses, gridding, and image warping and quintic interpolation (a smoothing algorithm). You can display complex 3-D objects using z-buffered graphics and iso-surfaces.

Price: $1500.

Contact: Research Systems, Inc., 777 29th St., Suite 302, Boulder, CO 80303, (303) 786-9900; fax (303) 786-9909.

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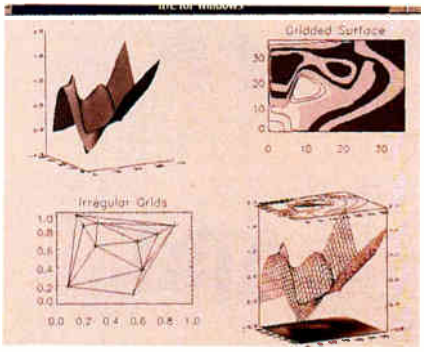

Ported from workstation-based hardware to the PC environment, IDL for Windows lets scientists and engineers perform high-powered scientific computing on low-cost machines.

Statistics and Graphics for the Mac

Systat has added statistical analyses, graphics features, and data-handling features to Fastat 2.0 for the Mac. The software lets you view data, analysis results, and graphics simultaneously in several windows, and it dynamically links data and graphics, so you can select points in a chart or graph and immediately view corresponding cases in Fastat's spreadsheet-like data editor.

Fastat 2.0 can analyze up to 150 variables with an unlimited number of cases. Statistical analyses include basic descriptive statistics, correlations, factor analysis, regression, analysis of variance, nonparametric statistics, and time-series analyses. Graphics options include 3-D and 2-D scatter plots, bar charts, pie charts, category plots, box-and-whisker plots, stem-and-leaf plots, scatter-plot matrices, and probability and function plots. Fastat 2.0 is 32-bit QuickDraw–compatible, so you can select a broad range of colors for your graphics, and it supports the QuickTime system software extension, which lets you view a series of Fastat plots or graphs as an animated movie and watch how data changes over time.

Data-handling features include numeric and character data types and nested sorts; complex numeric transformations; random number, distribution, and density functions; importing of Microsoft Excel and ASCII files; and exporting of ASCII files.

Price: $495.

Contact: Systat, Inc., 1800 Sherman Ave., Evanston, IL 60201, (708) 864-5670; fax (708) 492-3567.

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PROTECT YOUR SOFTWARE

NO BUTTON, NO ACCESS.

Dallas Semiconductor is re-shaping the world of software protection and distribution control with a new family of microchips called Authorization Buttons.

Put a Lid on It

We put the lid on software piracy by packaging microchips in button-shaped, stainless steel cans. The chips contain missing but critical information to make the software run. Execution rights are determined by possession of the Authorization Button. And thanks to the high-volume, low-cost nature of canning, Buttons are the lowest cost way to protect software.

Pick Your Button, Name Your Price

We offer a variety of Authorization Buttons and features so you can select the level of protection and price point that are right for you.

Current offerings include a laser-engraved serial number, a memory with an expiration date, and a multi-level, password-protected memory.

Security Continuum

Button Type	Unique Serial #	Read/Write Memory	Password Protection	Expiration Timer	Decoy Responses
DS1420 ID Button	X				
DS1427 Timer Button	X	4K bits		X	
DS1425 Multi Button	X	2K bits	X		X

Encourage the Trial

With the DS1427 Time Button, you can actually encourage software trials (and still sleep at night). Trial or lease plans can be based on calendar time, elapsed time, or the number of times an application has been accessed. When the trial period that you specify is up, the software no longer functions.

Snap In, Snap Out

Buttons interface to the PC's parallel port via the DS1410 Button Holder. They simply snap in and out. So an inexpensive Button can be sent out for a new release, a security update, or a lease extension. Each Button Holder accepts two buttons, so your customers don't have to piggy-back dongles to protect multiple packages.

The future will be a dongleless world. New computers that accept Buttons directly, including palm and notebooks, are being designed at OEM's today. Buttons are not parallel port-dependent.

Software Protection with Complete Compatibility

Dallas Semiconductor Buttons are compatible across all ISA, EISA, and MCA machines — on underpowered notebooks as well as the anti-compatible Brand X's. We achieve this total compatibility through microchips that are self-powered, unlike other protection devices that must draw power from the host machine.

Made in the U.S.A.

At Dallas Semiconductor, we design *and* manufacture our own microchips. And we're the only ones in the software protection business who do. Sixty intricate process steps and a 64-bit unique serial number lasered into each chip prevent duplication.

To learn how to button down your software, give us a call.

DALLAS SEMICONDUCTOR

FREE!
Authorization Button.
Call 800-258-5061

4401 South Beltwood Parkway, Dallas, Texas 75244-3292 Telephone: 214-450-0448 FAX: 214-450-3715

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NEWS

Medical Visualization with QuickTime

Evergreen Technologies offers two groups of software modules, called the Ciné Loop Module Set and the Nuclear Option Pak, for medical professionals to use with MedVision, the medical visualization environment for the Mac, and QuickTime to animate medical images.

The Ciné Loop Module Set lets you create, animate, and manipulate medical images, and the Nuclear Option Pak adds the ability to select from a variety of image color palettes and the ability to animate multiple images in a snake ciné loop.

Both packages include QuickTime extensions that let you create and view MedVision movies in the MedVision environment. You can also import other QuickTime movies into MedVision with full support for copy and paste functions and sound.

Price: Ciné Loop Module Set, $395; Nuclear Option Pak, $595.

Contact: Evergreen Technologies, Inc., Diamond Farm Office Park, 849-M Quince Orchard Blvd., Gaithersburg, MD 20878, (301) 948-1800; fax (301) 990-6844.

Circle 1324 on Inquiry Card.

Multimedia Presentations for SPARC

IslandPresents, a multimedia presentation and business graphics package for Unix, is now available for SunSoft's Solaris software environment. The WYSIWYG package helps you quickly organize your ideas into overhead presentations, on-screen presentations, 35mm slides, and color handouts. You can create full-color presentations containing up to 16.7 million colors, including 256-color raster graphics, and illustrate your presentations with clip art from IslandPresent's library of over 1100 images. IslandPresents also comes with 90 professionally designed presentation templates and 35 PostScript fonts; you can also add your own Type 1 fonts. You can annotate them with music or voice segments recorded with SunSoft's Audio Tool.

The package also includes charting, table-editing, and painting modules. With the charting features, you can create more than 16 types of data-driven color business graphics with multiple data sets, including bar, pie, and line charts, as well as symbol and *x*, *y* charts. You can import data from Lotus 1-2-3 or ASCII data files and generate single or multiple charts automatically from any portion of the data.

IslandPresents offers conversion utilities for graphics in Sun Raster, MacPaint, Group 3 fax, X Window System 11 bit-map, X Dump, and GIF formats.

Price: Single-user network license, $995.

Contact: Island Graphics Corp., 4000 Civic Center Dr., San Rafael, CA 94903, (415) 491-1000; fax (415) 491-0402.

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Using the Ciné Loop Module Set and the Nuclear Option Pak with QuickTime, radiologists can rapidly analyze sequences of images to determine areas that require closer examination.

SPREAD THE WORD

Please address new product information to New Products Editors, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Better yet, use your modem and mail new product information to the microbytes.hw or microbytes.sw conferences on BIX. Please send the product description, price, ship date, and an address and telephone number where readers can get more information.

Desktop Video Production on the Mac

Avid Technology's Media Suite Pro lets you create, edit, view, and record high-quality digital video on your Mac Quadra. The desktop video production system can combine video, graphics, animation, titles, scanned images, electronic photos, and music and other sound effects into full-screen, full-motion, TV-quality video on your Mac's hard disk.

You can output a single video presentation in any of three formats without additional hardware and software and immediately view the presentation on the computer under interactive control; directly record it from the computer onto videotape in real time; or distribute it as a QuickTime movie.

Media Suite Pro lets you import and export graphics, animation, and audio files in formats such as PICT, PICS, and AIFF. In addition, programs you start on Media Suite Pro can track SMPTE time code, and you can transfer them to Avid's Media Composer digital nonlinear editing system using the Open Media Framework interchange.

The package includes the Media Suite Pro software; video, JPEG compression, and audio boards; a SCSI-2 drive controller; and stereo amplified speakers with CD-quality sound.

Price: Under $14,000.

Contact: Avid Technology, Inc., Metropolitan Technology Park, 1 Park West, Tewksbury, MA 01876, (508) 640-6789; fax (508) 640-1366.

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JUST HOW FAST IS PROGRAMMING IN APL★PLUS?

This fast. APL★PLUS streamlines the whole programming process and screams through complex data manipulations with turbo speed.

APL★PLUS notation is like the math you already know. So you can solve problems the way you think about them, instead of wasting time figuring out *how* to solve them. And it's concise. A few lines of APL★PLUS can replace pages of code written in other languages.

Explore complex "what if" scenarios using built-in functions that manipulate tables of data like single objects. Prototype solutions and quickly put them to the test. Develop complete applications in record-breaking time with editing, graphics, screen windowing and communications facilities, mouse support and interfaces to spreadsheets and subroutines written in other languages.

Use our tutorial to jump start the whole programming process. Then, use APL★PLUS' speed and power to zoom through your development cycle so fast it's almost illegal. APL★PLUS. The programming language to use when you have miles of data. And the need for speed. Call today and we'll rush you a *free* demo disk.

APL★PLUS®

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Osborne/McGraw-Hill Computer Books Are Available At These Fine Stores

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Birmingham, AL
Jonathan Benton Bookseller
PH: 205-967-8840
FAX: 205-967-9812

Smith & Hardwick Bookstore
PH: 205-591-9970

Huntsville, AL
University Bookstore
PH: 205-895-6600

Madison, AL
Madison Books & Computers
PH: 205-772-9250
FAX: 205-461-8076

Tuscaloosa, AL
University Supply Store
PH: 205-348-6126

CALIFORNIA

Berkeley, CA
Cody's Books
PH: 510-845-7852

Whole Earth Access
PH: 510-845-3000

Capitola, CA
Capitola Book Cafe
PH: 408-462-4415

Chino, CA
Mr. B's Computer Books
PH: 714-464-2777
FAX: 714-464-2779

Citrus Heights, CA
Tower Books
PH: 916-961-7202

Concord, CA
Whole Earth Access
PH: 510-686-2270

Cupertino, CA
A Clean Well Lighted Place
PH: 408-255-7600

Computer Literacy Bookshops
PH: 408-973-9955

Stacey's Bookstore
PH: 408-253-7521

Davis, CA
UCD Bookstore
PH: 916-752-2944
FAX: 916-752-4791

Irvine, CA
Irvine Sci-Tech Books
PH: 800-229-9514
FAX: 714-733-0122

Long Beach, CA
Forty-Niner Shops
PH: 310-985-5093
FAX: 310-985-1593

Los Angeles, CA
OPAMP Technical Books, Inc.
PH: 800-468-4322
FAX: 213-464-0977

Technical Book Company
PH: 310-475-5711

UCLA Students Store
PH: 310-206-0763

Mountain View, CA
Printer's Inc.
PH: 415-961-8500

Palo Alto, CA
Printer's Inc.
PH: 415-327-6500

Stacey's Bookstore
PH: 415-326-0681

Stanford Bookstore
PH: 415-327-3680

Sacramento, CA
Hornet Book Store
PH: 916-278-5687

Whole Earth Electronics
PH: 916-489-1000

San Diego, CA
San Diego Technical Books, Inc.
PH: 800-346-0071
FAX: 619-279-5088

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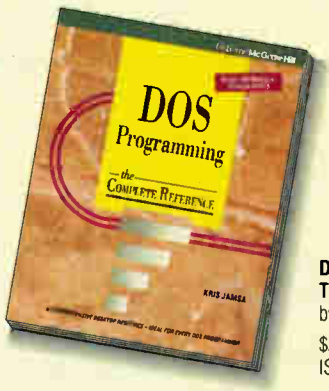

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PONDERING OS/2

I wonder if the people who mind our business for us think things through. That is: I'm making popcorn in the small microwave I just bought for my upstairs office. The microwave is perched precariously on a stack of cables, because the cord is too short to reach the wall socket from the sturdy bench I put in to hold the microwave. Tomorrow I'll get an extension, which of course will make the cord longer than it would have been if they'd made it a reasonable length in the first place.

Our cappuccino machine has the same problem: this very hot metal object has to be moved close to the edge of the counter if we want to plug it in. Meanwhile, my lawn mower has an enormous sticker that warns me not to put my feet under it when it's running; I wonder how many people (1) can read, (2) don't already know that putting your hands and feet under a running lawn mower isn't too bright, and (3) having read that warning will see the light. I suppose next some genius will make us put labels on our cats warning us not to carry them by the tail.

OS/2 at Last

We've installed OS/2. I wanted it to be a fair test, so we put it on the Gateway 2000 486/50, easily the fastest computer in the house just now. When we began the OS/2 setup, the Gateway had 8 MB of RAM, a Sound Blaster Pro card, and a Corel SCSI card supporting a Toshiba CD-ROM drive running off Corel software. The video card is a special edition of ATI Technologies' Graphics Ultra (with no mouse port) that comes with the Gateway. The ATI card is a good one for OS/2 because it has 8514/A emulation, and IBM software is fond of that.

The Gateway computer is a beautiful little machine, and I have no hesitation in recommending it. It comes with a good monitor, but I've been running it with a better one: NEC Technologies' MultiSync 4FG, which is an awfully good monitor for its price. One caution: if you're going to use the 4FG where there's glare, such as a bright window, you'll want the optional filter screen that slides into slots on the 4FG's case. That works wonders on glare and doesn't detract from the color and screen brightness. Unless you'll always be using the 4FG in an interior room, I'd recommend getting the filter.

On the other hand, the Nanao Flexscan F550i works wonderfully in any room under any light conditions. Of course, it costs more than the 4FG. The monitor that Gateway ships with their computer is good enough, but I recommend that serious users buy it without a monitor and get one from NEC or Nanao. The difference will be worth the price.

Prior to installing OS/2, we had the Gateway running Windows 3.1 and Norton Desktop for Windows under Quarterdeck's QEMM memory manager. The CD-ROM was available as drive D in both Windows and DOS. One CD-ROM program we had running was Sherlock Holmes, a game that has quite a bit of motion video with Sound Blaster Pro music and speech. It's a very impressive multimedia display and a rigorous test of the system, if a bit limited as a game (not enough cases).

OS/2 2.0 gets a real workout—and receives high marks—at Chaos Manor

OS/2 installs from 18 primary disks and half a dozen disks holding specialty printer drivers and the like. The installation takes about an hour if everything goes right. If things don't go right, it can take considerably longer.

Preparing for OS/2

First, you can leave in the Sound Blaster Pro card, but take out your SCSI card. Don't just disconnect the SCSI devices; take the card out entirely. Our first installation of OS/2 failed because we had that card in there.

Second, if you have Windows 3.1, remove it. If you have Windows 3.0, you can leave that installed. If you don't get rid of 3.1, you can get some screwy results when you start trying to run Windows applications in OS/2. Moreover, most of the Windows 3.1 applets, such as card file and calendar, won't work anyway. If you try to run them, you'll get a long delay, a screen of trademark information about as useful as a "no handle" tag on a cat's tail, and finally a message that this Windows session can't run that application. Better not to have them around in the first place.

Third, be sure you have 8 MB of RAM. I'm told that OS/2 will work with 6 MB, but people I trust say 8 MB is pretty much a practical minimum. Running OS/2 with

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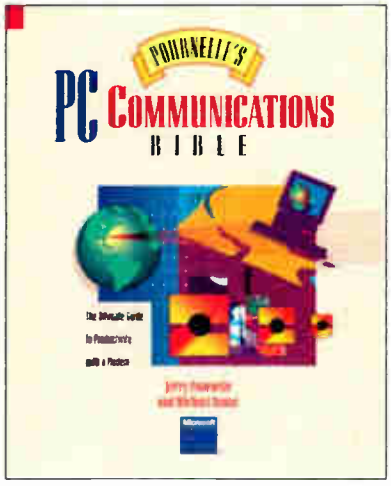

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4 MB is painful: the system will be accessing the disk a *lot*, and you'll wonder why you ever bothered.

I can't emphasize that enough. OS/2 is a robust operating system with a number of desirable features—we may even adopt it here at Chaos Manor if they get more peripheral drivers written and Windows 3.1 support as promised; but you *must* have proper hardware. That doesn't mean you need a superfast 486. A good 386/25 will run OS/2 nicely, *provided* you have a large hard drive, 8 MB of RAM, and a good, fast video card. Note that Windows needs a large hard drive and a fast video card, too, but it will run in 4 MB. I don't recommend either Windows or OS/2 unless you have the right hardware for the job.

Given the right hardware, OS/2 installation is relatively simple, if tedious. There aren't too many questions, and the booklets furnished with the program give explanations.

There's no Program Manager in OS/2. Instead, there's a folder full of "prompts."

You are asked two key questions. The first asks if you want the OS/2 advanced file system. Say "no." Otherwise, you will have to reformat your hard drive, and you will be unable to go back to DOS/Windows. There are enough problems with OS/2 that you will feel a lot better if you can easily retreat to DOS; and that's simple provided you don't go to the advanced file system. Stick with the simple one.

The second key question is resolution. High resolution is greatly to be preferred if your video card and monitor can handle it. Otherwise, you can use OS/2 in regular VGA, but that desktop gets pretty busy even in high resolution. Of course, this is all true of Windows as well.

After you've fed the system a few disks, the installation program begins multitasking and offers you a tutorial. If you have nothing better to do, you may as well let it teach you some fundamentals; you won't be using the machine for another few minutes, as OS/2 decompresses some files and begins to tidy things up. If you interrupt that process, you'll have to start the installation all over again.

Now What?

When you install Windows, the Setup program searches through your disk, looking for both Windows and DOS applications. If it finds any, it makes icons for them. In theory OS/2 does the same, but the only DOS program it found for me was Norton Utilities. Norton Commander, Procomm Plus, various text editors, and a number of games were ignored. I found I had to do most of that installation myself; and when I did, I got it very wrong. I tried it without reading the manuals. I don't advise doing that. Read your OS/2 manuals or a good third-party book on OS/2. It will save you time in the long run.

Understand, unlike Windows, which is a program that runs under DOS, OS/2 2.0 is a relatively *new* operating system. It is *not* a DOS program, nor is it merely "super DOS." It really is different, and it has its own philosophy that will have to be learned. That philosophy is self-consistent and has many features I wish had been incorporated into Windows; but it must be learned, and that is going to take some time and effort.

Installing DOS Programs

There's no Program Manager in OS/2. Instead, there's a folder full of "prompts." Open it by double-clicking. One of those is a full OS/2 window; another is a full-screen DOS prompt. There's also a windowed DOS prompt that—unsurprisingly—brings up DOS in a small window. Either of the windows that you get by double-clicking on one of the DOS prompts will work to let you run your DOS software's installation program or to copy the software from a floppy disk to the hard disk.

There's also a folder marked Drives, which has an icon for each drive and sort of functions the way the Windows File Manager works. That will also let you copy programs from floppy disks or run installation programs.

I didn't like any of these, so the first thing I did was to install Norton Commander. I use Commander in Windows, for that matter. It works just fine in Windows or OS/2, but, alas, I installed it incorrectly.

The proper way to do it (given that Commander was already on the hard disk, so I merely needed to tell OS/2 to create an icon for it) would be to open yet another folder, called Templates, and select the icon called Program. Use the right-

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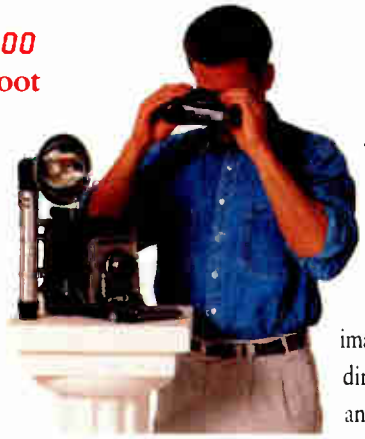

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hand mouse button—OS/2 uses the right-hand mouse button a *lot*—to drag that template out onto the desktop. This creates a copy of the template icon; the old template is still back in the Templates folder. Right-click on the copy, and a little notebook shows up; use that to name the program, specify the path, name the Icon, set a start-up directory, and so forth.

There are other pages to this "book," and in them you can tell OS/2 how much expanded memory to allocate, play about with video-system options, and do a bunch

The WIN-OS/2 Full Screen icon launches a bare-bones instance of Windows: no applets, no wallpaper, and no File Manager.

of other optimization stuff. Learning what to do with that is not easy. It's not well documented in the manuals, and the help files are from that peculiar school that teaches how to write text that is clear and informative only to people who already knew the information in the first place.

The best way to learn many of the features of OS/2 is from an OS/2 enthusiast. You can find them on BIX, GEnie, and other electronic information services; I strongly advise anyone trying to learn OS/2 to get on one of those services. An awful lot of essential knowledge about OS/2 is passed along only as folklore. That's also true of Windows and the Amiga. All powerful systems seem to have lots of badly documented, or undocumented, features.

Fortunately, for most DOS programs you will install on OS/2, the default settings will work just fine; you won't need to do any fine-tuning to get started, and later on you can learn the tips and tricks needed to optimize. The fact is, just about all DOS programs run better under OS/2 with the default setup than they do under Windows optimized or, for that matter, under DOS itself.

When you finish telling OS/2 about your

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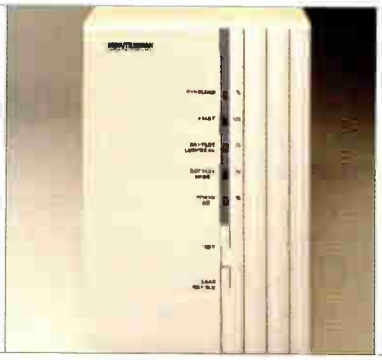

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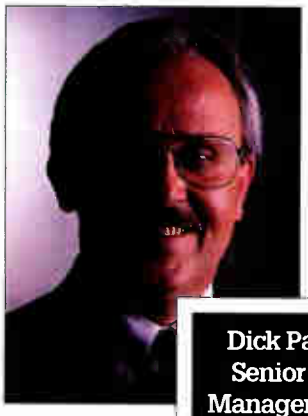

Dick Patefield, Senior Project Manager for Store Systems Support, JCPenney

Recently JCPenney Co., Inc. changed its operations from the old POS systems to the new PC-based technology, relying on PC platforms for point-of-sale and in-store support. And they back each one up with help from MINUTEMAN.

"There was a violent surge in one of our stores," says Patefield. *"If we didn't have the MINUTEMAN unit it probably would have seriously damaged all of our point-of-sale equipment.*

"The key was the switch-over time from AC to battery," says Patefield. *"It really has the best continuity of the UPS systems we evaluated. Also, the price was very favorable. When you're installing them in as many locations as we are, the pricing was very attractive."*

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new program, drag the icon to whatever group folder you like and drop it in. You can also create new empty group folders.

However, if you right-click on the Program icon *while it is still in the Templates folder*, the little notebook pops right up; and if you then give it a program name and path—I gave it the specs for Norton Commander—you're doomed. Thereafter, when you drag that icon out to the desktop, it starts the program you entered. You cannot install any other DOS programs. I had about 10 copies of Commander going before I got wise. The remedy is to go back to that Program icon in the Templates folder, right-click, and erase everything so that all the program specs are blank again. Enter program specs only on a copy of the program folder that you've dragged out onto the desktop.

There are several other gotchas, and as I said, the help files were largely written by people from the "clear only if previously known" school. Eventually, though, you will get your DOS programs installed and organized.

Alas, they will all have the same boring icons. OS/2 comes with an icon editor, which lets you draw your own icons; but OS/2 does *not* recognize icons done for DOS programs, and the OS/2 icon editor will not read those third-party icons. The good news is that there's a freeware program that will convert Windows icons to OS/2 format, so you can have the Commander's hat and gloves, or Civilization's city and pharaoh, if you take the trouble to download it from BIX or GEnie. What I really wish is that IBM would add the ability to read Windows icons into the OS/2 icon editor. Then they could be saved, modified or not, in OS/2 format.

Running DOS in OS/2

DOS programs run just *great* in OS/2. The memory management is invisible and nifty: extended memory, expanded memory, virtual memory up to 32 MB per program,

OS/2's learning curve is steep and long. A better DOS than DOS, yes. A better Windows than Windows, no.

no problem. I have not yet tested programs that run the Phar Lap memory extensions, but I'm told that they will work all right. I have run word processors, including Microsoft Word; Norton Commander, including Commander Mail; communications programs; and some really complicated games, including Wing Commander. I've run several copies of Wing Commander at once. It gets slow and jerky—hardly astonishing—but they all do work.

You'll have to muck about doing some fine-tuning. OS/2 substitutes its own AUTOEXEC.BAT for yours; and the Path, Prompt, and various Set Environment statements telling your system how to find, say, Grammatik V or the Sound Blaster Pro card, may be gone. You may not notice that at first. Wing Commander, for instance, has a setup routine that tells it what

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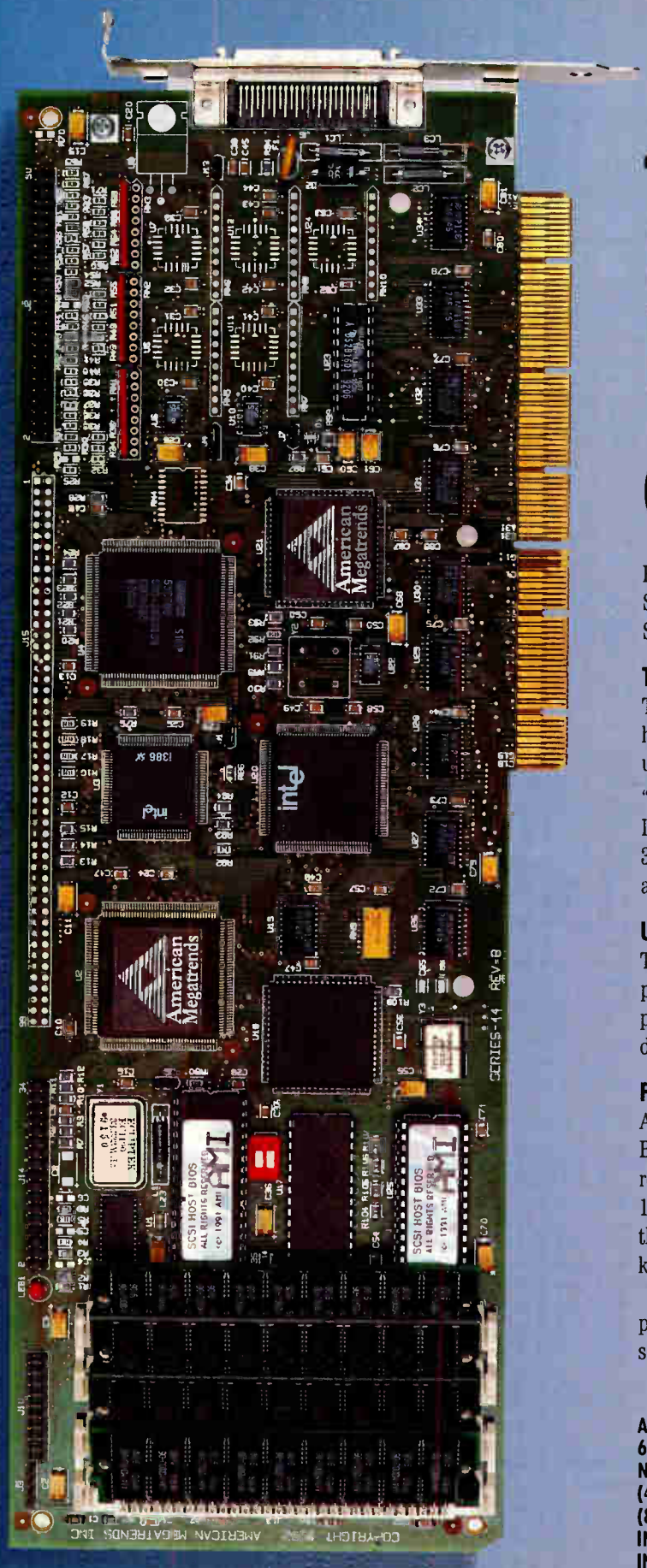

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...against piracy and unauthorized use, make sure that your protection system has all the following qualities:

A GOOD HARDWARE KEY

Hardware-based software protection systems are now the standard worldwide. However, not all keys are the same. A good key should have all the following features:

✔ Compatibility and transparency. The key should work without any problem on your customers' computers. The user should be able to forget the key after connecting it.

✔ Unbreakable electronics. A customized ASIC (Application Specific Integrated Circuit) component should be integrated in the key. This prevents reverse engineering and makes cracking virtually impossible.

✔ A unique and inaccessible software developer's code burnt into the ASIC. (This code should not be held in the key's memory, where it can be read and altered.)

✔ A Read/Write Memory inside the key should be available on demand. The memory should be writable in the field, on any PC, without any special programming equipment.

✔ Very low power consumption, enabling the key to work even under the worst power conditions, on PCs and laptops, with or without a printer.

POWERFUL SOFTWARE

Since it's practically impossible to crack or duplicate a key having all the features mentioned above, a pirate will usually go for the software linking the protected program to the key. Therefore, check that your protection software has all of the following:

✔ A Linkable Protection Module with which calls can be made to the key from any point in the protected program.

✔ An "Envelope" installation program. Such programs enhance security while making it possible to protect a software even without its source code.

✔ Sophisticated antidebugging and encryption mechanisms.

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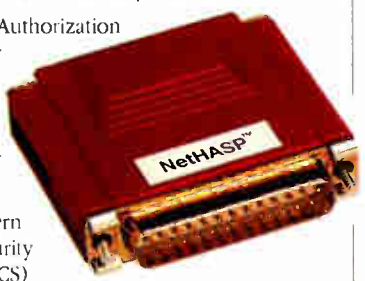

✔ A Full Authorization System for protecting dozens of programs using only one key.

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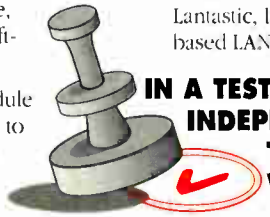

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* CT Magazine, May 1990.

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Design: Idan Peer

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kind of video and sound card you have; and it will go find the Sound Blaster Pro, and out will come the music.

On the other hand, Warlords, as an example, tries to find your sound card. If you have the proper environment settings, it will be able to under DOS or OS/2 (but almost never under Windows; I don't know why). If you don't have the right settings, it won't find the card and there will be no sound. In other words, when it comes to sound cards, OS/2 sometimes works the way Windows does: it requires evil and potent magic to enable the sound.

Windows Under OS/2

There are two ways to run Windows applications under OS/2. One is to open the folder called Windows Programs, find your program in there, and open it. The system will trundle for a while and then display some stupid trademark notices. If you had a bunch of Windows 3.1 applications on your hard disk, this is probably one of them and you'll get a message that the applications can't be run. Considerable time is wasted to no purpose.

If it does work that way, it will be slow. I mean *really* slow, and it won't matter much whether you have other processes going at the same time. It's just going to be slow. Video objects will drag across the screen—this on a 486/50 with a fast video card. It's worse on slower hardware.

The other way to run Windows applications under OS/2 is to open the WIN-OS/2 Full Screen icon. That will bring up an instance of Windows.

It's not a complete Windows. There are no applets and no wallpaper. (The applets are back on the OS/2 desktop; press Alt-Escape to change to that and run the OS/2 calendar and clock. There's no card file.)

There aren't any programs located and grouped as applications the way Windows does when installed. You'll have to figure out where your Windows programs are and install them one by one, building up your Windows desktop from scratch. Since there is no possibility of running a DOS window, you cannot save your new setup unless you exit WIN-OS/2, having checked the Save Setup box. Warning: if you merely close the WIN-OS/2 window from the OS/2 desktop, all the arrangement work you have done will be lost.

There is no File Manager; you're on your own in finding your Windows applications and their paths. If it will show you a directory tree, I wasn't able to find it. You can pop back to OS/2 and use the disk drives' "object," but that's a bit of a pain. I tend to use Norton Commander, but that too requires changing from the WIN-OS/2 window to a DOS application Window that wasn't on your WIN-OS/2 desktop. A better solution is to run Norton Desktop for Windows. That works. It has its own file manager and some of its own applets and utilities, and it lets you save your configuration without exiting the window.

WIN-OS/2 does recognize your familiar Windows icons, so you can build your desktop with those.

Within this WIN-OS/2 window, your applications will run faster than they do if opened one at a time directly from the OS/2 desktop; but they will be considerably slower than if you were running Windows 3.1 under DOS. So it goes.

Conclusion: it's not a better Windows than Windows. At least not yet.

Tricks and Limits

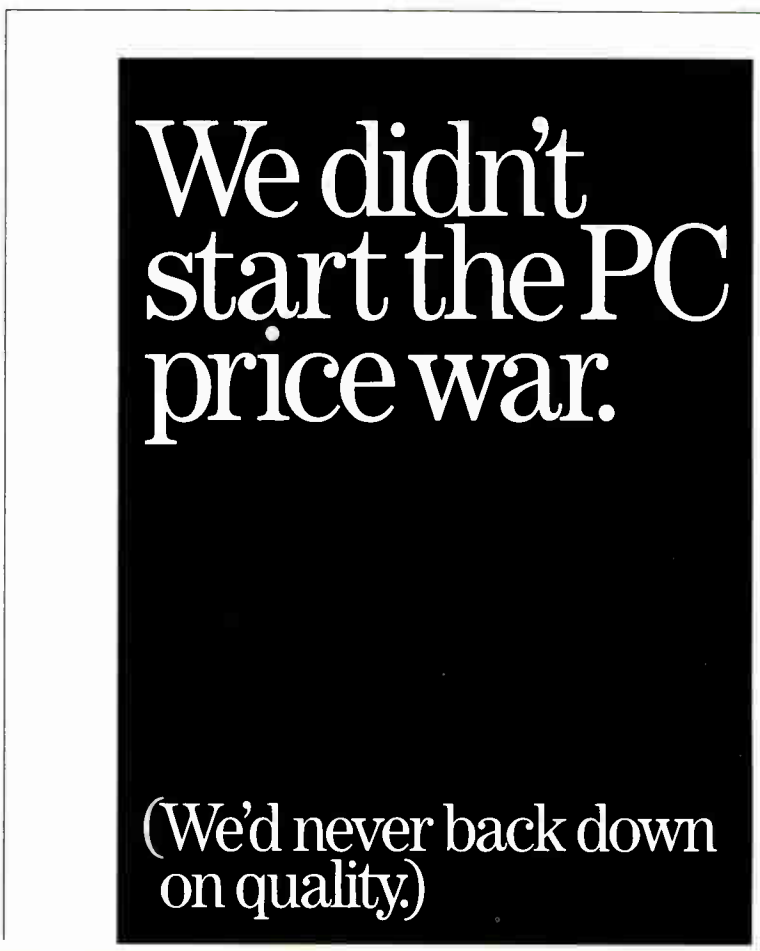
If there are any OS/2 CD-ROM drivers, I can't find them. I have some Corel drivers that purport to work with OS/2 but don't. Corel says they have CD-ROM working with OS/2, but no one else I have talked to knows how to do that.

Nor will drivers run in WIN-OS/2. Moreover, this limitation applies to all SCSI devices: tape drives, WORM drives, optical disks; as I write this, none work in OS/2 windows. A number of outfits are said to be writing OS/2 SCSI drivers—given Corel's usual success in systems integration, it's surprising theirs don't work yet—and by the time you read this, there should be good SCSI OS/2 drivers, so ask around.

There is a way to create a window in which you can run CD-ROM drives. It's called *double booting*, and it's an interesting trick.

What you must do is dump OS/2 and turn your machine back into a DOS system. This is surprisingly easy to do. An OS/2 command in the Prompts folder does it simply and painlessly. The system exits OS/2 and reboots itself as DOS (and will boot as DOS from then on until you enter the OS/2 subdirectory and issue the command BOOT /OS2, which will convert it back).

Once you are running DOS, format a floppy disk with the `/s` (i.e., system) option to make a bootable disk. Now transfer your old CONFIG.SYS and AUTOEXEC.BAT to that floppy disk and edit them so that they have all the drivers and commands (e.g., MSCDEX) required to access your CD-ROM. Keep that disk, open



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the A drive door, and do the BOOT /OS2 command. Your system will trundle for a while and come up in OS/2. Since OS/2 remembers everything you were doing when you shut down, you will first have to say "no" to the question "Do you want to exit OS/2 and reboot in DOS?"

Now open the Prompts folder, and you will see a Boot from A option. Put your new system disk in the A drive and click away. OS/2 will create a window containing a virtual machine with that floppy disk's CONFIG.SYS and AUTOEXEC .BAT. If you've done everything right, you *may* be able to use your CD-ROM.

I say *may* because I never did get the Corel CD-ROM system to work. We did get the slower CD-ROM drive that plays off the Sound Blaster Pro card to work. I am told that Future Domain SCSI boards can be made to work, but I don't know. Telephone calls to OS/2-using friends like Rich Heimlich get the information that they can use CD-ROM in one of those floppy-disk-booted windows under OS/2, but they do it only because they have to. They think this is a kludge and advise waiting for the OS/2 CD-ROM and other SCSI device-driver software. Everyone is sure that the drivers will be out by the time you read this. I sure hope so.

Incidentally, you can boot up a window running *any* bootable DOS-type operating system with that boot-from-floppy-disk trick. You can bring up DOS 3.3 or DR DOS 6.0. The one thing you cannot do is run QEMM in there. Being a memory manager, it conflicts with OS/2. On the other hand, you can run HIMEM.SYS and some of the Microsoft DOS memory manager stuff. The boot-from-floppy-disk deal is a neat trick; some may find it useful.

Bottom Line on OS/2

I've used more space on OS/2 than I intended. My conclusion is that if you run mostly DOS programs and you don't need a CD-ROM drive right away, OS/2 has a lot of advantages. It's fast, installation of DOS programs is harder to describe than to do, and memory management is smooth and effortless. DOS programs run just fine full-screen or windowed, and transfer of stuff between DOS windows under OS/2 is easier than doing those transfers in Windows.

If you want to run mostly Windows programs, get Windows 3.1. That will run DOS programs well enough and Windows programs far better than OS/2 will. That may change with new versions of OS/2, but right now it is not a better Windows than Windows. If you do get OS/2, Norton Desktop for Windows will make WIN-OS/2 considerably more convenient.

If you want to play with OS/2 and you can't live without CD-ROM and multimedia, it's all right to install OS/2 and begin getting used to it, but wait until you know those peripherals operate in OS/2 before making the change permanent.

The learning curve is steep and long. A better DOS than DOS, yes. A better Windows than Windows, no.

A Windows Problem

You can tell a Windows aficionado by the big monitor running at high resolution—1024 or 1280—and the cluttered desktop. However, if you run Windows at high resolutions, you have a problem: Windows games generally won't run full-screen. It's odd. DOS applications run full-screen: the resolution changes to accommodate. Windows applications can't do that. Solitaire, for example: on a high-resolution screen, the cards are tiny.

The result is that many games applications are not written for Windows at all because Windows can't scale from regular VGA when it encounters high resolution. Maybe this will be fixed in Windows NT.

Near Disaster

I was talking on the telephone. Windows was up and running. I'd be stuck on the phone for a while, so it seemed a good time to send Commander Mail out to collect my MCI Mail. The only problem was that I had the phone resting on my shoulder, and I needed my right hand to take notes. I couldn't reach the mouse with my left hand.

I remembered there is a way to control Windows from the keyboard. I tried Alt-W. That would actually have worked, had I then used the arrow keys to highlight the list of window names, but I was distracted by the phone and pressed Return. That rearranges your desktop windows to cascade format, which means that all the windows are the same size and arranged one behind the other. I think it's a lousy way to organize your desktop.

There isn't much you can do to get rid of that cascade arrangement and go back to what you started with. You can individually resize each window and move it to where you want it, or you can turn the machine off. Nothing else will work. Unfortunately, I was still distracted by the phone, and I exited Windows. That did it: now Windows had saved that horrible cascade

We didn't start the PC price war.

(Price isn't everything.)

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image as my normal desktop, and my carefully arranged desktop was gone.

At this point I must have taken leave of my senses. I was out of Windows, and it was going to take some work to restore my desktop; so for reasons I never will understand, I entered Palindrome's Network Archivist and told it to make a backup onto DAT (digital audiotape). It did, but now—now I had made a backup copy of that miserable excuse for a desktop arrangement. Absolutely stupid.

Fortunately, Network Archivist is smarter than I am. It keeps copies of old versions of files. By going into it and restoring PROGMAN.INI and all the .GRP files to one version previous to the current ones, in 10 minutes I had my desktop back. One more reason to cheer for Network Archivist; it's better than WORM drives. Incidentally, by the time you read this, Palindrome will have a new version that will copy to read/write optical disks. I like DAT: the medium holds a lot, and it's cheap—one-half cent per megabyte.

Intel Does It Again

Pournelle's Law states, "One user, at least one CPU." In fact, I believe in real multiprocessing: why time-share one CPU when you can have one CPU per task? Intel's Satisfaxtion system implements that philosophy.

This fax/modem board comes with its own CPU and half a megabyte of memory. That means it can truly run in the background. It can answer the phone, detect an incoming fax, and record that. Meanwhile, you are still working on whatever foreground tasks you've set yourself. You will not have heard the phone ring.

If there's another incoming call, the Satisfaxtion hears a voice request and rings the phone.

Later on you can give the Satisfaxtion a list of messages to send out by fax. You can specify a time for it to do that or have it start right in. All this works in DOS or Windows. I haven't been able to try it with OS/2 yet, and Intel didn't know if it would work.

The new Satisfaxtion 400E is a high-quality 14.400-bps modem with MNP, V.42bis, and all the trimmings, and it sells at a competitive price for such; but you also get the fax capability. Intel likes to say that the fax is free.

If that's not enough, if you get their software package, you get an OCR (optical character recognition) program that really works. We sent ourselves a newspaper article from the regular fax machine to the Satisfaxtion. Then we aimed their OCR program at it: it read the whole newsprint article and put it into Word for Windows. There were only three mistakes.

I have been a fan of the Intel communications coprocessing system since they first came out with it. Now this product is better and cheaper than ever. Recommended.

Visual Basic and Crescent

I've used up so much space and time on OS/2 that I won't be able to do a full report. Microsoft has Visual Basic for DOS. It's pretty much compatible with Microsoft QuickBasic and the BASIC compiler; the advantage is that it writes object-oriented code and makes creation of great user interfaces simplicity itself.

Best of all, it works with Crescent Software's library of BASIC tools. QuickPak Professional for Windows, including their communications library. You *can* do good BASIC programming without Crescent tools, including their PDQ library (link it

We didn't start the PC price war.

(This is where we draw the line.)

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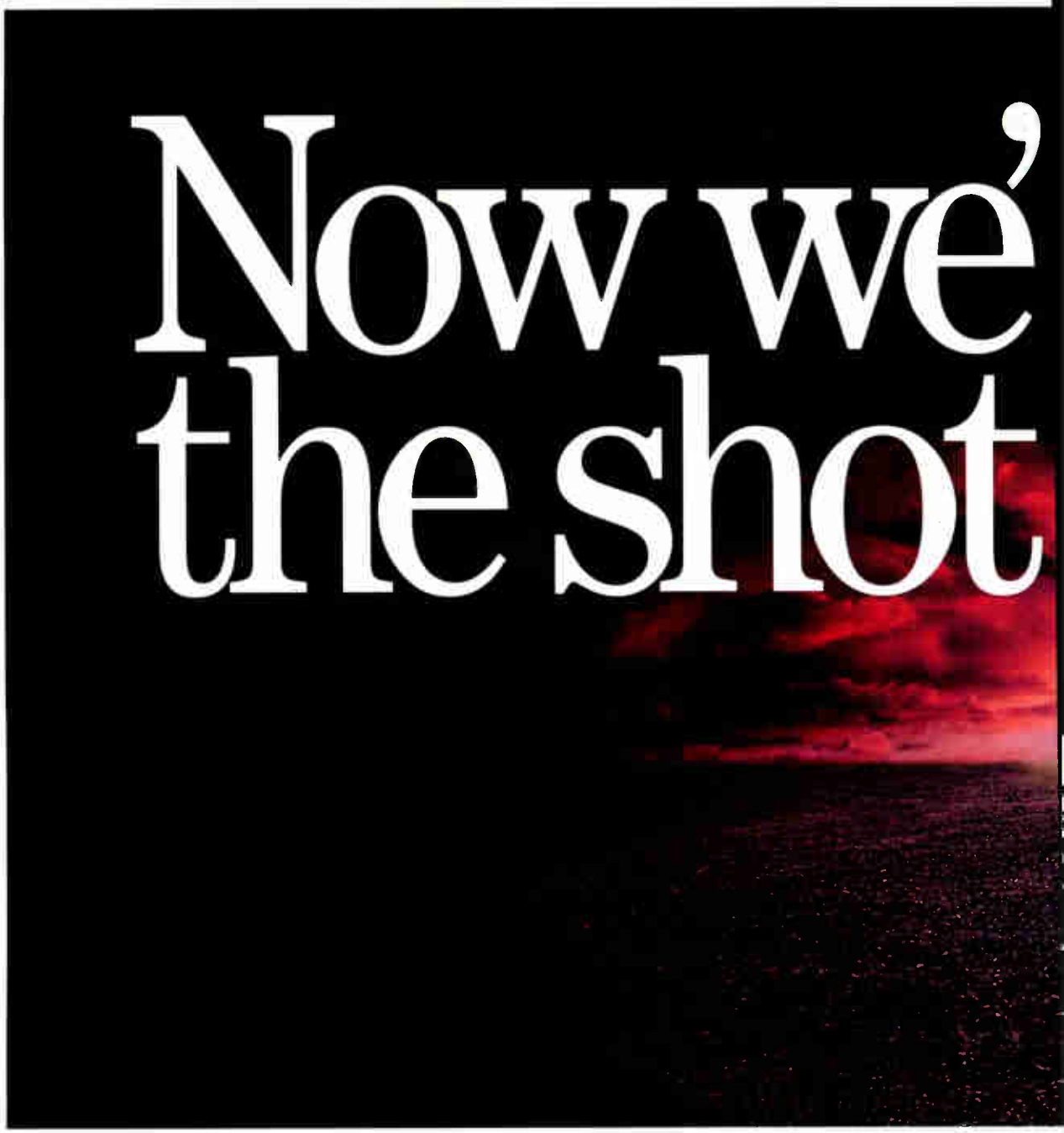

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HEWLETT PACKARD

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instead of the standard BASIC library at compile time; it saves time and space). You can, but you're needlessly handicapping yourself.

If you do much BASIC programming, get Visual Basic for DOS: it will be a good transition path to Visual Basic for Windows and a painless way to learn about OOP (object-oriented programming). While you're at it, get QuickPak. Between them, you'll find you can write and debug astonishingly complex programs in a very short time; they're the best programming productivity tools I know of.

Word for Word

I'll make this quick. Word for Word translates data files from one format to another, preserving as much information about formatting and fonts and suchlike as can be preserved. I use it. There's a new version of Word for Word. It has more formats, including Word for Windows, and some new spreadsheets as well as word processor formats. You can also use it to view files, even if you want to look at a file but don't *have* the particular word processor or spreadsheet that created the file. Recommended.

WinSleuth Gold 3.0

This is another product that deserves better than short shrift, but I'm out of room. This is about as complete a program for investigating your hardware and software as I know. It beats Quarterdeck's Manifest. It tells you all about everything, including which interrupts and ports are in use. You won't use this a lot, except when you have to install something new; then you'll want it bad. Recommended.

Procomm for Windows

I have used Procomm Plus for a long time. When I changed to Windows, I installed it with a PIF (program information file), giving it 2000 ticks in both foreground and background, and I've had no trouble with background downloads.

I was eager to get the Windows version. When I installed it, however, I found that the terminal window occupies only part of the screen, the default font is smaller and not as pretty as my DOS font, and it's actually harder to mouse around than it is to use commands and arrow keys. I used it a couple of times, and it works. There are some neat features here and there, but I find that Procomm Plus for DOS (running under Windows) works better.

Books About CD-ROMs

Meckler has been doing an amazing number of computer books on many subjects, but particularly CD-ROM books. I don't often see them in stores, which is a pity, because most of them are excellent. They tend to be specialized, the kind of thing that if you need them, you need them a lot: descriptions of databases, the massive *CD-ROMs in Print* (available as both a book and a CD-ROM version for $95 each), and technical books on how optical drives work. They're uniformly good, and libraries in particular should be sure to get the Meckler catalogs (Meckler Corp., 11 Ferry Lane W, Westport, CT 06880, (203) 226-6967).

Winding Down

I've just seen the cover art for the book jacket to *The Gripping Hand* by Niven and Pournelle. It's gorgeous. The book's scheduled for February release.

The book of the month is Robert Leonhard's *The Art of Maneuver: Maneuver-Warfare Theory and Air Land Battle* (Presidio Press, 1992). It's a thoughtful and thought-provoking look at the modern U.S.

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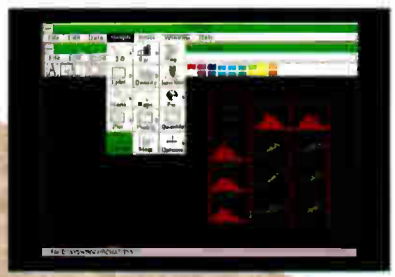

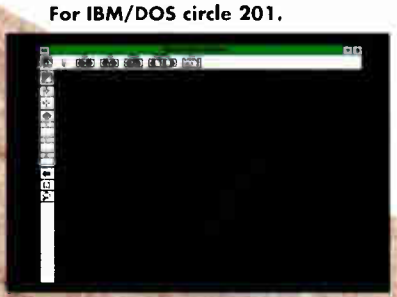

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Australia: Hearne Marketing 61.3.8661766, **BeNeLux Countries:** Oasis 31.3402.66336, **Denmark:** Agrolab 45.64.406575, **France:** Deltasoft 33.76.418508, **Germany:** STATCON 49.55.4272075, **Italy:** PiSoft 39.587.213640, **Japan:** HuLinks 81.33.5902311, **Malaysia:** Dagang Teknik 6.03.719.8299, **New Zealand:** Hoare & Assoc. 64.78.562675, **Spain:** AddLink 34.3.4590722, **Switzerland:** Fritschy & Partner 41.31.215151, **SYSTAT UK:** 44.81.4620093

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LIST: $895 **PS Price: $599**
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The PKWARE Data Compression Library
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The PKWARE Data Compression Library allows software developers to add data compression technology to applications. The application program controls all data I/O, allowing data to be compressed or extracted to any device or area of memory. Only 35K of memory is needed to compress data, and only 12K is needed to extract data. Compatible with MSC, BC++, TC, TP 6.0, Clipper, Basic 4.5,7.1, ASM.

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FastFaxts 3043-011

SVS C3 ANSI C, Pascal, or FORTRAN-77
by Silicon Valley Software

Only from the Programmer's Shop! ANSI compliant, optimizing, 32-bit compilers; DPMI-compliant, royalty-free DOS extender; source level debugger; utilities. Supports "flat model" code. Linker, librarian, make, i387 emulation, W31/4167 support. Interoperable languages!

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ANSI C	$325	**$315**
Pascal	$325	**$315**
FORTRAN	$395	**$375**

FastFaxts 1958-048: (C), 1958-050: (Pascal), 1958-049: (FORTRAN)

Genus GX Developer's Pak
by Genus Microprogramming

Incorporate graphics images into your programs quickly and easily with the GX Developer's Pak. Includes the *PCX Toolkit* which allows you to manipulate PCX graphics images; *GX Graphics* which is a complete graphics library supporting all graphics primitives; *GX Effects* which lets you add special effects to programs; *and GX Text* which allows you to display bitmapped text in any graphics mode.

LIST: $846 **PS Price: $695**
FastFaxts 1265-013

High C/C++ v3.0
by MetaWare Incorporated

MetaWare Incorporated introduces its newest product: the 32-bit High C/C++ compiler, version 3.0. High C++ is a true compiler, not a C to C++ translator. "Incremental Strengths" lets you specify the level of C++ compilation, allowing you to migrate from C to C++ one C++ block at a time. Included in the package is a C++-tailored source-level debugger, and a 32-bit Application Development Kit for Windows. MetaWare offers a full line of multi-language, multi-platform compilers for professional software developers.

LIST: $795 **PS Price: $749**
FastFaxts 89-063

SAYWHAT?! (v4.0)
by Software Science Inc.

Designing screens should be simple! With Saywhat?!, it is! Create slide shows. A terrific prototyping tool - design user interfaces with your user in seconds! Supports all programming languages, template based code generator, mouse, moving bar menus, screen libraries. If you use dBase files, access them while building screens. Sample screens, code and utilities, plus free technical support. Upgrade policy for owners of other screen designers. 60 day money back, no questions!

LIST: $79 **PS Price: $75**
FastFaxts 1098-001

F77L- EM/32 Version 5.0
by Lahey Computer Systems

Industry leading 32-bit Fortran Language System includes Phar Lap's 386/ DOS Extender. This VCPI, XMS, and DPMI compliant extender enables users to access up to 4GB and operate in the MS Windows DOS box. The extender is royalty free and includes virtual memory support. New withVersion 5.0: 32-bit debugger, arrays beyond 16MB, compression linker, and 486 optimizations. Support for popular VAX, IBM VS, and 90 features.

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FastFaxts 334-052

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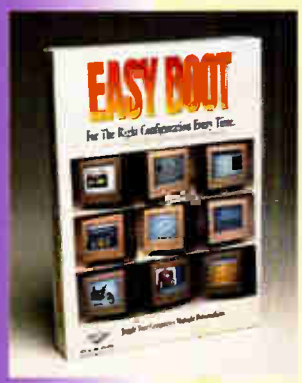
PRO	$495	**$415**
Standard	$199	**$159**

FastFaxts 502-408:(PRO), 502-407:(Stand.)



Easy Boot v1.0
by Clear Software Inc.

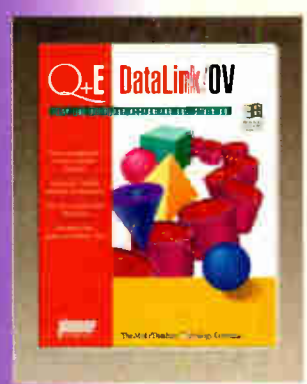
Easy Boot allows you to maintain 15 different system configuration sets, so that you can reboot your machine with the optimal configuration every time. Maintain 15 different AUTOEXEC.BAT and CONFIG.SYS files that can easily be copied, edited and printed. It's the perfect solution to lots of accessories.

LIST: $50 **PS Price: $45**
FastFaxts 873-011

SLATE with Graphics
by Symmetry Group

SLATE with Graphics is a universal printer driver library. It supports dot matrix, laser, and PostScript printers. It includes over 250 text and graphic printing functions to select fonts, print text, print images from the screen, PCX, and TIFF files, and much more. It allows royalty-free distribution of your application, the 750 printer database, and the setup and testing programs.

LIST: $448 **PS Price: $419**
FastFaxts 891-005



Q+E DataLink/OV
by Pioneer Software

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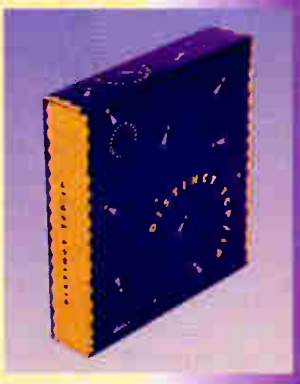
FastFaxts 2137-023

Distinct TCP/IP for Windows
by Distinct Corporation

Distinct TCP/IP for Windows SDK extends the TCP/IP and RPC/XDR networking capabilities to Microsoft Windows. Includes the smallest and fastest DLLs today available for Berkeley Sockets, RPC, Telnet, and FTP. Coexists on the same board with Lan Manager, Novell and Banyan. Supports Packets, NDIS and ODI drivers. Only 5KB of DOS memory required.

(SDK) LIST: $495 **PS Price: $439**
(Applications) LIST: $395 **PS Price: $379**
FastFaxts 1951-003:(SDK), 1951-007:(App.)



WindowPhone™ Software Developer's Kit
by AG Communication Systems

Write applications for WindowPhone™, the personal call manager with Caller ID teleconnections. Your Windows/WindowPhone program may connect millions of home-office and corporate users to customer service databases, PIMs, order entry and much more. Includes everything needed to write customer applications: WindowPhone board, FSKSPLY utility and source code, DLL, API documentation, on-line help, developer user manual and demo program.

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BLINKER 2.0
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FastFaxts 2933-006

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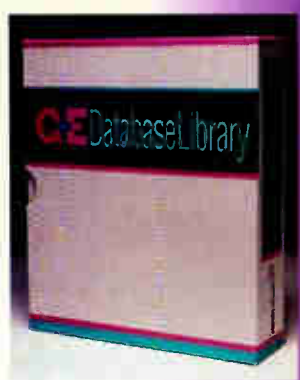
LIST: $399 **PS Price: $379**
FastFaxts 2137-012



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	LIST	PS Price
C-Dbug	$249	**$239**
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FastFaxts 3674-001:(C-Dbug), 3674-003:(C-Verify)

ProtoGen 3.0
by Protoview

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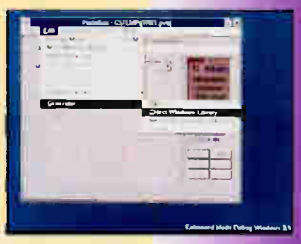

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Micrografx Designer 3.1 plus OLE is the only precision illustration program for Windows. Compatible with Windows 3.0 and 3.1, Designer includes Adobe Type Manager, Adobe TypeAlign, and more than 175 Type 1 fonts. Users get 15 drawing tools, object snap, 64 layers, automatic dimensioning, OLE and TrueType font support, 2,200 clip art images, more than 30 import and export filters, and 24-hour technical support.

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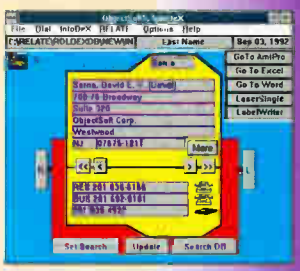
FastFaxts 615-039

RELATE
by ObjectSoft

RELATE Remembers So You Can Forget
RELATE is a personal information manager which is tightly interfaced with Word for Windows, Ami Pro, Excel and other Windows products. It allows you, within minutes, to organize your files to provide "information at your fingertips." You automatically link your documents as well as incoming and outgoing correspondence, voice notes and multi-media to a quick and easy-to-use electronic rolodex.

LIST: $149 **PS Price: $99**
FastFaxts 9095-001



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• Macro Assembler (MASM)	150	99
• MS-DOS 5.0 upgrade	100	65
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• MS Test for Windows	395	275
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• MS Word	450	239
• MS Word (Windows)	495	339
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military, with a good approach to integrating the lessons of the Gulf War into military theory.

The computer book of the month is *Waite Group's Visual Basic How-To* by Robert Arnson et al. (Waite Group Press, 1992). This is an intermediate programming book. Beginners will want something simpler for an introduction, but this gives oodles of examples and shows how to do some pretty tricky stuff. It was written when Visual Basic was for Windows only, but much of it is applicable to Visual Basic for DOS.

Two games of the month. First, Hardball III from Accolade. If you like computer baseball, you'll like this a lot; at least Richard, the baseball enthusiast in the family, does. Real play-by-play announcements through Sound Blaster Pro. Second, Gunship 2000 from MicroProse. I don't get to keep this one: my son Phillip is a Navy officer on a helicopter carrier, and the only thing those guys like better than flying choppers for real is flying them with a good flight simulator, and this way Marines can fly an Apache.

Finally, you can get the Lost Treasures of Infocom: 15 disks, 20 text adventures (including Zork, Planetfall, and Bureaucracy), and all the clue books and maps. There's no fancy graphics, but those old text games had something the modern computer games lack.

Next month: another look at palmtops, some math programs, and short shrift to a bunch of stuff that's too good to ignore but I never have room for.

And now we're off to the beach house, where with any luck I will turn out the final draft of *Janissaries IV, Hour Of Treason* and simultaneously run off 10 pounds. Wish me luck. ■

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."

ITEMS DISCUSSED

Corel SCSI.....$99
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1600 Carling Ave.
Ottawa, Ontario,
Canada K1Z 8R7
(613) 728-8200
fax: (613) 761-9176
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50-MHz 486DX2 EISA.....$3695
Gateway 2000, Inc.
610 Gateway Dr.
P.O. Box 2000
North Sioux City, SD 57049
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(605) 232-2000
fax: (605) 232-2023
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Flexscan F550i.....$1749
Nanao U.S.A. Corp.
23535 Telo Ave.
Torrance, CA 90505
(800) 800-5202
(310) 325-5202
fax: (310) 530-1679
Circle 1148 on Inquiry Card.

Gunship 2000.....$69.95
MicroProse Software, Inc.
180 Lakefront Dr.
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(800) 879-7529
(410) 771-1151
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Hardball III.....$59.95
Accolade
5300 Stevens Creek Blvd., Suite 500
San Jose, CA 95129
(800) 245-7744
(408) 985-1700
fax: (408) 246-0885
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Lost Treasures of Infocom
volumes 1 and 2.....$69.95 each
Activision, Inc.
11440 San Vicente Blvd.
Los Angeles, CA 90049
(800) 477-3650
(310) 207-4500
fax: (310) 820-6131
Circle 1151 on Inquiry Card.

MultiSync 4FG.....$949
NEC Technologies, Inc.
1414 Massachusetts Ave.
Boxborough, MA 01719
(800) 632-4636
(508) 264-8000
Circle 1152 on Inquiry Card.

Network Archivist.....$995
Palindrome Corp.
600 East Diehl Rd.
Naperville, IL 60563
(708) 505-3300
fax: (708) 505-7917
Circle 1153 on Inquiry Card.

OS/2 2.0.....$149
IBM
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Armonk, NY 10504
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QuickPak Professional for Windows.....$199
Crescent Software, Inc.
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Ridgefield, CT 06877
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Satisfaxtion 400E.....$549
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Hillsboro, OR 97124
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Visual Basic for DOS.....$199
Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
fax: (206) 936-7329
Circle 1157 on Inquiry Card.

WinSleuth Gold 3.0.....$169
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Cypress, CA 90630
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FEATURE

Penny-Pinching PCs: How They Did It

Before buying a budget PC, know which corners the vendor has cut

ANDREW REINHARDT

The dramatic plunge of PC prices in the last nine months has touched off a fundamental restructuring that will leave the PC industry forever changed. PCs will be made, marketed, and sold differently. Only the strongest, smartest vendors will survive. For the consumer, the benefits are great, but so are the risks.

On the upside, you will pay less for computers now and in the future, as they have become commodity items. As vendors' profit margins erode, they will be forced to find new, innovative ways to add value. Base systems will be configured more tightly to specific types of user needs.

However, buyers must be more careful than ever when choosing which PC to buy. Cutting prices usually means cutting corners, as vendors use less durable parts and eliminate features. Today's bargain PC might become tomorrow's orphan as weaker clone vendors fail, leaving their customers without support. By reducing R&D funds, companies could sacrifice their future to gain market share today.

Ironically, the catalyst for the PC price plunge was the move of vendors of traditionally high-priced products into the low-cost world. Compaq, AST Research, DEC, and IBM, among others, have introduced new PC lines that compete directly with those of the bottom-feeding clone vendors. Risking their reputations as providers of superior-quality systems in an effort to survive, these vendors have brought prices down using both innovation and good old-fashioned cost cutting.

The BYTE Lab tore apart six low-cost systems from Compaq, Dell, AST, IBM, DEC, and Apple to see exactly what you get for your money (see the text box "Less Expensive, or Cheap?" on page 132). Although all six companies made some trade-offs with these systems, they have maintained a high level of quality: A Compaq is still a Compaq, even at $1000.

A Folding Umbrella

In the past, as long as giants such as IBM, Compaq, and Apple kept prices high, clone makers had a fertile ground for selling less expensive systems to a hungry market. But when the giants dropped their prices to clone levels, the so-called price umbrella collapsed.

"Everybody suddenly realized that you didn't have to buy IBM and Compaq; brands like Gateway were acceptable," says David Blitzer, vice president and chief economist for Standard & Poor's in New York. The result was a steadily decreasing market share for vendors of high-priced products; according to Benny

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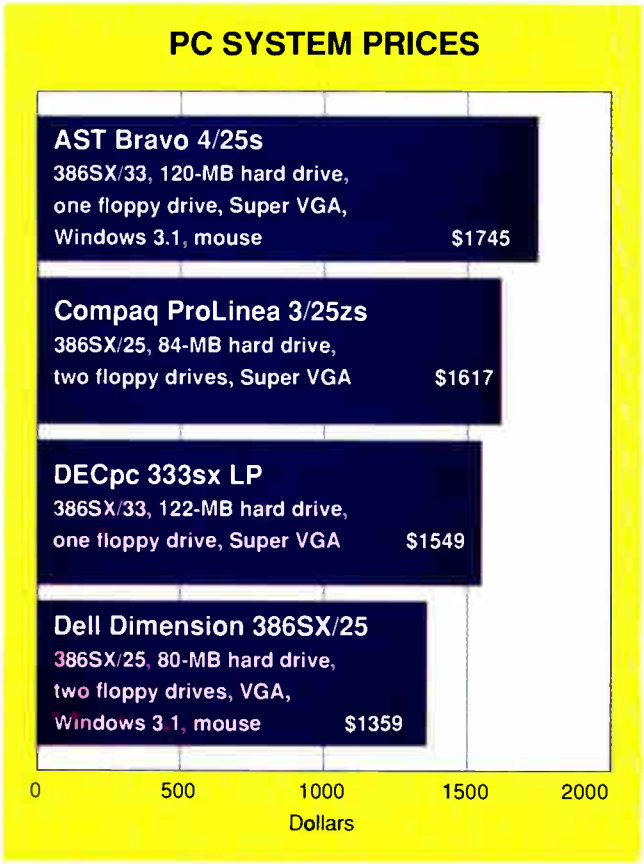

Figure 1: *Standard equipment for each of the systems compared here varies, but each listing represents the respective company's entry-level system. All come with 4 MB of RAM, MS-DOS 5.0, and a monitor. The Compaq and AST prices are retail, while the DEC and Dell prices are direct. Dealers generally discount retail prices, although the percentage varies. AST estimates the street price of the Bravo to be approximately $1500. IBM had not yet released pricing on its ValuePoint line at press time.*

Lorenzo, an analyst for the investment firm Dillon, Read, 50 percent of the market now belongs to off-brand clones.

Competition heated up in 1991, as a soft economy led to an overall 25 percent price decline in systems. Then, last February, Dell cut its prices by up to 38 percent; Tandy, DEC, Everex, CompuAdd, AST, Zenith, and Apple followed suit. In Europe, Siemens Nixdorf introduced a line of low-cost PCs. In May, IBM trimmed prices on its PS/2s, in some cases offering direct-order models below dealers' wholesale prices.

The turning point in the price war was Compaq's June introduction of its low-cost ProLinea line, which launched a new torrent of price cuts throughout the industry. IBM has since followed with its PS/ValuePoint line, and DEC recently introduced a low-cost line of PCs made in Taiwan (see figure 1).

Compaq's new ProLinea line is intended to complement its Deskpro series. Compaq wasn't the first to implement a dual-product-line strategy; AST and Advanced Logic Research, for example, have long offered different families targeted toward corporate and individual buyers. But with its clout, Compaq has accelerated the move toward a price-driven market. "This is happening a lot faster than anybody anticipated," says Sheridan Tatsuno, president of NeoConcepts, a consulting firm in Aptos, California, specializing in the Asian market.

Early reports indicate that, at least for Compaq, sales of low-cost, name-brand PCs are doing very well. Harry Henry, director of research at market research firm Computer Intelligence/Storeboard, says that Compaq moved about 10,000 ProLineas of all models through the retail channel in July, from essentially zero the month before. "Talk about a rebound," he says. In fact, Compaq is backlogged on ProLinea orders, although the company expected production to meet demand sometime last month.

Despite signs of success, not everyone believes the dual-line strategy is good for the long term. Chris Buckham, marketing director for U.K. computer maker Apricot, calls IBM and Compaq's decision to enter the low-price market "a panic decision to a passing trend that peaked some six months ago." He believes that as buyers sour on lower-quality machines and direct sales, "there will be a backlash against cheap machines; not everybody wants to drive a Lada." Noting that only 30 percent of systems in the U.K. are sold direct, he asserts that "the other 70 percent are sold to people who are interested in more than price."

Cutting Costs or Corners?

Vendors are coping with a mix of lower profit margins and reduced spending on everything from salaries to advertising to customer support. But much of the effort is focused on reducing the cost of systems themselves, through an interrelated combination of design changes and revised manufacturing processes.

The costliest parts of most systems are the hard drive and the motherboard (see figure 2). Other than renegotiating supplier contracts, manufacturers can do little to reduce these expenses. Many companies have turned to AMD and Cyrix for CPUs, which has prompted Intel to slash its own prices.

This leaves the rest of the motherboard as a prime target for cost reduction, says Roger Alford, a system designer with Programmable Designs and a BYTE consulting editor. Companies are designing "universal" motherboards that can accept a wide range of processors, from a 386SX up to a 486DX2. Many companies are reducing the number of PCB (printed circuit board) layers from six to four, for a savings of 20 percent to 40 percent per board. And all companies are seeking to reduce part counts wherever possible by using highly integrated chip sets.

Vendors also contend that some lower-rated parts can be used without affecting quality. "Everything was specced very robustly when the industry was young," says Daniel Sheppard, director of product marketing for AST Research. By using a less expensive SIMM socket, for example, AST is saving tens of thousands of dollars per year. The company most notorious for overengineering was Compaq, says Gerald Purdy, director of corporate marketing for Sundisk and former director of portable computer systems at BIOS vendor Phoenix Technologies. "Compaq was religious about this," he says. "They way-overspecced their systems." Many of those high specs, such as an external cache on the 386SX and extra RFI shielding, were the first to go when Compaq designed the ProLinea.

AST Redesigns Its Systems

Sheppard says AST has reduced costs by 35 percent while improving serviceability in its new Bravo systems. The reductions came from changes that saved anywhere from a few pennies to tens of dollars.

The most noticeable change is a new *L*-shaped universal motherboard that has only four layers instead of six. The unusual shape allows AST to punch out two motherboards from each sheet of PCB material, a raw savings of 50 percent. A new chip that AST codeveloped with VLSI Designs integrates all core

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logic into a single device. A "personality slot" on the motherboard permits users to add in features formerly on the motherboard, such as a network interface, without using up an ISA bus slot.

Some of the modifications implemented with the Bravo systems are minor. AST uses a less expensive speaker than before. The SIMM sockets, formerly rated for 1000 insertions, are now rated for 30. "How many times do you change your memory configuration?" asks Sheppard. "We save 2 cents on each socket, and that adds up because we buy millions." Likewise, serial and parallel connectors rated for 10,000 insertions were replaced with less expensive parts that will still outlast most users.

Some changes reflect different usage patterns. Because floppy drives see less use than in years past, Sheppard says AST can specify lighter-duty units. The same holds true for the floppy media shipped with systems. AST also cut 6 inches from the length of the keyboard cable. "Once upon a time, somebody decided 3½ feet was the right cable length," Sheppard says. AST now saves 200,000 feet of cable a year.

Some areas were off limits. "When you mess with the keyboard, you get into trouble because of ergonomics," Sheppard says. AST also kept the reset button on the front panel despite potential savings in moving it. The power supply, too, must meet exacting standards, but AST is saving money by using a unit in U.S. systems that meets FCC and UL ratings but not the tougher Nordic standards.

Cutting corners can lead to problems. Dave Kirkey, vice president of sales and marketing at ALR, warns that discount motherboards can delaminate. Programmable Designs' Alford is wary of inexpensive connectors, which can be unreliable. He is especially disturbed by the practice of substituting 8-bit RAM for parity-checking 9-bit RAM. "This saves RAM chips and the parity-generation and checking circuitry," he says. "But without parity checking, the system cannot detect RAM failure while it is running."

Hewlett-Packard, long known for quality, is seeking ways to trim costs from its Vectra line, built in Grenoble, France. Like the Compaq ProLinea, HP's new Vectra 486N uses an 85-watt power supply; since the system has limited expansion capability, the company claims a more powerful unit isn't needed. Product manager Alison McCallum-Varey says the 486N and the earlier 386N contain a total of about 450 parts, a 46 percent reduction from the approximately 840 parts used in the older Vectra QS16S. The lower part count saves HP money in raw materials, inventory management, assembly, testing, and service (see table 1). Another design focus was to reduce the number of screws on the motherboard, which saves on both manufacturing and service costs. "If you look at a Dell motherboard, it has about 25 screws," McCallum-Varey says. "Ours has just one screw, which we are working to get rid of."

Compaq Streamlines Manufacturing

For Compaq, designing a low-cost PC involved as many changes to process as to product. The company initiated a continuous-flow assembly line, where products go straight from board assembly to systems assembly, eliminating work-in-process queues. The company also reduced redundant testing of subassemblies; only a statistical sample of boards are evaluated before being installed in systems, and then all completed units are fully tested and burned in. Keith Maxwell, manager of new-products manufacturing for Compaq, says these process changes reduce inventory-carrying costs and the more substantial expense of rework.

Compaq has also implemented a flux-free soldering process that saves a washing step for PCB assemblies and conveniently eliminates the use of ozone-depleting chlorofluorocarbons. In

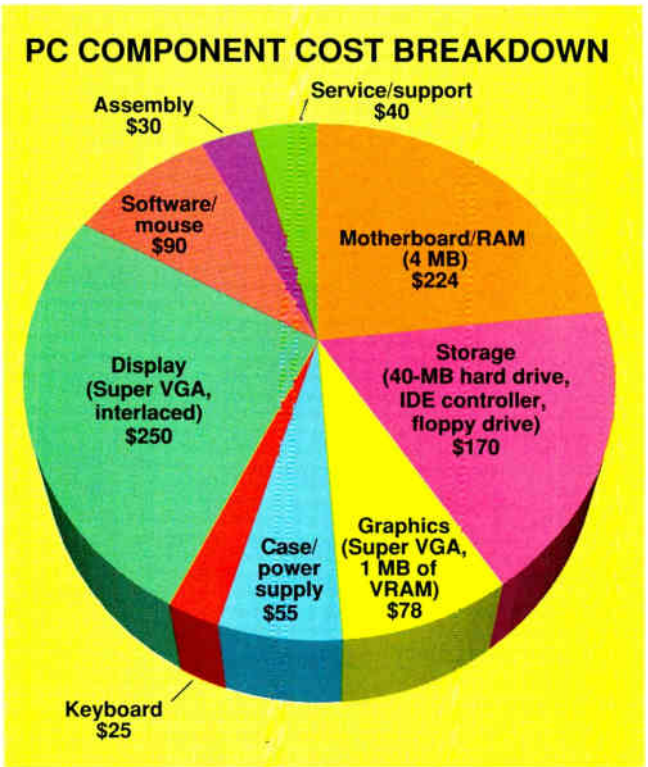

Figure 2: *BYTE compiled this breakdown of component cost using a variety of sources, including system vendors, design engineers, and analysts. Specific costs vary from manufacturer to manufacturer. The bulk of the cost is concentrated in a few areas, one of which, the motherboard, is a prime target for vendors to reduce costs.*

the realm of innovative accounting tricks, the company now stores completed systems inside rented trucks, which reduces its inventory tax liability. In the cutthroat world of low-cost PCs, you take your savings where you can find them.

AST's manufacturing is also tuned for low-cost systems, says Darius C. Power, managing director of the company's U.S. manufacturing. Power touts AST's commitment to concurrent engineering—the simultaneous development of product and process—which he says cuts both cost and time to market. AST uses an integrated materials-handling system and an automated shop-floor control system that manages everything from statistical quality control to system configuration to the downloading of test routines appropriate for each system. The company is constantly looking for ways to reduce cycle times: updating sales projections more often, propagating projections faster through the production scheduling system, and placing parts orders more quickly. "Any manufacturing technique can be successful," says Power. "It's the culture and efficiency that dictate whether or not it works."

Whether through design or manufacturing, argues NeoConcepts' Tatsuno, the ultimate goal for manufacturers must be simplification. "A danger for U.S. designers is that they love to get involved in complex technology," he says. To survive in the "ruthless" world of consumer electronics, he says, "the only way to cut costs is to eliminate complexity. The companies that survive will be the ones that reduce costs by 30 percent to 40 percent per year."

Although Apple has remained largely neutral during the recent

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Less Expensive, or Cheap?

STEVE APIKI AND TOM THOMPSON

YOU CAN'T MAKE A PERSONAL COMPUTER FOR LESS MONEY WITHOUT CUTTING AT LEAST ONE OR TWO CORNERS. WITH THIS IN MIND, THE BYTE LAB EXAMINED THE DESIGN TRADE-OFFS OF SIX LOW-COST SYSTEMS FROM BRAND LEADERS: COMPAQ'S PROLINEA 3/25ZS, DELL'S DIMENSION 386SX/25, IBM'S PS/VALUEPOINT 325T, AST'S BRAVO 4/25S, THE DIGITAL DECPC 333SX LP, AND APPLE'S MAC PERFORMA 600. THE QUESTION WE WANTED TO ANSWER WAS, ARE THESE INDEED HIGH-QUALITY SYSTEMS AT A LOWER COST, OR ARE THEY SIMPLY CHEAP?

Compaq ProLinea 3/25zs

The ProLinea 3/25zs is Compaq's least expensive system. What it most obviously sacrifices is expansion capability: Missing are a high-capacity power supply, an EISA bus, and lots of slots. While more slots and more drive bays are available in other ProLinea models, expansion and serviceability remain the areas where the ProLinea shows the most change from Compaqs of old.

Still, Compaq has built a high-quality, cost-effective machine. The motherboard and support ASICs (application-specific ICs) are all designed and manufactured by Compaq. The ProLinea's main board shows the same commitment to surface-mount components as does the system board of a Deskpro 386/33L (see photo A). The ProLinea is a more highly integrated system than the Deskpro. High integration and heavy emphasis on surface-mount components have made the ProLinea much smaller and less subject to faulty mechanical connections. These qualities have also let Compaq switch from the eight-layer, double-sided board of its older Deskpro to a less expensive, four-layer, single-sided PC board.

Compaq ProLinea

Shrinking the size and the expansion capability of the ProLinea shaved a lot of expense. Fewer expansion slots means a lower power-supply capacity, less demanding cooling requirements, and a smaller case with less need for reinforcement and shielding. Since expansion is so deemphasized, the ProLinea's case is not designed for ease of access. Screws, rather than thumbscrews, attach the cover, and the hard drive is inaccessible without removing the power supply.

Important components in the ProLinea remain top-notch: The 40-MB hard drive in the 3/25zs comes from well-regarded Quantum. The integrated video system is based on a Western Digital WDC-90C11, a solid—if not outstanding—VGA platform.

But Compaq did compromise on a few features. The old, heavy, mechanical Compaq keyboard is replaced on the ProLinea by a lighter, membrane-switch device that lacks the solid feel of the older keyboard. Gone, too, is the large proprietary power supply of the Deskpro, replaced by a standard 70-watt unit. Some traditional Compaq "overengineering" items—external cache on a 386SX, several layers of drop-in RFI shields, proprietary memory modules populated with RAM from only a few select sources—have also fallen by the wayside in the ProLinea. On the positive side, Compaq's use of standard components means you have third-party sources for ProLinea replacement parts.

The ProLinea still has what it takes in the important areas. Performance is good, and its high level of integration should make it a reliable system.

Dell Dimension 386SX/25

Dell has earned respect by manufacturing solid systems at a reduced cost to the buyer. In this sense, Dell had less to cut than Compaq in delivering its low-cost Dimension line.

The most obvious change between the Dimension and Dell's standard P series is that the Dimension's system board is made by SMC, not Dell, and the system is assembled by another contractor. While the 333P (a 386DX system) uses a six-layer board, the Dimension's board is a sim-

Dell Dimension

PC price wars, the company has been quietly reducing costs as well. Part of Apple's strategy is to accept somewhat lower profit margins, which are still among the industry's highest at 44 percent. But beyond that, Apple is seeking ways to economize without using lower-quality parts.

For example, the new Mac Performa 600—the highest-end model in Apple's line of home Macs—dispenses with the relatively costly aluminum coating that is sprayed inside the cases of other Macs to meet the FCC Class B standard for RF emissions. Instead, the Performa 600 has a sheet-metal casing that costs less to manufacture and easily exceeds the Class B rating.

On the Performa 600's motherboard is a new custom ASIC (application-specific IC) Combo chip that combines the SCSI-controller and serial-controller chips. Marc Auerbach, a Macintosh product manager, says Apple is developing even more integrated ASICs to reduce the size of motherboards, make the boards easier to manufacture, and improve reliability.

Another method that Apple is using to cut costs is reduced

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pler four-layer design. It lacks the modular CPU and cache-upgrade features of Dell's P series, which allows you to add cache memory or upgrade to a 486 with an option card. The Dimension also includes standard 30-pin SIMMs, versus the 333P's larger SIMM boards.

The Dimension still has good components, like a Conner IDE drive and 90C11-based VGA onboard. However, some of the nice touches of the P series have been cut. The Dimension's keyboard is much lighter than and lacks the feel of Dell's standard design. Although the drive controller, video, and I/O ports are integrated on the motherboard in both series, the Dimension board uses less-solid plug-in connectors for I/O and video in places where the P series has ports soldered to the board. Also, the Dimension's motherboard fits poorly in its case; the board has six ISA slots, but only four are accessible externally, and the chassis has room for only four cards. However, the Dimension also scores a few points over the slimline P series: It has more slots (the 333P has only three) and a larger power supply (150 W versus 84 W).

IBM PS/ValuePoint

IBM PS/ValuePoint 325T

The PS/ValuePoint may be IBM's idea of a low-end, low-cost system, but cost compromises are few and far between on this very solid design. High integration, standard rather than custom solutions, and existing IBM technology put to good use are the keys to the ValuePoint 325T's low price.

IBM's 386SLC processor, with its built-in 8-KB cache, gives the ValuePoint a slight performance edge over other 386SX-based systems. It also saves IBM from having to dedicate board space and additional external logic to maintaining an external processor cache.

The ValuePoint's four-layer, single-sided board is larger than that of the ProLinea, but it has about 20 percent fewer ICs. The high-integration support chips are from VLSI Designs and Oki/IBM. The system board has a built-in video and IDE controller, 2 MB of DRAM, and two plastic sockets for large SIMM boards. You can put in two more SIMM modules for a total of 18 MB, but the memory-support hardware supports only 16 MB.

The ValuePoint's on-board video is Super VGA, not XGA. The Super VGA is provided by a Cirrus 5422, a high-speed video controller that includes a 24-bit RAMDAC. There's also 1 MB of VRAM (video RAM) onboard, in just two memory ICs.

There are a few cheap points: a 145-W power supply to drive four drive bays and five ISA slots, a small piezoelectric speaker that doesn't deliver much of a beep, and a 3-volt coin battery for CMOS backup. But the big components are excellent: an IBM 80-MB IDE hard drive and a nice, heavy IBM keyboard.

The case has a plastic front bezel that snaps on with a plastic clip. The rest of the case contains a lot of metal, with a reinforcing bar across the middle of the chassis. The drive bays pop out easily with a few screws.

AST Bravo 4/25s

AST reduced cost long before it was cool; the company introduced its low-end, cost-cut Bravo series in 1988. In September, AST rolled out its most inexpensive Bravo line to date, which cuts cost even further, primarily

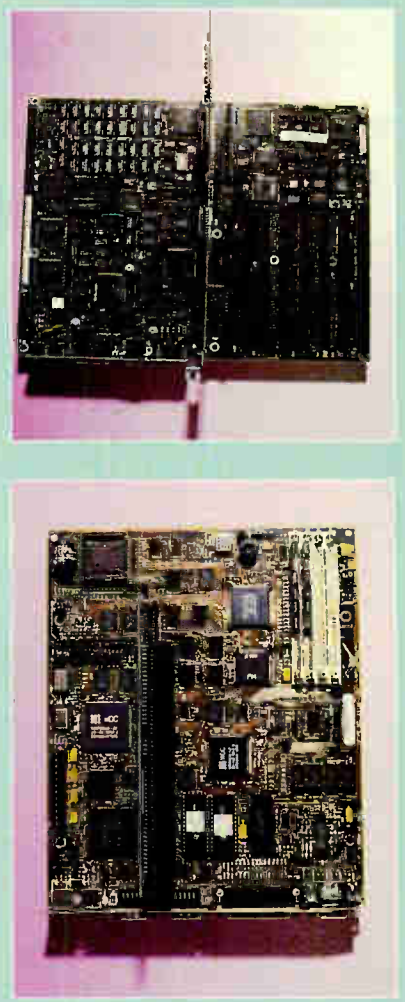

Photo A: *Old Compaq versus new: Compaq's older Deskpro 386/33L* ***(top)*** *includes a large, eight-layer, double-sided board; a custom power supply; and plenty of room for expansion. Compaq's new low-end ProLinea* ***(bottom)*** *is a much smaller ISA system that's based on a single-sided, four-layer board and runs on a standard power supply.*

packaging, which has environmental benefits, too. For instance, most Macs come in boxes that are 20 percent to 25 percent plastic foam, while the Performa 600's packaging is only about 17 percent foam.

Still another approach is to recycle proven designs. The Mac LCII, introduced last spring, uses the same motherboard as the older LC. The LC's 68020 chip has been replaced in the LCII with a 68030, and the system includes 4 MB of RAM soldered to the motherboard instead of 2 MB. This money-saving shortcut entailed a trade-off, however. When you add two 4-MB SIMMs, the LCII has a total of 12 MB, but it can address only 10 MB, because Apple saved months of development time by not redesigning the LC's memory controller.

Survival of the Fittest

Sometimes, says Ronald Chwang, president and CEO of Acer America, "you have to reengineer the whole company." With labor representing a fairly small portion of total system cost—

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BYTE LOW-LEVEL BENCHMARK RESULTS

Table A: *Although vendors cut a few performance features in these low-cost designs (e.g., scrapping the processor cache), system speeds remain respectable. All indexes are relative to a Compaq Deskpro 386/33L, which has an index of 1.*

	AST Bravo 4/25s	Compaq ProLinea 3/25zs	DECpc 333sx LP	Dell Dimension 386SX/25	IBM PS/ValuePoint 325T
CPU index	0.95	0.45	0.87	0.39	0.49
Disk index	1.07	1.04	1.15	0.97	1.04
Video index	1.11	0.57	1.08	0.53	0.90

through advanced integration.

The new Bravos are built around a redesigned system board, like the ProLinea's system board. All 486-class Bravo systems use the same motherboard, which can provide clock frequencies of between 16 and 40 MHz. Thus, you can plug any 486 CPU into it. The board also includes a soldered-on 486SX chip and space for an optional daughtercard. The daughtercard supports an Intel OverDrive processor and cache module; other Bravo models are built around the same system board with different CPU and cache combinations on the add-in card. The on-board 486SX is depopulated on factory-configured DX and DX2 systems.

AST Bravo 4/25s

The common 486 board is an *L*-shaped, four-layer, double-sided PCB (printed circuit board). The motherboards of older Bravos were six-layer designs and about twice as big. AST claims that the *L* shape and reduced size of the new boards enables the company to print two boards at a time instead of just one.

Despite its small size, the new board is only moderately populated. The heart of the system is a highly integrated VLSI Designs chip set that accounts for most of the system logic. The largest consumer of board real estate is the on-board VGA, which includes a Cirrus 5422 VGA controller (including a 24-bit RAMDAC) and 1 MB of VRAM. Serial and parallel I/O and an IDE controller are included on the system board. Finally, there is a proprietary connector designed to accept a network interface daughtercard.

Except for the system board, very little has changed from the last Bravo. The chassis is the same—a relatively cheap, mostly plastic case that disassembles easily and has room for four half-height drives. The unit the BYTE Lab looked at included a reliable Western Digital IDE drive. The power supply is also similar to that used on older models, although AST now ships different ones according to the standards of the country of destination.

AST also saved small costs by using a cheaper, clip-on coin battery and a cheaper speaker. But surprisingly, the new Bravo looks like a *better* machine than its more expensive predecessor; it's more highly integrated, and it packs more features into the same case.

DECpc 333sx LP

Unlike DEC's Tandy-built mainstream desktops, the LP series is assembled entirely in DEC's Taiwan facilities. The shift to lower labor costs undoubtedly contributes to DEC's aggressive pricing. But the LP series also shaves cost through its design—with high integration and limited expandability.

The main system board on the DECpc 333sx LP is a well-made, four-layer, double-sided PCB. Like the other manufacturers, DEC cut price while improving reliability by using highly integrated parts. The heart of the 333sx is an Eteq Panda chip set (an 82C390SX), a single chip that incorporates most of the support logic required for a 386SX design. As a result, the board has plenty of free space; the only other significant support chip is a Chips & Technologies 82C206 CMOS/clock device. There is room for eight SIMM modules on the system board, and each socket accepts 4-MB SIMMs. However, the Panda supports only 14 MB of total system RAM. The SIMM sockets use metal, not plastic, clips.

DECpc 333sx LP

The Eteq chip includes 64 KB of cache memory and a cache controller. The 333sx LP runs on an AMD 33-

around 10 percent—and material costs relatively equal across suppliers, the management challenge has become quality of execution.

Among the techniques for reducing costs are vertical and horizontal integration, use of off-the-shelf parts instead of custom designs, and leaving out options. One sign of how much the market has changed, however, is that other long-standing methods of cost reduction, such as outsourcing subsystems and manufacturing offshore, now run afoul of more-pressing needs for inventory reduction and fast turnaround.

Acer used to manufacture systems in Taiwan, where it is based. Now, says Chwang, "it doesn't matter where you manufacture; the key is how you manage inventory." Product life cycles have shrunk from as long as one to two years to as short as three to six months. Better-informed customers demand freedom to configure systems. The solution is to assemble PCs at the last possible minute, minimizing inventory on hand and maximizing flexibility. "When product spends six weeks on a boat, you lose money,

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MHz 386SX, and the combination of 33-MHz operation and cached memory provides good performance.

Other components of the 333sx are outstanding. DEC's integrated VGA is a Cirrus 5422, the same 24-bit device used in the ValuePoint and Bravo. The 52-MB hard drive is from Quantum. The power supply is a 145-W unit manufactured by Delta with a variable-speed fan for noise reduction. It's not a cheap supply, and 145 W is not bad for the three slots and four drive bays that the 333sx LP needs to support.

The case is not rugged, but it's very well thought out. Drive cages pop out with just a few screws. A single connector runs from all front-panel switches and indicators to the system board. The only obvious cost reductions are in the flimsy case lock and clips.

The 333sx is somewhat of an anomaly in the LP line, which is designed to share as many components as possible among systems—a major source of savings. All the LP systems share the same case, power supply, and drives. The 32-bit members of the LP line share a common motherboard, with a daughtercard for processor-specific features. However, the 333sx has a system board all its own. According to DEC, adding 16-bit data paths to the general-purpose board would add more cost than designing and stocking a dedicated 386SX motherboard.

Mac Performa 600

Mac Performa 600

The Performa 600 closely resembles the 25-MHz Mac IIci and has all the features you'd expect from a Macintosh: three NuBus slots, virtual memory, built-in color video, and sound I/O. Apple offers this 32-MHz, 68030-based Mac with extra features and a built-in CD-ROM for around $2500.

The Performa 600 has plenty of expansion capability. At the front is a half-height bay. A smaller internal bay holds a 3½-inch drive. Both bays support SCSI peripherals. The 112-W power supply is a universal type.

The Performa's built-in video supports 8-bit-deep displays of 640 by 480 pixels on 13-inch and VGA monitors. However, the Performa's video frame buffer resides in 512 KB of VRAM, while the IIci's frame buffer consumes a portion of main memory. Furthermore, this VRAM buffer can be expanded to 1 MB, so the Performa 600 can display 16-bit pixels (32,768 colors)—a feat the IIci is incapable of achieving.

A glance at the Performa 600's main logic board shows a high level of integration. The 68882 FPU is gone, but there is a socket for one for those who need it. The board has only four SIMM RAM sockets and two SIMM VRAM sockets. You can expand memory by replacing the existing SIMMs with higher-density ones.

A Combo chip on the main logic board combines the functions of a 53C80 SCSI controller chip and an 85C30 serial controller chip. Borrowed from the IIsi is a 68HC05 microcontroller that eliminates several custom chips by integrating the Apple Desktop Bus logic, real-time clock, power control, and parameter RAM.

A custom ASIC, called the Vasp, consolidates the clock-signal, video-generation, and memory-mapping functions that required several chips in the Mac IIci design. The Vasp also incorporates the sound circuitry found in another ASIC on the Mac LC and LCII.

Although the Performa 600's CPU is clocked at 31.334 MHz, the bus operates at only 15.667 MHz. This allows the use of inexpensive 80-nanosecond RAM, but it also exacts a performance penalty: The CPU and FPU often wait for memory reads and writes to complete.

BYTE LOW-LEVEL BENCHMARK RESULTS

Table B: *The feature-rich Performa 600 suffers only in system performance, due to its 16-MHz bus. All indexes are relative to a Mac Classic II, which has an index of 1. All tests were run with the displays in black-and-white mode to match the Mac Classic II's screen depth. The benchmarks were run on a prototype system and should be considered preliminary.*

	Mac Performa 600	Mac SE/30	Mac IIci
CPU index	1.54	1.39	2.17
Disk index	1.74	1.24	1.29
Video index	1.55	1.23	1.94

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and your lead time to change configurations is too long," Chwang says.

Parts that change infrequently, such as cables and cases, are made in Taiwan and are then shipped to Acer by boat. Motherboards, minus the CPU, arrive by air freight. Only days before the finished systems are sent to stores, locally purchased CPUs and hard drives are dropped in. Acer is therefore able to avoid paying import duties on the chips and is able to take advantage of the latest prices. Says Chwang, "This lets you use the hottest CPU of the month."

Chwang also believes that vertical integration is an important asset. Acer manufactures its own keyboards and monitors and designs 70 percent to 80 percent of the ASICs in its systems, as well as its own BIOS. "We gain a cost advantage and the opportunity to add value compared to someone who buys standard components off the shelf," Chwang says. Adds ALR's Kirkey, "One of the most important things is having in-house chip-design capability."

continued

World Radio History

HP CUTS PART COUNT

Table 1: *Hewlett-Packard reduced the number of parts in the Vectra 386N Model 50 to 452 from a total of 844 in the Vectra QS16S Model 40 a year ago.*

	QS16S	386N
CPU complex	503	228
Video system	160	119
Multifunction card*	110	76
Mechanical parts	67	27
Number of cards	4	2
Total parts	844	452

*Includes one serial and one parallel port and a hard/floppy drive controller.

But not everyone agrees with this view. Compaq reduced costs of its ProLinea line in part by moving away from its normal (and expensive) habit of designing custom components. And Dell, which already did less in-house design than Compaq, turned to outside suppliers for major subsystems in its Dimension computer line. Argues Ming Hsu, president of OEM supplier Asina Computer Systems, "The notion of vertical integration in the U.S. is not an advantage when functionally identical, reliable components can be obtained at significant cost savings from outside sources."

Another approach is to seek horizontal integration. Tatsuno predicts that even companies the size of Dell won't be able to go it alone and will need to seek technology, marketing, or manufacturing partners. "We'll see acquisitions by the majors of smaller companies that own market niches," he says. "This will produce economies of scale and a kind of horizontal integration more like that of GM and Ford than that of the vertically integrated Toyota."

New PC Order

The result of this price restructuring will be a dramatically different market. Tatsuno believes there will be a lot of failures and mergers. Paul Saffo, a research fellow at the Institute for the Future in Palo Alto, California, has a bleaker view. "This is the fire sale before the storm. The clone makers are doomed. They had better take the money and run," he says.

The change is permanent. "This is not a six-month correction, where prices plummet and then go back up," says Todd Bakar, an analyst with investment-banking firm Hambrecht & Quist in San Francisco. He sees the restructuring as a sign that the PC industry is maturing.

In a mature market, a company can sell different products to different buyers. Lorenzo says that profit margins on high-end systems and servers can range up to 40 percent or 50 percent, whereas low-end PCs run from a loss of up to 22 percent. By selling a range of systems, companies can achieve both high unit volume and high profits: For example, according to analysts' estimates, Apple earned overall profit margins of 44 percent last year due to the success of its higher-priced Quadras, Mac IIs, and PowerBooks.

Jeff McNaught, a PC product manager for Wyse Technology, says his company summarizes *differentiation* as "slots, watts, and bays." High-end systems offer a lot of all three, but "to build a truly low-cost system, you have to cut some out." But Blitzer argues that the job goes beyond just products; he says differentiation is "more in the marketing and perceptions than in manufacturing." Assuming that all systems offer a similar baseline (i.e., an Intel-compatible CPU, a hard drive, and VGA graphics), he predicts that service, support, and distribution channels will determine who buys what.

This view is echoed by Apricot's Buckham, who divides the market into three classes of users: price-dependent, brand-dependent, and value-dependent. Price-dependent customers will buy any PC at the lowest price; the brand-dependent are swayed by brand names; and the value-dependent balance the price, feature set, and vendor reputation. To satisfy value-dependent customers, he says, you have to invest heavily in R&D to add extra features.

R&D Cutbacks

Too much focus on rock-bottom pricing could dampen innovation and delay the wide adoption of newer technologies such as higher-capacity floppy drives and multimedia. "[When you focus too much on pricing,] you tend to eliminate some of the high-risk R&D efforts," says Acer's Chwang. Features that might make PCs more enticing to buyers—stereo sound, faster graphics, CD-ROM, on-board DSPs (digital signal processors)—are left out to cut costs. Unfortunately, this will beget a vicious cycle: Because these add-ons will remain nonstandard, they won't sell at the volumes necessary to drive down their cost. And with profits squeezed, vendors will see opportunities for high profit margins in options, thus keeping prices up and further reducing their volumes.

But most observers don't believe creativity is in jeopardy. "In the future, you'll have to innovate to make any money," says Esther Dyson, editor of the *RELease 1.0* newsletter. "We'll see a lot of price cutting and then a wave of innovation as a means of differentiation." Indeed, some argue that by aggressively stripping cost out of the basic PC unit, manufacturers will actually find it easier to sell advanced features.

Innovation, not cost cutting, will ultimately win the market. "Companies need to continue to develop new technologies and invest in R&D," says Hambrecht & Quist's Bakar. "It would be a big mistake to sacrifice the future."

Maintaining high R&D spending is a formidable challenge in an industry with tight profit margins. Compaq has already cut its spending levels: In the first half of 1992, it spent $89 million on R&D, compared to $101 million for the same period in 1991. On average, PC vendors spend about 1 percent of the cost of a PC on R&D, says Krish Shetty, managing director of Nascom Computer in North Andover, Massachusetts. Companies such as AST and Compaq spend approximately 3 percent. IBM might spend as much as 5 percent.

Tatsuno argues that the computer industry will have to follow the model of consumer electronics firms. "The Japanese learned that the only way [to succeed in consumer electronics] is with huge volumes," he says. "In five years, we'll have hundreds of millions of machines; companies will be making 2 percent to 3 percent margins, and they'll reinvest 40 percent to 45 percent of that back into R&D. That's the name of the game."

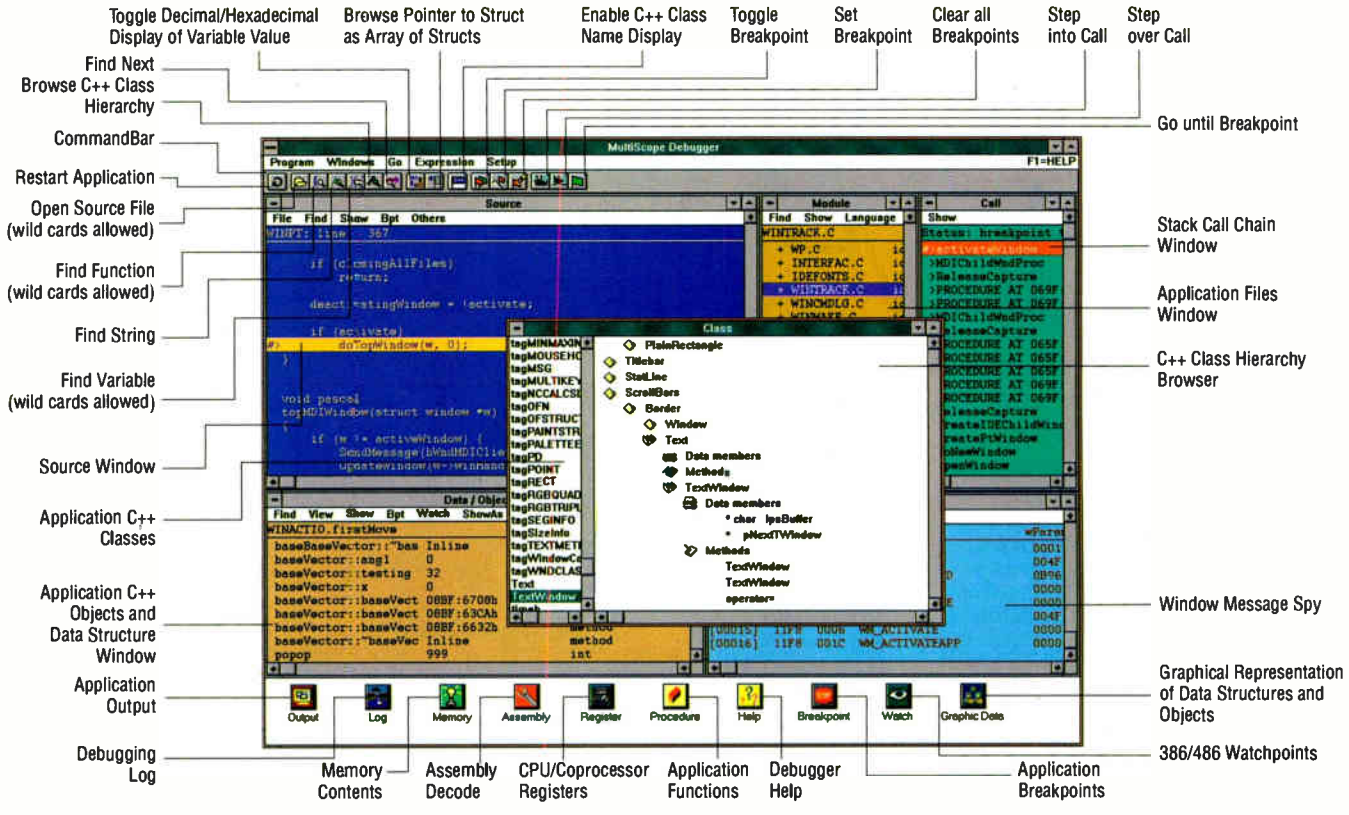
Companies will have to balance their immediate need to remain in business with a long-term view that allows them to pioneer new markets and invest in new technology. Says Bakar, "It's obvious that Apple, Compaq, Dell, and AST will prosper. But beyond them, it becomes less clear." ■

Editor's note: *BYTE's U.K./Europe bureau chief Andy Redfern and BYTE news editors Patrick Waurzyniak, Tom Halfhill, and Ed Perratore also contributed to this story.*

Andrew Reinhardt is BYTE's West Coast bureau chief. You can contact him on BIX as "areinhardt."

World Radio History

WINDOWS DEBUGGERS DO C++.



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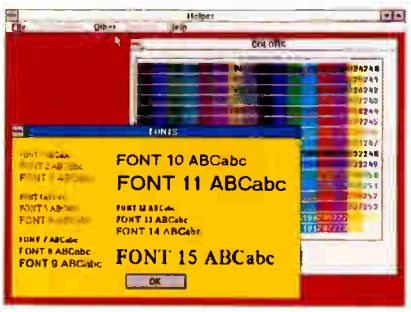

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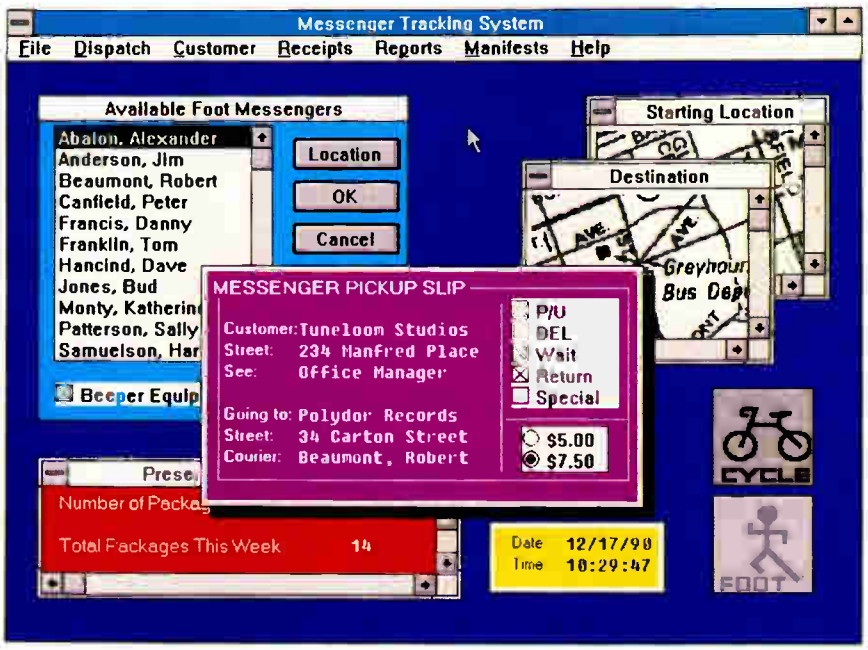

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FEATURE

Smile for the Computer

Digitally produced photos allow for quick output and distribution with near-film quality

PHILIP CHIEN

A camera is a camera is a camera. Right? Wrong. With the rapidly approaching acceptance and implementation of digital photography, a camera isn't just a camera anymore. Used in combination with computers, digital photography has become a hybrid environment that makes the best use of both technologies.

You can use many methods to convert a real-life image into its digital counterpart. You can create digital bit-map images by using video digitizer frame-grabber boards that accept composite video signals and by using hand-held, flatbed, and slide scanners.

Of course, you can still produce superior-quality images using conventional silver-halide film rather than digital methods. For many applications, however, digital images resemble film images so closely that differences aren't noticeable.

Practical Applications and Advantages

Digital cameras can produce and transmit pictures quickly. News services can use digital cameras to take photos in the field and transmit the data by modem to central locations for immediate distribution to their customers. With a digital camera, the speed of distributing still photos is close to the speed of a live TV broadcast, but the quality is much better—as good or better than that of conventional film photos transmitted over news wires.

For computer users, probably the most important advantage to using digital images is being able to put images into desktop publishing documents. I've used digital images to good effect in various ways; for example, I've inserted photographs of company executives into newsletters, diagrams into technical manuals, product photographs into sales brochures, and documentation photography into viewgraph presentations. If you want to add an image to your document, you can do so quickly.

Digital images are also well suited for developing an image library. You can use large hard drives, WORM optical drives, and other mass-storage devices to store huge quantities of high-quality images. If you properly index the images, you can access a digital library quicker than you can a collection of photographs. Digital imaging is also better for the environment than conventional photography in that the technology eliminates the need for developer chemicals.

Kodak (Rochester, NY) offers its PhotoCD service to develop your slide film and, for an additional fee, scan the slides and save them onto a CD-ROM. Presently, PhotoCDs are not compatible with current CD drives.

Digital photographs can be distributed less expensively and more quickly than film or photographs. You can transmit

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Photo 1: *This photo of the March 24 launch of the space shuttle Atlantis on the STS-45 mission was taken with a digital camera and transmitted by modem to BYTE. It was then sent directly to the typesetter and printer without any hard copy ever being produced. (Photo courtesy of Philip Chien,* Earth News*)*

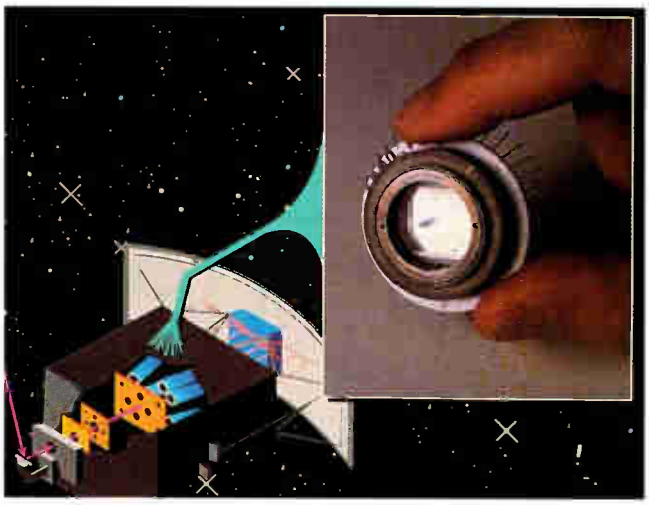

Photo 2: *Each of the Hubble Space Telescope's WF/PC's four thumbnail-size CCDs has 800 by 800 pixels with 12-bit resolution (4096 gray levels). The WF/PC has 48 filters to examine different kinds of chemical compositions and is sensitive in the near-infrared, visible, and UV wavelengths. (Photo courtesy of Texas Instruments)*

digital photographs by modem to individual locations or mass-distribute them via broadcast techniques. You can upload pictures to electronic BBSes and time-sharing systems, or even use a satellite broadcast to transmit high-quality images around the world. Also, the disks that you mail require less in-transit protection (and less postage) than photographs.

I used a digital camera, the Kodak DCS (Digital Camera System), to take pictures of a space-shuttle launch (see photo 1). I transmitted the picture by modem to a friend with a ham radio setup, who uplinked it to UoSAT-F, an amateur radio satellite in a polar orbit. Within hours, the satellite's flight path took it around the earth, and anyone with the proper hardware could download the picture.

Some people are concerned that digital cameras will eliminate the existence of photographic evidence, fearing that edited digital photographs could be passed off as original photographs. You can edit digital photographs to produce supermarket tabloid-style photos. But you can always determine that a photo was taken with a digital camera by magnifying the photo enough to show its square-pixel patterns. Conventional photos, as well as electronic text, have always been subject to "post-editing," and digital images aren't any different.

Collecting Images Digitally

Two types of cameras that use CCDs (charge-coupled devices) to collect images are *still-video* and *true digital*. Each has its own advantages and disadvantages.

True digital cameras are hybrids combining a film camera's optics with a computer's microprocessors. A digital camera's lens focuses the image on a CCD instead of on a roll of film. CCDs used in image applications are semiconductors arranged as a grid of microscopic light-sensitive detectors. Photo 2 shows CCDs that are extremely popular for aerospace applications. (See the text box "Digital Images from Space" on page 144.)

The CCD is the input for a fairly simple computer consisting of a microprocessor, memory, multiplexing circuits, and a power source. The images can be stored in the camera's memory or onto a more permanent storage device, such as a floppy or hard disk (see the figure).

Shutters are optional for digital cameras. A high-quality, accurate shutter is usually one of the most expensive parts of a good camera. For some applications, you can build a digital camera less expensively simply by eliminating the mechanical shutter. In cameras without shutters, the software acts as the shutter, accepting only the light falls on the CCD within a designated time. CCDs don't react to light as quickly as film, and for certain high-speed applications, a shutter may be necessary.

Once the image is stored in the camera's memory, you can use several methods to transfer it to a computer. You can connect a cable from the camera to the computer's serial, parallel, or SCSI port; transfer a removable hard drive from the camera to the computer; or outfit the camera with a standard floppy drive.

Still-Video Cameras

The first commercial cameras to use CCDs were still-video cameras, two examples of which are the Canon Xapshot and the Sony Pro Mavica. These cameras use nonstandard 2-inch floppy disks that store data in analog format; for this reason, these disks don't actually qualify as digital media.

Still-video cameras aren't true digital cameras. You can view images from still-video cameras on video monitors or output them on hard copy by using specialized video printers. To convert still-video images into true digital format, you need an additional video digitizer board to convert the video image into actual computer data. Digital Vision (Dedham, MA) sells a still-video camera as an option for its ComputerEyes boards.

Still-video cameras are limited to TV resolution—less than 500 scan lines. A

Reasons to Use Digital Photography

- Insert photos in documents
- Electronically transmit photographs
- Mail images on disk
- Create an image library
- Easily edit photo images

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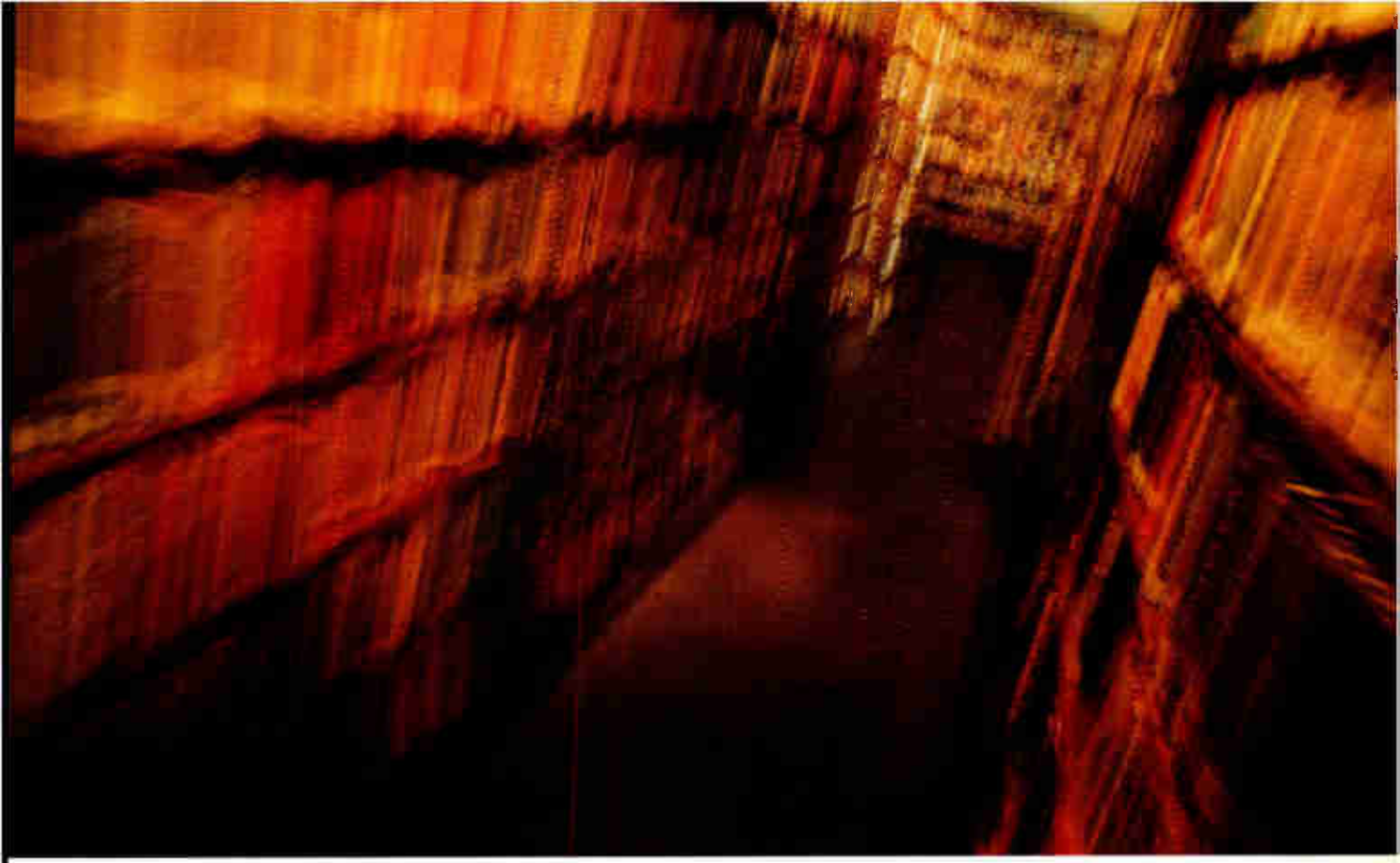

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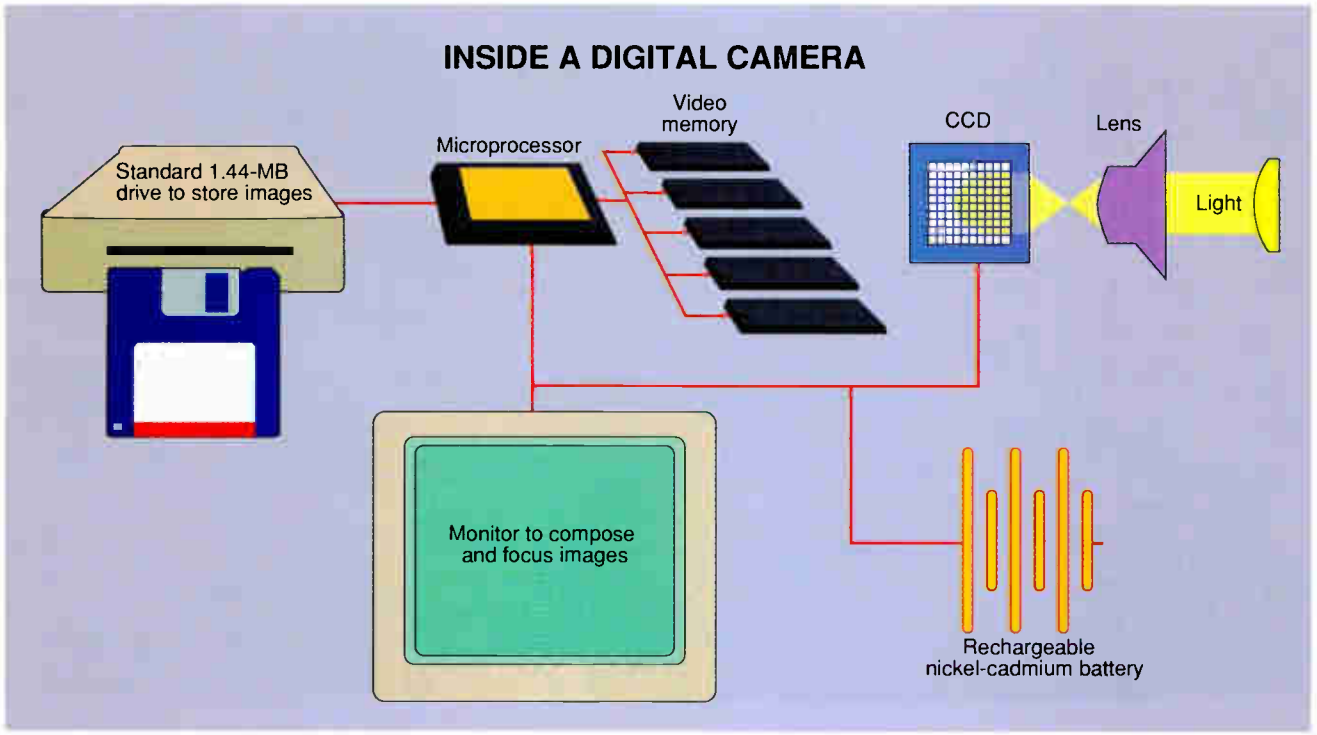

A digital camera uses a CCD to convert images into electronic pulses. In this example, a standard 1.44-MB drive is used to store the images. Alternatively, you could use a serial cable to transfer the pictures from your camera to the computer.

still-video image is similar in quality to an extremely grainy newspaper picture.

True Digital Cameras

The resolution of true digital cameras is limited only by the density of the light-sensitive pixels on the CCD and practical memory constraints. Presently, true digital cameras are either extremely expensive or extremely unsophisticated.

FILM, STILL-VIDEO, AND TRUE DIGITAL IMAGES

Film, still-video, and true digital images each have their own advantages and limitations.

	Film	Still-video	True digital
Hardware cost	Low	Medium	High
Per-shot cost[1]	High	Medium	Low
Speed[2]	Slow	Fast	Fast
Quality[3]	Excellent	Poor	Good/ Very good
Ease with desktop publishing	Poor	Poor	Excellent
Duplication cost	High	Medium	Low
Duplication speed	Slow	Fast	Fast
Ease of use	Easy	Easy	Difficult
Transmittable via modem?	No	No	Yes

[1] Film and developing.
[2] The time from when the photograph is taken until the picture is produced.
[3] Resolution and colors.

The least expensive and most practical method of creating still digital images is to take high-quality photographs and use a good flatbed scanner to digitize them. However, as true digital cameras become less expensive and the technology matures, you will find that the cameras provide several advantages.

I have experimented with two drastically different digital cameras—the $799 10-ounce Logitech Fotoman and the $20,000 19-pound Kodak DCS. The Logitech is the "Instamatic" of digital cameras. It is fairly lightweight but has very low resolution. The Kodak DCS produces excellent-quality images, but it's extremely complicated to use. (Kodak recently introduced a newer model—the Kodak DCS 200ci—that sells for less than $10,000.)

Right now, true digital cameras appear to be as unsophisticated as the earliest mid-1970s microcomputers: They have plenty of potential for future applications, but they are impractical for most uses. The table shows the qualitative differences between film, still-video, and true digital cameras.

Selecting a Digital Camera

Your most important criterion for choosing a digital camera is whether you need color. Monochrome cameras are capable of producing finer resolutions, and they work better in less light. If your primary application is using black-and-white images, you can use a typical office laser printer to create excellent-quality outputs. Color CCD cameras can produce fairly accurate color images on well-tuned RGB monitors, but only very high-end color printers can reproduce accurate colors.

Using a digital camera, you have the dual advantages of portability and immediate results. Unlike with film cameras, with a digital camera you can see exactly how your image will come out and make adjustments for composition and exposure on the spot. Advertisements for digital and still-video cameras suggest they can be effectively used in applications such as those performed by

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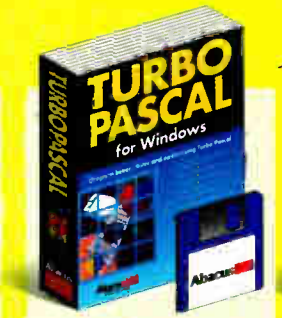

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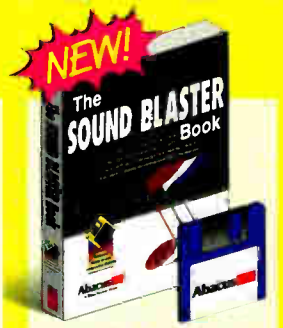

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Digital Images from Space

Most digital images are created with CCDs (charge-coupled devices), tiny detectors in a grid pattern residing on a silicon chip. In 1969, Bell Labs (Holmdell, NJ) developed CCDs, but they did not become popular until engineers found they could be used in various aerospace applications. CCDs are lighter, use less power, and are more efficient than photographic film or video tubes—all important features for spacecraft components.

Photo A: *The Hubble Space Telescope's WF/PC took this picture of Saturn in its wide-field mode. The image is the equivalent of observing Saturn with the naked eye at a distance of 500,000 miles. Virtually all the image's spherical aberration has been removed using computer deconvolution techniques. (Photo courtesy of Space Telescope Science Institute, NASA)*

An early CCD application was the Hubble Space Telescope's Wide Field/Planetary Camera, or WF/PC (pronounced "wiff-pic"). Each thumbnail-size CCD has an 800- by 800-pixel matrix capable of distinguishing 4096 gray levels (i.e., 12 bits). The four images can be electronically combined to create a 1600- by 1600-pixel picture. WF/PC operates like a zoom lens: In its wide-field mode, it can take images of relatively large areas, and in its planetary-camera mode, it can zoom in for close-up views of planets. Some of its results include incredible images of planets, galaxies, globular clusters, and nebulas (see photo A).

Other scientific satellites that use CCDs include the European Giotto, which returned the first close-up pictures of Halley's comet, and the U.S./German Galileo spacecraft, which is en route to Jupiter. Closer to Earth, thousands of home and professional video cameras use CCDs. In an interesting reverse-technology transfer, dozens of space-shuttle missions have carried along home camcorders. A handful of missions have carried a modified 35mm camera with a CCD.

The Electronic Still Camera

The Electronic Still Camera, built by NASA, uses the optics from a Nikon F4. Engineers at the Johnson Space Center (Houston, TX) installed a 1024- by 1024-pixel, 8-bit (256-light-level) CCD at the film plane. Other modifications included a microprocessor controller and a 42-MB removable hard drive "film cartridge." Since the ESC uses a standard F4 body, it can use normal Nikon accessories (i.e., lenses and a flash).

The ESC setup includes an MS-DOS laptop computer with two expansion slots: an adapter to transfer the data from the hard drive film cartridges, and a video board to display images on the shuttle's onboard video monitors. On some missions, the astronauts have the capability to downlink images to the control center through the shuttle's high-bandwidth (Ku-Band) data channel.

The data is received on a workstation where it is displayed and archived. On Spacelab missions, where the experiments have the highest priority for data transmissions, the ESC stores its pictures on the hard drive film cartridges for analysis after the space shuttle returns.

The ESC was carried on the STS-48 mission, which deployed an Earth observation satellite; the STS-42 IML-1 (International Microgravity Laboratory) mission; the STS-45 ATLAS-1 (Atmospheric Laboratory for Applied Sciences) mission; and the STS-49 mission, which rescued a stranded Intelsat satellite. Engineers and astronauts who have used the ESC are extremely happy with the results, and upcoming flight crews have requested that the camera be added to their missions.

ESC's downlink capabilities would be extremely useful on future long flights. Other versions under development include enhanced features such as higher resolution, color, and low-light capabilities.

instant cameras (e.g., real estate sales, medicine, R&D, and insurance claims). Besides current applications where digital cameras have marginal advantages, post-processing digital techniques will offer new benefits.

Even though true digital cameras have some inherent limitations, once you get used to using them, you'll discover the added flexibility of being able to store images on magnetic media. Being able to see a preview image on the camera's built-in monitor assured me that I would obtain the results I wanted. I discovered that I was much more comfortable taking several images at different exposures and settings, because I could easily delete pictures that didn't come out well.

Desktop publishing has allowed people to become their own publishers and printers. Digital image processing will extend conventional printing technologies and offers the potential to improve the quality and feel of images even further. ■

Philip Chien is an aerospace and microcomputer consultant. He started in the microcomputer field working with the original 1977 Apple II, and, since 1983, he has covered and written about computers and the U.S. space program. You can reach him on BIX c/o "editors."

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1 Introduction

This document is intended to provide end users and developers with an understanding of the capabilities and implementation of the DESQview/X product, along with the DESQview DOS multitasker and the X Window System.

Definitions

X Window System
The X Window System is a hardware-independent and operating system-independent graphics standard designed to operate over a network or within a stand-alone machine. Developed at the Massachusetts Institute of Technology in 1984, it has subsequently become an industry standard employed by companies such as AT&T, DEC, Hewlett-Packard, IBM, Sun Microsystems and others.

X Server
An X Server is a special X Window System graphics application that controls a computer's display screen, drawing windows, text, lines, pictures, circles, polygons and the like according to the requests (messages) from an application. An X Server may handle the screen drawing for multiple applications concurrently - each application typically displaying information with one or more windows on the screen.

X Client
An X Window System application program (such as a spreadsheet or drawing program) that communicates with an X Server is called an X Client. A well-defined messaging system links the two participants. This messaging system may occur over a network or within a single machine.

DESQview/X:

- Is a third DESQview (DESQview, DESQview 386 and now DESQview/X), adding distributed graphics and remote computing capabilities to Quarterdeck's multitasking DOS environment.
- Brings the X Window System to DOS — thereby enabling DOS users to participate in the many graphical and multimedia advances available today only on workstation platforms.
- Allows DOS PCs to participate in industry standard, multivendor, multi-operating system, distributed processing (cross-platform computing).
- Supports the latest advancements in font technologies and advanced memory management.
- Provides printer spooling for DOS PCs as well as remote printing capabilities for Unix X Window workstations and other DOS PCs.
- Gives users of Unix X Window workstations access to many off-the-shelf DOS and Microsoft Windows software packages.
- Gives DOS users access to Unix X Window workstations or mainframe programs (Clients).
- Gives DOS users access to Unix text-based applications (using xterm).
- Gives DOS users access to more powerful DOS and Microsoft Windows programs that are not capable of being run on their own machine.
- Promotes DOS to that of a multiuser system through its remote execution and security features.
- Provides file transfer capabilities between DOS and Unix or other DOS machines on a network.
- Provides developers with an industry standard "open", graphical development environment and choice of user interface.
- Supports industry standard methods for application programs to communicate across a network (Inter Process Communications), regardless of the network type.
- Provides X Client developers and manufacturers access to the huge installed base of DOS machines.

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Specifically, it:

- Runs either stand-alone or as a networked system.
- Adds a graphical 3D look and feel to DESQview.
- Provides a growth path from character mode DOS to industry standard graphical user interfaces.
- Gives users a choice of interfaces (window managers) - the DESQview/X, OSF/Motif or OPEN LOOK interfaces are prime examples.
- Dynamically scales the windows of DOS text applications to any size (scalable DOS windows), from just a few pixels to full screen, using scalable font technology.
- Can run applications up to 16MB (16-bit protected mode) or 4GB (32-bit protected mode) by supporting the use of 16-bit and 32-bit DOS Extenders.
- Supports the use of virtual memory and dynamic link library technology to drastically reduce the amount of memory needed to run large application programs.
- Incorporates the Adobe Type Manager and scalable font technology giving X Clients access to the vast array of Adobe Type 1 fonts.
- Allows users to run many off-the-shelf DOS and Microsoft Windows applications in windows side-by-side with local or remote X Window Clients.
- Incorporates a Print Server that can handle print requests from remote machines (both DOS and Unix) connected on a network, while spooling to a printer.
- Allows local users to display and use many off-the-shelf DOS and Microsoft Windows applications that are running on another machine on a network.
- Allows local users to display and use Unix graphical applications (X Clients) that are running on another machine on a network.
- Allows local users to display and use Unix text-based applications that are running on another machine on a network (using the xterm program).
- Allows local users to display and use DOS Clients written for X (graphical applications) that are running on another machine on a network.
- Allows X Window Unix users to display and use many off-the-shelf DOS and Microsoft Windows applications that are running on another DOS machine on a network.
- Provides a multiple level security feature to restrict access to a machine by other remote machines.
- Implements the File Transfer Protocol (FTP) for the peer-to-peer transferring of files to remote machines (DOS or Unix).
- Gives developers a choice of application styles - OSF/Motif, OPEN LOOK and others - or the freedom to design their own.
- Implements a printer imaging model that mimics X Window System display output so that X Clients need only support a single imaging model for both display and printer output, greatly simplifying the coding of X Clients.
- Implements the Berkeley Socket interface, providing Inter Process Communications between separate applications (on the same machine or even across a network) that is independent of the underlying network type.
- Provides developers a platform to port X Clients from Unix to DOS.
- Allows developers to create X Clients in a DOS environment for later porting to other operating systems using the X Window System.

The purpose of this document is to explain how the features of DESQview/X are possible. It provides coverage of the DESQview DOS multitasker, the X Window System and the integration of both of these technologies. This document also describes the development processes necessary to create X Client graphical applications for DOS.

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2 DESQview and PC Fundamentals

This section describes the fundamentals of the DESQview multitasking software and basic PC concepts. Readers familiar with these topics are still encouraged to read the information presented here.

2.1 Introduction

DESQview is a program that extends DOS (either PC-DOS,MS-DOS or DR DOS) into a fully pre-emptive multitasking system. Contrary to popular belief, DESQview can perform multitasking on *all* classes of processor - 8088, 8086 (PC-XT), 286 (PC-AT), 386 and 486. However, the technical advances of the later processors empower DESQview with greater capabilities.

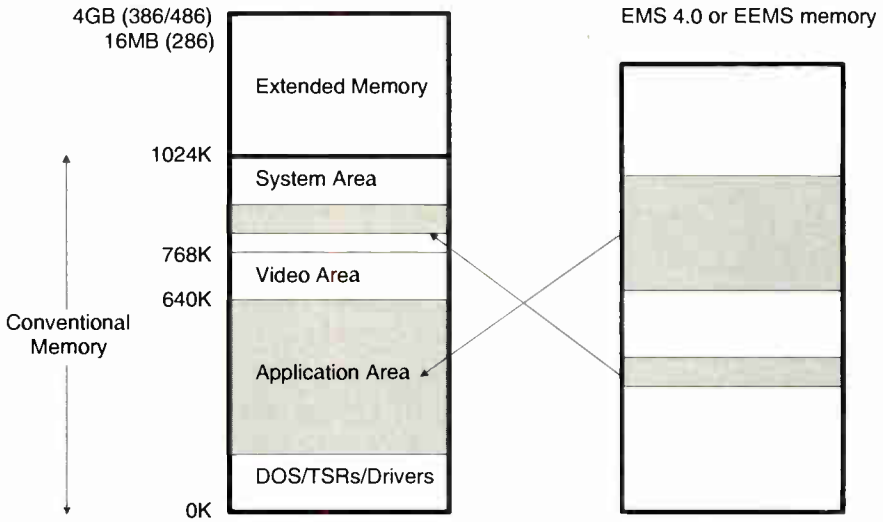
DESQview is compatible with most current PC software - and can even run Microsoft Windows 3.0, 3.1 along with Windows programs, GEM-based, as well as other graphic programs simultaneously.

A program in the DESQview environment may run occupying the whole display screen, or can appear in a small window, framed by a border. Multiple applications may appear on the screen simultaneously, each in its own window.

Certain applications may run in a small window and in "background", depending on how the program has been written and the type of processor being used - a table later in this section summarizes specific capabilities.

2.2 The PC Memory Map

A brief explanation of the architecture of a PC's memory map is beneficial to the understanding of this document. A PC's memory is laid out as follows:



2.2.1 Conventional Memory

Conventional Memory is memory that resides from 0K to 1024K (1MB). DOS, TSRs (Terminate and Stay Resident programs) and device drivers are loaded at the bottom of this memory with video RAM being located between 640K and 768K. Between the top of DOS and the bottom of video memory is the **Application Area.** Above the video area and below the top of conventional memory (1024K) is the **System Area** or what Quarterdeck refers to as High Memory. The System Area contains, for example, special system code such as the machine's BIOS (Basic Input/Output System) or RAM for a hardware card. Typically, this area is not contiguous, but contains portions of unused address space, sometimes more than 128K in size. See Quarterdeck's Manifest User Manual for a detailed description of High Memory (System Area).

2.2.2 Extended Memory

Extended Memory is memory that resides from 1MB and upwards (up to 16MB on a 286, 4 Gigabytes on a 386/486). It is available on machines that use a 286 processor or better and hence is not available on 8088/8086 machines. To be able to directly access this memory the processor must be in a special mode called **protected mode.** This mode is incompatible with DOS and DOS applications which run in **real mode.**

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2.2.3 Expanded Memory

Expanded Memory is memory that acts as a "pool" of memory which, under the control of a special program (the **Expanded Memory Manager**), can be "mapped" into one or more conventional memory areas. **Mapping** is a process whereby a portion of expanded memory "appears" at a specific memory location through the use of special hardware (or in certain circumstances via software control - see the section titled "Software Emulation of EMS Memory"). Note that no transfer of data is actually performed - EMS memory is a bank-switch type of system (and hence very fast).

Unlike extended memory, expanded memory is available for all processor types. There are 3 different types of expanded memory, EMS 3.2, EEMS and EMS 4.0.

2.3 EMS 3.2

EMS 3.2 can only map four 16K pages of memory (64K) into conventional memory at a time, typically into a 64K area within the System Area called the **EMS Page Frame**. EMS 3.2 memory is essentially limited to enhancing the data handling capabilities of a program and has been superseded by the other two types of expanded memory.

2.4 EEMS and EMS 4.0

EEMS and **EMS 4.0** memory can map multiple pages of varying size into conventional memory enhancing both data access and program execution capabilities - a far more flexible scheme than EMS 3.2. Note, however, that some EMS 3.2 memory boards were packaged with a 4.0 Expanded Memory Manager. Unfortunately, this gives the user an impression that EMS 4.0 memory is available with these boards, when only 3.2 capabilities are.

Note that for the remainder of this document, all references to EMS 4.0 memory are also applicable to EEMS memory.

2.5 Software Emulation of EMS memory

Due to the capabilities of the 386 and 486 processors, an Expanded memory manager like Quarterdeck's QEMM-386 can "convert" extended memory into EMS 4.0 memory. In the case of programs like QEMM-386, it is the Expanded memory manager that provides the mapping function through software control.

2.6 Multitasking more than 640K

Despite DOS normally being limited to 640K for its programs, DESQview can run more than 640K concurrently by using expanded memory. Programs are loaded first into the Application Area and when this is exhausted, DESQview will load programs into EMS 4.0 memory. As DESQview task switches from one application to another, it first maps the application from EMS memory into the Application Area and then runs it.

Note that EMS 3.2 memory is not used in this way due to the limitations of the specification; EMS 3.2 memory can only map a maximum of 64K and hence the available partition size is too small to contain the majority of programs.

On 8088/86 and 286 based systems, it is essential to disable motherboard memory to as low a value as possible (typically 256K) when using EMS 4.0 memory and DESQview. Due to hardware limitations of these processors, EMS 4.0 memory cannot be mapped on top of other memory (RAM or ROM) that is present in the system. If motherboard memory cannot be disabled, DESQview cannot multitask applications in EMS 4.0 memory. In the worst case, EMS 4.0 memory can act like EMS 3.2 memory to store "swapped" programs (see the "Program Swapping" section for details), but may still have the LOADHI capability outlined next.

2.7 LOADHI capability

Since DESQview uses the Application Area below 640K to perform its multitasking "magic", it can be seen that the larger this area is, the larger applications can be that run under DESQview (unless an application is a DOS Extended application - see the "DOS Extender" section for details).

Any TSRs (Terminate and Stay Resident programs) or drivers (such as mouse or network drivers) that are loaded before DESQview occupy space in conventional memory on top of DOS and reduce the amount of memory available to the Application Area. It is therefore advisable to keep the number of TSRs and device drivers using conventional memory to a minimum to ensure a maximum amount of space for applications.

One solution is available with the Quarterdeck QRAM, QEMM-50/60 and QEMM-386 products - the **LOADHI** capability. With this utility, TSRs and device drivers can be loaded into the unused regions of the System Area, thus freeing up more space below 640K and enabling larger applications to be run inside of DESQview.

2.8 Program Swapping

When all of the Application Area and EMS 4.0 memory has been used to store programs, any further loading of applications will cause DESQview to swap applications already running onto either a hard disk, a network drive, a RAM drive or expanded memory (even EMS 3.2 can support this type of operation). Any programs "swapped out" in this way will be suspended from running. Despite being suspended, any swapped applications can be swapped back in at the request of the user with only a

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short delay. Doing this will force one of the currently running programs to be swapped out in order to make room if there is not enough memory for the incoming program.

Note: DESQview/X version 1.0 does not support DOS program swapping.

2.9 Switching and Windowing

Since DESQview can multitask multiple DOS applications, a user can **switch** from one application to another using two or three keystrokes or mouse clicks. Because of this, there is a concept in DESQview of one foreground application and multiple background applications.

Some applications may be running in **windows** smaller than the screen size and others may occupy the whole screen. In addition, some applications may be running in background, while others are suspended. These capabilities are dependent on the video behavior of the program and the machine's processor type.

2.10 Application Video Behavior

DOS applications may be written to produce display output in either of two ways. They may call DOS and BIOS routines to perform the output, or alternatively may write directly into the video area. The latter method is usually employed for speed reasons. Applications that use the DOS and BIOS routines are termed **well-behaved** and others that write directly to the video area are **ill-behaved**. Typically, graphical applications are ill-behaved; text-based applications may be either.

2.10.1 Well-Behaved Applications

Since DESQview can easily intercept DOS and BIOS calls, well-behaved applications may run in a small window or in background on any machine regardless of processor type. When a well-behaved application makes a video BIOS or DOS call, DESQview intercepts and executes the call, but places the relevant information in a special save area called the **logical window buffer** as well as clipping and shifting the information to appear within a small window on the screen.

2.10.2 Ill-Behaved Applications

Since ill-behaved applications write directly to the video RAM, DESQview cannot run them in a small window or in background unless the processor is a 386 or a 486 (see the "Virtualization" section for details). These applications, when run on an 8088/86 or 286 PC, can only run full screen in the foreground. Application developers should note that in many cases it is very easy to make an ill-behaved text application well-behaved, simply by adding a single subroutine call - see "The SHADOW Call" section for details.

2.10.3 Virtualization

Due to the sophisticated memory handling capabilities of the 386 and 486 processors, DESQview can redirect an application that writes directly to video RAM to a portion of memory that DESQview calls the **logical window buffer.** DESQview copies the information from this buffer to the actual video RAM, clipping and shifting it as necessary to appear within a small window. In this way, DESQview coupled with QEMM-386 and a 386 or 486 processor can **virtualize** ill-behaved applications (including graphics ones) in small windows and run them in background.

The only exception to this process are graphical DOS Extended applications - see the "DOS Extenders" section for more information. This is because the virtualization process uses a special processor mode that is incompatible with the DOS Extender.

Note: Version 1.0 of DESQview/X does not support the virtualization of DOS graphics programs.

2.10.4 Loaders

For machines that do not have a minimum of a 386 processor, a loader may be available to run an ill-behaved text program in a small window and in background. **Loaders** are utilities that alter a program's operation while it is running and coerce it into being well-behaved. Quarterdeck supplies several loaders with DESQview for use with programs such as Lotus 123.

2.11 Microsoft Windows

Microsoft Windows (and any Windows applications running within it) appears to DESQview simply as a graphical application and is handled as such. Consequently, Windows 3.0 real mode can be virtualized in a small window on machines with 386/486 processors whereas Windows 3.0 and 3.1 standard mode runs full screen (Windows standard mode acts like a DOS Extended graphical application).

Presently, Windows 3.0 and 3.1 386 enhanced mode does not function under DESQview. Note, however, that some of the extra capabilities of 386 enhanced mode (such as the virtualization of DOS windows) are duplicated in DESQview and are best handled by DESQview.

Note: DESQview/X includes special Windows drivers that enables Windows 3.0 in real mode and Windows 3.0, 3.1 in standard mode to run in small windows and remotely.

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2.12 Application Types

There are three types of applications that exist in the DESQview multitasking environment: DESQview-oblivious, DESQview-aware and DESQview-specific.

DESQview-oblivious DESQview-oblivious programs are ones that know nothing about DESQview - this includes programs like Lotus 123, Microsoft Word or AutoCAD.

DESQview-aware A DESQview-aware program is one that has been modified slightly to make it run more efficiently in DESQview. Paradox, dBASE and WordPerfect are examples of DESQview-aware programs.

DESQview-specific A DESQview-specific program has been written to take advantage of the DESQview API (Application Program Interface). Consequently, these programs can only run when DESQview is present.

2.13 DESQview API

Present in every copy of DESQview is the **DESQview API** (Application Program Interface). This interface allows programs to call the DESQview subroutines and functions in order to start and close down other applications; move, resize and scroll their windows; perform intertask communication and many other functions. The DESQview API is callable by Assembler, C, BASIC, Pascal, Clipper and dBASE programs.

2.13.1 The SHADOW Call

One API call of particular significance is the **SHADOW** call. This call may be made whether DESQview is present or not.

An ill-behaved text application will typically determine the kind of system present (monochrome or color) and load a variable with the corresponding video RAM value for the system (either B000H or B800H). From then on, the application will use the variable in order to access video RAM.

If during initialization, a program performs the SHADOW call using the desired video RAM value before storing it, the program will then become well-behaved when running under DESQview. This is because DESQview returns the logical window buffer for that application, whereas under DOS, the SHADOW call returns the value unchanged.

Since the application stores the returned value and uses it whenever video RAM access is required, the application is writing directly into the DESQview logical window buffer instead of to the screen. DESQview **shadows** from the logical window buffer to the screen, clipping and shifting as necessary, so the otherwise ill-behaved text application can run in a small window and in background on all processor types. This process is fast enough to be rarely noticeable by the user. WordPerfect, Dbase and Paradox are examples of commercially available programs that do this.

2.14 Processor Types and Modes

Since the original PC was introduced in 1981, various processors have been used, each one superseding the previous version and providing greater functionality. This functionality was always gained with the advantage of backward compatibility with all the previous processors.

2.14.1 The 8088/8086 and Real Mode

When the PC was first introduced, it used an Intel 8088 microprocessor. This is a 16-bit architecture processor with a segmented memory scheme capable of addressing 1MB. The 8088 used an 8 bit external data path unlike its otherwise functionally equivalent bigger brother, the 8086 which used an external data path of 16 bits. The mode of operation of these two processors is termed **real mode.**

2.14.2 The 286 and Protected Mode

The 286 processor supplies a real mode capability, but improved upon the 8088/86 by providing a new mode called **protected mode.** In protected mode, the 286 can access up to 16MB of memory (again by using a segmented addressing scheme), however certain operations available in real mode (such as segment arithmetic) are prohibited in protected mode. In addition, protected mode also has the hardware necessary for an operating system to "protect" an application from crashing the system or overwriting another application.

Unfortunately, protected mode is sufficiently different from real mode that DOS and regular DOS applications cannot operate in protected mode. For a long time this limited applications to running in real mode and hence constrained them to the 1MB limit. Thankfully, a solution has become available that addresses this called the DOS Extender - see the "DOS Extenders" section for details.

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2.14.3 The 386 and V8086 Mode

Next to be introduced was the 386. Providing backward compatibility means that the 386 has both a real mode and protected mode capability. But in addition to this, Intel added a third mode called **Virtual 8086 Mode** that can operate under the auspices of protected mode. This mode supplies a virtual 1MB 8086 style environment while running in protected mode. This elegant solution enables regular DOS and real mode applications to run under protected mode without modification. The 386 also has an effective addressing range of 4 Gigabytes. It supports a flat memory model as well as a segmented addressing mechanism.

Also included in the 386 were memory mapping capabilities, a 32-bit architecture and hooks for a paged virtual memory system as opposed to a somewhat meager segmented virtual memory system that became available in the 286.

Note that 386 technology has been realized in several processors including the 386SX, 386SL and 386DX. The 386SX processor uses the 386 32-bit architecture internally, yet has a 16-bit external data path. The 386SL chip is a low power version of the 386SX with built-in power management features and is primarily designed for battery-powered computers. The 386DX processor (basically a renamed version of the original 386) uses an internal 32-bit architecture and a 32-bit external data path.

All 386 processors are functionally equivalent and are referred by the 386 moniker for the rest of this document.

2.14.4 The 486

The latest member of the 80x86 family to be introduced was the 486 processor. Basically this is similar to a 386 processor with an internal memory cache and is faster due to improved instruction execution. The 486 appears in several variants including a basic 486SX, a low power 486SL and a 486DX version that sports an internal math coprocessor (an optional external component with the 486SX,SL and all the other previous processors). Another variant is the 486DX2 processor which appears to a computer system much like a regular 486DX chip, but executes instructions internally at twice the speed of a 486DX.

All 486 processors are functionally equivalent (save for math functions) and are referred by the 486 moniker for the rest of this document.

2.15 DOS Extenders

Since DOS cannot run in protected mode, a way was devised for protected mode applications to run under DOS and use other real mode services. Protected mode applications are desirable since they have access to up to 16MB of memory on a 286 and 4 Gigabytes on a 386/486.

A **DOS Extender** is a special utility that is linked in to a protected mode application. Whenever the application makes a DOS call or any other request that requires real mode, the DOS Extender copies down any necessary data into the 1MB conventional memory area and switches into real mode. It then calls the requested function and on return switches back into protected mode, returning any results to the protected mode application.

There are usually two types of DOS Extenders - 286 DOS Extenders and 386 DOS Extenders.

286 DOS Extenders — These run 16-bit protected mode applications on a machine with a minimum of a 286 processor. They have access to a 16MB address space.

386 DOS Extenders — These run 32-bit protected mode applications on a machine with a minimum of a 386 processor. They have access to a 4GB address space.

Note that some DOS Extenders combine the capabilities of the two different types and can handle both 16-bit (286) protected mode applications as well as 32-bit (386) protected mode applications.

Most DOS Extenders also have a **virtual memory** option. That is, a DOS Extended application may run in less memory than normally is required by using virtual memory techniques.

In essence, the DOS Extender becomes the system's **control program.** This normally would have posed a problem to DESQview as protected mode allows only one control program in a system. Since DESQview multitasks applications, multiple DOS Extended applications would conflict with each other as each expects to be the control program. This is compounded with the fact that DESQview 386 (DESQview plus QEMM-386) is also a control program.

To obviate this problem, Quarterdeck and Phar Lap (one of the companies that produce a DOS Extender) developed the VCPI (Virtual Control Program Interface) specification which has been adopted by all major 386 DOS Extender manufacturers - see the "VCPI Specification" section for details.

It should be noted that VCPI is a specification for 386 and 486 processors, yet 16-bit protected mode applications may be run on 286 machines. In order for DESQview to multitask multiple 16-bit protected mode programs on a 286 so that they do not assume control of the same blocks of extended memory, their individual 286 DOS Extenders must use the **XMS** (Extended Memory Specification) interface specification. A utility program called QEXT.SYS supplies the necessary XMS

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services for 286 DOS Extenders running under DESQview on a 286 machine whereas QEMM-386 supplies the services for DESQview 386.

Note that a DOS Extended application consists of two parts. A real mode portion of the DOS Extender resides in conventional memory and interfaces with the protected mode portion that resides with the protected mode application in extended memory. When DESQview performs a task switch to a DOS Extended application, it ensures that the real mode portion of the application is mapped into the conventional memory Application Area and that the protected mode portion is "visible" in extended memory. Since the majority of the application resides in extended memory and only a small portion (the real mode part) need occupy the Application Area, DOS Extended applications tend not to be constrained by the size of the Application Area as regular real mode applications are.

Note: DESQview/X includes a built-in DOS Extender supporting 16- and 32-bit virtual memory and dynamic link libraries.

2.16 VCPI Specification

The **VCPI** specification was developed so that multiple protected mode control programs can coexist and interact within a single 386 (or 486) system. The specification consists of two parts - a VCPI server and several VCPI clients. The VCPI clients request memory and mode switching services from the VCPI server.

In a DESQview 386 system, the VCPI server is implemented within QEMM-386 and the DOS Extended applications become VCPI clients. Whenever a DOS Extended application requires memory services it calls upon the VCPI server to perform them. When QEMM-386 is not present, the DOS Extender performs all services for itself. The end result is that DESQview is able to run a mix of real mode and DOS Extended (protected mode) applications concurrently on a 386/486.

As mentioned earlier, 286 machines may run multiple 286 DOS Extended applications only if the DOS Extenders utilize XMS services.

2.17 DESQview Capabilities

DESQview's ability to window an application and run it in the background is a function of the machine's processor and the type of application. Here is a table that summarizes the possible combinations:

DESQview Capabilities		8088 8086	286	386 486
Well-behaved Text Application or Ill-behave Text Application with Loader	Real Mode	W	W	W
	16-bit Protected	-	W	W
	32-bit Protected	-	-	W
Ill-behaved Text Application	Real Mode	D	D	W
	16-bit Protected	-	D	WD
	32-bit Protected	-	-	WD
Graphics Application	Real Mode	D	D	W
	16-bit Protected	-	D	D
	32-bit Protected	-	-	D
Microsoft Windows 3.0, 3.1 and Windows Application	Real Mode*	D	D	W
	Standard Mode	-	D	D

W Application can run in a window and in background.
D Application can only run direct (full screen) and not in background.
WD Dependent on individual application - most run as W, some may run as D.
- Processor cannot support this type of application.
* Available only with Microsoft Windows version 3.0.
Note: The above table presents the capabilities of the DESQview multitasker. For information on DESQview/X capabilities please see page QD-26.

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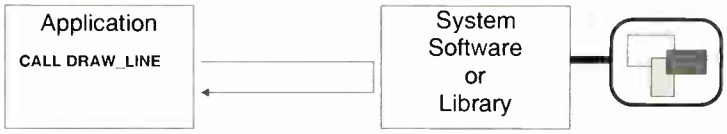
3 An Introduction to X

The basic concepts of the X Window System are described in this section. Readers familiar with X may elect to skip this section.

The X Window System is a powerful concept that utilizes machine and device independence as well as providing a graphical interface to users with both keyboard and mouse support.

3.1 Traditional Graphics Output

In traditional systems, if an application wishes to produce graphical output on a computer's display device, it will typically call a library or system software graphic subroutine. This subroutine performs the task requested (in the example shown, draw a line) and once the task has completed, control returns to the application.



Traditional Graphics Output

3.2 X Servers, Clients and Protocol

In an X Window System, the system software is replaced by an application called the **X Server** - it is this application that has complete control of the display screen. An application that wishes to produce graphical output instructs the X Server to perform a specific task by sending it an information "message" that describes the task required. Sending a message to an X Server returns control immediately to the application and may or may not provoke a response from the Server.

The different types of messages are collectively called the **X Protocol**. One message draws a line, another a circle and yet another may print some text.

Any application that displays graphical output by sending X Protocol messages is labelled an **X Client** in contrast to an application that uses some other means.

X Window Graphics Output

In return the X Server may send back to an X Client special messages, such as event messages or error messages. These special messages are also part of the X Protocol.

X Clients typically create windows for their output. It is quite feasible (and generally the case) that a single X Client will create and utilize several windows on the X Server's screen simultaneously.

Note that an X Server may handle the graphics output for multiple X Clients concurrently and only understands X Protocol requests as a means to produce graphical output - it usually does not produce graphics output any other way.

3.3 An Event-Driven System

X is an **event-driven** system. That is, X Clients are typically suspended until an action occurs on the X Server for which they have a vested interest. X Clients are restarted by the X Server sending them special X Protocol messages. These event messages include ones that instruct an X Client to redraw its window (for example, if a part of its window becomes uncovered by the movement of another window), that a window's size has changed or that a key has been pressed. An X Client processes these messages, producing whatever output may be necessary and then returns to a suspended state until another message is received.

This is in direct contrast to the way traditional applications have been written. Those applications are **procedure-oriented** and are written to assume an active role in the interrelationship between the user and the program. Typically, the program will steer the user through the execution of the task at hand, forcing the user down a narrow set of predefined procedures. The program only accepts input (be it keystrokes or mouse clicks) from the user at predictable times. An order entry application is a good example of a procedure-oriented program.

Event-driven applications take a more passive role in that they respond to input from the user or the system at unpredictable times. This type of application can provide a more flexible framework within which a user may operate. Typically there are no predefined procedures and many ways to complete a task - a user is free to use whatever tools the application provides and in any manner desired to achieve the final result. A drawing/designing type of program is a good example of an event-driven application.

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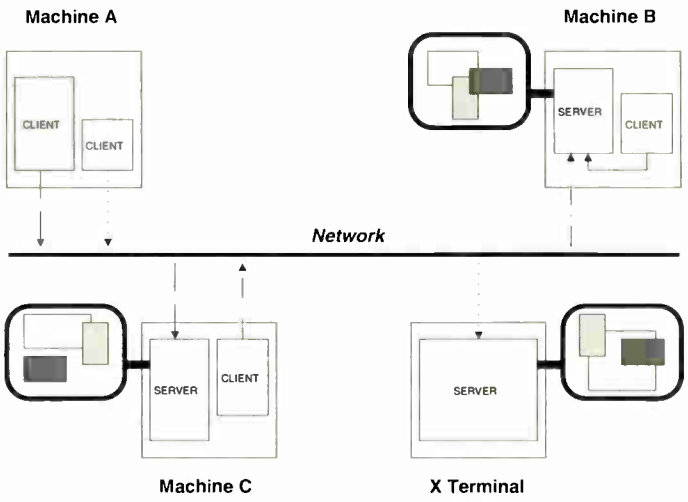
3.4 A Distributed System

Since the X Client communicates with the X Server through information messages, it is possible for the X Protocol requests to be sent over a network to an X Server running on a different machine.

In fact the X Window System was designed around a system of messages specifically to be a networked graphical system.

In the diagram, an X Client executing on machine A is displayed on machine C's screen (using the X Server on C) and an X Client executing on machine C is being displayed on machine B's screen (using machine B's X Server).



3.5 Operating System and Architecture Independence

None of the machines need be from the same vendor or running the same operating system, since all communication between X Clients and Servers is performed over a network using a well-defined message protocol (the X Protocol). Naturally, a program cannot be copied to a different type of machine on the network and subsequently run - it would have to be recompiled for a different machine's architecture/operating system.

3.6 X Terminals

In the previous diagram, one of the clients running on machine A is being displayed by a special machine that only has an X Server running on it - in effect acting as a remote graphics terminal to machine A. This type of machine is called an **X Terminal** and its sole purpose is to display graphics from X Clients running on remote machines.

Typically, the majority of PC implementations of the X Window System have been as X Terminals. PCs are notorious for memory limitations and hence an X Server application would normally occupy all of the PC's memory. With the advent of DESQview/X, however, PCs can run X Servers, DOS applications, Microsoft Windows and X Clients simultaneously.

3.7 A Stand-Alone System

In the previous diagram, machine B's X Server was displaying output from an X Client running on machine C, but is also displaying graphics from an X Client running on itself. In this case, the X Protocol messages are not sent out over the network to another X Server, but are routed within the machine to the local X Server.

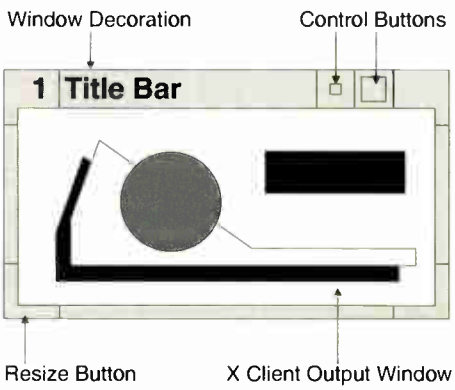
This concept can be extended to include a scenario whereby the machine is not connected to a network - all X Clients run locally and are displayed by the local X Server. Naturally, this requires a multitasking operating system - such as DOS with DESQview.

3.8 The Window Manager

The X Server only produces graphical output according to X Protocol requests and does not provide functions for the user to control the size, position and stacking order of the displayed windows.

These functions could have been implemented within each X Client, but would have lead to much redundant programming. They could have been implemented within the X Server itself, but the designers of the X Window System took a more flexible approach.

A special X Client is run (either locally or remotely) for each X Server, called the **window manager.** This program is given special privileges and is allowed to "supervise" all of the windows being displayed by the X Server. The window manager will typically place some form of window decoration around the outside of each X Client window that includes resize and move buttons as well as a title bar. It then becomes a function of the window manager to resize, move, rearrange a window according to the wishes of the user by mouse clicks on a window's decoration or selections from a window manager menu.



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At present, there are several managers for the X Window System, the most prominent of which are the OSF/Motif, OPEN LOOK and the Tab (previously known as Tom's) Window Managers. DESQview/X also supplies its own window manager, DESQview Window Manager (DWM).

Due to the design of the X Window System, a window manager may be closed down and another may be subsequently started--without affecting any of the X Clients being displayed on the screen! The old window decorations disappear from the screen and are replaced by new decorations created by the incoming window manager.

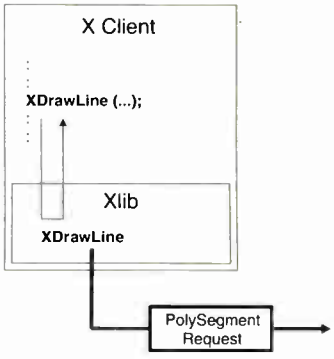
Note that the window manager only creates the "look and feel" of an X Client with regards to its window decoration. Whatever an X Client chooses to display in its output window is independent of the window manager. Program libraries are available to X Client developers that allow them to create an application with a specific look - either an OPEN LOOK or OSF/Motif look, for example. These program libraries are called toolkits and are explored in the next section.

3.9 X Development Layers

In order to create an X Client, a developer will call upon a variety of program libraries for assistance. For DESQview/X, these libraries can be linked into each X Client, or may be a shared resource among all X Clients on a system through the use of Dynamic Link Libraries (DLLs).

3.9.1 Xlib

For an X Client to be able to communicate with an X Server, it needs to generate X Protocol requests for transmission to the Server. Building these requests can be cumbersome and hence a library was created called **Xlib**. Xlib is (generally) the lowest level interface that an X Client uses to communicate with the X Server. It is a set of C subroutines that, for the most part, are a one-to-one mapping from C to X Protocol requests, though some Xlib functions can generate multiple X Protocol requests.



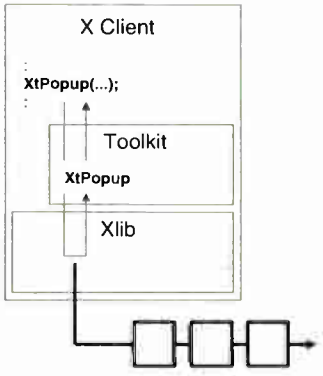
For example, if an X Client uses the function XDrawLine it calls the appropriate code inside Xlib which builds a PolySegment request and transmits it to the X Server.

Note that the Xlib library imparts no specific "look and feel" to an X Client - it merely consists of requests to create a window, draw a line, print some text, etc. The appearance of an application is generally determined by another program library - a toolkit.

X Clients may be written so that they use only Xlib and no other program libraries (toolkits).

3.9.2 Toolkits

Since Xlib is rudimentary in the scope of its capabilities, another program layer may exist on top of Xlib - the **toolkit**. Toolkits generally have routines for building menus, push buttons, slider controls and the like. Since the toolkit generates these basic window components for the X Client, it is the toolkit which creates the actual "look" of an application.



An individual toolkit function may call several Xlib functions, which in turn can create multiple X Protocol requests.

For example, if the X Client wishes to make a popup window appear, it could call (using one specific toolkit) XtPopup to perform the function. XtPopup in turn makes several Xlib calls which may generate multiple X Protocol requests.

An X Client may still (and often does) call Xlib functions even if it uses a toolkit.

Some of the more prominent toolkits that are generally available are as follows.

Athena Toolkit — A fairly rudimentary toolkit supplied by MIT (Massachusetts Institute of Technology).

OSF/Motif Toolkit — This toolkit is supplied by the Open Software Foundation and provides a sculptured 3D look. This toolkit (and its complimentary window manager) is promoted by a consortium of companies (OSF) that include DEC, Hewlett-Packard and IBM.

Olit Toolkit — A toolkit conforming to the OPEN LOOK* graphical user interface standard that is 3D in appearance. This toolkit and its OPEN LOOK window manager is promoted by Unix System Laboratories.

XView Toolkit — A toolkit conforming to the OPEN LOOK* graphical user interface standard, but with a different programming interface (SunView) than Olit. It is promoted by Sun Microsystems.

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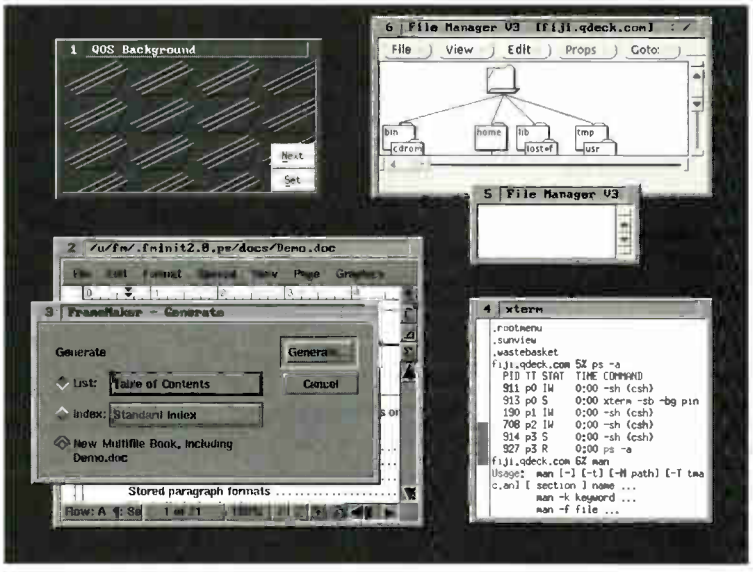
*Note that OPEN LOOK is not a toolkit or window manager in itself - it is merely a design specification for the appearance of a user interface. Olit and XView are toolkits that adhere to this specification and hence create the same look and feel.

The following screen shots should help to illustrate the concepts of a Window Manager, Toolkits and the like.



The X Clients in the previous picture are:

QOS Background — An X Client written using only Xlib. A Toolkit is not necessary since it only creates a simple output window.

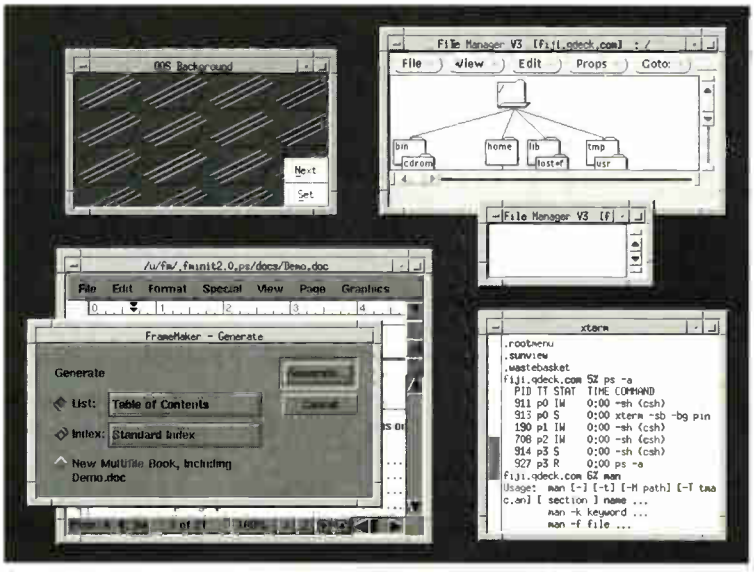
FrameMaker — This electronic publishing package was written using the OSF/Motif Toolkit. The X Client is currently displaying two windows - an edit window and a "Generate" window.

Sun File Manager — OPEN LOOK has characteristic buttons with rounded ends. This file manager, which uses an OPEN LOOK toolkit, has these rounded buttons. This X Client is currently displaying two windows - a directory tree and a wastebasket box.

Xterm — This X client uses the Athena Toolkit to display a terminal session with a scrollbar on the left.

All of these X Clients are running under the control of the DESQview/X Window Manager. The window manager has placed a frame around many of the windows on the screen, along with decorations such as title bar and window number.

If the DESQview/X Window Manager is closed down and the OSF/Motif window manager is started, the following display appears:



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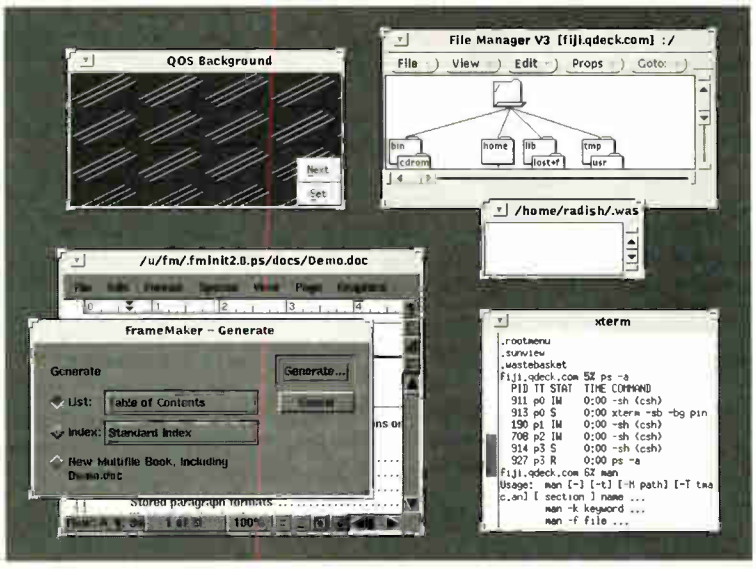
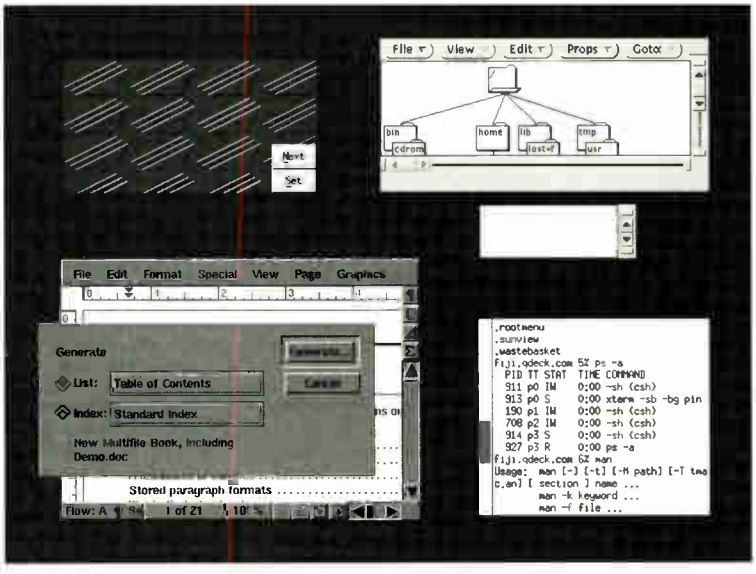
Despite a change in window managers, the X Clients' window contents remain the same. Only the window decoration has changed - in this case to an OSF/Motif 3D effect. Note that with the OSF/Motif window manager active, the X Client built using the OSF/Motif toolkit (FrameMaker) blends well into the environment, since it has the same appearance style as the window manager.

If the OSF/Motif window manager is now replaced by an OPEN LOOK window manager, the following display appears:



Once again a change in window managers does not change the contents of the X Clients' windows - only the window decoration has altered. In a similar fashion to FrameMaker and the OSF/Motif window manager, it can be seen that the Sun File Manager windows complement the OPEN LOOK window manager's window decoration. This is because both of these products were built using an OPEN LOOK toolkit and hence have an OPEN LOOK appearance.

Although it is unlikely that a user would want to run X Clients without a window manager, the following picture shows how this would appear:



As can be seen in the previous picture, the usefulness of having no window manager is debatable, but not impossible. Having no window manager active would most probably occur when only one X Client is being run on an X Server.

These pictures highlight the concept of a window manager as being a special X Client that decorates the outside of all other X Clients' windows and allows a user to control their size, position and ordering on the screen. The pictures also show how a toolkit influences the look and feel of an X Client and how its appearance is independent of the active window manager.

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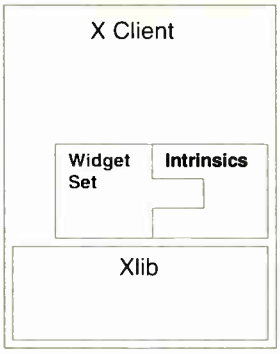
3.9.3 Intrinsics and Widgets



Some toolkits may only be regarded as a single entity, but others are conceptually split into two parts. One of these parts is termed the Intrinsics and the other part, a Widget Set.

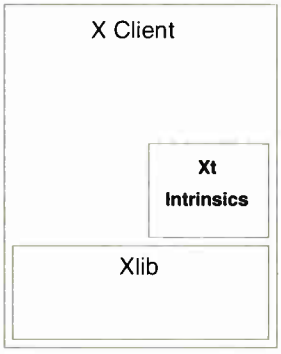
The Widget Set

Widgets are abstract data objects such as buttons, scrollbars and other such objects. An X Client can be easily constructed from a number of widgets. The X Client does not have direct control of the actual appearance of a widget - only its general form, size or contents. The appearance is determined by the toolkit.

A **Widget Set** uses both function calls in the Intrinsics as well as Xlib.

The Intrinsics

The **Intrinsics** provide an object-oriented framework on which a Widget Set depends. It handles the creation, deletion and management of widgets as well as their event message handling. It is possible for an X Client to call the Intrinsics directly as well as the Widget Set (and of course, Xlib).



The Athena, OSF/Motif and Olit Toolkits consist of a Widget Set and the first Intrinsics to be developed for X - **Xt**.

3.9.4 Xt Intrinsics

In some cases, an X Client may only call the Xt Intrinsics and Xlib library. This type of application provides its own widget set, hence supporting its own unique set of abstract data objects (widgets) that are manipulated and managed by Xt.

An application that does this is able to provide its own look and feel, all the while saving its developer time and effort by using the object-oriented functions of Xt.

3.10 X11

MIT in association with a consortium of companies who have a vested interest in the X Window System (The X Consortium) releases MIT X distribution tapes containing the Xlib and Xt libraries as well as sample X Clients and an X Server. It is these tapes on which all other toolkits and X products are based.

The current revision of these distribution tapes is the X version 11 release 5 of the X Window System, otherwise known as **X11 R5**.

3.11 Toolkit Summary

Here follows a table of the Toolkits discussed in this document in summary form for quick reference:

Toolkit	Supplier or Promoter	API	Interface
Athena	MIT	Xt	(rudimentary)
OSF/Motif	OSF	Modified Xt	OSF/Motif
Xview	Sun Microsystems	SunView	OPEN LOOK
Olit	USL	Modified Xt	OPEN LOOK

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4 DESQview/X

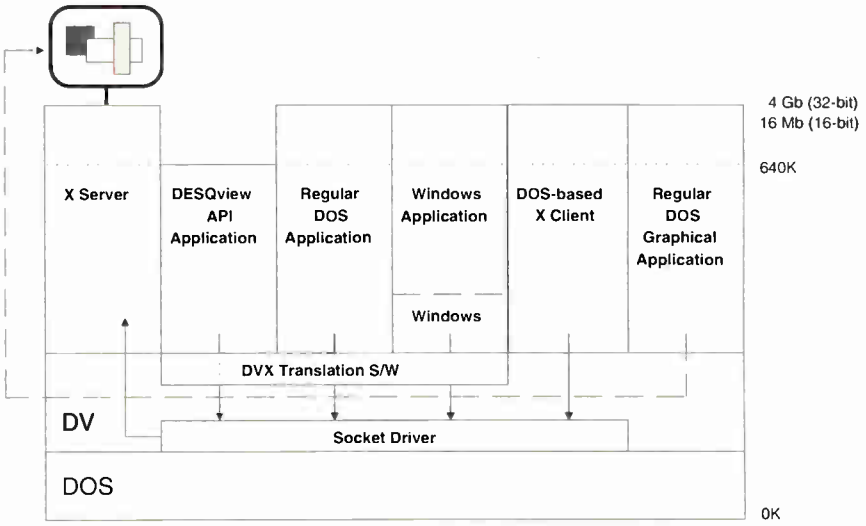
This section describes how the X Window System is integrated into the DESQview environment resulting in DESQview/X and highlights the capabilities of the combined system.

4.1 Minimum Requirements

DESQview/X currently requires a minimum of a 386SX processor, an EGA display, 4MB of RAM and 10MB of free hard disk space. In addition, a mouse is highly recommended.

4.2 General Structure

The general structure of a stand-alone DESQview/X system is shown to the right.



DESQview is loaded on top of DOS, the first program booted into the computer. Multitasking within DESQview can be several program partitions - one containing an X Server in the case of DESQview/X.

4.2.1 The X Server

Display output for the system is provided by the X Server program. The X Server is run within a DESQview partition and is multitasked along with all of the other programs in the system. The X Server in DESQview/X v1.0 is based on Release 4.0 of the X Window System.

The X Server controls the display screen (for the most part) and hence the display resolution of the system and compatible display types are determined by the X Server and not by DESQview. Currently EGA, VGA, Super VGA, 8514/A and DGIS displays are supported. XGA, TIGA and S3 displays are expected for the future - check with Quarterdeck Office Systems for an up-to-date list of displays supported.

The X Server is run as a DOS Extended application (up to 16MB) - this gives the X Server more workspace to perform its display functions and enables it to handle more windows concurrently. It is also available in virtual memory form so that it may use less memory than is normally required.

4.2.2 Socket Driver

Communication in most X Window Systems is accomplished using the Berkeley Socket interface. Consequently, DESQview/X includes the DESQview/X Socket Driver, which accepts these communication requests and intelligently routes the message to the appropriate destination. In the case of a standalone DESQview/X system, the messages are always routed between the X Server and the applications using the X Server for output. Note that the DESQview/X Socket Driver is loaded as part of the DESQview multitasking kernel.

4.2.3 Regular DOS Applications

If a regular real mode DOS application (for example WordPerfect or Lotus 123 release 2) is running within the system, its display output is translated dynamically (that is on-the-fly) by special DESQview/X Translation Software into X Protocol requests. These X Protocol requests are sent using the Berkeley Socket interface to the Socket Driver which routes them to the X Server for output. In effect, a DOS application is made to appear like a regular X Client.

DESQview/X does this for well-behaved applications by trapping their BIOS and DOS calls and converting them into X Protocol requests.

In the case of ill-behaved real mode applications DESQview/X **virtualizes** the application. DESQview/X remaps the application's video RAM to a different portion of memory and scans this **logical window buffer** for any changes, producing X Protocol requests from the scanning process. Note that this process requires a minimum of a 386 processor - the 286 processor lacks the necessary hardware to perform the remapping operation.

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If a regular DOS application is DOS Extended (for example Lotus 123 release 3 or Paradox) and is running within the system, it is treated much the same as a regular real mode DOS application. The major difference being that DOS Extended applications have a far greater workspace available to them than do regular DOS applications (up to 16MB for a 16-bit protected mode application, 4GB for a 32-bit protected mode application).

4.2.4 DESQview API Applications

DESQview API Applications are, by their very nature, well-behaved DOS applications as they use the DESQview API to perform display output. However, the DESQview API allows these applications to create multiple windows as well perform display output to these windows.

This is handled in DESQview/X by intercepting all of the DESQview API calls and generating equivalent X Protocol requests, turning a DESQview API application into what would appear to be an X Client, just as with a regular well-behaved DOS application.

4.2.5 Microsoft Windows and Windows Applications

If Microsoft Windows 3.0 or 3.1 is running in a DESQview/X system along with one or more Windows applications, DESQview/X dynamically translates all Windows display output into X Protocol requests, much the same as it does with regular DOS applications. In effect, Microsoft Windows and Windows applications are made to appear like a regular X Client.

Because of this, a Microsoft Windows session can appear within a resizeable DESQview/X window alongside other X Client windows.

4.2.6 Regular DOS Graphical Applications

Translating a DOS application's graphics screen into X Protocol requests is possible, but is not implemented in DESQview/X Version 1.0. Currently, DESQview/X runs all regular DOS graphical applications as full screen applications only.

4.2.7 X Clients

X Clients may be running on a DESQview/X machine in one of three forms. If small enough to fit within the conventional memory Application Area, they may run in real mode. If larger, they require a DOS Extender to reside in the system. If the X Client is a 16-bit protected mode application, it may be as large as 16MB. If it is a 32-bit protected mode application, the X Client may (theoretically) be as large as 4GB.

Since X Clients already produce X Protocol requests (unlike DOS or Microsoft Windows applications), they need no translation software. Instead, their X Protocol requests are sent to the Socket Driver from the applicable Xlib routines using the Berkeley Socket interface (the standard method of communication in an X Window System). The Socket Driver then routes them directly to the X Server for display output.

Note that these X Clients may be ported from other X platforms (such as many Unix machines) or else may be developed directly under DESQview/X - see the "Development Issues" section for details.

It should be remembered that an X Client is similar to a DOS graphical application in that it produces graphical output, but is very different in the way it achieves this. DOS graphical applications usually write directly to video RAM; an X Client uses X Protocol requests to an X Server to produce the same effect. Thus an X Client can always be windowed.

4.3 Direct Windows

Note that regular DOS and Microsoft Windows applications can be configured to bypass the DESQview/X translation software and run as full screen direct windows (like regular DOS Graphical applications). Doing this eliminates the overhead of translating an application into X protocol requests, resulting in an increase of display speed, but at the expense of the application not being able to display on a remote machine.

4.4 Available Memory

In a typical DESQview/X system, real mode applications usually have at least 500K available to them regardless of their type - DESQview API, regular DOS or otherwise.

DOS Extended applications (which includes Microsoft Windows in standard mode), on the other hand, are usually constrained only by the total amount of memory in the system.

4.5 The Window Manager

Since a user will want to control the windows displayed on the screen by the X Server, a minimum of one X Client will normally be run in a DESQview/X system - the window manager. The window managers that are currently available include:

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DWM	The DESQview/X Window Manager provides a 3D sculpted look and has a menu system similar to DESQview. In addition, it boasts popular DESQview features such as Mark & Transfer and scripts. Best of all, DWM is under 100K in size!
OSF/Motif	Using the OSF/Motif 3D sculpted look, this window manager is a DOS Extended X Client.
OPEN LOOK	This window manager implements the OPEN LOOK graphical user interface and is a DOS extender X Client.

4.6 Fonts

The X Window System (through Release 4.0) has typically relied on bitmapped fonts to produce text output on an X Server. That is, a bitmap exists for a specific typeface (for example, Helvetica or Times Roman) realized at a specific point size. If an X Client requests a particular size of typeface and that size is not available (even though other point sizes in that typeface are available), the X Server would normally tell the X Client that the font does not exist and the X Client either terminates or uses a different font.

Drawbacks to this technique include the limited availability of a typeface to a few point sizes (typically 8 to 24) as well as excess use of hard disk space to store the different sizes that are supported.

4.6.1 Scalable Fonts

With the advent of laser printers, Adobe Systems, Inc introduced the PostScript printing language that took a different approach. Each typeface file was coded in such a way that the printer could scale an individual typeface to any size required. This new file format and the typefaces that were encoded in it are termed "Adobe Type 1 fonts".

The "intelligence" inside of the laser printers that produces the scaling function is actually a sophisticated computer program developed by Adobe Systems, Inc. This technology has been licensed by Quarterdeck Office Systems, Inc and has been incorporated transparently into the DESQview/X system. These font extensions, in no way prohibit continued support of Quarterdeck's scalable fonts when DESQview/X supports the X Window System Release 5.0 (which does define the use of scalable fonts).

When an X Client requests a typeface at a particular size, the DESQview/X X Server first checks its list of available fonts - this font list contains both bitmap and Adobe Type 1 fonts. If it cannot find either a bitmap font of the correct size or a scalable font that can be scaled appropriately, the X Server will return an error. If, however, a font was found, the X Server checks to see if it is presently loaded into memory (for another X Client). If necessary, the X Server will load the font and (in the case of Adobe Type 1 fonts) scale it to the requested size.

4.6.2 Using Scalable Fonts

Advantages of the scalable font technology include an almost endless choice of point sizes for a particular typeface as well as the subsequent economies of hard disk space. In addition, the Adobe Type 1 font format has proved to be the most popular and prolific file type resulting in a vast choice of Type 1 typefaces currently available.

Since the interface for using a scalable font is identical to that for requesting a bitmapped font, an X Client which has no knowledge of scalable fonts may, in fact, be given a scalable font realized at a particular point size if the requested bitmapped one is not present!

On the other hand, an X Client that has been written to recognize scalable fonts can use them to its advantage by creating fully scalable windows, wherein if a user resizes a window, the contents of the window (including the text) scales accordingly. In addition, this kind of X Client can also make use of the fractional spacing and kerning information that is stored in the scalable font file. One example of an X Client that uses scalable windows is the Adobe Type Manager that is supplied with DESQview/X which allows a user to install or delete Adobe Type 1 fonts from a DESQview/X system.

4.6.3 Scalable DOS Windows

Scalable fonts have also been used to great advantage in DESQview/X when displaying DOS text windows (regular DOS applications). When instructed to do so, DESQview/X will scale a DOS window to whatever size the user resizes the window - from a window that occupies the full screen all the way down to a size where each character in the window is represented by only a single pixel!

The benefits of this technology become clear within minutes of using it - a user can view many more DOS windows simultaneously than was previously possible and can shrink a window down to its minimum size in order to keep an eye on the DOS application's progress in background (for example, when performing a long file transfer with a communications program).

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4.7 Advanced Memory Management

Incorporated into DESQview/X is the DOS/4GX Extender technology from Rational Systems, Inc that provides many useful benefits in the area of memory management.

With this technology, it is possible for DESQview/X to run all three types of application for the PC (real mode, 16-bit protected and 32-bit protected) directly. This produces a substantial saving in memory overhead for protected mode applications.

In addition, the DOS/4GX technology also provides both virtual memory and dynamic link library (DLL) capabilities to protected mode applications.

Note, however, that only applications generated specifically for the DOS/4GX Extender can call upon the DOS/4GX technology in DESQview/X. This does not, however, preclude applications developed using other DOS Extenders from running in a DESQview/X system - they will simply not be as memory conscious as a DOS/4GX application since a separate copy of the DOS Extender will be loaded for each instance of the program. In addition, they will not be able to take advantage of virtual memory or dynamic link libraries unless their individual DOS Extender supports these features.

4.7.1 Virtual Memory

Virtual Memory is a technique used in advanced computer systems, wherein an application is divided up into discrete chunks - usually these chunks are regular in size and are called "pages" (otherwise if the chunks are irregular in size, they are called "segments", though for the rest of this section the former term will be used).

When an application is actively running, it typically only uses a few pages of the program in a given time frame - these active chunks are referred to by computer scientists as the "working set" of pages. Since only a few pages are being used at any one time, a large program can waste a lot of memory in a system with inactive pages that may never even be used.

To maximize the use of memory, a computer can load only the working set of pages into memory and run the application as normal. If the application requires a page that is not currently in memory (for example, when "jumping" to a different part of the program, crossing over from one page to the next or accessing a piece of data), a "page fault" is generated by the computer hardware. At this point, the computer chooses a page not being used, swaps it out to hard disk, reads in the required page and then continues executing the application. This process is totally invisible to the application and requires no special programming by the application's developer, hence the term "virtual memory" since the memory always appears to be present to the developer, though physically it may not be all the time.

It is important, however, that sufficient memory is available to hold an application's working set - too little memory will cause page faults to happen with greater frequency so that the computer will spend most of its time accessing the hard disk.

With its DOS/4GX technology, DESQview/X provides this virtual memory option so that more applications can be run concurrently than the amount of memory would normally dictate.

4.7.2 Dynamic Link Libraries

Most applications call on a standard set of routines which need to be duplicated in every application that uses them. Typically these routines are stored in a library of routines and are "linked" in when an application is being generated (at compile time). A good example of this would be the Xlib programming library that is required by X Clients.

Naturally, this leads to a waste of both computer memory and hard disk space as the same information appears in separate applications.

Dynamic Link Libraries (or DLLs) are a way of sharing these routines among several applications. The routines are stored on disk in only one place - the dynamic link library - saving space on a computer's hard disk. Whenever an application is loaded that requires a specific DLL, the computer first checks to see if that DLL has already been loaded for another application. If it has been loaded, the computer points the application to the DLL already in memory. If it is not loaded, the computer will load the DLL first before it can be used by the application. Since multiple applications use the same copy of the DLL while running, memory space is conserved. Note that when all applications using a DLL terminate, the DLL is discarded from memory as it is no longer needed.

Along with the advantages of saving disk and memory space, DLLs also provide another benefit known as "late-binding". Early-binding occurs when routines are linked into an application at compile/link time on the application developer's machine - the application becomes a single entity that cannot be changed unless the developer issues an update. DLLs, by their very nature, exhibit late-binding - the linking process occurs at run time, on the user's machine, after the application was compiled.

This difference seems trivial until a scenario is considered whereby several different applications from different manufacturers (or even the same manufacturer) use the same DLL. Assume the DLL provides access to a particular type of device, a tape drive for example, and that the drive manufacturer releases a new drive with a slightly different hardware

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interface. Without DLLs, all applications that used the previous tape drive would have to be recompiled by their respective companies and updates sent to existing customers that purchase the new drive. With DLLs, only a new DLL need be produced and distributed to customers along with the new drive. The more applications that use a particular DLL, the bigger the advantage of late-binding. Note that DLLs are not updated solely because of new features, but can also be updated because of enhancements to a DLL's routines.

With its DOS/4GX technology, DESQview/X can conserve both disk and memory space as well as delivering the advantages of late-binding through the availability of a dynamic link library option.

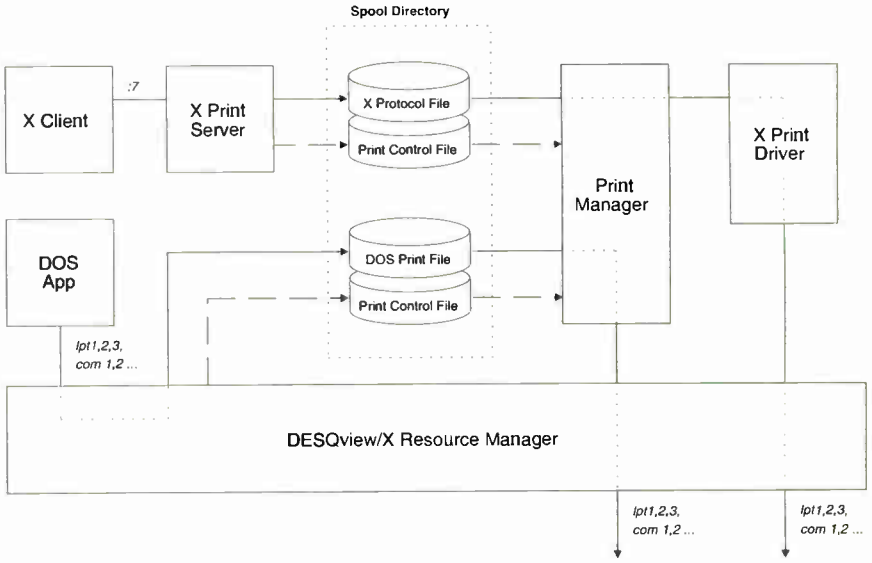
4.8 Print Server

The DESQview/X Print Server consists of several components - a Print Manager, an X Print Server and an X Print Driver. In addition, the Print Server calls upon the services of the DESQview/X Resource Manager when printing from DOS applications.

For DOS applications, DESQview/X may be configured such that it will manage contention for the same printer and can spool the print information to disk until a printer is ready to receive it. (Note that DESQview/X can also be configured such that no spooling or contention management is performed and printer output is routed directly to a printer.)

For X Clients, DESQview/X always spools X Protocol requests to disk and translates these requests into the appropriate printer commands thus providing a single output imaging model.

The components of the DESQview/X Print Server and the interrelationships between those components are shown to the right.



Despite there being the interaction of several components in order to print a file under DESQview/X, the user normally only sees and interacts with the Print Manager (which provides choices such as holding, resuming and killing print jobs). The X Print Driver is a "daemon" (unseen) process that is both created and killed by the Print Manager, the X Print Server is implemented inside of the X Server process and the DESQview/X Resource Manager is a special driver loaded by the DESQview multitasker.

4.8.1 DOS Application Printing

When a DOS application prints to a printer, it does so through either the printer ports LPT1, LPT2, LPT3, the communication ports COM1, COM2, or the DOS file handle 4. When running in DESQview/X, the DESQview/X Resource Manager traps these requests and spools the print information into a DOS print file as well as creating a print control file that specifies additional information (such as which printer to print the file on and the number of copies). These two files are created in the DESQview/X spool directory. The Resource Manager then informs the Print Manager of the file that needs printing, whereupon the Print Manager adds the request to the end of its print list.

When the Print Manager is ready to print a particular file, it reads the information from the relevant printer control file and routes the DOS print information from the file to the correct printer. The Resource Manager recognizes that it is the Print Manager trying to print and allows the printer information to pass through (via the printer ports LPTx, communication ports COMx or DOS file handle 4) instead of trapping the print operation.

Note that DESQview/X does not alter the DOS print information in any way. Therefore, all DOS applications must be configured correctly for the printer type attached to a DESQview/X system (PostScript, IBM Proprinter or otherwise).

4.8.2 X Client Printing

Unfortunately, the X Window System does not define a standard for X Clients to produce printer output, with each system manufacturer taking their own approach. It was decided for DESQview/X that printing from an X Client should be performed using exactly the same method as for displaying output on the screen, that is, by using the X Protocol.

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This single imaging model has the distinct advantage of simplifying the coding of X Clients as they need only support one type of output device - regardless of whether the output is destined for the screen or printer. In addition, this also makes existing X Clients easier to update to include printing capabilities.

Under the X Window System, an X Client specifies on which X Server it wishes to display output by means of an address that takes the form machine_name:display_number.screen_number (note that in X, the term "display" refers to a workstation that consists of a keyboard, a pointing device and one or more screens). Hence the address radish:2.1 refers to the second screen (0 is the first and 1 is the second) on the third workstation (0,1 then 2) on the machine called "radish" on the network.

If an X Client connects to a DESQview/X workstation using the display number 7, for example radish:7, (note that if a screen number is not specified it is presumed to be 0), the X Print Server in the DESQview/X X Server recognizes this and spools the X Client's X Protocol requests into a file in the DESQview/X spool directory. In addition it also creates a print control file that specifies additional information for the Print Manager.

When the X Client disconnects from display number 7, the X Print Server informs the Print Manager of the file that needs printing, whereupon the Print Manager adds the request to the end of its print list.

When the Print Manager is ready to print a particular file, it reads the information from the relevant printer control file and, recognizing that the file is an X Protocol file, passes the file over to the X Print Driver for processing. Note that the X Print Driver is under the control of the Print Manger which both starts and removes the X Print Driver from the system as necessary. When the X Print Driver is handed an X Protocol File, it translates the X Protocol requests into the necessary printer codes and outputs them to the X Printer connected to the DESQview/X system.

The Resource Manager recognizes that it is the X Print Driver trying to print and allows the printer information to pass through (via the printer ports LPTx, communication ports COMx or DOS file handle 4) instead of trapping the print operation.

Note that only one printer may be designated as the X Printer (though, DOS applications may also output to this printer if they are configured to recognize the printer type) - the selection of the X Printer is performed using the DESQview/X Setup program.

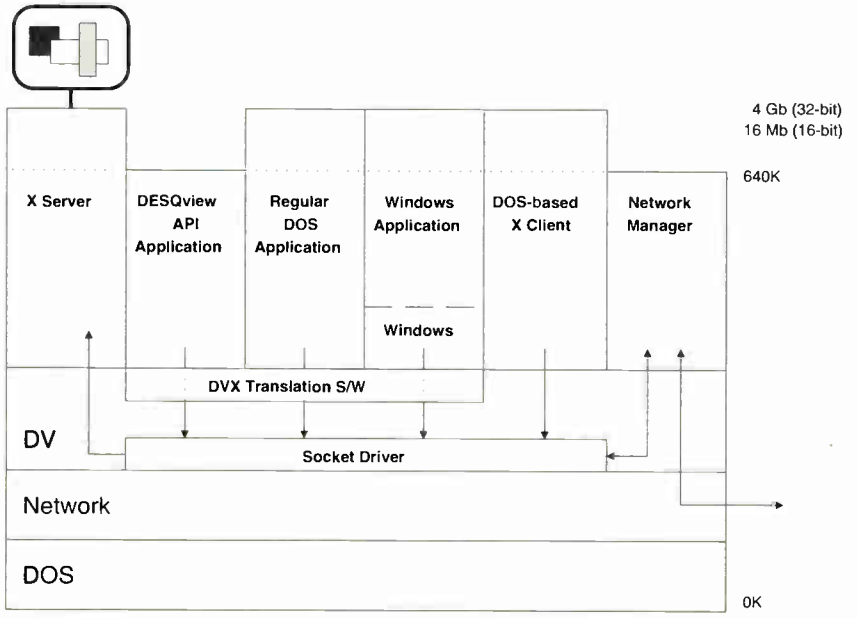
4.8.3 Print Manager

The Print Manager can be thought of as a traffic officer, directing files to the appropriate printers at specific times or alternatively to the X Print Driver. It is possible for the user to interact with the the Print Manager, list and reorder files in its print queue, suspend and resume printing as well as other operations.

Note, however, that DESQview/X may be configured such that spooling can still occur even if the Print Manager is not present in the system. When the user then starts up the Print Manager, it searches the spool directory for printer control files, produces a resulting print queue and begins printing.

4.9 The Network Connection

When a DESQview/X system is connected to a network, the structure is identical to that of a stand-alone system, but with the inclusion of network software and the DESQview/X Network Manager.



4.9.1 The Network Manager

The DESQview/X Network Manager is the bridge between the DESQview/X Socket Driver and the underlying network software. Since PC networks and their supporting network software vary greatly, a different version of the Network Manager is supplied depending on the type of network installed. Currently, the DESQview/X Network Manager can communicate using the following network APIs and network software: NetBIOS, Novell Netware IPX/SPX, FTP

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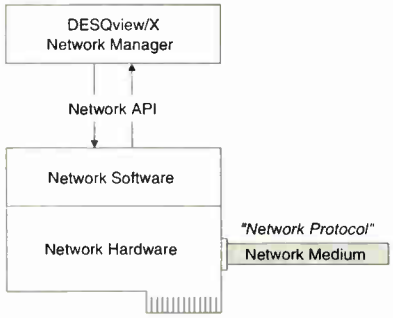
Systems PC/TCP, and Novell's LAN WorkPlace for DOS. Check with Quarterdeck Office Systems for an up-to-date list of network APIs/software supported.

Note that there are many pieces in the network puzzle that must be compatible with each other in order for DESQview/X (or any other piece of software) to function over a network.

The DESQview/X Network Manager communicates with the Network Software using a network API. The network software in turn communicates with a piece of network hardware (using the hardware's specific interface) which then sends the network data out over a network medium (usually a cable of some sort) according to a network protocol (a particular format for the data). The examples at right should make this relationship clear.



Because of the tremendous variety available between network software and hardware, Quarterdeck Office Systems cannot publish an exhaustive list of networks supported. Quarterdeck has an ongoing program to support popular network API's/software and will be making them available as soon as they are developed.

API	Software	Hardware	Medium	Protocol
IPX/SPX	Netware (Novell)	NE-2000 Adapter	Ethernet Cable	IPX/SPX
NetBIOS	IBM Token Ring Network (IBM)	IBM Token Ring Adapter/A	Token Ring Cable	NetBIOS
private	PC/TCP (FTP Systems)	NE-1000 Adapter	Ethernet Cable	TCP/IP

Examples of Network Software and Hardware Combinations

4.9.2 Operation over a Network

When an X Client (DOS-based X Client, DOS or Microsoft Windows application translated to X Protocol requests) is started under DESQview/X, a parameter is supplied that specifies which screen the program's output should be displayed on. (This is standard procedure for any X Window System.) If the display specified is not the local DESQview/X screen, the DESQview/X Socket Driver will route the X Protocol requests to the DESQview/X Network Manager. The Network Manager then uses the appropriate network API to transmit the request to the correct machine on the network via the network software. If, on the other hand, the output should appear on the local screen, the Socket Driver will route the X Protocol requests directly to the local X Server as in the case of the stand-alone system.

Conversely, if another machine on the network sends X Protocol requests to the DESQview/X system for display on its screen, the request is first accepted by the Network Manager. The Network Manager will then route the requests to the local X Server via the Socket Driver by using the Berkeley Socket interface.

4.9.3 Communication Ports

Most networks rely on the notion of "ports" when communicating. An application will connect to a port on a remote machine in order to communicate with it. In machines that run the X Window System, TCP/IP or the Unix operating system, several of these ports are "reserved" and imply a special type of connection.

For example, port numbers starting at 6000 are the X Protocol ports (remember that a machine can have multiple X Servers connected to it so that 6000 refers to the first X Server (or "display number" 0), 6001 to the second, etc). Whenever an application connects to port (for example) 6002 on a remote machine and sends a message to it, the receiving machine knows that it is an X Protocol request by virtue of the port number. It is then the receiving machine's duty to dispatch the request to the appropriate X Server (the third X Server, or display number 2, in this case).

Note that there can be multiple connections to a single port. This is because a connection is defined by both the sending machine/port number and the receiving machine/port number. Since most reserved ports do not take into account the number of the sending port, one machine can have multiple connections to another machine's port by choosing different send ports. This is necessary when (for example) multiple applications on one machine connect to the X Server on another.

Other reserved ports imply several other functions - RSH (Remote Shell), REXEC (Remote Exec), FTP (File Transfer Protocol) and Telnet. Unlike the X Protocol port, these 4 other ports typically spawn "daemons" - programs that are invisible to users of the remote machine and execute in the background. DESQview/X supplies daemons for RSH, REXEC and FTP, but not Telnet - see the Telnet section for deatils.

4.9.4 Remote Shell

A **remote shell** (RSH) is one method for starting up applications on remote (other) machines anywhere on the network. When a user types in an RSH command on one machine, the RSH program connects to the RSH port on the remote machine. At this point, the remote machine (recognizing that the RSH port was connected to), spawns an RSH daemon.

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This RSH daemon takes the command supplied in the RSH message and executes it on the remote machine for the user specified in the message, sending any output back to the originating port - typically this output is simply echoed to the screen by the originator's RSH program.

DESQview/X supplies both an RSH daemon to respond to RSH requests as well as an RSH program that can send RSH requests to another machine.

This is a very powerful concept - remember that X Protocol requests produced by an X Client may be routed to any X Server on the network. A user seated at one machine (be it DESQview/X or Unix) may use the remote shell feature to start up an application on another machine, yet have its output appear on the user's local machine (or any other display on the network). The user is now able to operate and use the X Client that is running remotely. X Clients that are run this way are termed remote clients.

Naturally, there are safeguards in the RSH feature that are intended to stop unauthorized access to remote machines, however, they are far from complete. Because of this, the Remote Exec feature was developed.

4.9.5 Remote Exec

The **remote exec** (REXEC) function is very similar to the RSH command except for how it guards against unauthorized access. With REXEC, the user supplies a password that is transmitted along with the REXEC command. If the password is not valid for the user name specified in the message, the command will fail.

DESQview/X supplies both an REXEC daemon to respond to REXEC requests as well as an REXEC program that can send REXEC requests to another machine.

4.9.6 File Transfer Protocol

The **file transfer protocol** (FTP) function is used to transfer files to and from a remote machine, as well as list directories on the remote machine.

The FTP daemon responds to a limited set of english-like commands that specify actions such as listing a directory, changing to another directory and receiving or transmitting a file. The DESQview/X File Manager application uses these capabilities to perform sophisticated file operations between machines. It connects to the remote machine's FTP port and issues the low-level FTP commands to gather information required and transfer files.

DESQview/X supplies an FTP daemon to respond to FTP requests and the DESQview/X Network Manager - DESQview/X to Other X Systems includes an FTP program that can send basic FTP requests to another machine. The FTP program is not included in the base product as the File Manager companion is easier to use and more advanced.

4.9.7 Telnet

The **Telnet** function is used to create a terminal session on a remote machine which is displayed on the local machine. A Telnet request invokes the Telnet daemon, which in turn (typically) starts a "shell" program, such as the login program on most Unix machines. The session then behaves much like a modem communications session - the shell program on the remote machine (and any programs run under the shell) send characters and terminal control sequences which are routed via the Telnet daemon to the Telnet requestor and then to the user's display. In turn, the Telnet requestor will also send characters typed by the user to the Telnet daemon which routes them to the shell program.

Since Telnet was primarily designed for communicating with a TTY-style (line and character-oriented) device, the Telnet daemon has not been implemented for DESQview/X as this would require a program capable of translating DOS screens into TTY-style commands. Instead, a remote machine running the X Window System can use RSH or REXEC to start a DOS session. Note, however, DESQview/X does supply a Telnet client that can start a Telnet session on a remote (non-DESQview/X) machine.

4.9.8 Remote Clients

The remote shell and remote exec functions open up a wealth of possibilities for users connected over a network by spawning **remote clients**. All of the X Clients on an X network can be started up and used by any X Window user on the system.

Since regular DOS and Microsoft Windows application screens can be dynamically converted to X Protocol requests by DESQview/X, DOS and Windows applications appear on a network as X Clients. Because of this, non-DOS users on a network may use DOS and Windows applications available on a DESQview/X machine. Applications that may not be used this way are those which cannot be translated into X Protocol requests on the host DESQview/X system. Currently, those applications are regular DOS graphical applications.

In effect, any DESQview/X machines on a network appear somewhat as Unix machines with their DOS and Microsoft Windows applications running as X Clients.

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The converse to the above is also applicable - a networked DESQview/X machine may use X Clients available on other non-DOS machines (for example, a Sun or SCO Unix system.)

4.9.9 Interprocess Communications

Communications between processes is implemented in DESQview/X through the industry standard Berkeley Socket interface - the primary means of IPC communications for Unix machines.

This interface was designed to be totally independent of any underlying network and hence can be used by one process to communicate with another on a different machine across a network, regardless of the type of network (TCP/IP or Novell, for example). In DESQview/X, Berkeley Socket interface calls are accepted by the DESQview/X Socket Driver which routes them to the appropriate destination - whether to another application in the same machine, or to an application on a remote machine by broadcasting the message over a network. This results in the simplified coding of an application as it communicates with both local and remote applications in exactly the same way.

In a similar fashion to the DESQview API mailbox interface, the Berkeley Socket interface does not dictate the content of the message sent to another process, hence any manner of dialog may be implemented between two processes.

4.10 Stand-Alone or Networked?

DESQview/X may be run either as a stand-alone system or networked.

If run as a stand-alone system, applications typically run on the system will be the X Server (for display output), a window manager (to control the windows), multiple DOS and Windows applications and multiple X Clients.

If a DESQview/X machine is networked, the minimum required running is the X Server and Network Manager. The window manager and any X Clients (be they regular X Clients or dynamically translated DOS or Windows applications running on another DESQview/X machine) may all be run remotely on other machines on the network. Usually, some local applications will also be run.

4.10.1 Unix Machines and DOS/Microsoft Windows programs

Assume a network to primarily consist of Unix machines and/or X terminals. If a DESQview/X machine is added to the network that has a powerful processor (such as a 386 or 486), all of the Unix X Window users would then be able to use many of the DOS and Microsoft Windows applications that are available on the DOS (DESQview/X) machine.

4.10.2 DOS Machines and Unix Programs

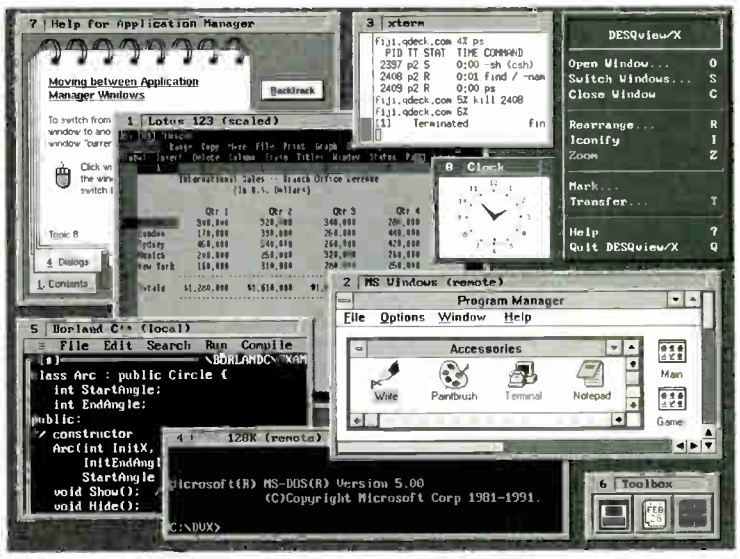
The converse to the above situation is also true. On a DOS-based (DESQview/X) network, the addition of a Unix machine provides the DOS users access to any X Clients on the Unix machine. Large, powerful applications now become feasible that are not available for DOS and which would suffer running under a slower processor. In addition, by using the Xterm application on a Unix machine enables DOS users to access that machine's character-based non-X applications as well.

4.11 A User's View

It is not important to the user whether an application being used is running locally or remotely. It is possible with DESQview/X to hide all of these details, such that a user views a screen much like the one shown.

The screen shot shows a DESQview/X system with the DESQview/X Window Manager. Some applications are labelled "remote" or "local" for illustration purposes only, though a user's implementation of this system may elect not to show this kind of information.

In the picture, DOS 128K (COMMAND.COM) and Borland C++ are DOS applications, one running on a remote DESQview/X machine, the other locally; Lotus 123 is also a local DOS application, but is displayed in a scalable DOS window. Application Manager (labelled "Toolbox"), its Help window and Clock are DOS-based X Clients; Xterm is a remote X Client running on a Sun workstation; and MS Windows is a Microsoft Windows session that is being run on another DESQview/X system, but displayed locally.



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4.12 A Consistent Growth Path

DESQview/X is built on the existing technology of DESQview and DESQview 386 - two time-proven DOS multitaskers that are popular worldwide. Because of this, Quarterdeck can provide users with an excellent and consistent growth path that starts with DESQview:

DESQview — DESQview provides the DOS user with a multitasking environment on machines with as little as 640K, a hard disk, a monochrome monitor and an 8088 processor. DESQview is a character-based environment, but can also run graphics applications. Features include windowing and program swapping as well a keyboard macro program, a help system, a DOS Services utility and easy-to-use keyboard or mouse control.

DESQview 386 — In addition to DESQview's features, DESQview 386 provides the 386/486 DOS user with a multitasking environment that incorporates superior memory handling, windowing features and program protection.

DESQview/X — DESQview/X incorporates the functionality of DESQview and DESQview 386, yet sports a graphical interface that is consistent with the menuing system used by those products. Because of its complete X Window capability, DESQview/X also gives users the capability to run local X Clients as well as access to DOS or Microsoft Windows applications and X Clients on remote machines (using the appropriate network software).

DESQview/X and OSF/Motif, OPEN LOOK Window Managers — When DESQview/X is joined by either the OSF/Motif or an OPEN LOOK window manager, users will have a consistent look and feel across all machines on a network, from DOS machines (DESQview/X) to X Terminals, Unix workstations, minis and mainframes.

4.13 DESQview/X System Capabilities

The capabilities of a DESQview/X system outlined in the preceding sections can be dependent on many factors. Consequently, here is a table of DESQview/X's capabilities:

DESQview/X Capabilities	386 486
Remote X Client, Remote DOS Application or Remote Microsoft Windows and Application	**W**
Local X Client — Real Mode	**W**
Local X Client — 16-bit Protected	**W**
Local X Client — 32-bit Protected	**W**
Local Well-behaved DOS Text Application or Local Ill-behaved DOS Text Application with Loader — Real Mode	**W****
Local Well-behaved DOS Text Application or Local Ill-behaved DOS Text Application with Loader — 16-bit Protected	**W****
Local Well-behaved DOS Text Application or Local Ill-behaved DOS Text Application with Loader — 32-bit Protected	**W****
Local Ill-behaved DOS Text Application — Real Mode	**W****
Local Ill-behaved DOS Text Application — 16-bit Protected	**WD****
Local Ill-behaved DOS Text Application — 32-bit Protected	**WD****
Local DOS Graphical Application — Real Mode	**D**
Local DOS Graphical Application — 16-bit Protected	**D**
Local DOS Graphical Application — 32-bit Protected	**D**
Local Microsoft Windows 3.0, 3.1 and Windows Application — Real Mode*	**W****
Local Microsoft Windows 3.0, 3.1 and Windows Application — Standard Mode	**W****

W	Application can be displayed in an X window and can act as a remote X Client for another X Server on a network.
D	Application can only be displayed direct and cannot act as a remote X Client for another X Server on a network.
WD	Dependent on individual application - most run as W, some may run as D.
-	Processor cannot support this type of application.
*	Available only with Microsoft Windows version 3.0.
**	Application may be run as a direct window (full screen) for fastest performance.

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5 Development Issues

This section outlines the development procedures for the different program types that DESQview/X supports and examines how these relate to the development of X Clients under DESQview/X.

DESQview/X supports the following kinds of applications: DOS text (regular DOS applications), DOS graphical (regular DOS graphical applications), DESQview API, Microsoft Windows and of course, X Clients. Most of these application types can appear as either real mode, 16-bit protected or 32-bit protected.

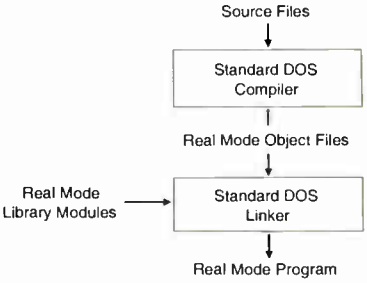
5.1 Real Mode Applications Development

In order to generate a real mode application, a developer will follow the traditional steps to produce an application:

First, all necessary source files are compiled using a regular DOS compiler to create real mode object files. Next, a regular DOS linker is used to link those object files with real mode library modules to produce a runnable application.

Often the compiler, linker and library modules are supplied by a single manufacturer as a complete package.

Library modules are available (sometimes from third party manufacturers) with graphic routines to produce a graphical application or Microsoft Windows routines to produce a Windows application.



5.2 Protected Mode Applications Development

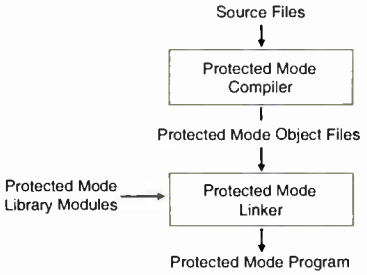
To generate a protected mode application for DOS, a developer will require the use of a DOS Extender package and normally follows one of two paths.

5.2.1 Using a Protected Mode Compiler and Linker

If a protected mode compiler is used, it will generate protected mode object files. (Note that the words "protected mode" in the name "protected mode compiler" are referring to the kind of output the compiler generates, not the kind of program the compiler may be - it could actually be a real mode program or a protected mode program running under a DOS Extender!)

These protected mode object files are then linked with protected mode library files and DOS Extender modules to create a protected mode application that is runnable from DOS.

Typically the compiler, linker and library modules are supplied by a single manufacturer as a complete package.



- If a 16-bit protected mode application is required, then a compiler and linker capable of handling 16-bit protected code must be used as should 16-bit protected library modules.
- For a 32-bit protected mode application, a compiler and linker capable of handling 32-bit protected code must be used as should 32-bit protected library modules.

As in the case of real mode applications, library modules are available (sometimes from third party manufacturers) with graphic routines to produce a graphical application or Microsoft Windows routines to produce a Windows application.

Note that a trend in protected mode compilers is to offer a DOS Extender as part of the compiler package, obviating the need to choose and purchase a DOS Extender separately.

Previously, there was not as big a selection of 16-bit and 32-bit protected mode development packages as there are today. To address this situation, many DOS Extender manufacturers supply an alternate route: using regular DOS compilers.

5.2.2 Using a Regular DOS Compiler

If a regular DOS compiler is used, this will create real mode object files. This may seem inconsistent, however real mode is very similar to 16-bit protected mode code, save for a few constraints. Note that if generating code for a 32-bit environment, using a regular (16-bit) DOS compiler will result in code that will not take advantage of the 32-bit architecture of the processor.

At this point either a regular DOS linker or a protected mode linker may be used. Whatever linker is used, it will typically link in real mode library routines and some protected mode modules as well in addition to the DOS Extender modules. The real mode library routines are ones supplied by the regular DOS compiler manufacturer that do not violate protected

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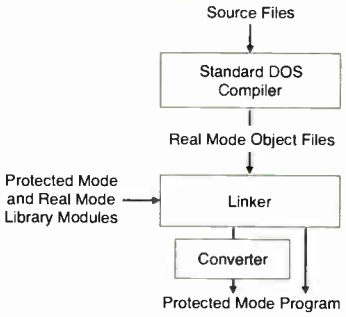
mode guidelines and hence may be used in a protected mode environment. Any library modules that do violate those guidelines are replaced by modules that have been rewritten by the DOS Extender manufacturers and are linked in as protected mode modules.



Sometimes it may be necessary to run a conversion program after the linking stage to create the final protected mode program.

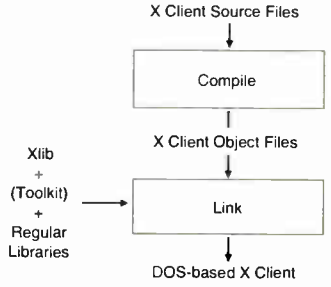
Note that a need for protected mode linkers has become apparent because many regular DOS linkers have certain limitations when creating protected mode programs (since they were not designed to produce these kinds of programs).

5.2.3 DOS Extenders

In order for a protected mode application to run under DOS (or DESQview/X) it requires the use of a DOS Extender. A third-party DOS Extender may be used, though many compilers now supply their own DOS Extender and protected mode libraries. DESQview/X includes the DOS/4GX DOS Extender and the DESQview/X Development Kits (see later) supply the necessary protected mode libraries.

5.3 X Client Development for DESQview/X

Developing or porting X Clients to the DESQview/X platform requires a developer to follow the general steps outlined in the previous section.



Depending on the size of the resultant X Client, a developer will create either a real mode, 16-bit protected mode or 32-bit protected mode application. Typically, X Clients that are ported from another environment (usually Unix) will be implemented the easiest as a 32-bit protected mode application.

In order to create an X Client as opposed to a regular DOS or DOS Extended application, the X Client object files are linked with Xlib and/or Toolkit function libraries in addition to the usual program libraries.

5.3.1 DESQview/X Development Kits

The development kits that are (or will be) available for the development of X Clients in DESQview/X are:

X11	includes XLIB, Xt Intrinsics, Athena Toolkit and sample X Clients.
OSF/Motif	add on to X11 Toolkit
OPEN LOOK	add on to X11 Toolkit

Each development tookit includes different versions of the program libraries for use by particular compilers. The versions that are (or will be) available include:

Library	Real Mode	16-bit Protected	32-bit Protected
X11	B,M,Z	B,IC,M,Z	G,HiC,W
OSF/Motif	-	?	?
OPEN LOOK	-	?	?

B	Borland C/C++ 3.1	M	Microsoft C version 5.1 or 6.x
G	GNU C/C++	W	Watcom C/386 9.0
HiC	Metaware High C 1.7 or 3.0	Z	Zortech C/C++ 3.0
IC	Rational Systems Instant-C	?	Not determined yet

OSF/Motif and OPEN LOOK libraries will not be supplied for use by real mode applications due to the size of their libraries.

Rational Instant-C is of interest in that it is an incremental compiler - it recompiles functions as they are changed to provide a fast development environment much like interpreted BASIC. For final code, however, a program should then be compiled with a fully-optimizing compiler such as Microsoft C.

This table is by no means exhaustive and is expected to change - check with Quarterdeck Office Systems for a list of compilers/program modes currently supported.

5.3.2 DOS/4GX Support

Because DESQview/X contains DOS/4GX DOS Extender technology, a separate DOS Extender is not required for use with the DESQview/X Development Kits. Compilers supported by the DESQview/X Development Kits produce code that is compatible with the DOS/4GX support.

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6 DESQview/X Products

There are several products available in the DESQview/X suite of system software - base products, additional window managers, development kits and additional network manager product.

> Contact Quarterdeck Office Systems Customer Service at (800) 354-3222 for a complete list of products and services offered as well as current list prices.

DESQview/X (for 386 PCs)

This product enables a single user to implement on a 386 processor (or better), the DESQview/X graphical environment system for running DOS, Microsoft Windows and/or DOS-based X Clients. In addition, remote computing facilities are provided so that the DESQview/X system can interact with other DESQview/X systems using either a Novell (IPX/SPX) or NetBIOS network. Specifically, a DESQview/X system may use remote DOS, Microsoft Windows or DOS-based X Clients on other DESQview/X systems as well as being able to transfer files.

It includes QEMM-386, Quarterdeck Manifest, the X Server product, the DESQview/X Window Manager (DWM), several graphical utilities (the DESQview/X Companions - Application Manager, File Manager, Icon Editor and Adobe Type Manager) and support software such as a Print Manager and DESQview/X to DESQview/X Network Manage for IPX/SPX and NetBIOS.

OSF/Motif Window Manager

An addition to the DESQview/X base product, the OSF/Motif Window Manager replaces the default DWM window manager to sport an OSF/Motif look and feel.

OPEN LOOK Window Manager

An addition to the DESQview/X base product, the OPEN LOOK Window Manager replaces the default DWM window manager to sport an OPEN LOOK style interface.

DESQview/X Network Manager - DESQview/X to Other X Systems

This network software product is an addition to the DESQview/X base product and enables a DESQview/X system to communicate with other X machines (DESQview/X or otherwise) over a variety of networks. Note that the DESQview/X base product includes support for NetBIOS and IPX/SPX (Novell) networks - this additional package delivers support for other network APIs such as PC/TCP (FTP Systems) and LAN WorkPlace for DOS (Novell) and includes a coupon for a free copy of Novell's TCP/IP Kernel for DOS. Since this list may change, check with Quarterdeck Office Systems for an up-to-date list of network APIs that DESQview/X supports.

Note that this package permits a DESQview/X system to communicate with other DESQview/X and X Window machines over a network. It is not a substitute for and does not replace the standard network software that is required to form a network.

DESQview/X X11 Toolkit

The DESQview/X X11 Toolkit enables developers to port existing X Clients to the DESQview/X platform or create new ones. This kit contains the X11 program libraries for all supported compilers (Xlib, the Xt Intrinsics, the Athena Toolkit) and sample X Clients. In addition, the kit includes the DOS/4GX Extender tools, Rational System's Instant-C and Oxygen utility, full printed documentation, and developer support from Quarterdeck Office Systems.

Check with Quarterdeck Office Systems for a list of compilers/program modes currently supported for this and other development kits.

DESQview/X X11 Library Kit

The DESQview/X X11 Library Kit is a less expensive version of the DESQview/X X11 Toolkit that does not include Rational System's Instant-C and Oxygen utility. In addition it only includes standard 90-day end user support from QOS.

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DESQview/X X11 Starter Kit

The DESQview/X X11 Starter Kit consists of the GNU C/C++ compiler and GNU versions of the DESQview/X X11 Libraries (Xlib, Xt Intrinsics and Athena Widgets). In addition, minimal printed documentation is included that describes compiling X Clients as well as specific details on programming and configuring the DESQview/X environment. No documentation regarding generic X Window programming is supplied with this kit.

Even though this kit does not include the DOS/4GX Extender tools, 32-bit protected mode applications may be developed as the GNU compiler includes its own DOS Extender.

This kit is provided at a very competitive and inexpensive price and only includes standard 90-day end user support from QOS.

DESQview/X OSF/Motif Toolkit

An addition to the DESQview/X X11 development kits, the OSF/Motif Toolkit enables developers to create applications with an OSF/Motif look and feel. It consists of the OSF/Motif program libraries, the DESQview/X OSF/Motif Window Manager, Motif and DESQview/X Programming manuals at a very attractive price.

Check with Quarterdeck Office Systems for a list of compilers/program modes currently supported for this development kit.

DESQview/X Developer Passport Support

DESQview/X Developer Passport Support (included only with the DESQview/X X11 Toolkit and available separately) provides a year of special access to DESQview/X development support technicians and to the DESQview/X porting laboratories. The porting laboratories offer individual personalized assistance when porting to the DESQview/X platform or creating new DESQview/X applications. Two locations currently exist - Santa Monica, California and Chelmsford, England with more planned.

Note that many components of the DESQview/X Development Kits (including developer support) are available separately - please contact Quarterdeck Office Systems for a complete list of products/services and current list prices.

FREE EVALUATION DEVELOPMENT KIT

DESQview/X X11 Libraries for GNU C/C++

The GNU C/C++ versions of the DESQview/X X11 Libraries (Xlib, Xt Intrinsics and Athena Widgets) are available on Internet (anonymous ftp server barnacle.erc.clarkson.edu, qddvx100.zip file (note '100' denotes version 1.00 - this can change) in directory /pub/msdos/djgpp) and from the Quarterdeck Office System BBS ((310) 314-3227). Note that the GNU C/C++ compiler is also available from Internet and the QOS BBS.

Even though this libraries do not include the DOS/4GX Extender tools, 32-bit protected mode applications may be developed as the GNU compiler includes its own DOS Extender.

These libraries are offered free of charge, but include no documentation or support from QOS.

Internet Downloading Instructions

FTP users:

```
File location:
    host:      barnacle.erc.clarkson.edu
    login:     ftp
    password:  <your email address>
    directory: ~ftp/pub/msdos/djgpp
```

Non-FTP users:

```
% mail archive-server@barnacle.erc.clarkson.edu
Subject: <none>
help
index msdos/djgpp
<ctrl-D>
```


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TRADEMARKS

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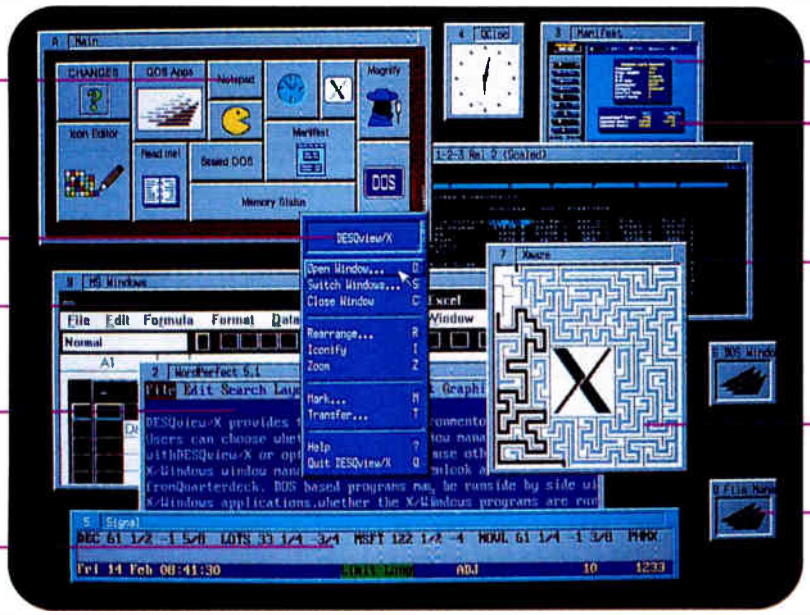
Raising DOS to the Power of X™

DESQview/X Application Manager, for organizing programs and projects

Comfortable DESQview look and feel for BOTH keyboard and mouse users

DOS and Windows applications compatibility

Multitasking



Award winning memory management with Manifest and QEMM-386

Scalable fonts and scalable DOS windows thanks to Adobe Type Manager™ for DESQview/X

Built-in X Window System graphics, the international standard for graphical windowing and distributed computing

QESQview/X File Manager for managing files on your PC and on remote systems

DESQview/X takes your 386 or i486 computer where it has never gone before. Beyond mere windowing, beyond ordinary graphical interfaces. With DESQview/X your computer is no longer limited to the power of your PC and DOS applications.

DESQview/X brings you the windowing, multitasking, DOS and Microsoft Windows compatibility, data transfer, and key-stroke macro facilities, that you would expect from Quarterdeck, the leader in DOS multitasking. With the addition of X Window System graphics, Adobe Type Manager™ for scalable fonts and scalable DOS windows, a graphic desktop, customized menus and icons, and remote computing, DESQview/X redefines the limits of personal computing.

Technical Support: 310/392-9701 Fax: 310/314-3217

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FEATURE

The Information Theater

You've never seen your data quite like this before

MARK A. CLARKSON

The promise of the information age is instant access to the sum of human knowledge from anywhere, at any time. The reality is vast numbers of disconnected databases, each with its own search engine, procedures, and classification scheme. Nothing is more frustrating than knowing that the information you need is out there and having no way to retrieve it.

Retrieving the information you want—and only the information you want—is the focus of an exciting research project at the Xerox PARC (Palo Alto Research Center). The result, called the Information Theater, combines a novel interface with search-and-retrieval technologies to create an information system that brings the promise of the information age closer to reality.

Roots

The notion of the Information Theater was born out of the Interactive Information Access project at Xerox PARC. The Information Theater is about text. It exploits PARC's strengths in user-interface design and natural-language processing to develop new ways of organizing and presenting text on a computer. The results transform database searches and text retrieval into a kind of interactive TV show—with a heavy emphasis on real-time computer animation.

The Information Theater calls on the work of PARC's User Interface Research Group on Information Visualizers (see "An Easier Interface," February 1991 BYTE), which enable databases to appear as physical, 3-D structures that can stretch, slide, and spin in the air (see photos 1 and 2). Information Visualizers use familiar perceptual cues, such as light and shadow, to draw you into their artificial, animated reality. You can see your information, touch it, and rearrange it, achieving a deeper, almost tactile understanding of its structure.

Information Visualizers exemplify the Information Theater's high-bandwidth interaction. This interaction requires high-speed computers, sophisticated graphics, and whole new user interfaces and paradigms. To be effective, the Information Theater has to be more than engaging—it has to be fast. Speed is crucial to maintain the illusion of seamless animation and to make the indexing and searching of large databases quicker. Even if you are merging and sorting a couple of encyclopedias, you don't want to wait forever.

People and Machines

The Information Theater doesn't try to replace human intelligence. Rather, it applies intelligence in ways that seek to

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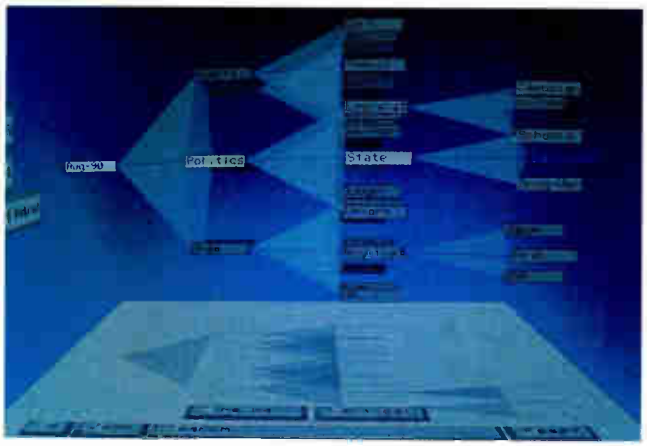

Photo 1: *Topics emerging from one month's (August 1990) articles from the* New York Times *news wire are displayed using an Information Visualizer called the Cam Tree. (Photo courtesy of Xerox PARC)*

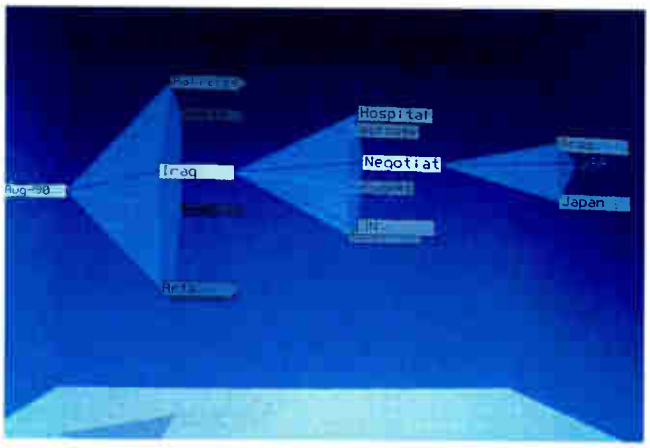

Photo 2: *The interface lets you zoom in on a subject of interest. Here, one topic, Iraq, has been emphasized by pruning away all other branches of the tree. (Photo courtesy of Xerox PARC)*

bind you more tightly into the process. In the Information Theater, the computer focuses on those tasks at which it excels. Pattern recognition and language understanding are left, by and large, to you.

Per-Kristian Halvorsen, head of the project's NLTT (Natural Language Theory and Technology) group, says, "An information search-and-retrieval system is most effective if it is viewed as a team consisting of the machine and the user." Each member of the team performs those tasks best suited to him, her, or it: A fast computer is ideal for tasks such as computing the angle between two vectors, each with 10,000 dimensions; you are best suited to understanding your E-mail messages.

In contrast to other natural-language projects that seek ways for the computer to understand text (i.e., drawing conclusions and producing new facts about the text), NLTT's work emphasizes the intelligence needed for the computer to find important text and present it to you in an effective and interesting way.

Theater Foundations

Before the Information Theater could be built, it first needed a foundation: the Text Database. To the Text Database falls the less glamorous tasks of reading, sorting, and, to some extent, understanding tens of megabytes' worth of documents. The Information Theater was built by the NLTT group, which is made up of Halvorsen and the Text Database designers Doug Cutting and Jan Pedersen.

The Information Theater needs a flexible foundation to support research into different information search-and-retrieval systems. The Text Database supplies this flexibility. It is an object-oriented, modular system written in Common Lisp. You can plug in different modules (e.g., search engines, user interfaces, and natural-language analyzers) as you can with Nintendo games.

An important piece of the Text Database is the analysis module. It works like a pipeline, pumping information from the documents to the other parts of the database. As the text passes through the pipeline, it is broken into tokens that are manipulated, massaged, and sometimes discarded. The text emerges at the other end as an inventory of terms. These terms are typically words, but they could be anything from individual letters to noun and verb phrases or whole concepts. These word terms are typically reduced to their roots. For example, *banks*, *banker*, *banking*, and *banked* might all be reduced to *bank*.

Along with the terms come statistics about their use in the text (e.g., the number of times the word *festoon* appears in the document *foo* and at what positions). You can select or design a different analysis to suit a particular task. Likewise, the analysis results can be translated into several different indexes, depending on your task.

Queries and Indexes

In most text-retrieval systems, a typical search calls for an *inverted index*. For each term in the Text Database, the inverted index contains the term, the documents it occurs in, and the word positions. In practice, an index might contain more, or less, information. As a rule, the more information you pack in the inverted index, the faster your searches will go.

Inverted indexes are just what the doctor ordered for Boolean search engines featuring queries like "find me all documents containing *terrorist* and *bombing*." You can look up the terms *terrorist* and *bombing* in the index and see what documents they both occur in.

The Boolean search paradigm dominates the personal computer text-retrieval marketplace, but there are other ways to search for documents. For example, in a similarity search, documents are compared on the basis of the words they have in common. For similarity searches, you select an index that provides a simple list of the terms occurring in the documents and their frequency.

Beyond Boolean

The problem with Boolean and similarity searches lies in the nature of text data. Databases are becoming huge. You can easily find yourself with hundreds of megabytes of information at your fingertips. Projects such as WAISes (wide-area information servers) (see "Browsing Through Terabytes," May 1991 BYTE) promise to up the ante further, providing untold terabytes of information on-line. This raises some fundamental questions: Once you've got the world at your fingertips, what do you do with it? How do you know what to pick up? How do you find what you're looking for amid the morass of uninteresting or nonapplicable data?

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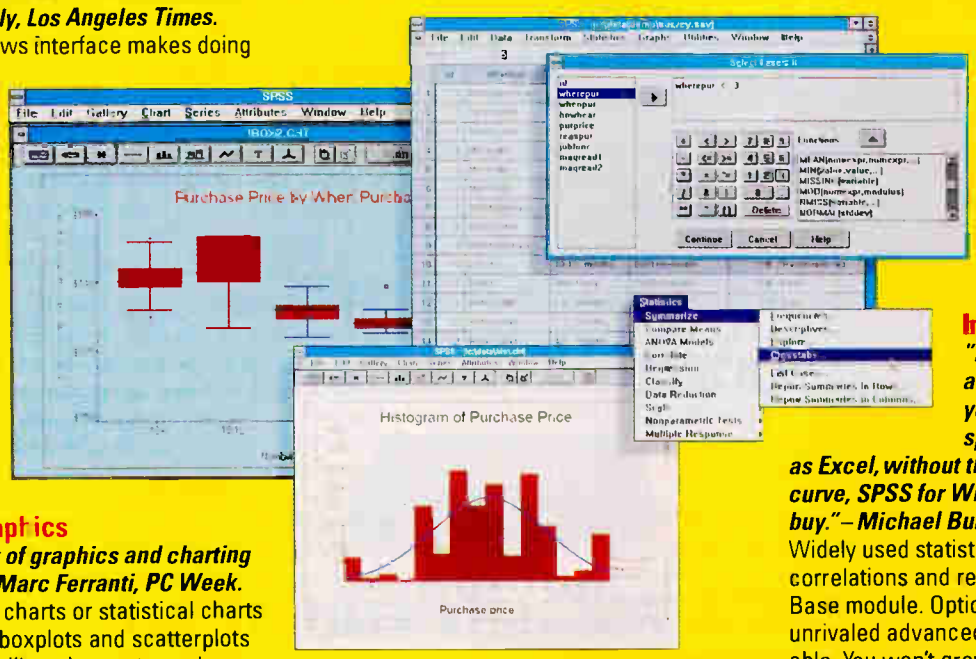

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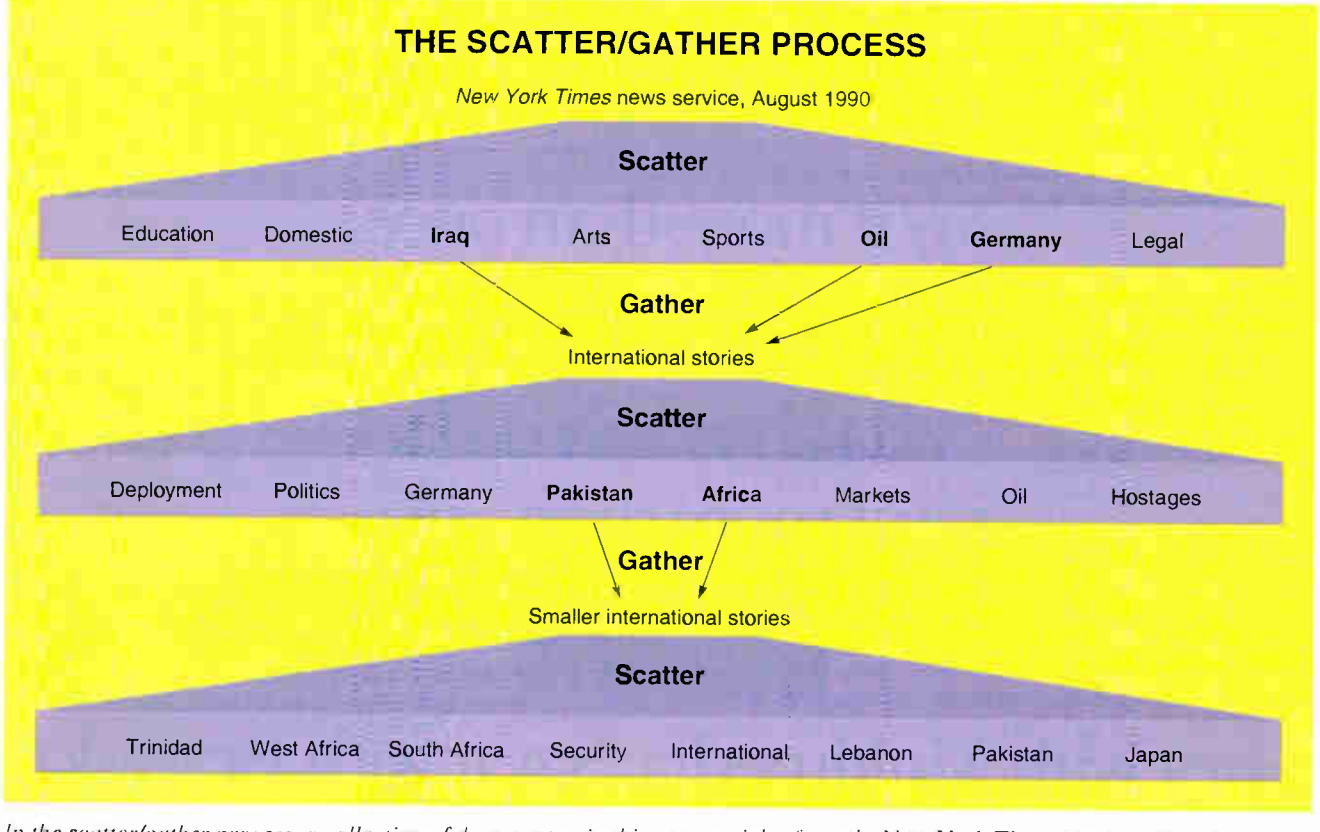
so-called intelligent agents. While great in containing those works so you can see how

THE INFORMATION THEATER



In the scatter/gather process, a collection of documents—in this case, articles from the New York Times *news service—is scattered or broken up into topics. Some of the resulting topics (e.g., Iraq, Oil, and Germany) are gathered together, forming a smaller, more focused document collection, which is scattered again into new topics. You can iterate this process as often as you wish. (Figure courtesy of Xerox PARC)*

you were talking about," says Halvorsen, "this would not work. But since, typically, the words you use correspond in some way to what you're talking about, this does work. It can tell you whether two documents talk about related matters."

A natural-language query, such as "find me articles about copy machines," is also converted into a vector in this document space. The documents closest to the vector—those containing lots of references to both *copy* and *machine*—are returned.

When the similarity search returns documents, you may select one or more of them as relevant. These selected documents become the new query vector, and the documents that are closest to it are returned. Again, the similarity search lets you iteratively approach your target, without encountering a conventional search language.

Calculating Distances

Calculating which documents lie close together seems simple enough, but in practice, it can be complicated: for example, *Grolier's Encyclopedia* contains about 30,000 articles. Comparing each document with every other document requires almost 450 million vector-to-vector comparisons, and each of these vectors contains 100,000 elements—one for every unique word in the encyclopedia. This relationship between the number of documents in the collection and the number of possible comparisons between them is quadratic: Double the number of documents in the collection, and the number of comparisons between them increases fourfold.

This quickly gets out of hand with increasingly large document collections. The Text Database avoids this labor-intensive document-to-document comparison by using the statistician's old trick: the random sample.

Using an algorithm called Shotgun, the Text Database selects a representative sample of documents for extensive comparison. For example, such a search of *Grolier's* 30,000 articles might call for a sample of only 574 articles. These require a comparatively manageable 164,000 vector-to-vector comparisons. Moreover, the number of comparisons increases linearly, not quadratically, as the document base increases.

Because of the nature of sampling, a few documents might be misfiled, although not enough to make any significant difference. If you require higher precision, more precise—and slower—algorithms can perform the analysis off-line.

Scattering and Gathering

When documents are plotted as vectors in document space, those documents that use many of the same words will lie close to each other. They appear to be *clustering*. Until now, clustering has been used mostly as a tool to try to improve similarity searches. In contrast, the Interactive Information Access project is exploring clustering as a means to navigate through large or strange document collections.

At the broadest level, clustering divides a document collection into a handful of clusters—say, 10—that correspond loosely to subjects. An on-line collection of BYTE might yield clusters of articles about *Macintoshes*, *IBMs*, *laser printers*, and *programming*. In the case of an encyclopedia, clusters might

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correspond to *economics*, *history*, *science*, and *art*. The computer designates a cluster with a list of keywords that distinguish it from other clusters and with titles from documents most typical of the cluster (i.e., those nearest the center of the cluster).

Like a table of contents, basic clustering gives you an overview of a document collection and how it breaks down. Even if you had never seen a particular database before, you would already have some idea of what's available to you.

Now you can select a few of these clusters, say, *IBMs* and *laser printers*, and tell the system to cluster the documents again. The IBM and laser-printer clusters are gathered into a single cluster, which is then scattered into new clusters. These new clusters might be *LaserJets, using IBMs with Apple printers*, and *programming for laser printers*.

Every time you iterate this process, the clustering becomes more fine-grained as progressively fewer documents are distributed among the same number of clusters (see the figure). You can iterate this scatter/gather process as often as you like, collecting clusters together and then scattering them apart again, backing up if you make a wrong turn. You could theoretically iterate all the way down to a single document.

The collection can be broken up in an almost infinite number of ways, to whatever granularity suits your purpose. At any time, you can jump into a similarity or snippet search to track down a particular document.

As with the snippet search, nothing here resembles a search language. Indeed, since you will rarely use the scatter/gather process to actually locate a single document, it is not really a search program at all. The NLTT group sees it as an information structuring and management tool (i.e., an aid to navigating large databases and understanding their contents).

Dynamic Data

Some databases do not sit still like an encyclopedia. Data accumulates off the *New York Times* news wire at about half a megabyte a day. Thus, while you're, say, in the Rockies for two weeks on vacation, your news database will accumulate another 7 MB of text.

Inevitably, some of this news will fall outside of existing categories. A new country will be formed, or someone will invent cold fusion. At this point, existing classification schemes fall down. But in the Information Theater, you can use the scatter/gather process to reorganize the database to accommodate this new category. In fact, you can reorganize the entire database around this new category. Halvorsen foresees a time when large text databases (e.g., encyclopedias) will be shipped with something like a scatter/gather capability to allow you to reconfigure or reindex it to suit your own needs.

Information-retrieval tasks run the gamut from simply browsing through a database to searching for a specific document. The Information Theater supports that range of uses. On the one end, it aids you in visualizing the structure of a space of documents. At the other end, it helps you to formulate queries and home in on documents.

All parts are fully interchangeable. You can jump from snippet search to similarity search and back again. If a search returns too many documents, you can use the scatter/gather process to organize them and extract the topics you want.

Now you can find those documents you've forgotten you own, or uncover the hidden structure in your hoard of forgotten PROFS notes, or set megabytes of data spinning in the air. It's all possible in the Information Theater. ■

Mark A. Clarkson is a freelance science writer living in Wichita, Kansas. You can reach him on BIX c/o "editors."

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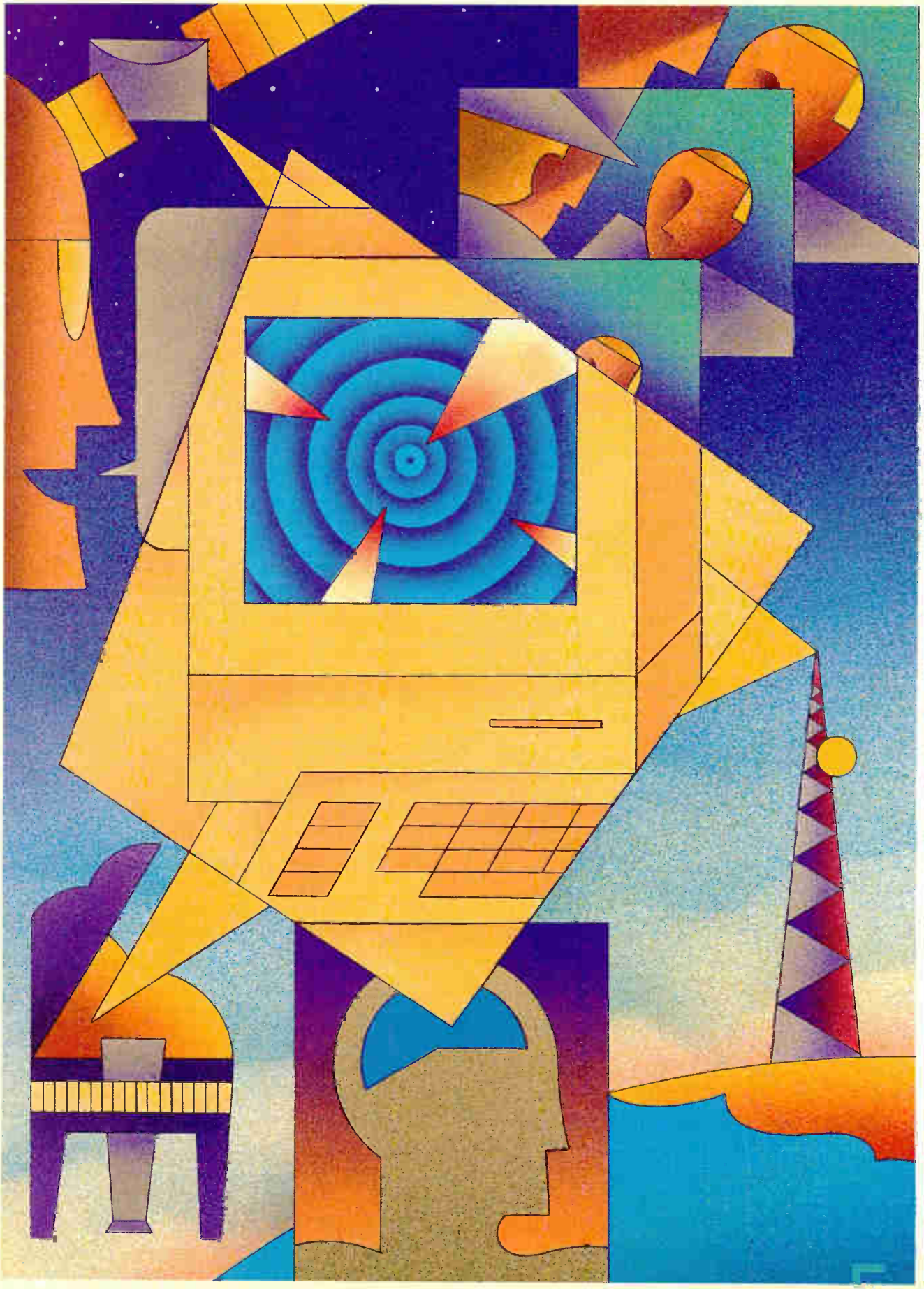

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SIGNAL COMPUTING

Signal processing enhances a system's audio, video, graphics, and communications capabilities

ERIC C. ANDERSON, STEPHEN SHEPARD, AND PHIL SOHN

Digital signal processing makes it possible for computers to interact with the world by enabling them to process real-world signals, usually in audio, video, or electromagnetic form. Signal processing can let you understand the information in a signal, transform it into a practicable form, or use it to synthesize information.

For example, a CAT scanner gathers information about the human body and uses sophisticated signal-processing algorithms to help medical professionals diagnose internal disorders. An audio-compression algorithm allows more audio to fit on a storage device. And signal processing is used extensively to create signals: You can now control an orchestra of instruments using a modern music synthesizer.

Signal processing is getting more attention in the personal computer arena because many host processors are now fast enough to do simple signal processing. More important, fixed-function and programmable DSP (digital signal processor) chips are coming down in price, making it feasible to build them into motherboards. Signal processing makes practical specific applications (see the text box "Digitally Speaking" on page 160). Some people call DSPs the math coprocessors of the 1990s—ICs that provide a significant performance boost for specific applications or operations, including audio, video, graphics, and communications. If the computer you are using doesn't have a DSP in it, your next one most likely will.

What Is a Signal?

People use the term *signal* in many different ways. You talk about radio and TV signals, traffic signals, and automobile directional signals. In signal processing, *signal* refers to physical properties that change with time, such as electromagnetic waves. These signals are converted by a transducer into another form (usually electrical) that can more easily be manipulated or processed. Examples of such signals include audio, radio, and TV signals. Other types of signals include multidimensional correlated data (e.g., photographic images and sonograms).

An example of a transducer is a microphone, which converts sound-pressure variations into a voltage that varies proportionally with the sound pressure. Another common transducer is a speaker, which does the reverse of a microphone, converting an electrical voltage to an air-pressure signal.

The electrical signal produced or used by a transducer is referred to as an *analog* signal. The only limits on the accuracy of a re-created analog signal are the physical properties of the transducer and interference, or noise, in the system.

Signal Parameters

The two basic parameters for signals are the *frequency* and the *amplitude*. The frequency of a signal refers to the number of times that the signal varies per second. Frequency is measured in hertz (i.e., cycles per second). For example, human speech is in the frequency range of 300 to 3000 Hz. AM radio is in the 550- to 1650-kHz range. And FM radio is in the 88- to 108-MHz range.

Frequency (f) is an inverse function of the time (T) between fundamental peaks or valleys in a signal: $f = 1/T$. The time (T) is called the *period*.

Amplitude is a measure of the strength of a signal. It's measured in various units depending on the application. For audio signals, the measurement is in decibels, which is a logarithmic scale based on human-hearing sensitivities. For audio,

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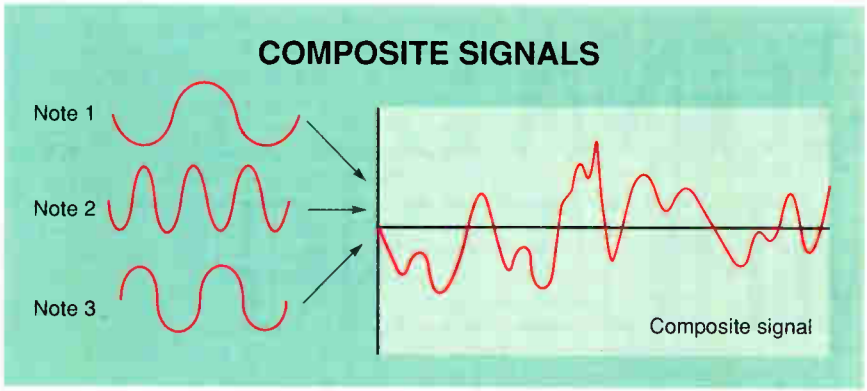

Figure 1: *The three notes that make up a chord each produce their own simple signal, harmonics aside. The composite signal results from the combination of the simple signals. DSP systems use techniques based on Fourier's theorem to deal with the construction and decomposition of composite signals.*

amplitude is volume; for video, it's image contrast.

Signal Characteristics

A signal characteristic can change depending on the frequency and amplitude. For example, at very low frequencies, air pressure is barometric pressure. This signal has a period in the range of hours or days. The same signal at shorter periods, however, is called *subsonic* and ranges from only a few cycles per second to approximately 20 Hz. These signals cannot be heard, but if they are strong enough, they can be felt.

The audio range is higher than the barometric or subsonic ranges in frequency (from 20 Hz to around 20 kHz), depending on your age and the condition of your ears. Above 20 kHz is the ultrasonic range. This is the range of dog whistles and some remote control devices. Ultrasonics are directional in nature and can follow fairly tight beams.

Note the difference in the function of a signal depending on its frequency. All the signals are from the same physical property: air pressure. However, the function of the signal changes drastically with the frequency range.

Composite Signals

A signal can consist of many separate components that propagate at different frequencies and amplitudes. Such a signal is called a *composite* signal. An example of this would be a recording of a chord from a pipe organ: Each note produces a single tone, but when several notes are combined, they form a complex waveform (see figure 1). Another example is the radio spectrum, which is composed of hundreds of signals from radio and TV stations, aircraft, and so forth.

Another important signal parameter is *bandwidth*, which describes the range in frequencies of a complex signal. For instance, the bandwidth of a high-fidelity audio signal is 20 kHz; the bandwidth of a video signal is 6 MHz.

While a complex signal may be difficult to use directly, it's possible to select portions of the signal by using filters. A filter allows the passage of a signal within a range of frequencies and prohibits the passage of signals with frequencies outside of that range. A radio tuned to a station contains a sharp filter that selects only the signal from that radio station and eliminates all others. At higher frequencies (e.g., visible light), you use filters to select or to filter out colors (i.e., frequency ranges). Tone controls on audio equipment are another common type of filter.

Underlying an understanding of composite signals is the Fourier theorem, which states that any periodic signal can be described as the sum of single-frequency sine waves of various amplitudes. This makes it possible to extract the individual component sine waves that make up a composite signal and to synthesize any composite signal with a set of sine-wave generators. The former technique is used to extract information from a signal; the latter is used for music, speech, and waveform synthesis.

Signal types

- audio
  (e.g., voice, sound, and music)
- video
- radio
- microwave
- images

Digital and Analog Signals

Historically, most electronic signal processing has been done on analog signals with analog components (e.g., transistors, transformers, and capacitors). But it's difficult and costly to create analog-signal-processing components with precise values that do not change significantly with time and environmental fluctuations. Digital electronics let you compute the effect of components on a signal using mathematical operations. Digital signal processing is a precise method unaffected by time and environmental changes.

As digital processing speeds have increased, people have begun to use DSPs to do processing that is not practical in the analog domain. This is due to a number of factors. First, unlike normal electrical components, digital components operate precisely as expected, with no losses, distortion, or other physical effects to the accuracy of the numeric representation used. Second, mathematical operations representing component functions that are not physically realizable are easily computed. And third, because digital components are programmable, you can change the signal-processing function by reprogramming it rather than by resorting to a soldering gun.

The result of digital technology is new or better signal-processing functions. For example, selective filters are possible in the digital domain that are impossible at any cost in analog signal processing.

Discrete-Time and Discrete-Amplitude Signals

Most of the signals discussed thus far are continuous-time signals, which can have any value from an infinite number of values within a specific range. This value can be measured at any time. Signals that have values only at specific times are called *discrete-time* signals. An example of one is the number of people in a theater at a specific time. This will be an integer from 0 (a very bad movie) to the maximum seating limit (a hit movie). The discrete period is one day. You can enter a set of values from this signal into a digital computer for processing in many useful ways.

A discrete-amplitude signal has one of a set of values at any given time. A simple example of this is a traffic light, which can have only one of three values—red, yellow, or green—at one time.

Sampling and Quantization

Before digital computers can process signals, the analog signal must be converted into a digital signal. A digital signal has

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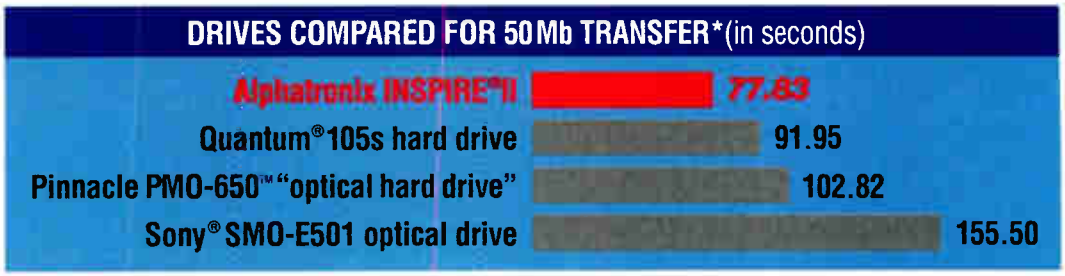
Who's Really The Fastest?



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both discrete time and discrete amplitude. The first step of the conversion is accomplished by a process called *sampling*, which converts a continuous signal to a discrete-time signal.

A motion picture is a good example of sampling. The seemingly continuous motion of a movie is made up of a series of discrete-time images presented at a rate of 24 frames per second. The original action is sampled at a rate of 24 samples per second by the movie camera. The human eye reconstructs the original motion from the series of still images.

The second step in converting an analog signal to a digital signal is called *quantization*, which converts a continuous-amplitude value into a discrete amplitude value. The most common type of quantization is called *uniform* quantization.

Uniform quantization is simply a matter of putting the analog value of each sample into one of a set of possible bins. For example, if you are converting a voltage from 0 to 1 volts into an 8-bit number (values of from 0 to 255), each digital bin has a voltage range of 1/256 V, or approximately 0.0039 V. Bin 0 is used for voltage from 0 to 0.0039; bin 1 is used for voltage from 0.0040 to 0.0078; and so forth, as shown in figure 2. Clearly, quantizing the signal loses information and introduces quantization noise into the signal. The greater the number of bins, however, the less noise is introduced. This is why a 16-bit audio system sounds so much better than an 8-bit system.

The process of sampling and quantization is called *A/D conversion*. The converter normally operates at a fixed sampling rate, measuring and quantizing the value of the signal once per sample period. These values are passed on to the digital system for storage and processing.

For multidimensional signals (e.g., a photographic image), conversion into the digital domain is accomplished by using a scanning process. This process generates a two-dimensional array of digital pixel values. Video uses a similar process called a *raster scan*.

Time vs. Frequency

You can represent and view signals in various ways. The two most popular representations are the time and frequency domains. The time domain shows the signal amplitude on the *y* axis and time on the *x* axis. Figures 1 and 2 are time-domain representations of signals. Time-domain representations show the signal within a particular time slice. You can see a continuous display of time-domain representation with an oscilloscope.

Often, you need to analyze the frequency content of a signal. For this, you must have a frequency-domain representation of the signal. This type of representation has amplitude on the *y* axis and frequency on the *x* axis (see figure 3). This representation shows the frequency components of the signal for a particular time slice instead of the time-domain representation. A continuous version of this type of display is often found on more expensive high-fidelity equipment. The equivalent to an oscilloscope for frequency domain is the spectrum analyzer.

The process of going from the time domain to the frequency domain is called a *Fourier transform*, a mathematical transformation based on Fourier's theorem. A naturally occurring example of such a transform is the prism, which takes in a composite signal—natural light—and breaks it up into the separate frequencies (i.e., colors) that are contained in the light. In effect, the prism is a signal processor.

In the analog domain, the amplitude of a signal at any given frequency is generated by a series of sharp filters tuned to progressively higher frequency bands. In the digital domain, the frequency content of a signal is calculated by using the DFT (discrete Fourier transform). An effective DFT algorithm is called the *FFT* (fast Fourier transform). This algorithm eliminates unnecessary or duplicate calculations from the DFT and produces the same number of frequency spectrum values as sample values.

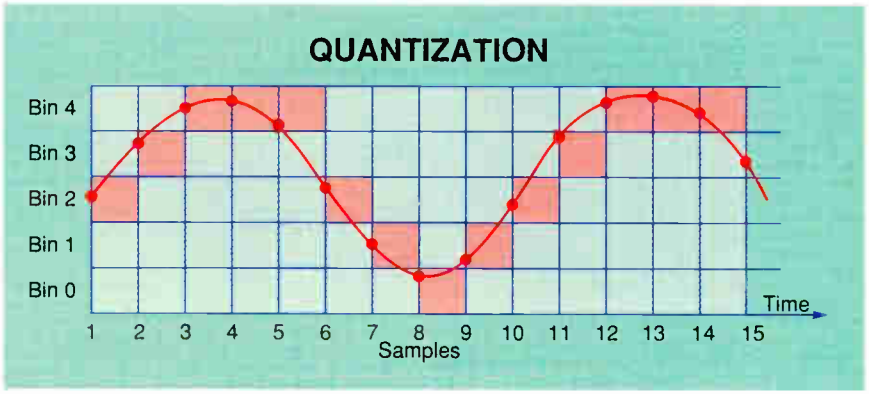

Figure 2: *Note the noise introduced by quantization. Sample 5 is placed in bin 4, and sample 6 goes to bin 2. The signal clearly passes in the range of bin 3, between these two samples, but the sample rate is too coarse to detect this.*

The Nyquist Theorem and Aliasing

When designing a digital signal-processing system, an important consideration is selecting the sampling rate. If the input signal is band-limited (i.e., the frequencies in the input signal are below a frequency *f*), the input signal can be reconstructed from the sampled signal provided the input signal is sampled at least 2*f* times per second. Frequency *f* is called the *Nyquist frequency*. Thus, a 20-kHz bandwidth audio signal must be sampled at at least 40 kHz for it to be properly reconstructed.

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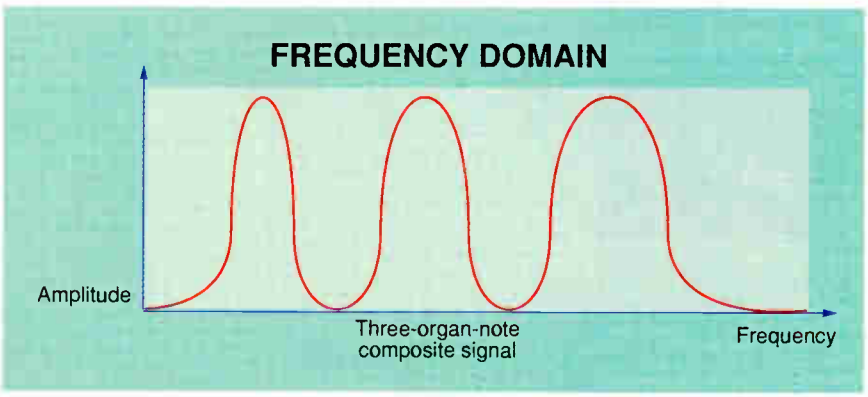

Figure 3: *Applying Fourier's theorem in the form of a Fourier transform allows you to move from the time domain to the frequency domain, where a composite signal is represented by the frequencies of its constituent simple signals.*

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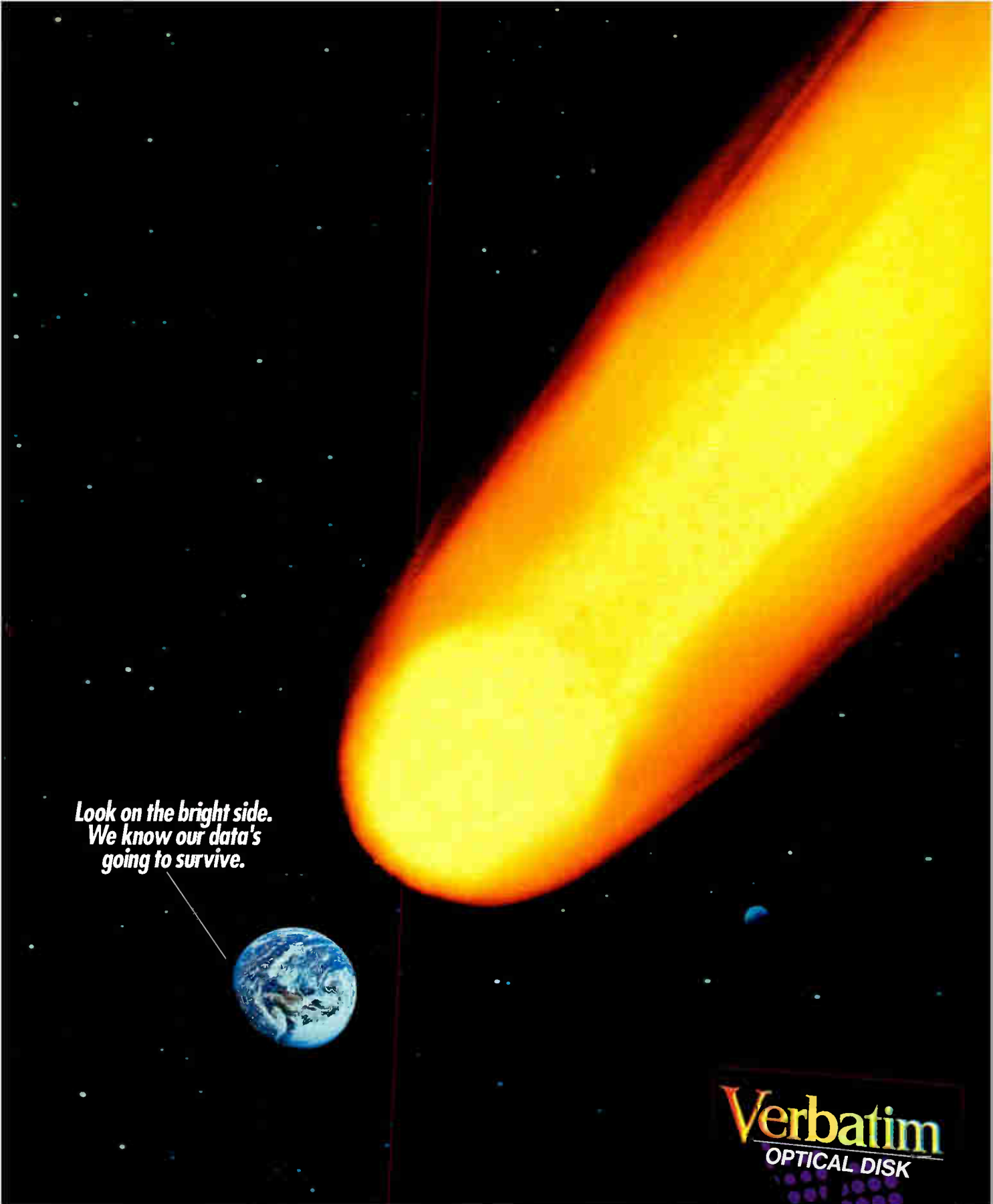

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Digitally Speaking

GEORGES ZANELLATO AND BART VERHAEGHE

The introduction of DSPs (digital signal processors) has contributed immeasurably to speech-based applications. DSP power is used in many areas, including transmission-noise reduction; signal amplification; speech synthesis for text-to-speech conversions; speech recognition; and voice-message coding.

In text-to-speech conversions, the DSP processes ASCII text, generates a phonetic transcription, and produces the synthetic speech. In speech recognition, the DSP system, in conjunction with an A/D converter, acquires the speech, compares it to stored templates, and indicates what word was uttered. The applications determine how to process the recognition results.

Voice Coding

Coding has gained wide use in voice-mail storage. The idea is to let you record messages to a hard disk for future retrieval. Such voice messages, or even voice-annotated documents, can also be sent over networks. On request, you can retrieve, decode, and play back these messages.

Coding rates provide great savings in storage space, an important factor in applications such as dictation, voice annotation, PC-based automatic answering machines, voice mail, and digital telephone-answering machines. An uncoded voice file typically requires about 0.5 MB of memory for 1 minute of recorded speech. Using a DSP on the motherboard or on an add-in board can reduce the memory required by as much as 85 percent. And coding algorithms are a must when documents containing voice annotations are sent over a network or through a modem.

The SBCELP Algorithm

A number of different types of voice-coding algorithms are available. Lernout & Hauspie Speech Products of Belgium introduced a coding technique called SBCELP, which is based on a CELP (code-excited linear prediction). It performs coding and decoding of speech signals at fixed bit rates in the range of 2000 to 10,000 bps. After coding, the memory requirement for 1 minute of speech is reduced to a range of 15 to 75 KB. This is as much as a 30-fold savings in storage space over unencoded speech.

The SBCELP algorithm consists of three major parts, each one corresponding to a section of the human speech production system. In the first part, the STP (short-term prediction) analysis extracts the envelope of the input signal. This is performed via a tenth-order LPC (linear prediction coding) filter. The envelope corresponds to the first part of the vocal tract, from the lips to the vocal cords.

You can view the LPC filter as a succession of 10 acoustic tubes that represent the vocal tract. As the vocal tract is warped along the speech signal, the corresponding tubes are modified in length and diameter, furnishing new values for the LPC coefficients. (Because those coefficients are sensitive to quantization errors, the algorithm uses the LSP [linear-spectrum-pairs] coefficients, which are less sensitive to these types of errors.)

The second part of speech—the vibration of the vocal chords—is characterized by frequency, or pitch. The LTP (long-term prediction) analysis furnishes a value related to the pitch of the input signal.

The third part of a speech signal represents the excitation of the signal (i.e., the air coming out of the lungs). Determining the spectral shape of the excitation is important if you want to keep the natural quality of the human voice and avoid the metallic effect of digital-speech playback. To solve this problem, the algorithm determines the best possible excitation candidate for the excitation signal from among the reference signals. These references can be prefixed and stored in a dictionary or codebook, or they can evolve dynamically with the signal, as is done in the LHS SBCELP algorithm.

If you sample a signal below the Nyquist rate (sub-Nyquist sampling), you get aliasing: The sample points do not contain enough information to reconstruct the original signal. Aliasing causes frequencies in the input signal above the Nyquist frequency to generate undesirable frequencies in the digital signal. These frequencies form a mirror image around the Nyquist frequency. For example, if there is a 22-kHz signal in the audio before it is sampled at 40 kHz, the digital signal will contain an 18-kHz signal but not the 22-kHz signal. To ensure that aliasing does not occur, you must filter the signal to remove any components above the Nyquist frequency before it's converted to the digital domain. This type of filter is called a *low-pass filter* because it passes all signals below a specified frequency.

You can see aliasing at work in a movie whenever the 24-frame-per-second sampling rate is too low to capture rapid motion. A well-known result is the effect of wagon wheels appearing to turn backward. In effect, there is insufficient information for the human eye to properly reconstruct the original signal.

Signal Reconstruction

Once a signal is digitized and processed, you often want to return it to the analog world so that it can be reconverted to its original form. This can take place in real time, or it can be delayed. Playing a CD is an example of a delayed reconstruction of a digital signal.

A raw digital signal that has been passed through a D/A converter would normally be unsuitable for direct use, because the converted signal is a staircase function following the path of the original signal and contains many additional signals above the Nyquist frequency (see figure 4). According to the Nyquist theorem, you can use a *perfect* filter to reconstruct the original signal from the staircase generated by the D/A converter. A perfect filter passes all frequencies below the Nyquist frequency and blocks any signal above the Nyquist frequency. Such a filter has a pass-

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To carry out this three-part coding on a DSP, you must first sample the analog speech signal at a frequency that varies according to the application. The speech quality offered by the telephone network is usually satisfactory for voice mail, answering machines, and voice annotations. In these cases, the sampling frequency chosen is usually 8000 Hz. Each sample can be represented by 8, 12, or 16 bits, which fixes the amount of memory needed to store a second of speech signal (64,000 bits, or 8 KB, in the first case). The digitized input signal is divided into successive frames of 15- to 40-millisecond duration, depending on the chosen final bit rate (from 2000 to 10,000 bps). The system performs an STP analysis. The corresponding 10 LSP coefficients are then quantified into a 24- or 32-bit number, depending, once again, on the bit rate. These bits are the code for the STP analysis.

At this point, each frame is divided into two, three, or four subframes for the computation of the LTP analysis and the dictionary search. The number of subframes is determined by the final bit rate. This allows you to deal with short frames (of about 5 ms) to keep the values for the pitch and the dictionary as precise as possible all along the speech signal. This is necessary because of the continuously changing shape of the excitation and of the vocal cord's vibration frequency.

Obviously, there is a trade-off between the speech quality and the number of bits used to code the LTP analysis and the dictionary candidates. The number of bits allocated to each feature, linked to the size of the frame and the number of subframes, determines the bit rate. The existing values are 2400, 4000, 4800, 7200, and 9600 bps. However, any bit rate between 2000 and 10,000 bps can be adopted after some fine-tuning of the algorithms. Enhanced perceptual- and dynamic-filtering techniques enable the algorithm to keep good speech quality, even for bit rates as low as 4800 bps.

Coded speech is stored in 8-bit chunks. The decoding process enables the reproduction of coded speech in real time. The coding algorithm needs about 12 MIPS of computational power; decoding requires 1.5 MIPS. Numerous low-cost DSPs are available that can perform these tasks. Such processors will enable a new generation of speech applications.

Georges Zanellato is the R&D manager of speech and music coding at Lernout & Hauspie Speech Products. Bart Verhaeghe is the manager of the company's U.S. marketing operations. You can contact them on BIX c/o "editors."

band from 0 to the Nyquist frequency, a zero-width transition band, and a stop band from the Nyquist frequency to infinity. A frequency-domain plot of the perfect filter is shown in figure 5.

The process of filtering the output signal is called *convolution*. You multiply the time-domain representation of the characteristics of the frequency-domain filter by the current sample, n previous samples, and n future samples for each output sample. These multiplications are called *filter taps*. A filter that requires 10 multiplication operations is referred to as a 10-tap filter.

Because you must use future samples to calculate the reconstructed signal, the filter processor must wait until these samples are available. This causes a time delay in the filter of n samples.

The time-domain representation of the perfect lowpass filter is the synchronization function $(\sin x)/(x)$. Unfortunately, this function extends to infinity in both directions, so the convolution computation must include an infinite number of multiplication operations and an infinite delay. So, you need a way of reducing the value of n.

In the real world, you reduce n with a filter that has a transition band of significant width. This is done by windowing the synchronization function to limit its nonzero value range and, therefore, the number of calculations per sample to an acceptable level. This technique also reduces the passband to below an optimal level. However, this can be compensated for by using a higher sample rate than the minimum Nyquist rate. This is why the CD sample rate is 44.1 kHz. The 22.05-kHz Nyquist rate is beyond the human hearing range, but the extra bandwidth allows a low-cost sampling and reconstruction filter to begin rolling off into the transition band at around 18 to 20 kHz, as shown in figure 6.

Digital Filtering

There are many forms of filters in signal processing; they are classified according to the function they perform. For example, lowpass filters pass low frequencies while attenuating the higher frequencies. Highpass filters pass high frequencies and attenuate lower frequencies. Bandpass filters pass frequencies in a range, or band, while attenuating frequencies outside the band.

Filters are also classified according to the way they are implemented. One common implementation uses both the input and output samples to calculate the filtered output signal. Because you feed back the past output samples of the filter to compute the current output sample, you continuously recycle energy within the filter. This means that the response of the filter to an impulse (or spike) is infinite in length. This type of filter is called an *IIR* (infinite impulse response) filter.

IIR filters are often used because of their ability to create sharper transitions with little computation. However, one of the desirable attributes of a filter, called *linear phase*, is missing in an IIR filter. Linear phase refers to the characteristic where all frequency components of the original signal are delayed by the same number of samples before they arrive at the output.

Another common filter implementation called an *FIR* (finite impulse response) filter uses only its input samples to calculate the filtered output signal. In this case, an impulse applied to the filter will die out after n samples, where n is the number of taps in the filter.

The advantage of FIR filters is that they are linear phase. Unfortunately, more computation is required to achieve the desired sharp transitions with this filter design.

Digital Storage and Real-Time Processing

Digital signals can be stored on hard disks for editing and playback. Although this is an obvious use of these signals, only recently have desktop computers had enough storage and processing speed to make this possible.

Processing-speed requirements can be divided into two major categories: real-time

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Nonuniform quantization is also used for compressing signals. One of the most widespread techniques is called *vector quantization*. Instead of the signal being stored one sample at a time, a token representing an entire set of samples (called a vector) is stored. For example, if the sequence "one, two, three, four, five" occurs often in a signal, a token can be used to represent the sequence. This technique derives the correct set of tokens at the compression end and requires an enormous number of calculations. Decompression is fast, however, and requires only a simple table lookup. This allows the use of low-cost playback equipment to decompress the signal.

Sample-Rate Converters

It is often useful to convert a signal from one sample rate to another. This is generally required when passing a signal from one system to another. For instance, a signal recorded at 48 kHz on a professional digital tape deck may have to be converted to 44.1 kHz for storage on a CD. Another example of sample-rate conversion is when a signal is passed between an audio system and a telephone system. Each of these systems has a different sample rate, selected for optimum utility for a given function. Digital telephone systems typically use an 8-kHz sample rate, and digital audio systems usually use 44.1 kHz or 48 kHz.

Sample-rate converters are of two types: up converters and down converters. The up converter generates more output samples than input samples; the down converter does exactly the opposite. In either case, the computational process takes the basic form of a digital filter that removes aliases and unwanted out-of-band artifacts.

Adaptive Filtering

There are numerous cases where simple filtering is not effective or where the cost of the filter is too high for an application. In these cases, adaptive filtering is often used. An adaptive filter adjusts its parameters based on the content of the signal. In fact, adaptive processes can select from a set of possible filters, depending on the signal.

An interesting example of this is the CD-XA compression algorithm. In this technique, audio is broken up into blocks of 28 samples. Depending on the content of each block of audio, one of four different filters is selected that will best match the original signal during decompression. This takes substantial processing during the compression stage—each block must be compressed four different ways and then decompressed and compared to the original signal. The best match is selected, and the coded form becomes part of the compressed data stream. The filter selection is included in the data stream to allow the decoder to use the correct filter for that block.

DSPs will change the way you interact with your computer.

The advantages of this approach are that the highest computation is required during encoding and that simple filters can be used during decoding. This is desirable because compression usually happens once at the production facility and playback can occur hundreds of times by many people in different locations. Similar operations can be performed with adaptive filters in noise-canceling and noise-reduction applications.

Future Signals

As digital signal processing becomes widespread and processing power increases, more focus will be placed on functions for personal computers and digital assistants that until recently were only dreams. Digital signal processing makes it possible for your computer to use multimedia information in real time.

You can look forward to a rapid proliferation of amazing new capabilities over the coming years based on the marriage of DSPs and standard CPUs. From speech recognition to real-time digital video, DSPs will change the way you interact with your computer. ■

Eric C. Anderson is manager of the Sound & Signal Processing Group within the Advanced Technology Group of Apple Computer (Cupertino, CA). Stephen Shepard and Phil Sohn are members of the group. You can contact them on BIX c/o "editors" or on AppleLink as "anderson13."

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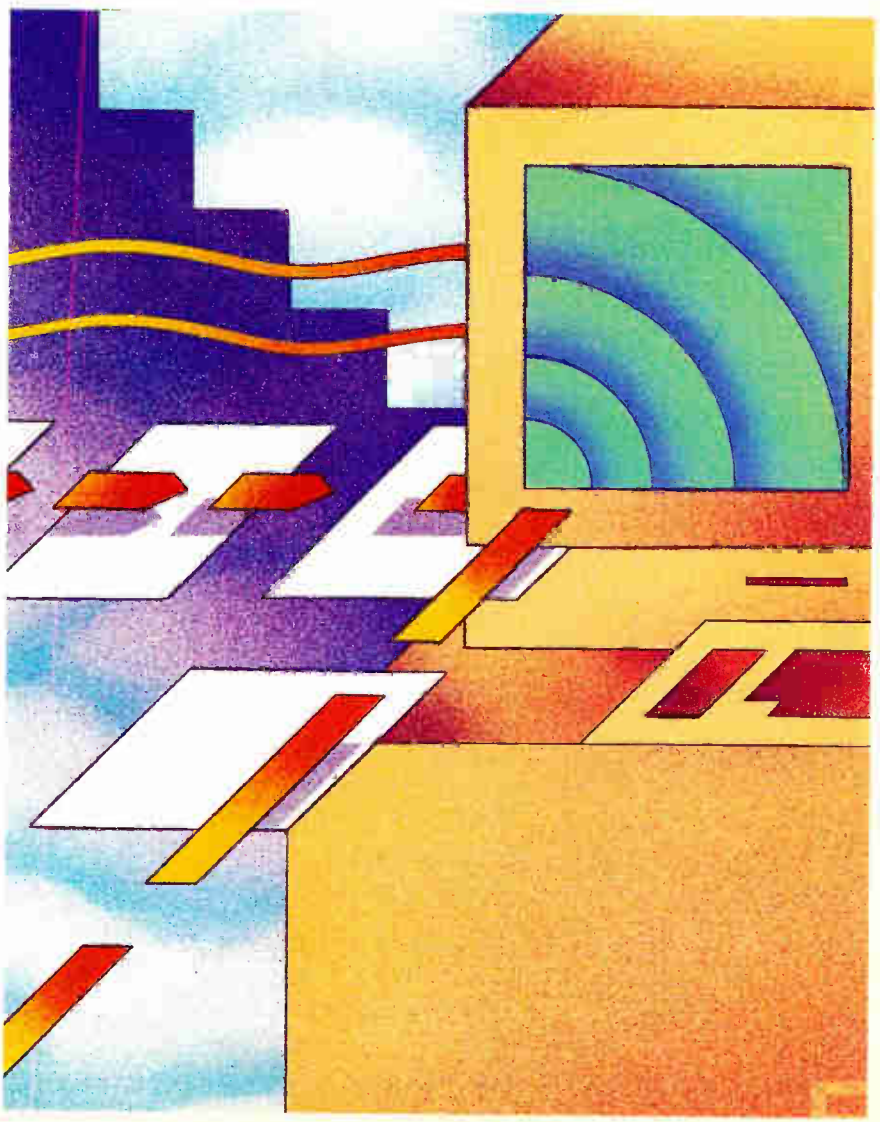
SIGNALS ON THE DESKTOP

The integration of DSP technology on the desktop is already under way

JOHN BRYAN

The integration of DSPs (digital signal processors) on the desktop, either as an add-in board or as a part of the motherboard, brings technologies such as continuous speech recognition closer to everyday reality. And programmable, powerful signal processors are being used for various other new applications.

DSP technology has been available for quite awhile, but until now, only specialized applications (e.g., disk head positioning, spectrum analysis, dedicated audio and video processing, and PBX systems) have migrated to personal computers. With recent advances in hardware, firmware, and software, signal processing is moving into desktop applications that will bring excitement to business computing.



The DSP Difference

What is the difference between a standard CPU and a DSP? There are architectural differences, certainly (see "Inside Signal Computing" on page 177), but the fundamental difference lies in the ability of the DSP to handle real-time data streams generated by sampling analog data patterns. By their nature, signals are constantly changing. If a computer is unable to act on the data as it happens, the computational results, if any, will be invalid. So, signal processors must be able to quickly interpret and react to data and perform the necessary calculations, such as multiply and accumulate.

One of the main advantages of integrating a DSP with a standard CPU is that such an arrangement can provide concurrence of signal-processing operations with respect to general computing tasks. A DSP isn't inherently any faster than a similarly

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clocked CPU, but DSPs excel at particular functions. The relationship between a DSP and a CPU in a desktop system is analogous to that of a math coprocessor and a main processor. A fixed-point 386 can do all the floating-point calculations that the 387 would normally handle, but the 387 is a lot faster. The same is true for DSPs. For example, for the types of calculations that call for signal processors, Texas Instruments claims that its TMS320C 16-bit fixed-point DSP can deliver three to five times the MIPS of a 386 CPU.

DSP Data

One of the most important facets in determining how to implement a DSP application is ascertaining the sampling rate for data. Speech—at least at the quality you hear over the telephone—is one of the less demanding DSP applications from a processing point of view. A microphone, which is a transducer that converts sound waves into voltage levels, is the most common data source. The data flows into an A/D converter, which produces *samples* of the data 8 bits wide at the rate of 8 KHz, or 8000 times a second. A DSP takes this data stream and performs whatever calculations the software calls for. The output goes to a D/A converter and then to a speaker, which turns the electrical signal back into sound. If this data goes to disk, it takes up about 8 KB of disk space per second of speech.

ARTA is a multiprocessing system that supports multiple DSPs.

An 8-KB-per-second sampling rate is about as low as you can go and still get decent sound quality. CD-quality sound must be sampled at a faster rate (up to 44 KHz), and the word size of the sound bytes should be 16, 24, or 32 bits. Storage requirements scale accordingly, with typical high-quality stereo sound taking up to 176 KB per second of sound.

Sound is a lightweight in the consumption of storage capacity. Real-time video can require as much as 1 MB per second, which quickly fills up a 40-MB hard drive. In fact, one of the primary uses of the DSP in an application is the compression/decompression of the data stream as it moves onto and off of the disk.

Given that DSPs are adept at handling speech and video data, it's not surprising that the prime motivation for using DSPs in personal computers is multimedia applications. In fact, without DSPs, true multimedia would remain a pipe dream, because general-purpose CPUs just don't have the horsepower to handle multimedia data effectively.

DSP on the Desktop

Next (Redwood City, CA) was the first major system manufacturer to recognize the value of bringing DSP technology to the desktop. It has included DSP hardware and the necessary operating-system support in every workstation it has produced. Next uses the Motorola 56001, a 24-bit

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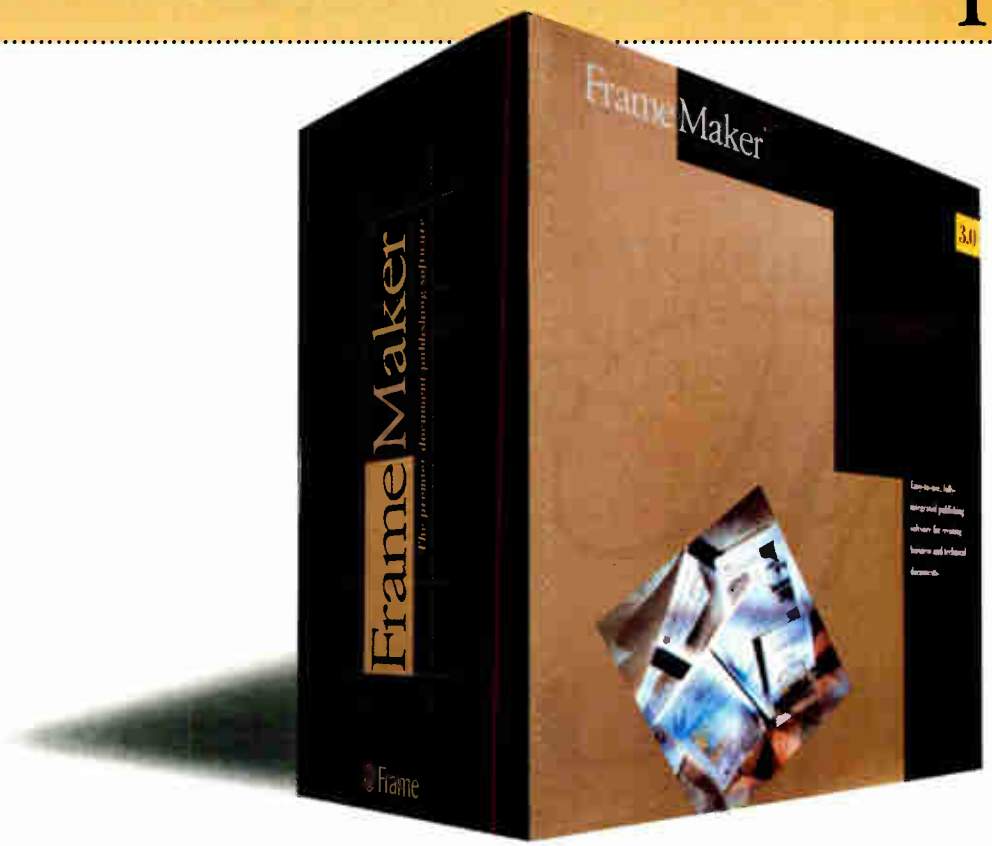

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processor with expandable local RAM, to support the multimedia efforts of their ISVs (independent software vendors). Next's object-oriented NextStep operating system also includes objects for audio and video data manipulation, ISDN telephony, CD sound (you can listen to your favorite music while you're computing), and other functions.

Another system manufacturer with a commitment to using DSPs is Apple (Cupertino, CA). Apple has always emphasized the value of quality sound in a computing environment, but it has only recently announced its intention to integrate a full-fledged programmable DSP into the Mac platform. Apple started the project in 1987, and after trying synthesis chips, phase-locked loops, and static-program DSPs, the company finally decided that it needed a fully clean, 32-bit, big-endian, byte-addressing processor (e.g., the 68030 and the 68040).

Apple has teamed up with another industry giant, AT&T, to produce ARTA (Apple Real-Time Architecture), a real-time multitasking and multiprocessing signal-processing extension for the Mac. The goal of this DSP architecture is to provide a scalable standard platform for most types of signal processing, including speech, sound communications, image processing, and music.

ARTA features the AT&T DSP3210 processor, which is a fully programmable 32-bit DSP with on-board cache and a 32-bit bus to local static RAM or to page-mode DRAM. The DSP3210 is capable of clock rates of up to 66.6 MHz. ARTA's kernel is only 512 words (2048 bytes) and takes up one-quarter of the DSP3210's on-chip memory.

DSP desktop applications

- data compression/decompression
- data communications
- speech recognition
- speech synthesis
- sound synthesis
- image processing

The platform's software component is composed of two parts. The host portion takes care of management functions, and the DSP portion performs real-time data-stream processing.

ARTA is actually a dual API system. In System 7.0, developers work with the API Toolboxes, which use drivers that link to the hardware of the Mac. For DSP applications, there is the DSP Module (a toolbox equivalent), which links the DSP kernel to the DSP hardware. With this dual-API system, the DSP programmer can write code without knowing or using any Mac code, and the Mac application developer can produce software that takes advantage of the DSP without knowing or using any DSP-specific code.

ARTA is a multiprocessing system that supports multiple DSPs. Apple will supply DSPs only as a part of the motherboard, not as NuBus cards, although it will license ARTA to NuBus developers. Applications developed under license from Apple will operate seamlessly within the ARTA environment. And Mac systems with integrated DSPs will be available next year.

Apple has an array of uses planned for ARTA. Besides digital audio functions (e.g., compression, noise reduction, and

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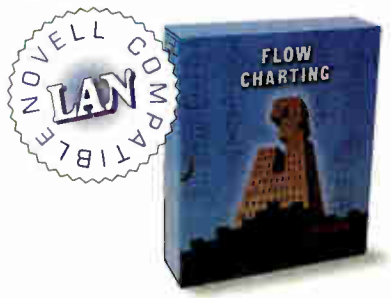

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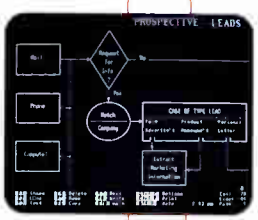

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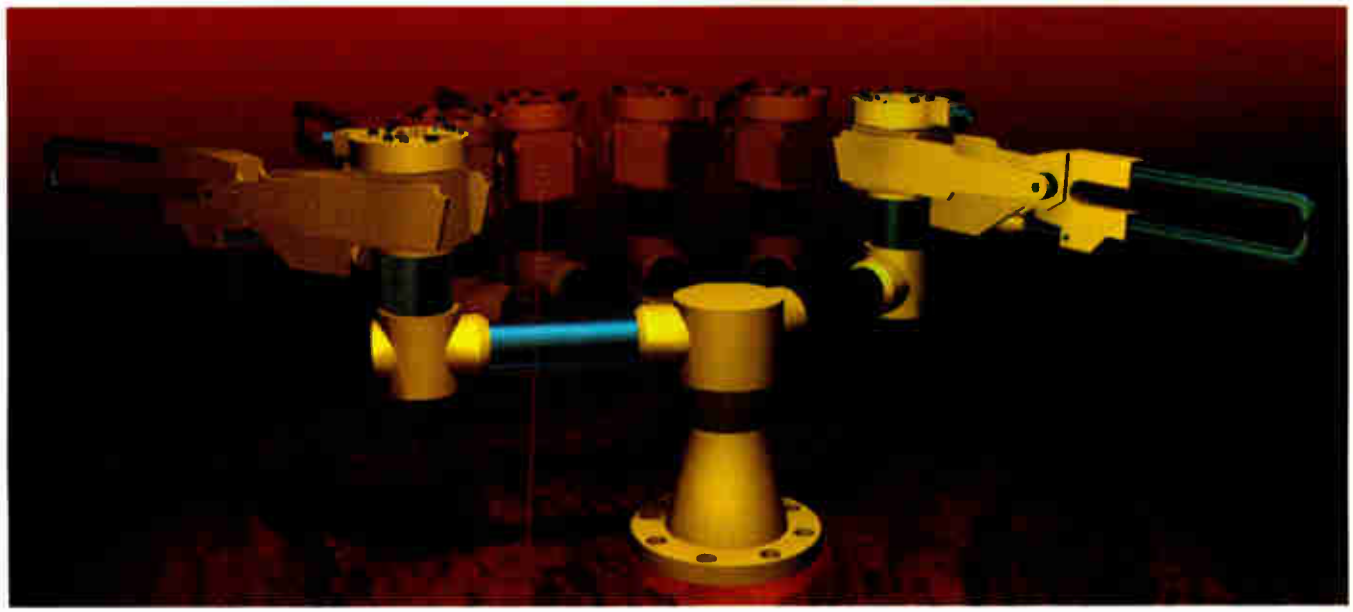

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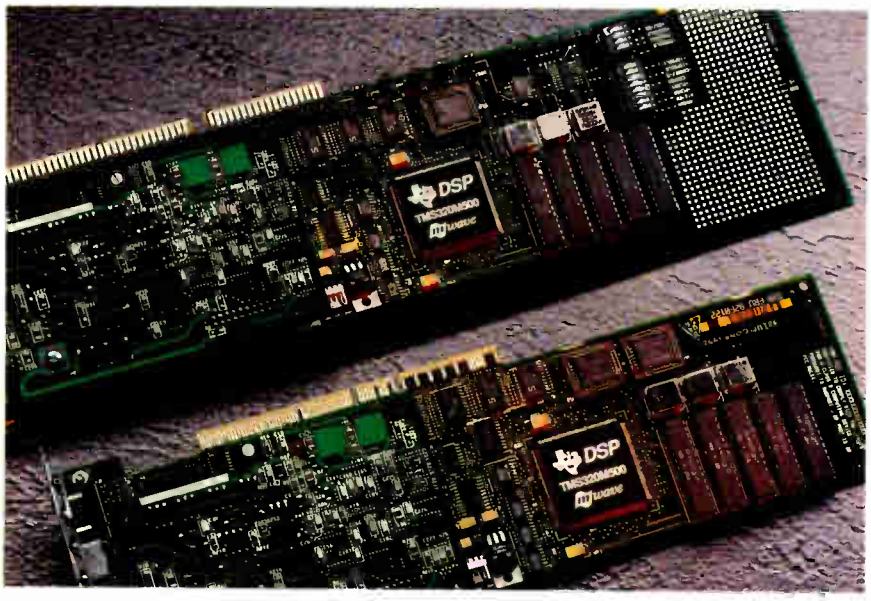

Photo 1: *MWave is a collaborative effort by IBM, Texas Instruments, and Intermetrics to produce a DSP board for the PC. The heart of MWave is TI's TMS320M500 DSP chip, which delivers 17-MIPS performance in a 16-bit data fixed-point package.*

mixing), Apple plans to promote the development of speech and communications programs. Speaker-independent speech synthesis and speech recognition are an exciting step toward creating the first truly user-friendly human-computer interface. With this feature, a computer could tell a novice user, in English or in any other language, exactly how to set up the system to best suit the environment and proposed uses. Other possible applications are voice-edited documents, video telephones, video- and audio-enhanced software installation, and presentation and education software.

Twin Peaks

In addition to working with Apple on the Mac platform, AT&T has also come up with a DSP solution for MS-DOS computers. VCOS (Visible Caching Operating System), AT&T's operating system for the DSP3210, is multitasking and resides in the memory local to the signal processor. Developers can use the VCOS and VCAS (Visible Caching Application Server) modules to integrate AT&T's DSP technology into general-purpose computing systems. And VCOS relieves applications programmers and system integrators from having to deal with the complexities of DSP programming.

Not to be outdone, IBM (Armonk, NY) has also announced its intentions to get into the personal computer DSP market. IBM has formed an alliance with Texas Instruments and Intermetrics, a software development company, to bring out a product called the MWave (see photo 1). IBM will first be producing a plug-in board for the ISA or Micro Channel architecture bus, but it also has plans to produce PS/2 systems with DSP technology on the motherboard by mid-1993.

TI engineered the DSP chip used in the MWave. The TMS320M500 delivers 17-MIPS performance in a 16-bit data fixed-point package. The processor has seven lines for serial data input and a bus data line (which is host-specific) and multichannel DMA for all I/O. Although the chip deals with 16-bit data, the program memory bus is 24 bits wide. The DSP is integrated into a board that includes a MIDI port, a UART (universal asynchronous receiver/transmitter), stereo A/D converters, and telephony AIC interfaces.

TI will develop an OEM distribution channel for the MWave, offering it to systems manufacturers for integration into their motherboards. At this fall's COMDEX, TI was scheduled to announce a DDK (Driver Development Kit) with sample drivers for speech, audio, and telephony.

Operating-system support is provided by IBM, whose Burlington, Vermont, product group developed a multitasking operating system for the MWave project. This embedded operating system, the MWave DSP manager, sits on top of OS/2 or Windows and can handle functions like JPEG (Joint Photographic Experts Group) video compression, voice recognition, data and fax modems, echo cancellation, music, and text-to-speech conversion.

The MWave DSP manager is a virtual device driver that provides a high-level API for digital signal processing in either environment. This API is the platform that provides a socket for device drivers. IBM wants to use this technology to increase desktop functionality—integrating the fax, telephone, dictation machine, and other office appliances into the PC.

IBM's objective is for this product to become as pervasive as the math coprocessor. For this to occur, application development will have to proceed at a pace with the development of support hardware. To further this end, IBM is out to enlist the support of major software development houses, such as Microsoft, Borland, Lotus, and WordPerfect.

To support the creation of all these applications, Intermetrics was tagged to come up with the development tools for the programmer. What it's providing is a standard ANSI C software development kit, complete with language, compiler, assembler, debugger, and a set of programming tools that are generic to the world of C programmers. A provider of DSP applications for the space-shuttle program, Intermetrics has been in the business of developing system application software for embedded systems for 23 years (until recently, most DSP applications were implemented in embedded systems).

One of the more helpful tools in the MWave environment is a nice visual debugger that enables you to trap signals coming in to the DSP in real time and observe their interaction with the host application. Intermetrics will provide one set of tools for Windows and another for OS/2.

DSP and Communications

Besides the major systems vendors, other companies, of both hardware and software orientation, are in the desktop DSP market. Many of them, especially the software firms, create products for Next workstations, mainly because Next has had integrated DSP support longer than anyone else. But many vendors have produced hardware/software solutions to specific vertical markets (e.g., radar research or digital instrumentation) for both the PC and the Mac platforms, and many more are moving in this direction, as DSP technology becomes more of a standard than a standout.

This year, Hayes Microcomputer Products (Atlanta, GA) announced the Hayes ISDN Extender, a network-interface module that provides ISDN Basic Rate Access and analog telephone-line connectivity to Next computers. The ISDN Extender can be used for remote LAN connections and

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Photo 2: *The Lightning Effects I Macintosh accelerator from Spectral Innovations targets specific applications. This product provides enhanced performance for image-processing applications.*

high-speed digitized voice, data, and fax modem, as well as other multimedia functions (e.g., video transmission).

Ariel (Highland Park, NJ) is another vendor that has concentrated its efforts in the Next market, for which it makes a wide range of products, from the $500 Digital Microphone to the $15,000 IRCAM signal-processing workstation. Even though the Digital Microphone, ProPort, and DAT-Port all deal specifically with CD-quality sound and use the Nextstation's own Motorola DSP56001 DSP, the IRCAM and the QuintProcessor each feature their own DSPs. The QuintProcessor contains five 27-MHz 56001 DSPs, four of which handle DSP functions while the fifth manages on-board memory, storage, and interprocessor communication. The IRCAM uses two Intel 860 RISC processors to provide a parallel-processing environment, with a 56001 DSP for data I/O. The IRCAM also comes with its own operating system, CPOS.

Metaresearch (Portland, OR) is a software firm whose products Digital Ears, SoundWorks, and Color Digital Eye can be used creatively in multimedia presentations. SoundWorks is essentially a sound mastering board, a digital version of the professional mixing board that you might find in any recording studio. Digital Ears is a stereo digitizer that captures CD-quality sound for the Next. And Color Digital Eye is a video frame grabber for entering and editing video images.

Another company that concentrates on sound, music, and professional recording is Digidesign (Menlo Park, CA). Digidesign has been producing products for the Mac for three and a half years, although it does not target the Mac user as much as the recording engineer or broadcast professional. Its three products (Audiomedia II, Sound Tools II, and Pro Tools) combine the Motorola 56001 with high-end software to do stereo or multitrack recording and mixing functions (e.g., compression, waveform editing, equalization, chorusing, echo, and pitch shifting). They can also do SMPTE (Society of Motion Picture and Televison Engineers) synchronization.

Processing Pictures

Giga Operations (Berkeley, CA) is a start-up company whose aim is to develop a low-cost, massively parallel digital signal-processing board for desktop computer systems. GigaOps uses the Analog Devices 2105 DSP, a 16-bit processor rated at 10 MIPS. Giga Operations puts four 2105s, 1 MB of DRAM, and a Xilinx PGA (Programmable Gate Array) into a single

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surface-mount module called a SIIMOD (Scalable Intelligent Image Module). Each of the SIIMODs provides 40 MIPS of signal-processing power. The end product, an ISA bus card called the T-800, supports up to eight of these modules, for a total power throughput of 320 MIPS, with 32 DSPs and 8 MB of RAM. With four cards in one system, the total processing power becomes 1280 MIPS, hence the company name.

Giga Operations is targeting the image-processing market. Its long-term goal is the execution of real-time math-intensive image processing at the read/write rate of a fast hard drive. To do this, it provides a proprietary C compiler called the Stream Splitter, which takes the serial data stream of signals and converts them for operation in parallel mode. One of the slick features of the T-800 is that the PGAs allow the user code to dynamically configure the board in real time (on the order of microseconds). Thus, alternative virtual machines can in parallel take advantage of resources as they are required.

Spectral Innovations (Santa Clara, CA) has been making DSP accelerator cards for the Mac since 1988. Like ARTA for the Mac, its cards use AT&T signal processors. But unlike Apple, the company makes a NuBus card with separate software modules for a variety of DSP functions (see photo 2).

In the past, Spectral Innovations focused its attention on the technical marketplace (e.g., signal analysis), but now it's in the process of producing more mainstream application modules. It intends to announce a fax/modem/telephony module by the end of the year, and it has a number of other projects in the works. The company provides a development environment with each card, and other vendors have made modules that use their hardware to accelerate Adobe Photoshop, LabView, IPLab, and MatLab.

From a consumer's point of view, one of the terrific things about the integration of DSP technology onto the desktop is that each function—whether it is audio, video, modem/fax, or some other tool—essentially exists as a virtual machine. The underlying hardware does not change while the application software creates the product. Besides keeping the cost down by reducing the number of pieces of hardware you must buy to accomplish various tasks, this could also reduce the size of the host system, especially as DSPs are integrated onto the motherboard. This also simplifies the upgrade process, because vendors need only send another disk to fix bugs or provide new functions.

Forging Ahead

CPUs are not up to the task of working with audio and video data. There are just not enough MIPS available. For now, the best way to handle multimedia data is to add a DSP to your system. You will see more system and peripheral vendors adding DSPs to their products in the coming year.

The logical next step, of course, is the integration of a DSP into general-purpose microprocessors. With advances in chip integration and with the 80x86-architecture vendors trying to differentiate their products from their competition, the addition of DSP functionality to an industry-standard CPU is inevitable. In many ways, DSPs are poised to become the math coprocessors of the 1990s. ■

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

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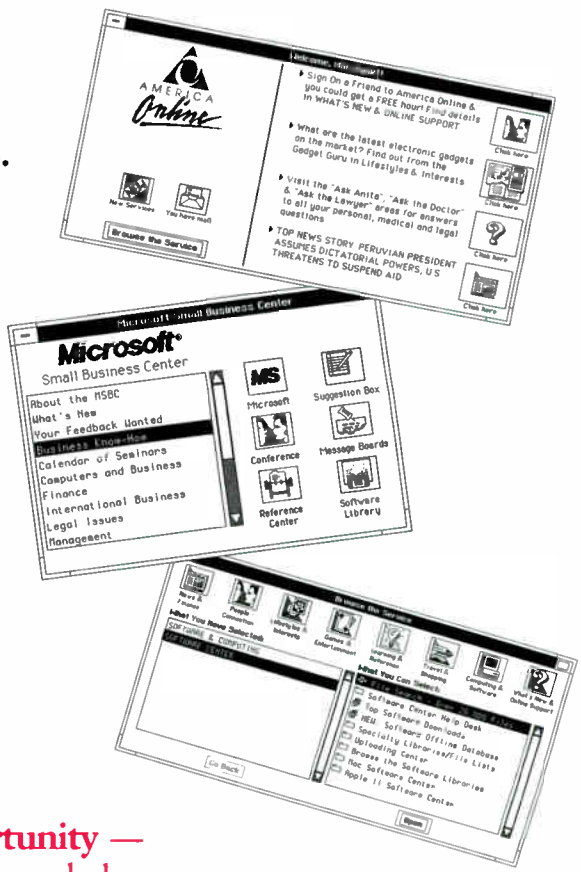

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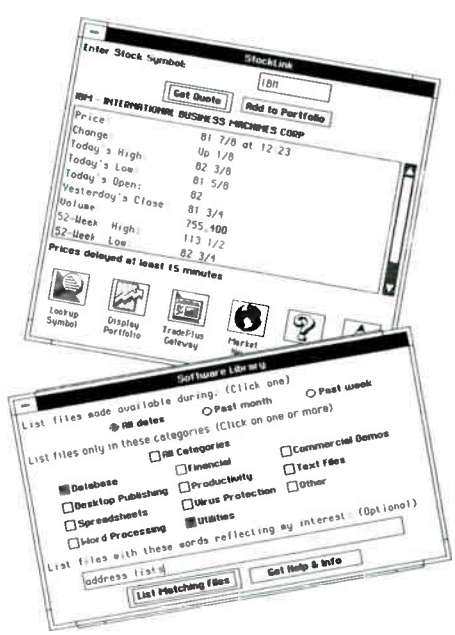

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INSIDE SIGNAL COMPUTING

Unlike general-purpose processors, DSPs are designed to perform a limited number of functions quickly

PETER WAYNER

Many cutting-edge desktop computer applications require the processing of real-world information, such as video and speech. Even though general-purpose CPUs can perform this processing, it is decidedly not their forte. The best way to turn an ordinary computer into a multimedia master is to add a digital signal-processing chip. These chips provide the ability to create and modify complicated video and audio signals in real time. That's why every Next machine is sold with a DSP (digital signal processor) on board, why IBM and AT&T are centering their multimedia offerings on DSPs, and why future Macs will come equipped with them.

What do DSPs do that is unique? Nothing, actually. Standard chips such as the 486 can do everything that a DSP does—just not as fast. Conversely, a DSP can do most things that a standard microprocessor can, but in most instances, a DSP would be much slower than a general-purpose CPU. Occasionally, it would even be incapable of handling certain problems.

The secret of the DSP's success is the modification of standard microprocessor architectures, which greatly enhances the chip's ability to compute the operations common in digital signature processing. The canonical signal processing function is the weighted sum. This is usually called a *digital filter*, or a *vector dot product*. One simple application of this function is noise reduction via smoothing by averaging the last *i* values of the signal. Most signal-processing functions are more complex, but by providing an architecture geared to handling this class of problems, DSPs easily outshine general-purpose CPUs.

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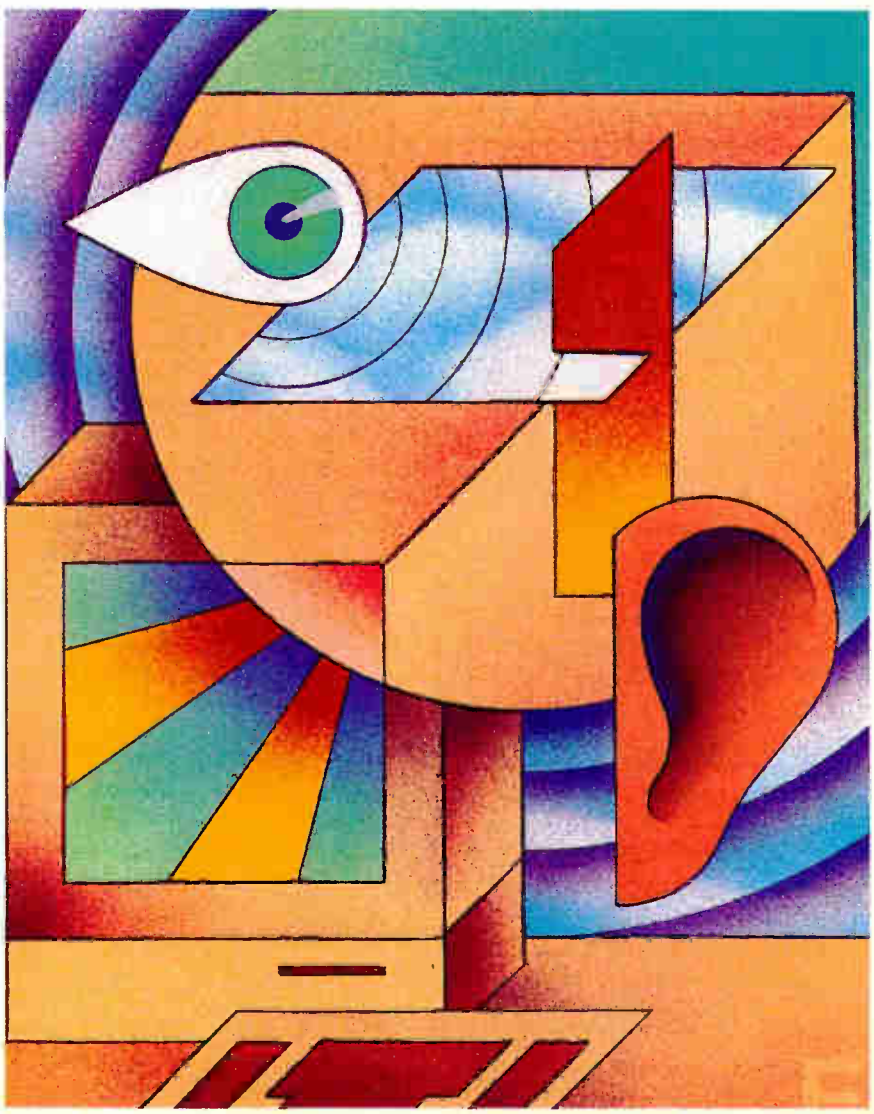

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Architectural Highlights

DSPs contain special addressing features and beefed-up data buses that allow them to keep up with the flow of data and compute signal-processing functions quickly. Many general-purpose DSPs are on the market, and each of them has a different approach to finding the fastest way of moving bits in and out. The differences between a standard microprocessor and a DSP are usually found in four categories: instruction sets, addressing modes, interrupt structures, and structural changes.

Many of the examples in this article are taken from the architecture of the Motorola 56000 and Analog Devices' line of signal processors, but DSPs made by companies such as Weitek or Texas Instruments share many of the same features. This article concentrates on the architectural themes shared by most DSPs.

Instruction Flux

The easiest way to get a processor to compute weighted sums quickly is to add one instruction that computes *v1*v2+v3 -> v4* quickly. *v3* and *v4* are usually the same register or a memory location called the *accumulator*, and it holds the partial total of the weighted sum as it's calculated term by term. *v1* and *v2* hold the weight and the value of the function. A digital filter can be computed by stringing together a number of these operations.

DSPs use small looping programs that process large streams of data.

Adding this instruction to a processor forces you to make changes to standard processor architectures. Most DSPs devote a large section of silicon to a multiplication unit that can multiply *v1* by *v2* in one instruction cycle. This unit is often pipelined to save silicon space. In contrast, early versions of the Sun SPARC processors did not have a multiplication instruction. The compiler would simulate the multiplication out of shifts and additions. This points out a major difference between DSPs and CPUs: General machines spend more time moving information and bits around than they do multiplying them; DSPs spend their lives doing multiplication, so it pays to devote a lot of silicon to this feature.

The basic *v1*v2+v3 -> v4* instruction takes three values from a register file and sends one back. A general DSP could execute the instruction when *v1*, *v2*, *v3*, and *v4* are different registers, or memory locations. This would make it easier for the compiler to reduce complex arithmetical expressions to machine code. RISC architectures often place no restrictions on the use of registers for just this purpose.

The architectural cost of this approach, though, is often too high, even in the age of 3-million-transistor chips. You would need three data buses on the chip and extra circuitry to handle all the general cases that might come up. In almost all cases, however, the generality wouldn't be used by a DSP processing filter, which usually includes instructions where *v3* and *v4* are the same register. For that reason, many

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DSPs include a special accumulator register and can process only functions of the form *v1*v2*+ACC->ACC (where *ACC* is the accumulator register). This accumulator is usually twice as big as a regular register to avoid rounding off the results of the multiplication after each step.

Another important addition to the instruction set of a DSP is the *loop counter*. A general microprocessor must be ready to execute `While` loops, where a block of code is executed until a specific test is satisfied. Loops that execute a set number of times are only a fraction of the loops in general code for RISC or CISC CPUs. Filter functions, however, almost always use a set number of passes through the loop. In many cases, there is only one multiply-and-accumulate instruction in the middle of the loop. The extra test-and-branch instruction executed at the end of each pass through the loop takes considerable time, and the time spent on this can nearly double the execution time of the loop.

The solution is to add a special counter that can be set at the beginning of the loop. At each pass through the instructions in the body of the loop, the counter is decremented and compared to zero in parallel. This allows the loop to execute as fast as the instructions in the body of it because the increment, test, and branch instructions are handled at the same time the main body is executing. The extra circuitry involved in this loop counter is extensive, but it's worthwhile because DSP applications are heavily devoted to tight loops of predetermined length.

Some DSPs, like those from Analog Devices, include special barrel shifters that speed computations of functions (e.g., the fast Fourier transform). These allow the programmer to quickly shift a word of data over several bits.

The DSP difference

- single-instruction multiply-accumulate
- multiple data buses
- programmer-accessible caches
- specialized interrupt schemes
- loop-optimized addressing

Address Change

The architects who design DSPs also look at the pattern of memory references to determine the quickest way to increase the throughput of data. The standard addressing mode of a RISC microprocessor is to load a value from a direct address. Older CISC architectures (e.g., the 80x86 and the 680x0) also include indirect addressing modes, where a pointer is followed and occassionally incremented. These modes are usually supported by a DSP.

However, DSP designers also included stranger addressing modes that are immediately useful for implementing filter functions on the DSP. In most cases, a DSP takes a signal at time *t* and computes a filter function over the previous *i*-1 values. The best way to store these *i* values is as a block of *i* words of memory. At time *t*, the signal value is stored in word *t* MOD *i* (*t* MOD *i* is what is left over after dividing *t* by *i*).

Many DSPs include a modular addressing mode that will look up a value at a location and an offset; increment the offset; and if the new offset is greater than the size of the buffer, reset the offset to zero. It can do all this in one instruction cycle.

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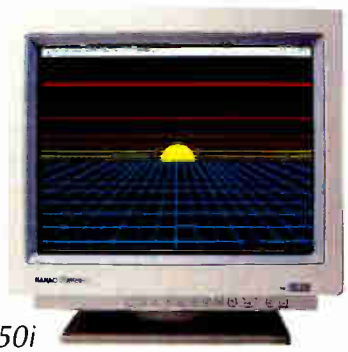

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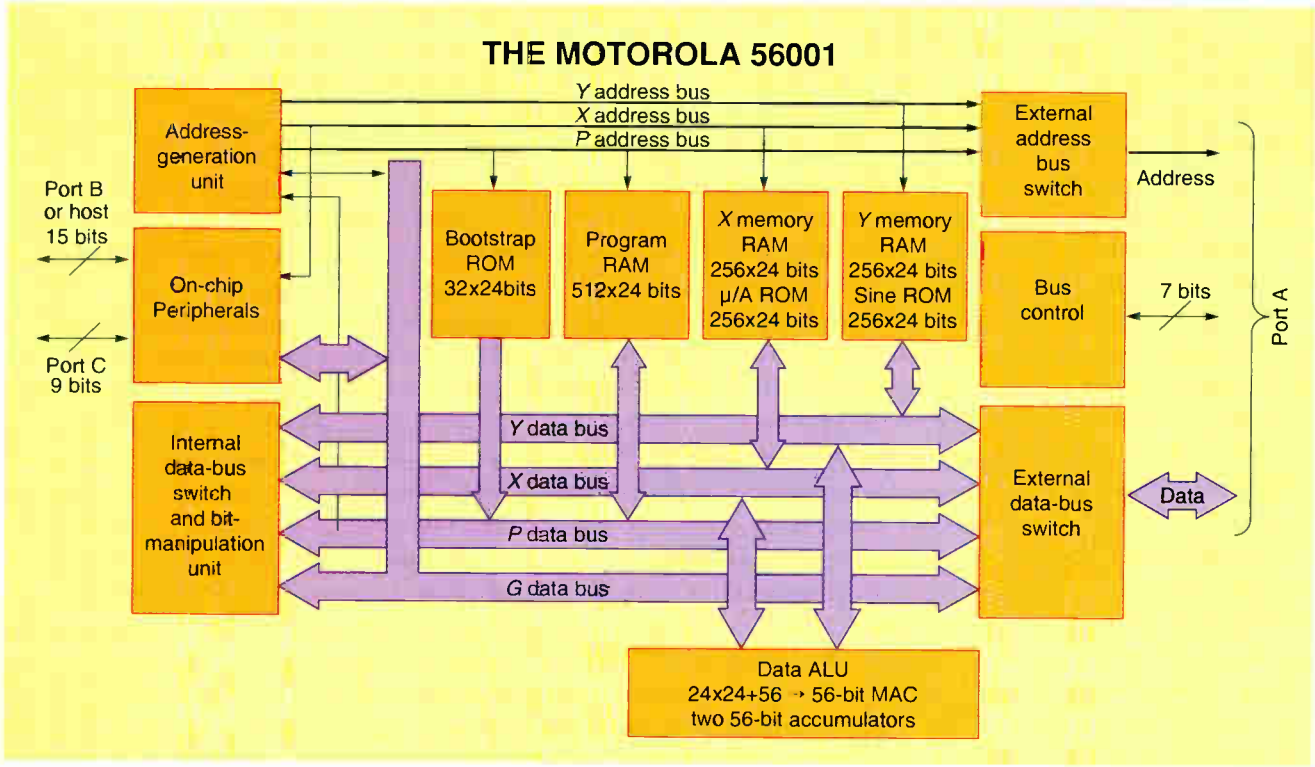

Figure 1: *The main feature of the 56001 is the two 24-bit data buses (i.e., XDB and YDB) that feed into the ALU. The ALU can multiply the values on these buses and add the result to the 56-bit accumulator in one operation, speeding up many signal-processing operations. The 56001 also features large on-chip instruction and data caches. The separate address-generation unit saves the ALU from having to calculate the address of the next data item.*

This work is handled by a separate ALU for computing the addresses. RISC systems, in contrast, have only one addressing mode to remove the need for the extra ALU, and processing a circular buffer takes many extra cycles. Here is the string of instructions that would handle this for a RISC processor:

```
t <- t+1; increment time
r1 <- t mod i
r2 <- base+r1; add offset to
    base
store value in r2; store it
    away
```

Another popular but seemingly strange addressing mode of DSPs is to reverse the bits. For example, an address such as 18 (1010 in binary numerals) is interpreted as 5 (0101 in binary numerals)—in a chip, the addresses take up the full word: 32 bits. This simple flip makes programming fast Fourier series expansions quicker—often as much as 10 times faster than on a similar RISC chip with the same cycle time and MIPS rating. It should be easy to see why when you imagine trying to reverse the bits in a word using standard RISC operations.

Double-Decker Buses

Getting information on and off the chip is a problem for any microprocessor designer, but DSP architects have made changes to standard processor design that have tuned these chips for high-speed data transfer. The most obvious change is splitting the processor/memory interface into an instruction stream and a data stream. This is an easy modification to make because DSPs often use small looping programs that process large streams of data. This allows the programmer and the processor to optimize the use of both of these paths.

Many DSPs from Motorola, Analog Devices, and other companies take this one step further. They have two data buses that grab data from the main memory simultaneously (see figure 1), which lets the chip read the two operands to be multiplied in the weighted sum in one step. This significantly increases the speed of the DSP because it reduces the bottleneck between memory and the processor.

DSPs don't go the next logical step (i.e., adding a third bus to write the data) because most filter functions take many inputs for each output. Not as much information flows in the other direction.

A traditional microprocessor (see figure 2) has a cache that lies between the chip and the main memory. This cache keeps a copy of the last *n* memory items that were referenced by the processor. Thus, it's able to supply these items to the processor faster than the main memory system can.

Caches work on the principle that much of the data that is touched by the processor is often reread a short time afterward. DSPs, on the other hand, have different access patterns. Most data comes into the chip once, and the result computed from the data leaves immediately afterward. When the data is reused, it's often done in a predictable way that can be exploited by the programmer.

Smoothing filters that use circular arrays, for instance, look only at the last *i* values of the function. Caches could keep track of these values, but it's better to leave this functionality off the chip because the circuitry required to determine the oldest values in the cache takes up silicon and adds a delay to the data bus.

This is worth the trouble in a general chip, where the complex data-access patterns would not be easily anticipated by the programmer. With DSPs, however, speed is so important that the optimization

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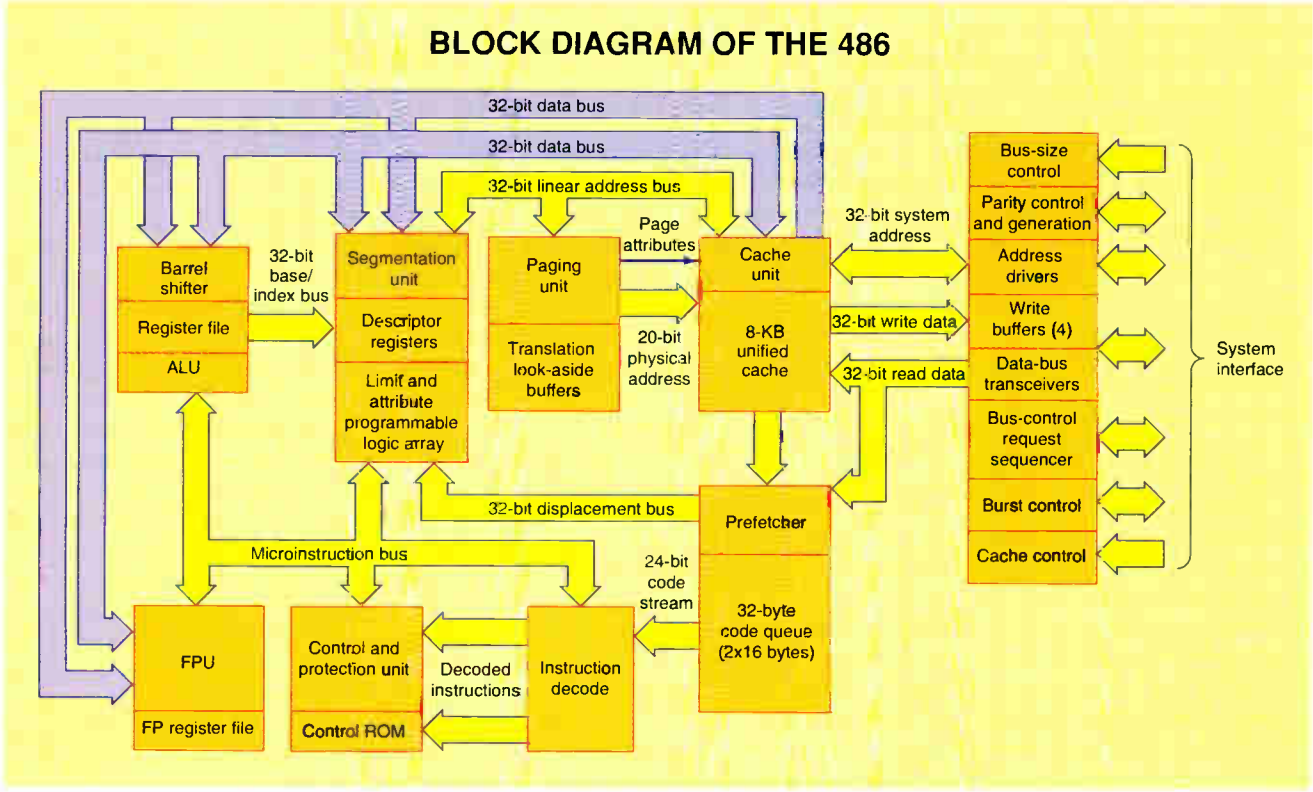

Figure 2: *Like other general-purpose processors, the 486 is optimized to keep irregular blocks of data moving on and off the chip. The cache keeps copies of the most recently accessed data, but there is no facility for the programmer to designate what information is to be kept on-chip. The ALU is split into FPUs and integer units because the chip must handle both types of arithmetic, but the ALU doesn't have an accumulator or a fast multiplier to speed up multiplication and accumulate functions.*

of performance in tight loops and other areas that normally fall to a cache is handled by the programmer.

DSPs often provide a small amount of local memory. For example, the Motorola 96000 has two banks of 512 32-bit words—one for each incoming data bus. The programmer can access each of these banks directly and arrange the access pattern of the program to keep the necessary data on the chip. Someone calculating a smoothing function of the last i values would keep the circular buffer in this memory space. A program that did not reuse the data, though, wouldn't use this special cache.

The instruction stream is handled in much the same way for similar reasons. The chips often provide a small amount of on-chip memory to hold small loops, and it would be possible to include the cache hardware to do this automatically. But that takes circuitry, and a cache cannot do the job as well as a programmer.

Here's one obvious case. Imagine that a program spends most of its time in a small loop that adds reverb to a guitar signal. After every million times through the loop, the programmer/composer slightly tweaks the weights used in the filter functions. When it goes to do this tweaking, a cache would dutifully load the recalibration code on top of the loop. This would slow the system down when it returned to the loop. A programmer, however, would be able to properly allocate the small on-chip instruction memory to avoid this delay. In most cases, programs that run on DSPs have a simple enough structure that programmers can easily predict the pattern of instructions and subroutines.

Making Connections

Many DSPs also include several ports for communicating with other chips. Both Analog Devices and Motorola's DSP chips have two serial ports for exchanging data with modem chips, A/D converters, and other DSPs. These two lines allow the DSP to maintain its own connection with the outside world without bothering the main CPU. It can get a signal from a modem and interpret it, notifying the main CPU only when the data is ready for consumption.

In the most high-end signal-processing implementations, several DSPs are linked in a long chain. These arrangements can do many different calculations, including complicated matrix operations. But in most cases, each DSP is responsible for its own filter function, and the result of one DSP is fed into another.

Floating-Point vs. Fixed-Point

General-purpose CPUs usually handle two types of numbers: integers and floating-point values. In many cases, however, they don't explicitly support floating-point calculations in hardware, because most tasks don't require them. You may need a special floating-point chip (e.g., a 387 or a 68882) to handle floating-point values.

For the same reason, DSPs often come in two flavors: fixed-point and floating-point. Fixed-point DSPs are a cross between integers and real numbers that provides only a fixed level of precision.

An example of such a fixed-point system is the U.S. monetary system. Dollars can be broken down into numbers that have only two decimal points of precision. The complexity of the mathematics is closer to integer arithmetic than floating-point arithmetic, because the fractions can be easily converted into integers. For instance, you can do integer arithmetic on U.S. currency by converting everything into cents.

Floating-point chips must be able to

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handle wide ranges of numbers, though. They must be able to multiply 1×10^{23} with 2.2×10^{-10} and find the right value. This requires large shifters that can shift the bits of the two numbers until they align correctly for the operation. This takes space and adds plenty of complexity.

Why have fixed-point chips? Most DSP operations involve plenty of fractions, and the fixed-point representation makes life easier for the programmer who would rather not convert everything to integers. In fact, overflows and underflows are the only big differences a programmer will find between fixed-point and floating-point DSPs. The programmer must watch for numbers that get too big or too small and trap for them.

Interrupts

One of the most important jobs of a DSP is processing data in real time. It must be able to handle information from an instrument like a seismometer while the ground is still shaking.

Standard CPUs come with an interrupt structure, which allows other hardware to get the CPU's attention. These general systems are designed to be used in many ways. When the interrupt is called, the state of the system is saved, and the process jumps to a new location determined by the operating system. When the work is done, the interrupt system restores the old state and gets back to work. This is simple, and it handles all possible cases that come its way.

The DSP, however, must handle incoming data without slowing down the process. That's why most DSPs come with a special interrupt mode that inserts a small number of instructions into the standard instruction stream. For example, the Motorola 56000 allows the programmer to define two general instructions as the interrupt. When the signal arrives, the two instructions are placed at the top of the pipeline, and the standard instruction stream is held up for two instructions. Usually, these instructions are enough to grab a value from one of the serial ports and store it in memory. This type of interrupt can be dangerous, because the two instructions can do anything to the state of the machine. When it's used correctly, though, it keeps the data coming in as fast as possible.

A Workhorse for the 1990s

DSPs are becoming popular for attacking problems that involve heavy number crunching. The architecture is tuned to get data onto the chip, do multiplication and accumulate instructions, and get the data off-chip as fast as possible. The modifications in the standard processors' instruction set, data buses, and interrupt structure are simple and general enough to be useful in a number of nonsignal applications (e.g., matrix multiplication or neural networks).

In one sense, DSPs are the last thriving remnants of CISC architectures. The chips include many special-instruction formats that are useful for frequently occurring instructions. These features are difficult for a compiler to use efficiently in all cases, but this is not a limitation because DSPs spend most of their time in small loops that programmers can hand-tune in assembly code.

An ordinary computer can be converted into a multimedia master by adding a digital signal-processing chip. The popularity of multimedia applications could make DSPs as popular in the 1990s as math coprocessors were in the 1980s. ■

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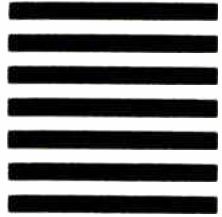

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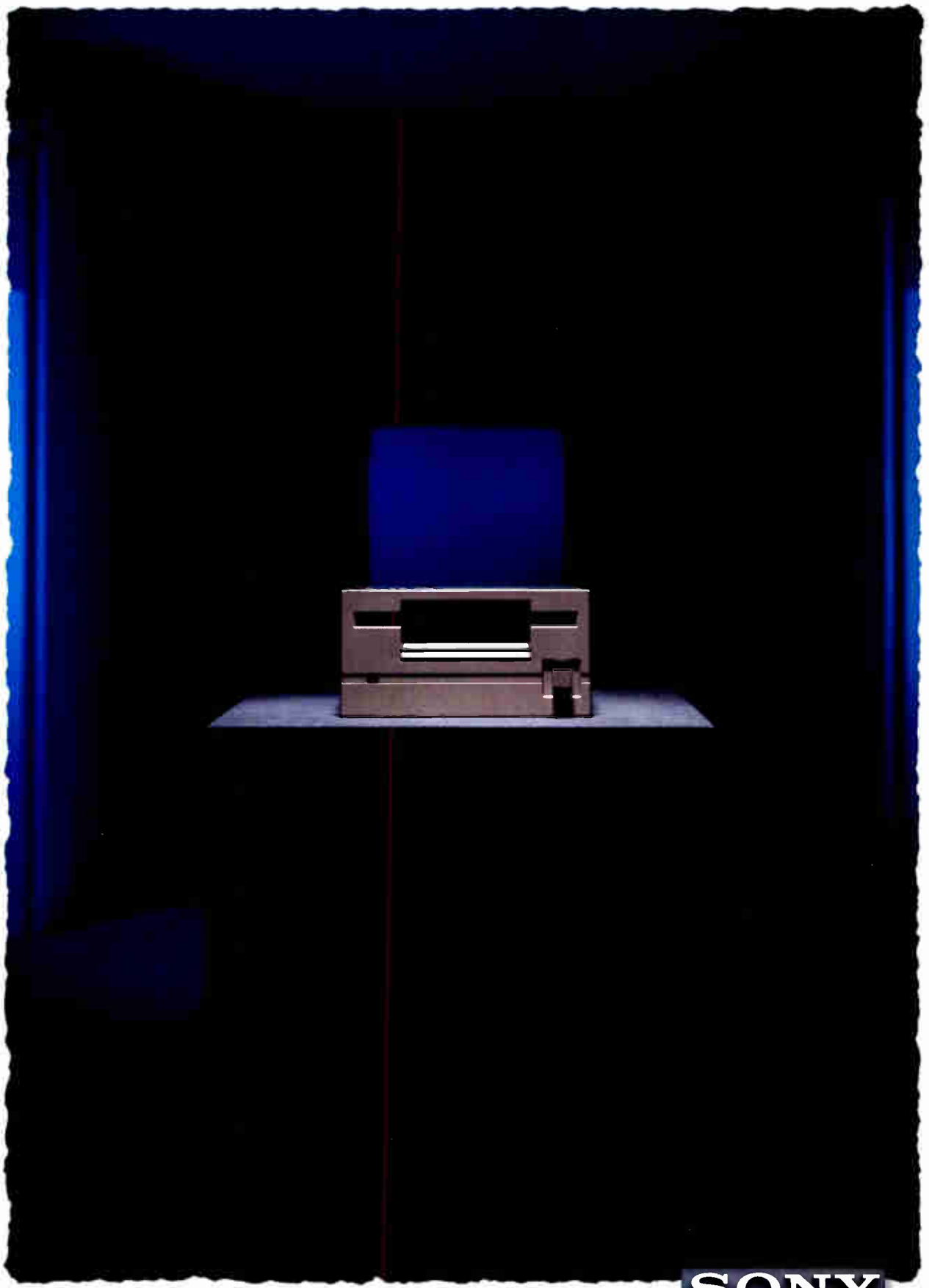

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World Radio History

A PLATFORM FOR SIGNAL COMPUTING

Analog Devices couples a reprogrammable signal processor with a standard API to create an open platform

TIM COUNIHAN

Signal computing integrates dynamic, new real-time data types into the static world of data processing. In turn, these data types will move your computer interface beyond the GUI to the point where even neophytes will feel comfortable using a computer.

Analog Devices has developed an open, reprogrammable signal-processing environment capable of manipulating these real-time data types. This is an environment for real-time, signal-based software applications, developed and run on a reprogrammable signal processor under the control of host-based applications. Within this environment, applications-specific signal I/O ports acquire and generate the real-time signal I/O.

The primary data types of this environment are voice, audio, wired and wireless communications streams, and video. With such a platform, you can bring real-time multimedia applications (e.g., digital photography, high-speed image compression, language translation, and teleconferencing) to the desktop.

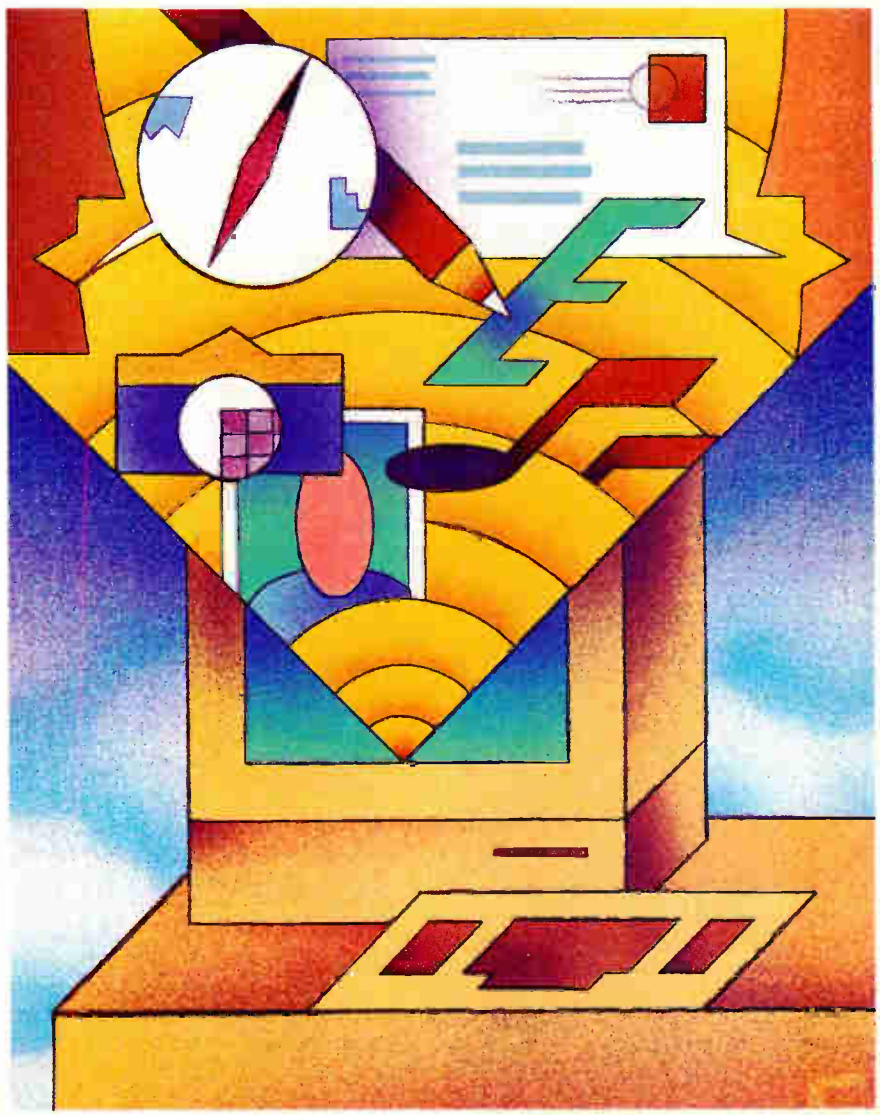

ILLUSTRATION: MARK FISHER © 1992

Multimedia Signals

Many of the above applications already exist. However, each one usually has its own proprietary plug-in hardware platform, with its own signal processor, memory, signal I/O peripherals, proprietary host interface, proprietary applications monitor, and proprietary applications code. Because these were developed as standalone, fixed-function applications, it is expensive and difficult to incorporate them into other personal computer–based software.

A low-cost signal processor (supported by inexpensive signal I/O ports and

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open software standards), coupled with an open software environment, can generate the widest developer base and, consequently, the greatest variety of applications. Software developers will be able to license these turnkey signal-processing libraries from entrepreneurial signal-processing experts and incorporate the new data types into their own applications.

Soft Modems

Two years ago, Ken Kretchmer of Action Consulting (Palo Alto, CA) described a soft modem as a modem that uses a totally RAM-based signal processor to implement all the controller functions (e.g., V.42bis and the Hayes AT commands) on the same signal processor that runs the V.32bis modulation algorithms. Kretchmer projected that the modem would be the first signal-processing application to achieve true software status, where all the modem's software algorithms resided in memory.

Digicom Systems (Milpitas, CA) held the same view and pioneered in the use of reprogrammable signal processors in high-performance modems. Last June, at the New York PC Expo, Digicom became the first modem manufacturer to announce a soft modem, the first signal-computing software product providing throughput of up to 57,600 bps and using the 14,400-bps V.32bis with V.42bis data compression. In addition, the modem includes Group 3 V.29 fax, all modem and fax fallback standards, and controller functions, such as the AT+Voice command set, MNP level 5, and class 1 fax. For less than $30, personal computer integrators are able to purchase all this software and two chips: a reprogrammable signal processor and a modem front end.

Beyond Data Processing

Analog Devices sees signal computing as an industry model to enable the open development and use of real-time signal-processing applications. It has defined inexpensive, reprogrammable chip sets and developed a nucleus of IAVs (independent algorithm vendors) to leverage signal computing's development.

Two unique features of the signal-computing chip set are its reprogrammability and extensibility. First, Analog Devices' product is RAM-based. The modem can be reprogrammed, patched, enhanced, and upgraded through software. This is especially valuable to closed hardware platforms (e.g., laptops and palmtops). Second, the chip set is based on an inexpensive, general-purpose 16-bit DSP (digital signal processor), and the companion chip is a fully integrated modem front end. At an integrator's discretion, additional signal I/O ports (providing voice I/O, stereo audio I/O, and so forth) can be added to the base chip set. Voice-recognition, text-to-speech conversion, or music-synthesis software can also be added to incrementally extend the base chip set's capabilities. Speech recognition, music synthesis, and image compression become software products that essentially run on your fax/modem.

Signal-computing components

- reprogrammable signal processor
- signal I/O devices
- algorithms for natural data types
- open hooks for applications

Signal-Processing Data Types

The major difference between signal processing and data processing is the real-time nature of the data being processed. Real-time data is simply a signal (e.g., an audio waveform) that is sampled or generated in real time. Signal processors are designed to handle the unique numerical requirements of processing real-time data and to interface with real-time signal-acquisition components.

Modems compress data into real-time communications streams to fit narrowband channels. Similarly, high-speed wired networks, infrared LANs, mobile radios, and satellite RF links use signal processors to compress and decompress data in real time. If a real-time processor fails to process a millisecond or two, the consequence is lost signals, resulting in garbled voice or corrupt data.

Voice applications (e.g., cellular phones and digital answering machines) require real-time signal I/O at frequencies as high as 8 kHz for compression and up to 16 kHz for speech recognition (to capture the high-frequency voice tones, such as an *s*). Audio applications (e.g., digital stereo playback, music synthesis, and digital stereo recording) require real-time signal I/O at frequencies as high as 48 kHz to capture high-frequency audible signals, such as crashing cymbals. And motion video requires real-time signal I/O at frequencies between 1 and 30 MHz, depending on the size and update frequency of the image.

Many other real-time signal-processing systems (e.g., noise cancellation and encryption) require lossless I/O. The lossless characteristic of real-time signal I/O places burdens on the signal processor, especially on its architecture, I/O peripherals, and interrupt capabilities. The signal processor needs the computational bandwidth

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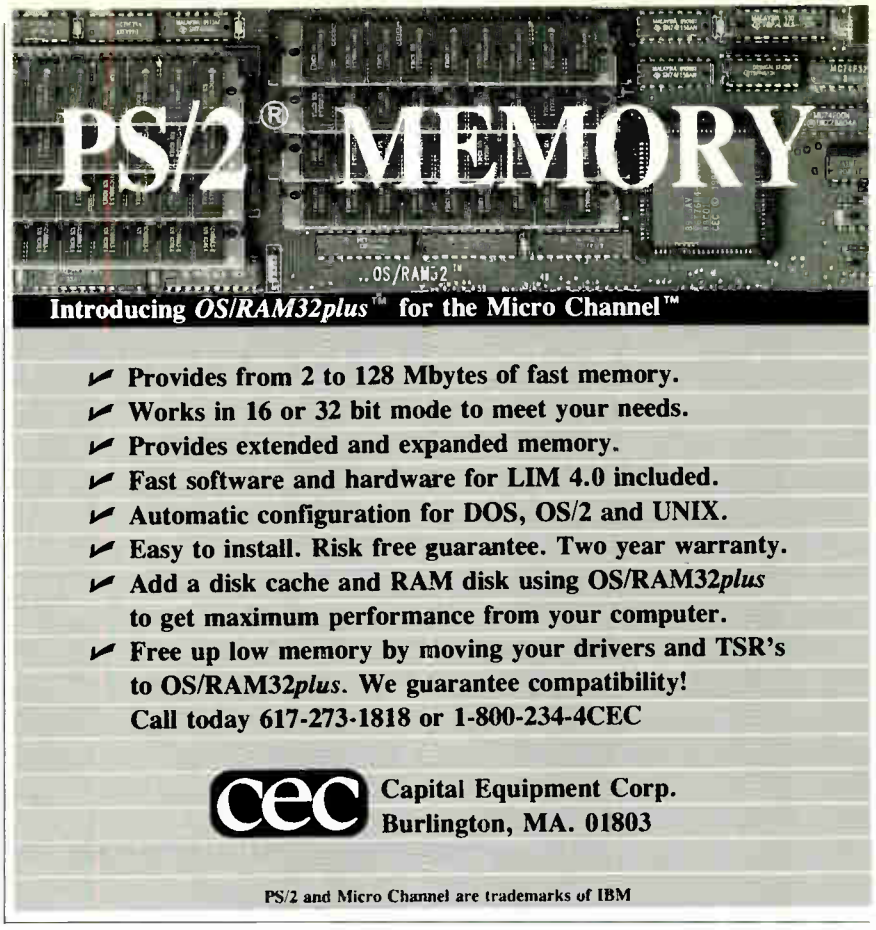

to process the signal data within the sampling frequency. Although data processors can handle some real-time signal applications, they were not designed for these tasks.

Signal I/O

To incorporate real-time data types into a personal computer, you need real-time signal I/O ports or mixed-signal peripherals. Such devices preserve the information contained in a signal while transforming its format into one appropriate for the next stage in its journey—for either processing or transmission. They must be capable of sampling the signal stream at a frequency appropriate for the data type with the necessary accuracy or fidelity. They must also be able to preprocess the acquired data. When generating signal output, the devices should postprocess the digital data stream and output signals with a data type–appropriate frequency, accuracy, phase, and gain. When used in signal-computing environments, the devices should easily interface with the signal processor.

Third-party companies are integrating audio-band I/O ports into the A/D-signal-computing platform. Wireless communications and video I/O ports (e.g., baseband I/O and infrared/RF components, video-capture boards and scanners, and real-time video-compression components) will be designed into the integrated personal computers of the future. Note that the performance of these signal I/O ports is just as important to signal computing as the performance of the keyboard, disk drive, mouse, and display is to personal computing.

PSTN (public switched telephone network) applications on a personal computer (e.g., modem, fax, and speech) require a direct-interface, single-chip, echo-canceling front end. This component must handle standard sampling frequencies and include on-chip resampling/interpolation filters for real-time signal synchronization and phase adjustment.

Voice I/O applications require a linear voice-band codec that provides a direct interface with a signal processor, a microphone, and an amplified speaker. The codec should offer on-chip antialiasing and anti-imaging filters and good group-delay characteristics that simplify accoustic echo cancellation when the signal is to be broadcast in mobile (i.e., wireless) computer environments.

Audio applications require a single-chip, 16-bit, stereo audio-band codec, which provides a direct interface with the data processor or signal processor; stereo line-level inputs and outputs; stereo microphone-level inputs; and speaker outputs. The audio codec should have on-chip programmable gain amplifiers and automatic-calibration circuitry, as well as support the full spectrum of personal computer audio-sampling frequencies between 8 and 48 kHz.

Video I/O ports will be designed into the integrated personal computers of the future.

Signal I/O ports must also be fully integrated and designed to provide the functionality required by a wide variety of applications for a given signal data type. They will be fabricated with CMOS-process technology at both 5-volt and 3-V levels to enable the signal ports' integration into the chip sets of the future.

Signal-Computing Applications

Today, signal processors are pervasive in communications systems such as high-performance modems, digital mobile radio, digital cordless telephony, satellite communications, and videophones. Narrowband communications channels require the compression and reconstruction of data, and signal processors are the engines.

Voice and data compression are also used in such applications as voice mail, digital answering machines, and data compression for floppy/hard-disk conservation. Real-time data types take up a lot of hard disk space. Even compressed, a minute of motion video can fill a hard drive. More efficient algorithms are being developed to reduce channel usage and data-storage costs.

Digicom Systems, Specom (Santa Clara, CA), and Lernout & Hauspie Speech Products (Ieper, Belgium) are the first IAVs to provide data- and voice-compression technology for communications applications within the signal-computing environment. Digicom provides modem and fax capability. Specom provides CELP (code excited linear prediction) and TIA IS-54 VSELP voice compression capability. And LHSP provides SBCELP.

Signal processors are pervasive in speech-recognition and speech-synthesis applications (e.g., voice navigation, hands-free/eyes-free control, security access control,

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The Signal-Computing Environment

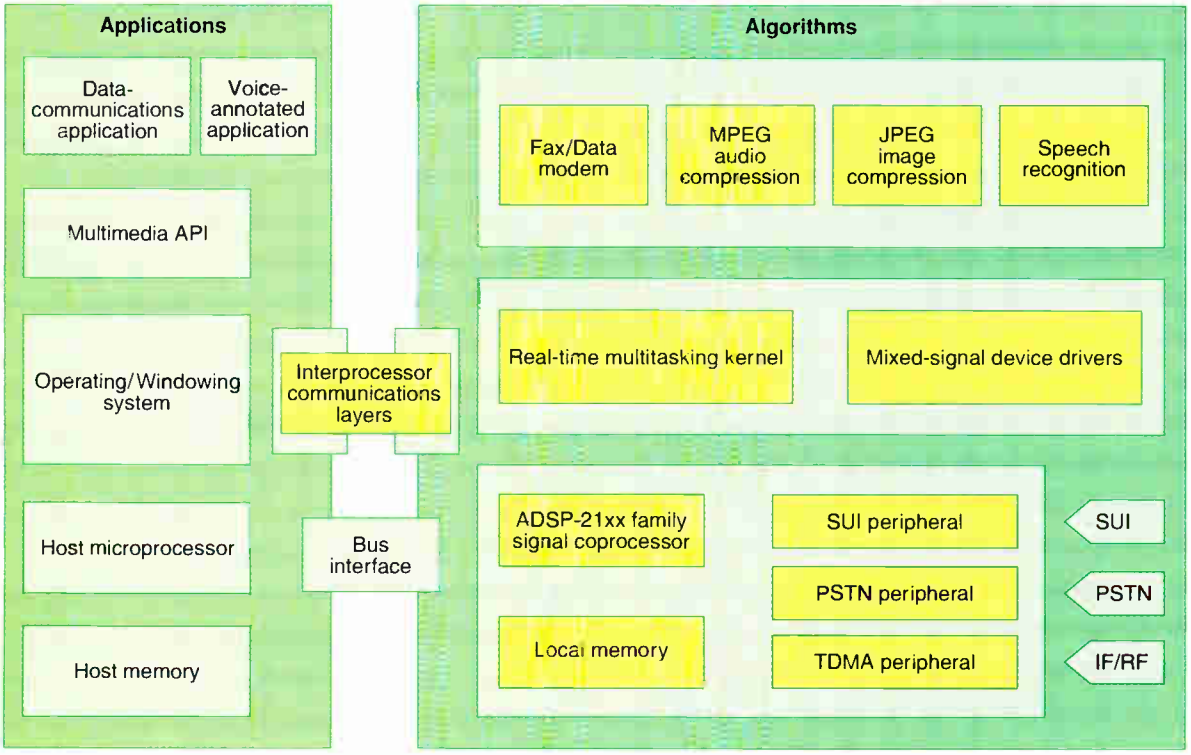
The essence of signal computing lies in the integration of three fundamental competencies into a signal-processing solution: signal I/O ports, signal-processing software, and a reprogrammable, digital signal processor.

The signal I/O ports capture or generate the applications' signals, converting them back and forth between the analog and digital domain. In the figure, there are three signal I/O ports: a SUI (Sound User's Interface), which provides voice- or audio-quality I/O; a PSTN (public switched telephone network) interface, which connects to the phone lines for modem and fax I/O; and a TDMA (Time Division Multiple Access) peripheral, which connects to infrared/RF transmit and receive components for wireless communications.

The algorithm software performs the mathematically complex and intensive signal-processing algorithms. The figure shows algorithm code for a fax/data modem, MPEG audio compression, JPEG image compression, and speech recognition. When not in use, the code resides on the personal computer. It's downloaded as necessary by the host processor.

The signal coprocessor provides the mathematical horsepower to process the signal-computing algorithms. It has support circuitry to interface with the signal I/O ports, as well as with a host

THE PERSONAL COMPUTER–DSP CONNECTION



Using the abstraction of a multimedia API, the signal processor and its algorithms are invisible to host-based applications. Interprocess communications between the signal-computing platform and the host are bus-independent, letting the signal processor reside on a motherboard, on an expansion card, or in a peripheral device.

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processor. The signal-computing applications' RAM sits alongside the signal processor, enabling the reconfigurability of the signal-computing engine.

As signal-computing applications grow and become more complex, there will be an increasing need for a real-time multitasking kernel and mixed-signal device drivers. Spectron Microsystems (Santa Barbara, CA) has pioneered in the standardization of the DSP operating system with SPOX. The company has also defined and standardized an OSPA (open signal coprocessing architecture) for layered host/DSP interprocessor communications. These software tools decouple the algorithm code from the signal processor and the signal I/O port hardware and enable the portability of applications software. OSPA and SPOX work with signal processors from Analog Devices, Motorola, and Texas Instruments.

On the applications side of the signal-computing environment are the traditional components of most personal computer applications: the host microprocessor, its memory, the operating/windowing system, and applications software. In the figure, a data-communications application and a voice-annotation application access the signal-computing software. These applications can be databases, spreadsheets, word processors, or yet-to-be-developed programs.

APIs are also needed to provide applications with standardized calls to the signal processor. The Interactive Multimedia Association, Spectron Microsystems (with its MINT [Media Integration] architecture), and other applications groups are standardizing multimedia and signal-processing APIs for use by independent software developers. These standards will be determined by the free-market interaction of the IAVs and the software developers.

and text-to-speech conversion). Speech systems can have various vocabularies, languages, training requirements, and accuracy rates; be continuous or discrete; and use options such as word spotting, lexical and syntactic analysis, and semantic processing. Speech recognition and speech synthesis rely on constantly evolving algorithms for vector quantitization, acoustic and language models, neural networks, hidden Markov models, and expectation maximization. In a signal-computing environment, you can incorporate these improvements with shrink-wrapped software upgrades.

Signal processors will soon be found in car audio systems for improving stereo imaging.

LHSP provides speech-recognition and speech-synthesis technology for speech I/O integration within the signal-computing framework (see the text box "Digitally Speaking" on page 160). LHSP provides speaker-independent and speaker-adaptive American English, German, French, Spanish, Dutch, and Korean speech-recognition and speech-synthesis systems. And it is working on systems for Japanese, Italian, British English, South American Spanish, and tonal languages (e.g., Mandarin and Cantonese). All the systems use a text-to-speech conversion tool called DEPES (Development Environment for Pronunciation Expert Systems) for rapid language development.

Digital Audio

Signal processors are widely used in audio and electronic music. Music synthesizers use signal processors as envelope generators and as digital oscillators to create various voices and such effects as tremolo and pitch blending. One of the first applications of signal processors was in professional audio for delay and artificial reverberation. Now DPSs are also being applied in consumer audio for such functions as surround-sound decoding and equalization. In the near future, signal processors will be found in car audio systems for canceling noise or improving stereo imaging.

One IAV working in this area is EuPhonics, whose first algorithm toolkit will be an implementation of Dolby Laboratory's AC-2 audio-compression algorithm, which provides a 6-to-1 reduction of storage requirements for CD-quality audio, with no audible degradation of the sound. EuPhonics also plans to offer unique digital synthesis algorithms that will improve the quality of FM synthesis components that are used in popular add-in cards, such as SoundBlaster from Creative Labs (Santa Clara, CA).

Digital Imaging

Signal processors are widely used in static imaging (e.g., graphics accelerators and digital photography), CAT scanners, magnetic-resonance imaging, satellite imaging, and bar coders. They are also used in real-time imaging applications, such as videophones, radar, and sonar.

One IAV with offerings in the imaging field is Xing Technology (Arroyo Grande, CA), which will initially provide CCITT JPEG (Joint Pictures Experts Group) image-compression algorithms and CCITT MPEG (Motion Pictures Experts Group) audio-compression algorithms. Xing Technology is active on the JPEG, MPEG, and Interactive Multimedia Association committees and has developed its software products using a scalable compression architecture. In real-time video, the viewed size, compressed size, refresh rate of the image, and quality of the image can be scaled to the computing resources available. Future IAVs will offer print- and cursive-handwriting-recognition software, as well as graphics and digital-imaging algorithms.

Signals in Your Future

Analog Devices created an open signal-computing platform to move the power of DSP beyond proprietary constraints. It's an environment for real-time, signal-based software applications. With this platform, you can bring real-time multimedia computing to your desktop.

Analog Devices has defined low-cost, reprogrammable chip sets for this platform. But, as with the original personal computer, the success of the platform depends on the imagination and hard work of applications developers. ■

Tim Counihan is the strategic marketing manager for signal processors at Analog Devices (Norwood, MA). You can contact him on BIX c/o "editors" or on the Internet at tim.counihan@analog.com.

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Image and Signal Processing Corp.
120 Linden Ave.
Long Beach, CA 90802
(310) 495-9533
fax: (310) 495-1258
AP-4, 4E, 6 (proprietary)
Point (PC)
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Olsson Engineering
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Edmonds, WA 98020
(206) 778-9480
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DSP200 (VME bus)
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Antex Electronics Corp.
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Gardena, CA 90248
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(310) 532-3092
fax: (310) 532-8509
AV-16 Audiographics (PC)
Circle 1003 on Inquiry Card.

Echo Speech Corp.
6420 Via Real
Carpinteria, CA 93013
(805) 684-4593
fax: (805) 684-6628
Echo DSP (PC)
Echo Speech Processor DSP (Unix)
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Singular Solutions
959 East Colorado Blvd.
Pasadena, CA 91106
(818) 792-9567
fax: (818) 792-0903
A/D64x (Next)
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Cambridge, MA 02142
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NetBridge (Mac and LocalTalk)
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Highland Park, NJ 08904
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DSP Technology, Inc.
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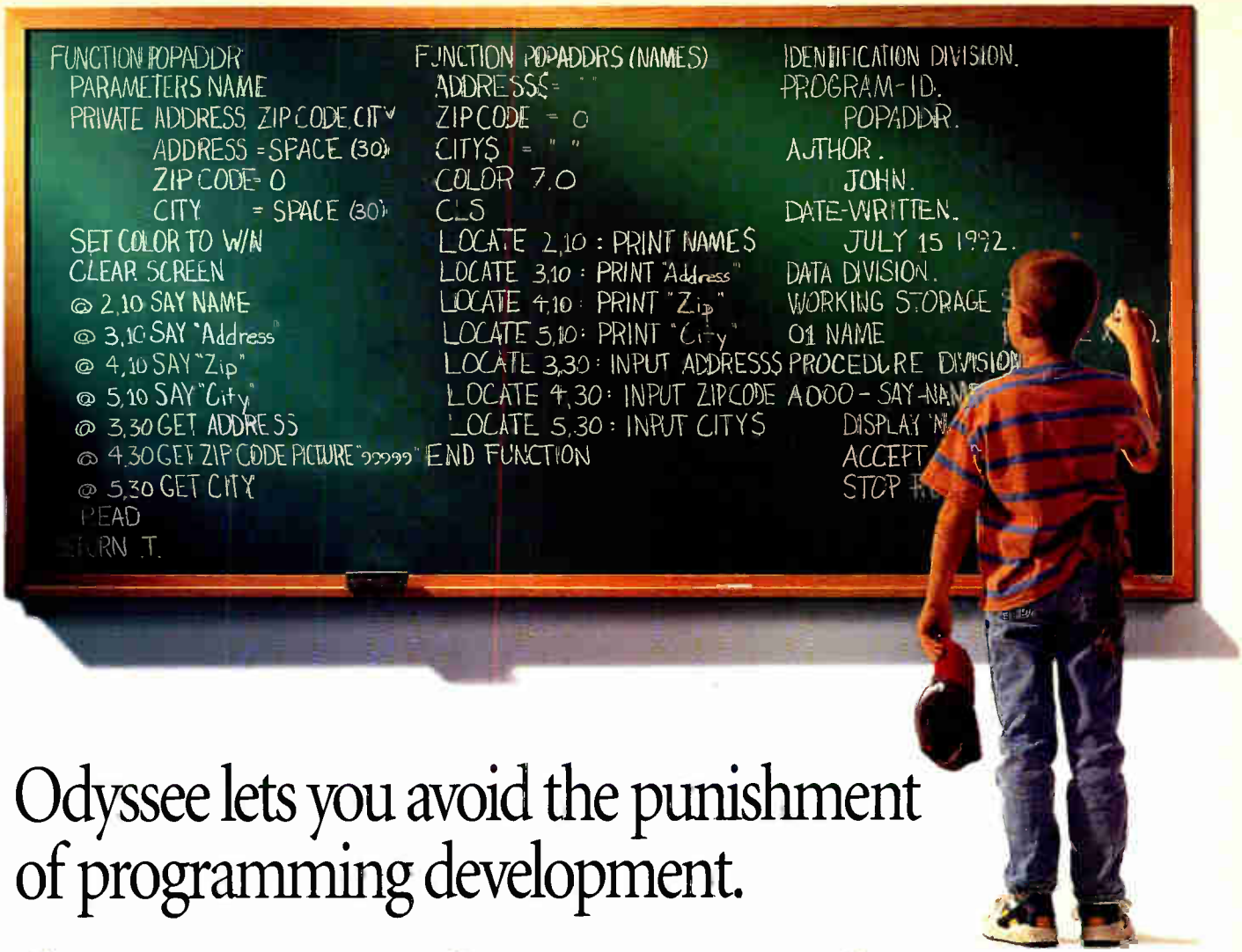

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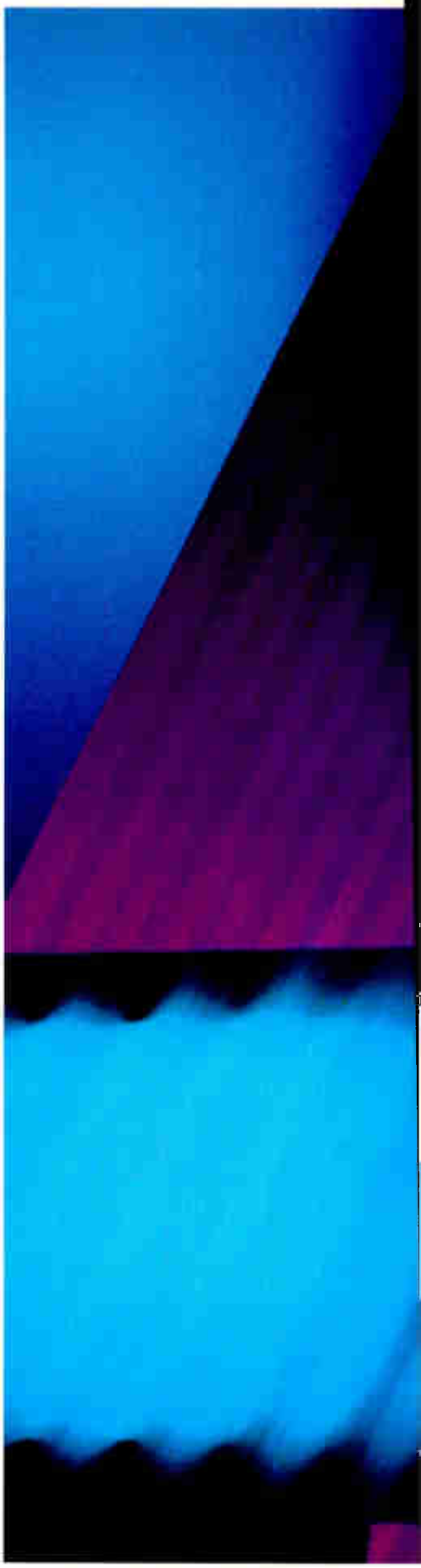
STALKING THE ULTIMATE WORKSTATION



The BYTE Lab tests eight workstations with CAD and DTP applications

BEN SMITH AND RAYMOND GA CÔTÉ

This month, the BYTE Lab goes in search of the ultimate workstation. We put eight high-end machines through their paces. We tested performance on real applications, concentrating on CAD and DTP (desktop publishing). And we looked beyond the numbers to the element that most contributes to (or detracts from) productivity—the operating-system environment.

Taking all these factors into consideration, we arrived at some surprising results. If you're willing to look beyond the nameplate and put aside preconceptions about processors and operating systems, you may find yourself rewarded with good performance, reasonable cost, a system that's easy to work with, and a wealth of off-the-shelf applications.

To Begin With, a Definition

The term *workstation* has been applied to everything from Sparcstations to computer furniture, so, to begin, here's our definition: For us, a workstation is a computer designed for a single user, built for network integration, and equipped with high-resolution graphics and enough speed to handle demanding engineering and graphics tasks. Notice that we don't say anything about running Unix or about RISC architectures. If a DOS PC fits well into a network and makes a suitable host for CAD applications, we call it a workstation.

In this review, we've included four pure workstations: Sun Microsystems' Sparcstation2 GX, DEC's DECstation 5000/120, Hewlett-Packard's Apollo 9000 Model 710, and IBM's RISC System/6000 Powerstation/350. We also looked at two more personal workstations, Next's Nextstation and Silicon Graphics' Iris Indigo, which focus on blending the rich toolkit environment of Unix with desktop ease of use. And finally, we evaluated two not-so-humble personal computers, the Apple Mac Quadra 950 and the Compaq Deskpro 50M. Two notable platforms are not represented: Amigas and OS/2 systems. Commodore declined to participate in these applications, citing the Amiga's multimedia orientation; for the OS/2 story, see the text box "Where's OS/2?" on page 200.

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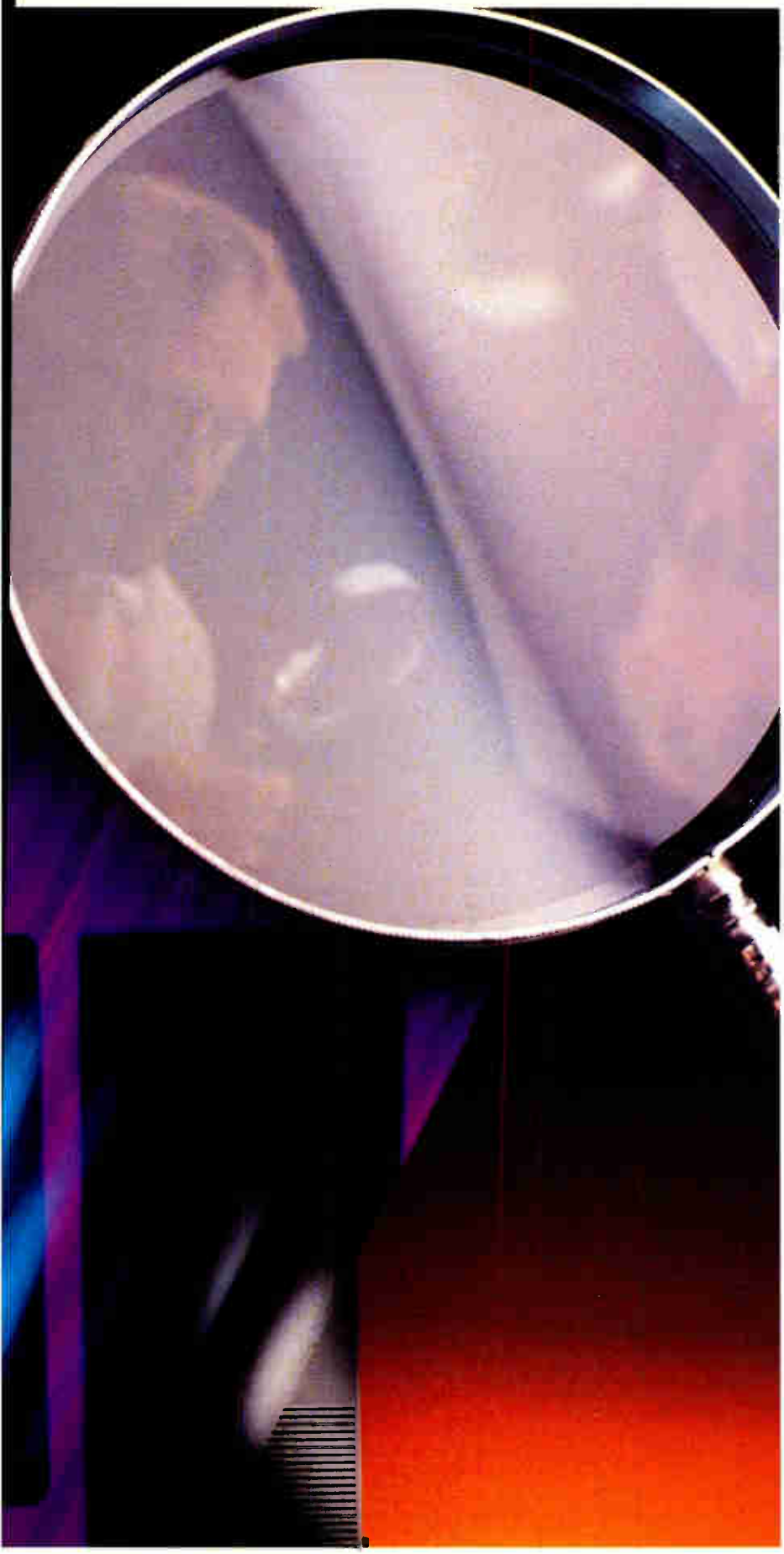

BYTE ACTION SUMMARY

- **WHAT WORKSTATIONS ARE**
  They are fast, powerful, personal systems with high-end graphics hardware and network support. We measured these systems on their performance in CAD and DTP applications.
- **LIKES**
  The systems are fast and easy to use; they present consistent environments and offer broad software support for popular platforms.
- **DISLIKES**
  Some systems delivered surprisingly slow performance and had poor administrative tools.
- **RECOMMENDATIONS**
  The Mac Quadra 950 is the ultimate DTP machine. For CAD and raw high-end processing power, we recommend the IBM RS/6000 Powerstation/350.

Two Test Environments

There is no way to divorce an evaluation of these workstations from their underlying operating systems and the implementation of the applications software. We tested the systems on CAD and DTP, two of the most common workstation applications, which are demanding of graphics and floating-point hardware, as well as CPU speed. Besides performance, we evaluated features like ease of use and administration, which are critical in determining the most productive environment in which to work.

For our performance benchmarks, we ran tests using the same application on each system. The results appear in the benchmark figure, and the testing details are fully outlined in the text box "Modus Operandi" on page 198. Naturally, the quality of the software implementation varies from platform to platform, so the applications play a big part in determining performance. However, the whole environment—including applications software—will determine the performance that end users see, so that is what we timed.

We timed CAD operations with Autodesk's AutoCAD, and DTP jobs with Frame Technology's FrameMaker. Both are available on every platform we tested. However, we also ran Ashlar's Vellum 3D 2.12 on the Mac; Interleaf 5 on the DECstation, HP/Apollo 710, and Sparcstation2 GX; and Aldus PageMaker on the Mac and under Windows 3.1 on the Compaq Deskpro. Thus we got a feel for the breadth of applications available for each system.

continued

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WORKSTATION FEATURES

Comparing features illustrates how broadly the term workstation *can be applied. These systems present an eclectic mix of processors, processor speeds, and peripherals. Note that the prices for the configurations (CAD and DTP) we tested represent complete packages, including operating-system and applications software as well as hardware. (N/A = not applicable.)*

	Apple Mac Quadra 950	Compaq Deskpro 50M	DECstation 5000/120	HP/Apollo Model 710	IBM RS/6000 Powerstation/350
Operating system	System 7.0.1	DOS 5.0/Windows 3.1	Ultrix 4.2	HP-UX 8.05/HP VUE 2.01	IBM AIX/6000 3.2
Configured prices					
Baseline tested [1]	$9498	$5319	$9495	$13,890	$26,500
CAD configuration [3]	$17,196	$12,163	$12,995	$17,390	$36,260
DTP configuration [4]	$14,491	$7013	$10,980	$15,385	$30,790
COMMON CONFIGURATION INFORMATION					
CPU/memory system					
Processor	33-MHz Motorola 68040	50-MHz Intel 486DX2	20-MHz Mips R3000A	50-MHz PA-RISC	42-MHz IBM Power
Floating-point processor	Integrated	Integrated	Mips R3010A	Integrated	Integrated
Processor cache (KB)	8	256	128	32/64 [5]	8/32 [5]
RAM (MB)	12	8	16	32	32
Maximum RAM (MB)	64	64	120	64	128
Mass storage					
Hard drive size (MB)	400	510	330	420	800
Interface	SCSI	IDE	SCSI	SCSI	SCSI
Type	Internal	Internal	External	Internal	Internal
Other storage in tested configuration	SuperDrive floppy drive	1.44-MB floppy drive	CD-ROM, DEC Tape	1.44-MB floppy drive	150-MB QIC tape, 1.44-MB floppy drive
Networking/communications					
Network support	LocalTalk, AUI Ethernet	None	Thin-wire Ethernet	Thin-wire, AUI Ethernet	Thin-wire, AUI Ethernet
Serial ports	2	2	2	2	2
Parallel ports	0	1	0	1	1
Other ports	ADB, audio	Audio	None	Audio	Tablet, audio
Expansion					
Bus type	NuBus 90	EISA	TurboChannel	None	Micro Channel
Total expansion slots	5 NuBus 90, 1 PDS	5	3	None	4
Internal mass-storage bays	4	7	2	2	2
Service					
Warranty	1 year	1 year	1 year	90 days	1 year
On-site service	Option	1 year	1 year	90 days	Option
CAD CONFIGURATION					
Video controller					
Company	Radius [6]	Matrox [6]	DEC	Hewlett-Packard	IBM
Model	PrecisionColor 8X	MG-124/color upgrade	Included	Included	2770 Color Graphics Adapter
Price	$899	$1695	Included	Included	$2310
Maximum resolution (pixels)	1152 × 882	1280 × 1024	1280 × 1024	1536 × 1024	1280 × 1024
Color depth	8-bit	8-bit	8-bit	8-bit	8-bit
Monitor					
Company	Radius [6]	ViewSonic [6]	DEC	Hewlett-Packard	IBM
Model	PrecisionColor Display/20s	ViewSonic 7	VRT 19	A1497A	6091
Price	$3299	$1399	Included	Included	$3950
Maximum resolution (pixels)	1280 × 1024	1280 × 768	1280 × 1024	1024 × 768	1280 × 1024
Diagonal screen size (inches)	20	17	19	16	19
Tested software	AutoCAD 11, Vellum 3D 2.12	AutoCAD 12	AutoCAD 11	AutoCAD 11	AutoCAD 11
DTP CONFIGURATION					
Video controller					
Company	Radius [6]	Compaq	DEC	Hewlet-Packard	IBM
Model	PrecisionColor 8X	QVision 1024/E	Included	Included	2760 Gray-Scale Adapter
Price	$899	Included	Included	Included	$1450
Maximum resolution (pixels)	1152 × 882	1024 × 768	1280 × 1024	1536 × 1024	1280 × 1024
Color depth	8-bit	8-bit	8-bit	8-bit	4-bit
Monitor					
Company	Radius [6]	Compaq	DEC	Hewlet-Packard	IBM
Model	PrecisionColor Display/20	QVision 150	VRT 19	A1497A	8508
Price	$3299	$899	Included	Included	$1345
Maximum resolution (pixels)	1280 × 1024	1024 × 768	1280 × 1024	1024 × 768	1280 × 1024
Diagonal screen size (inches)	20	15	19	16	19
Tested software	FrameMaker for Macintosh 3.0, Aldus PageMaker 4.2	FrameMaker for Windows 3.0, Aldus PageMaker 4.0	FrameMaker DECX 3.1, Interleaf 5	FrameMaker HPLX 3.1A, Interleaf 5	FrameMaker IBMX 3.1A

[1] As-tested price is for configuration listed below, plus keyboard, mouse, OS, and documentation. It includes monitor and graphics adapter only if they are listed below as "Included."
[2] System evaluated included a 400-MB drive, nonstandard on the Nextstation. Pricing is for the standard configuration, which includes a 105-MB drive.
[3] The CAD configuration includes baseline features plus CAD graphics features and AutoCAD.
[4] The DTP configuration includes baseline features plus DTP graphics features and FrameMaker.

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WORKSTATION FEATURES

Next Nextstation	Silicon Graphics Iris Indigo	Sun Microsystems Sparcstation2 GX
NextStep 2.1	IRIX 4.0.1	SunOS 4.1.2/OpenWindows 3
$4995 [2]	$12,995	$22,190
Not tested	$16,495	$25,940
$5790 [2]	$14,490	$23,685
25-MHz Motorola 68040	33-MHz Mips R3000A Mips R3010A	40-MHz SPARC
Integrated	32/32 [5]	Integrated
8	16	64
8	96	32
32		128
105	236	424
SCSI	SCSI	SCSI
Internal	Internal	Internal
2.88-MB floppy drive	1.3-GB DAT	1.3-GB external HD, 150-MB QIC tape, CD-ROM drive, 1.44-MB floppy drive
Thin-wire, 10Base-T Ethernet	AUI Ethernet	AUI Ethernet
2	2	2
0	1	0
DSP, printer	Audio	None
None	GIO32	SBus
None	2	3
2	3	2
1 year	90 days	90 days
Option	90 days	Option
Not tested	Silicon Graphics	Sun Microsystems
N/A	Entry Graphics	GX
N/A	Included	Included
N/A	1024 x 768	1152 x 900
N/A	8-bit	8-bit
N/A	Silicon Graphics	Sun Microsystems
N/A	GDM-1630SG	19-inch color
N/A	Included	Included
N/A	1280 x 1024	1152 x 900
N/A	16	19
N/A	AutoCAD 11	AutoCAD 12
Next	Silicon Graphics	Sun Microsystems
Included	Entry Graphics	GX
Included	Included	Included
1120 x 832	1024 x 768	1152 x 900
2-bit	8-bit	8-bit
Next	Silicon Graphics	Sun Microsystems
MegaPixel Display	GDM-1630SG	19-inch color
Included	Included	Included
1120 x 832	1280 x 1024	1152 x 900
17	16	19
FrameMaker for Next 2.0D	FrameMaker iABI 3.0	FrameMaker SUNX 3.1A, Interleaf 5

[5] Instruction cache/data cache.
[6] System also includes built-in video as part of common configuration; we tested with these additional products for greater resolution and/or monitor size.

Common Factors

Whether you intend to set up a group of workstations for CAD, DTP, or some other application, you should consider some factors beyond the desired application. Chief among them is the availability of commercial applications software for the platform you choose. Although applications such as AutoCAD and FrameMaker are available on a wide variety of platforms, they are not necessarily the best applications to solve your problems. In many cases, you'll end up selecting applications from the same companies that provide the hardware. HP, for example, which is well known for engineering applications, offers a wide variety of software support that is tightly coupled to its own hardware.

Another consideration is your current environment. If you are already a Unix shop, you've invested in the steep learning curve associated with the operating system, and scrapping it for better applications support is probably a bad option. Keeping Unix and adding a modern windowing interface may be a suitable answer. Remember that windowing systems add a lot of overhead to your system and that the applications you are using must support the windowing system as well as the operating system.

But don't let an installed base keep you from adding a little variation to your environment. The name of the game today is compatibility. Unix workstations have always communicated well, and now PCs and Macs are joining the chorus. Silicon Graphics is making the added effort to ensure that its Iris Indigo systems blend in well with Macs by supporting Apple file-sharing protocols and a wide variety of data formats. Even a moderate-size network can take advantage of a mix of desktop personal computers linked through Unix workstations or communicating with minicomputers and mainframes.

Finally, don't forget the system administrator. Ease of setup and installation and the sophistication of management tools should play a part in your decision.

To identify our ultimate workstation, we spent quite a bit of time setting up these systems, performing some basic system maintenance, linking each workstation into the network, and using the system-supplied applications and tools. Of course, we also ran the benchmark applications and other applications, as noted above.

Our evaluations follow. In each case, we balanced the application timing results with our feel for the environment the system provides, and the type, breadth, and scope of applications available. The table gives configuration details for each workstation.

continued

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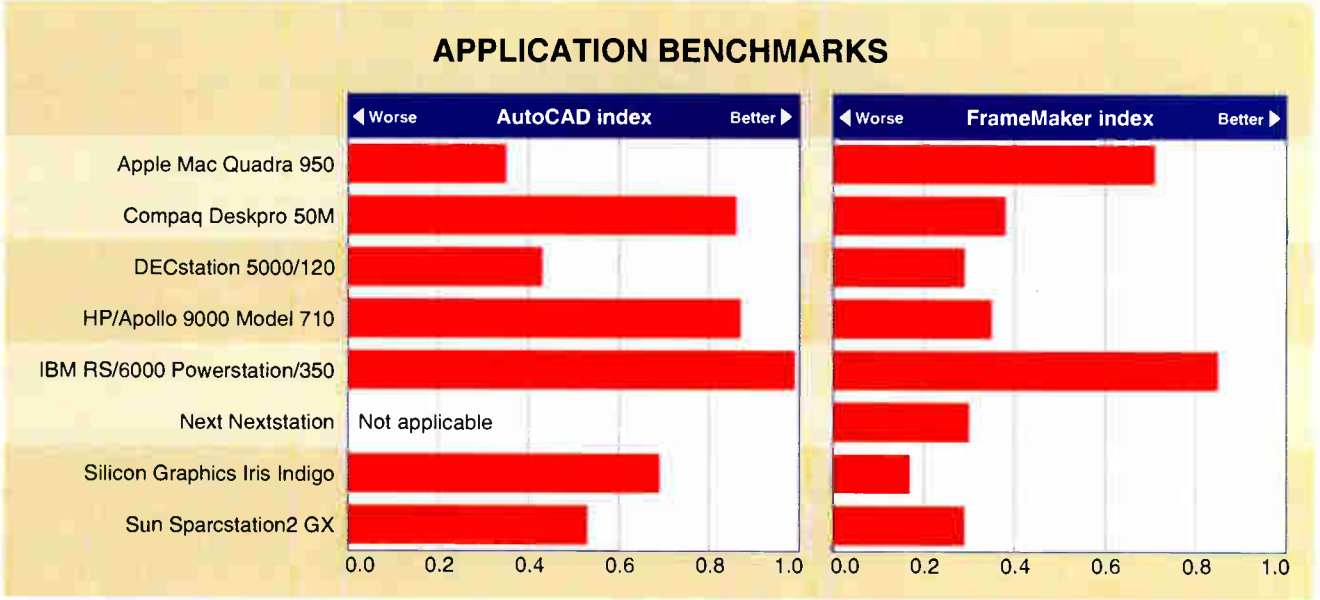
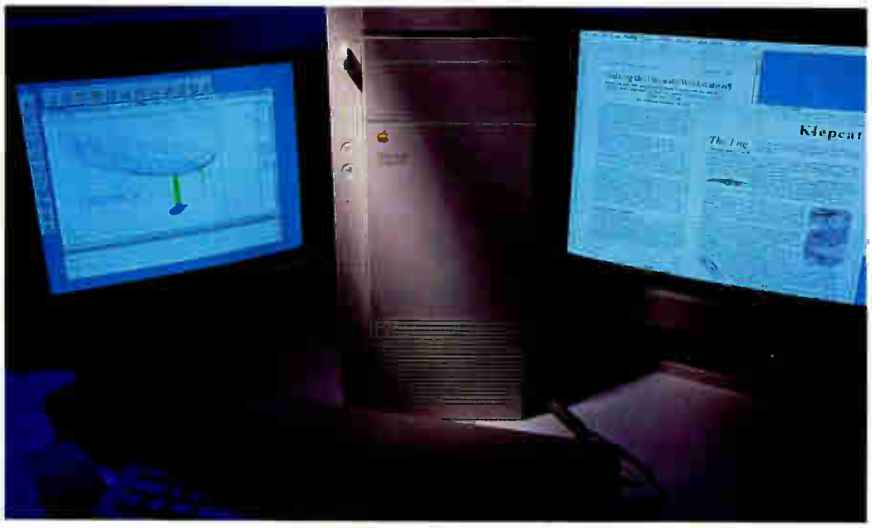


Performance tests show that the 42-MHz IBM Powerstation/350 outruns the other systems in both CAD and DTP tasks. These indexes represent the relative speed of each workstation running a suite of operations in AutoCAD and FrameMaker; different application packages may produce different results.



Apple Mac Quadra 950

In our opinion, a major attribute of the Quadra 950 is simplicity. It's simple to install, simple to administer, and simple to use. For example, it took us a mere 10 minutes to add a second monitor to the system and only 2 minutes to connect the system to the network. Once connected, the extra monitor was immediately recognized by all our test applications without our lifting a finger. This level of attention to detail is what makes the Quadra a joy to use (see "Racing at 33 MHz: Quadra 950 and Radius Rocket 33," October BYTE).

When we started this review, we were prepared for the Quadra to fare poorly. After all, it's only a personal computer up against some of the most powerful RISC-based workstations on the planet. However, experience proved otherwise. The speed of its 33-MHz 68040 and the elegance of System 7.0.1 created an unbeatable combination.

In head-to-head competition in the DTP arena, the Quadra 950 excels in its user interface and holds its own in speed (see the benchmark figure). Not so surprising, the Quadra 950 also beats most of the other workstations on price, coming in at $14,491 for a full DTP configuration, including a 20-inch Radius monitor and a Radius PrecisionColor 8X display adapter. The added screen real estate helped to make the Quadra 950 an outstanding DTP system.

We used the Quadra 950 to produce the bulk of our sample document. FrameMaker proved to be well adapted to Mac user-interface conventions, as did PageMaker. We quickly and easily exchanged data among multiple text editors, image scanners, and photo touch-up software, and between networked applications on multiple machines. None of the other workstations provided such a tightly integrated environment.

However, some cracks did show around the edges. For example, although PageMaker 4.2 ran properly on a second monitor, it insisted on moving the active window to the primary monitor whenever the window was zoomed.

The Quadra 950 did not fare as well on the CAD testing. Again, price was very good ($17,196), but, as the benchmarks show, AutoCAD performed poorly on the Quadra. Vellum 3D 2.12 ran most of our tests close to twice as fast, but even with this advantage the Quadra wasn't able to compete with the other workstations.

Also, there simply isn't the variety of engineering applications for the Mac that there is for other platforms. Apple is consciously targeting this area for improvement, but today this is a weak spot for the Quadra. However, Vellum 3D is an

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Modus Operandi

We benchmarked system performance on CAD and DTP (desktop publishing) jobs using two popular commercial applications, AutoCAD and FrameMaker. Although these two products are not the most popular programs in every environment, they are available—and among the leaders—on every platform we tested.

The benchmark figure shows the results of these tests. Each bar is a composite score based on timing a series of operations. For each operation, the fastest machine scores 1, and the other systems receive fractional scores based on their relative performance. The bar in the figure represents the average of these scores.

Designed to Sail

Our data file for AutoCAD performance tests was a 3-D hull and keel design for an America's Cup–class racing sailboat. Pedrick Yacht Designs of Newport, Rhode Island (designer of the *Stars and Stripes*), provided us with the test file. The AutoCAD drawing contains 327 polylines, each averaging about 450 vertices (roughly 150,000 points in 3-D space) split into eight drawing layers. We timed four tasks: loading the file from disk and generating the drawing, regen, redraw, and a 30-degree rotation of the entire hull in user-coordinate space.

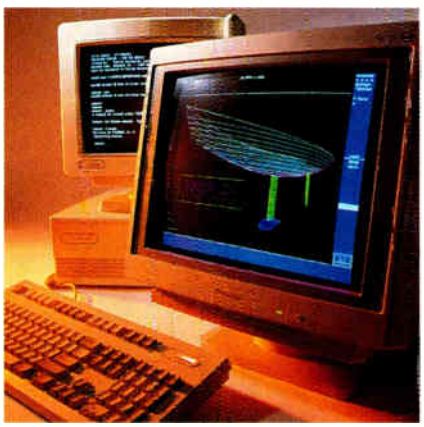
We measured system speed for DTP by timing three tasks with FrameMaker. First, we opened a 100-page formatted document that included four EPS (Encapsulated PostScript) bit maps (i.e., 180-KB, 5-MB, 1-MB, and 150-KB images). Then we measured the time it took to reformat the body of the text after changing the default font from 10- to 12-point type. Finally, we timed an import of 100 pages of raw ASCII text and the 5-MB image.

excellent CAD package that does run on the Mac. We discovered that Vellum 3D is among the easiest CAD packages to learn and use on any platform.

But the Quadra's real strength is its environment. It provides fully integrated support for text, graphics, sound, images, and video. Network support is simple and solid. Connecting to network printers, fax servers, and modem servers is a simple matter of selecting the appropriate item once, within the Chooser. When a new printer is added to the network, the administrator does not need to inform everyone of the new service—it just appears. You can mount folders on remote machines by setting a sharing option available through the main menu system. And standard methods for accessing SCSI hardware frees users from worrying about driver conflicts between SCSI devices.

The Mac Quadra 950 also represents a marked advance in Apple networking. The Quadra has an integrated EtherTalk port for direct connection to high-speed Ethernet networks. This is a dramatic improvement over the relatively slow LocalTalk.

With the exception of engineering software, the number and quality of applications available for the Quadra are outstanding. By developing and promoting an evolving set of interface standards, Apple has helped to establish consistent interface methods that ensure you'll be comfortable using applications for the first time. Applications that are inconsistent with these guidelines without good reason simply don't last long. Finally, unlike owners of Windows PCs or users of Unix workstations with graphical shells, Mac users don't need to live in two worlds, balancing their time between graphical and command-line interfaces.



Compaq Deskpro 50M

If you need to run one application, run it very quickly, and do little else, then a PC running DOS is nearly unbeatable. PCs have several advantages: The hardware is well standardized, there are lots of speed-increasing add-on peripherals (e.g., the vector-based Matrox MG-124 video card we used for AutoCAD testing), and the small operating system allows your application to have almost complete control of the hardware. When an application runs on a PC, it receives nearly 100 percent of the available processor time.

Our AutoCAD benchmark shows that the Deskpro 50M held its own against most of the workstations. The reason is twofold. First, the Matrox video card provided display-list processing with drivers tuned specifically for AutoCAD. Second, since DOS is a single-tasking operating system, AutoCAD did not need to contend with the overhead of a Unix installation.

AutoCAD looks the same no matter which system it runs on. This is annoying at best on graphical platforms, which have their own ideas of what a windowed application should provide, but AutoCAD is right at home on the Deskpro 50M. As the best environment for the world's most popular CAD package, the Deskpro certainly earns a few points.

Adding a second high-resolution monitor for the AutoCAD benchmark was straightforward. The MG-124 video card worked straight out of the box; we just added an AutoCAD driver. Installing the 17-inch ViewSonic 7 monitor was a matter of connecting a few cables, and it provided an excellent display. Unlike the Mac environment, however, the operating system itself (DOS and Windows) doesn't recognize the second monitor.

Including AutoCAD and the optional video hardware, the Deskpro came in at $12,163, making it the least expensive CAD platform by far. Furthermore, even using standard Qvision video and a Compaq monitor, the Deskpro came in second to the Nextstation as the least expensive

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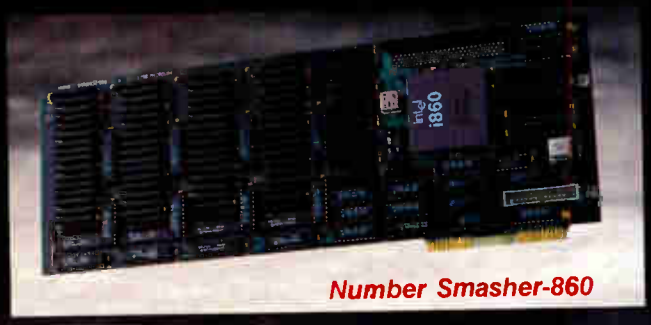
486-B²T

486/860 Speed... Microway Quality.

Microway has engineered four distinctive black tower systems. The **486-B²T** is designed for high-end users. It comes standard with American 486 motherboards and power supplies, yet has a reasonable starting price of $2,195. A broad range of options can be installed including high speed and capacity hard disks, intelligent serial controllers, tape back-up units, high end graphics adapters and our *Number Smasher-860*. These systems are ideal for configuring Novell or UNIX file servers, multiuser systems, and workstations for graphics, CAD and scientific uses. The **486-B²T** comes with dual fans, *Across the Board*™ Cooling and American industrial grade power supplies. All systems are thoroughly tested, burned in and include the best technical support in the industry, which we've provided since 1982.



Number Smasher-860

The key to stunning workstation performance in Microway's 40MHz *Number Smasher-860* is its four-way interleaved 64-bit memory system that runs at 160 megabytes/sec. The *Number Smasher's* i860 has been clocked at 80 megaflops doing matrix multiplies, 67 megaflops doing FFTs and 11.8 Double Precision Linpack Megaflops on large arrays—ten times the speed of a 486 and twice the speed of a Cray 1F! One happy user recently reported that his "Baby Cray" was happily humming away saving him thousands of dollars per month in 3090 rentals. The *Number Smasher* comes with the finest i860 compilers on the market, your choice of Microway's NDP™ FORTRAN, C|C++ or Pascal.

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DTP platform ($7013).

DTP on the PC has come a long way with the popularity of Windows. The Deskpro 50M finished a respectable third on our DTP timings. FrameMaker for Windows and PageMaker both take good advantage of the Windows interface. DTP typically requires multiple applications cooperating on a single document. For example, our test document consists of text that originated from a word processor, combined with scanned images and clip art. True multitasking may not be required, but cooperative multitasking greatly simplifies the task.

The user environment on the Deskpro 50M, typical for DOS/Windows PCs, still leaves a lot to be desired. Many of today's PC users find themselves time-sharing between DOS and Windows. Unfortunately, the boundary between these two environments is rather fuzzy. Windows users still have to resort to the DOS command line to perform most maintenance and administrative jobs.

DOS has two rather serious difficulties. First, you must continually worry about the amount of available memory being used in the first megabyte of address space. Even with DOS-extender-based applications such as AutoCAD, which take full advantage of system memory, you still need to worry about how much space is being consumed by network and peripheral drivers.

Second, multitasking DOS applications is a risky proposition. Windows and environments like Desqview have made multitasking possible, but these environments are incredibly complex and hardly stable. Windows' greatest difficulty is its tendency to crash, leaving behind only a cryptic message or sometimes just leaving you staring at the DOS command line with no indication of what went wrong. Although the Deskpro was not by any means the only system we crashed during this review, it seemed the easiest to break while running Windows.

Even though Windows has been around for several years, it still struggles through its infancy. System administration remains difficult, with many administration functions needing to take place in DOS before Windows is run. Windows' dual requirements of compatibility with DOS applications and having to run on a broad range of nearly compatible platforms have also given rise to a set of arcane initialization files that have to be tuned for each environment.

In all fairness, most of these difficulties are the result of Windows' need to remain backward-compatible with DOS applications. Windows was neither a ground-up original work (like the Mac operating system) nor an overlaid interface (like any of the X Window System–based Unix GUIs).

Although it lacks a pleasant working environment, the Deskpro 50M is an inexpensive, fast performer on single applications. In summary, if you have a very focused, single-application environment, a DOS platform like the Deskpro 50M is an excellent choice.

Where's OS/2?

Although it is not discussed in this article, we also reviewed an IBM PS/2 Model 90 XP 486 as part of our quest for the ultimate workstation. The Model 90, running OS/2 2.0, was a fast, stable platform. At $10,150, including a monitor, it's definitely a strong contender on the price/performance front.

Unfortunately, we found a dearth of commercial OS/2 CAD and DTP (desktop publishing) applications. The major software vendors either don't support the platform at all (e.g., Frame Technology and Interleaf) or offer only outdated versions (e.g., Aldus and Autodesk). The only major DTP player that is now actively supporting OS/2 applications is Ventura Software, which offers Ventura Publisher for OS/2.

OS/2 is a very strong player in the financial and general-business arenas, with outstanding client-server database support and excellent support for other server products like Lotus Notes and Imara. But although some publishers have announced plans to deliver engineering and graphics applications for OS/2 2.0, it's currently not much of a contender for traditional, single-user workstation tasks.

DECstation 5000/120

Until recently, DEC has demonstrated a lack of commitment to advanced development for Ultrix, its BSD-based version of Unix. The DECstation line still seems to be an Ultrix adjunct to DEC's extensive VAX/VMS offerings. When they first came to market, DEC's R3000-based DECstations were performance leaders, but they have been losing ground ever since. Given this history, it's not surprising that the DECstation lacks the dazzle of other workstations.

We configured the DECstation identically for CAD and DTP; the price difference ($12,995 for CAD, $10,980 for DTP) represents differences in AutoCAD and FrameMaker licenses only. The DECstation 5000/120 came in second to last in both application tests. The lack of speed comes not only from its 20-MHz processor; the system's hard drive was the slowest of any of the systems we evaluated.

In addition to running AutoCAD and FrameMaker, we spent a great deal of time with Interleaf 5, a very popular DTP system on the DECstation, Sparcstation, and other Unix platforms. We found that Interleaf, like AutoCAD, has a very demanding interface that's inconsistent with the system's resident GUI. Like AutoCAD, Interleaf 5 is a windowing application within a windowing environment.

The DECstation 5000/120 requires two separate boxes: a CPU box (with a CD-ROM drive) and an expansion chassis. The tape format is the proprietary single-spool DEC tape cartridge.

Like all DEC equipment, the DECstation 5000/120 is reliable and predictable—

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even simple. Software installation went without a hitch. DEC was instrumental in the development of X and Motif, so its implementation of the user interface is excellent. Each user's session is controlled by a session manager, a special console window from which you launch application programs and receive messages from the system. The User Executive (i.e., file manager) is character-based and simple to understand and configure. As a rule, the system software extensions are designed so that they work as well in an X window as on a character terminal. Our only complaint is that the default icons (for scrolling the window and launching programs) are very small and require fine dexterity. There are no other frills to the GUI.

The clumsiest elements of the DECstation are the keyboard and mouse. The keyboard has no Escape key (you have to map it to another key for each program). The mouse is circular, like a hockey puck, which means that you have no automatic registration between your hand and the mouse buttons when you grab it. Despite the raised pattern on two of the mouse buttons, it's easy to press the wrong button. The mouse is light, is easy to move accidentally, and lacks feedback. The keyboard and mouse complaints may sound trivial, but these input devices are the human interface for the workstation, and it's important that they be comfortable.

HP/Apollo Model 710

The Hewlett-Packard/Apollo 9000 Series 700 workstations have the reputation for being the fastest in their price range (see "A New Workstation Standard," June 1991 BYTE, page 52). Surprisingly, the Model 710 did not perform very well on the DTP application benchmarks despite its prowess on our low-level tests. This discrepancy underscores the importance of the application you choose in determining system performance.

As with the DECstation, we ran the Model 710 with the same configuration (16-inch color graphics) for both DTP and CAD tests. With AutoCAD, the Model 710 sells for $17,390; with FrameMaker, it sells for $15,385. These prices put it generally on a par with the Quadra 950.

If engineering is your field, you may already be sold on the HP/Apollo workstation; Hewlett-Packard is a very popular name in engineering. Along with this reputation come many fine engineering applications (including CAD) that may not exist on other platforms. This alone is reason enough to put an HP/Apollo workstation on your list of preferred systems.

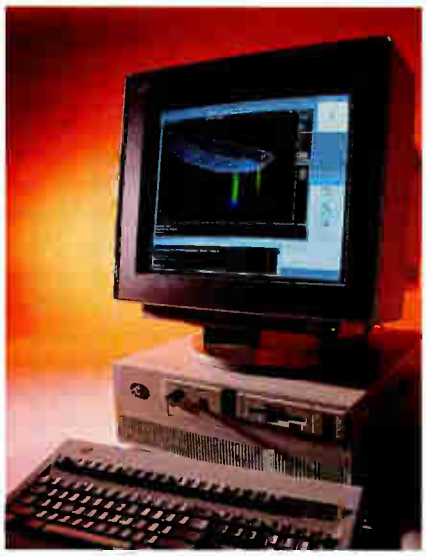
The 710 performed well on our CAD tests, scoring second only to the IBM Powerstation/350. However, its DTP score placed it a disappointing fourth, behind even the Deskpro 50M. As with the DECstation, Interleaf is the better-known DTP package for the 710. However, with the advance of Motif and X on HP workstations, we expect that FrameMaker will supplant Interleaf, especially if Frame Technology polishes it up for this platform.

The 710 is a classy workstation. You can replace the internal floppy drive with an optional DAT (digital audiotape) drive. Its internal disk storage space is sufficient for a stand-alone workstation.

HP's VUE (Visual User Environment) is the most elegant Unix interface. An X- and Motif-based window manager, VUE lets you have several different workspaces, each with its own collection of windows and applications. You toggle between workspaces via the screen button (an icon, of sorts) that represents that workspace. When you end a session, you can save information about what applications are running and where their windows are located so that when you start a new session, VUE puts you back where you left off.

Besides VUE, HP provides a simple but useful icon-based file manager. However, in no way does it rival the file-handling systems of the Mac or Iris Indigo. System administration is simplified thanks to HP's SAM (System Administration Menu) and special features of HP/UX.

HP has maintained a consistency over the years in its keyboard and terminal-screen layouts. This has led to some problems, particularly with HP's DOS systems, where they've conflicted with the designs of PC compatibles. However, HP's terminal design works well for Unix. Keyboards are more compact and take up less space.



IBM RS/6000 Powerstation/350

There is little question that IBM's RISC System/6000 Powerstation/350 is a robust and well-engineered machine. The monitor is crisp; the display is snappy. In performance, the Powerstation was undisputed champ, handily taking first place on CAD and DTP applications tests.

On the negative side, the 42-MHz RISC System/6000 system is much more expensive than most of its competition. We tested a color Powerstation for CAD ($36,260) and a monochrome system for DTP ($30,790). The 19-inch displays are gorgeous, and the system runs like a thoroughbred, but the prices are well beyond those of the other systems in this review.

Also, AIX is far from easy to become used to, particularly if you have worked with more standard versions of Unix. The default user interface is merely the character-based screen, not Motif/X. The GUI is there, but the administrator must install it as the default log-in interface. IBM is lagging behind the other workstation manufacturers in its development for OSF/Motif, even though it was one of the original members of OSF (Open Software Foundation). Although its Power Desktop icon-based file and application control looks as though it might develop into something very attractive, the window manager and file manager still have a long way to go.

However, AIX is not only different from other versions of Unix, it's also very sophisticated. It has unique features like the virtual volume manager, which lets you modify the size of disk partitions without going into single-user administrative mode.

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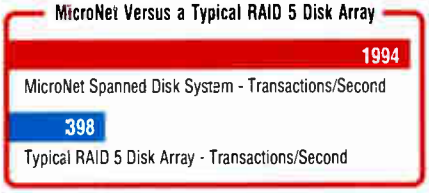

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With this feature, you can even change the size of a file system on the fly.

IBM also offers a system-administration tool called SMIT (System Management Interface Tool). SMIT is a hierarchical tree of menus for configuring and controlling the operating system and installing hardware. Admittedly, learning SMIT is far simpler than learning the esoterica of Unix system administration through editing the dozens of syntactically divergent tables that underlie any Unix system. But SMIT and AIX are so unlike any other Unix variation that a system administrator seasoned on a more conventional system will agonize over learning entirely new procedures. Despite IBM's creation of a better Unix than that delivered by Unix Systems Lab (or even OSF), it's unlikely that the rest of the world will follow IBM's lead.

We had more difficulty installing the software on the Powerstation than we did on any other system. SMIT is not idiot-proof—we corrupted the boot file system by improperly attempting to enlarge another file system. Once we rebuilt the disk and operating system, we still had problems installing FrameMaker. Even the common Unix commands that are part of the installation have uncommon options and actions. IBM can be commended for its work in trying to improve Unix, but there is something to be said for going along with industry standards.

Next Nextstation

The Nextstation is a marriage of Unix capability and well-designed graphical-interface flexibility. Although out of the running for CAD (there simply isn't much support), the Nextstation offers a wonderful DTP environment. Unfortunately, the Nextstation is one of the great undiscovered machines. Although it's advertised and discussed widely, it has yet to attract the hordes of developers and software publishers who will bring their multiplatform applications with them. The problem for Next continues to be market share.

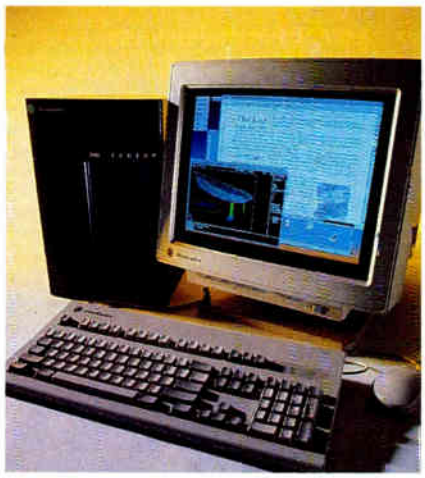
We tested the entry-level Nextstation. At $4995 ($5790 with a FrameMaker license), it's the least expensive machine we tested. Our test Nextstation also included a nonstandard 400-MB hard drive instead of the standard 105-MB model. We've listed pricing for the standard system because configuring the Nextstation the way we tested it (as a custom package) would cost almost as much as buying a 33-MHz Nextstation Turbo with the 400-MB drive built in.The 25-MHz Nextstation ran through the DTP benchmarks at speeds comparable to those of the 20-MHz DECstation 5000/120—an acceptable performance but generally behind the pack.

The Nextstation's limited display can show only four shades of gray. High-color images (e.g., the scanned map on our DTP test) display as slightly grainy. This limited pixel depth doesn't present any great difficulties for page layout, where the positioning of images is the major concern, but it does present problems for any image-processing applications.

Next provides a tightly integrated graphical interface. Unlike other Unix implementations, the Nextstation keeps you within the graphical environment at all times, unless you specifically ask for a command line. Even the most complex program development and system-administration processes can be completed without leaving the graphical shell. The ability to perform all tasks, including system administration, from the graphical environment approaches the Macintosh's and far exceeds Windows' ability on the PC.

The Nextstation excels in its powerful, object-based development and user environment, NextStep. NextStep and Interface Builder provide a leading-edge visual environment that insulates programmers from the command-line operating system. Even on the Mac, the standard development environment reverts to a command-line interface.

While this system is extremely useful in a corporate environment where custom applications will be developed, it provides little advantage in mixed-platform or standalone environments. A lack of standard software support is the main reason the NextStation does not make our top-three list.



Silicon Graphics Iris Indigo

One of us has had an Iris Indigo on his desk for many months, choosing it over a number of other workstations. Its user interface makes it a very comfortable system, and we found day-to-day performance to be adequate. But quantitative benchmarks are another matter: The Indigo came in dead last on our DTP tests and placed only fourth among CAD systems.

Nevertheless, the Indigo presents an outstanding user environment and an attractive price. At $16,495 for the system plus AutoCAD and $14,490 for the system plus FrameMaker (including an optional DAT drive), the Indigo is one of the least expensive workstations we tested.

Unlike most other Unix workstations, the Indigo case is a mini-tower that can sit in the back corner of a desk or on a bookshelf. You can upgrade hardware and install peripherals without tools. The keyboard is laid out like PC keyboards, and the mouse can plug into the right or left side, as it can on a Mac.

Of all the Unix workstation environments, the Indigo is unquestionably the nicest for casual users. But it still has all the tools that experienced technical users and system administrators want.

Silicon Graphics' Workspace GUI doesn't have multiple workspaces, like HP's VUE, but the Workspace file manager rivals even that of the Macintosh. It can determine a file type using a rule set that includes information on permissions, filename, and data within a file. This makes it possible to define actions that are appropriate for any number of different files. The files appear as icons corresponding to applications. Double-clicking on a file brings up the application—just as on a Mac. You can also drag and drop

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files to applications. Finally, you can carry out most common system-administration jobs through the iconic interface.

We had no difficulty installing any software on the Indigo. Everything about the machine is attractive and fun; it's no wonder that software developers provide excellent support for it. What the Indigo lacks in performance, it more than makes up for in ease of use and support.

Sun Sparcstation2 GX

Say the word *workstation*, and most people will probably think Sun Microsystems. Big screens, paper-white displays, and graphical interfaces have always been its trademark. Sun systems are the quintessential workstations, and application support is phenomenal. A quick browse through Sun's software-support catalog shows just about every possible application category you can imagine—from CASE to CAD to DTP to medical imaging and more.

The Sparcstation2 GX came in a single configuration that we used for both DTP and CAD benchmarking. The "GX" designation means accelerated graphics. Including AutoCAD, our test workstation costs $25,940; including FrameMaker, it costs $23,685. Although these prices put the Sparcstation2 GX close to the top in price, our configuration also included several mass-storage options: you can get units minus the CD-ROM drive, QIC tape drive, and 1.3-GB hard drive for $15,295.

The system is available with a variety of windowing environments, among them Sun's own Solaris Open Windows. Open Windows is a combination development and user environment. The user portion delivers a set of 15 standard productivity-enhancing applications, including a file manager, text editor, calendar manager, and multimedia mail tool.

Several of these tools are designed to increase group productivity. For example, the calendar manager provides password-protected access to other people's calendars. The multimedia MailTool allows you to attach arbitrary binary files, including audio and image data, to a standard mail message.

The Open Windows environment also provides ToolTalk, a development service that gives users a standard high-level interprocess communications protocol. The major advantage of ToolTalk is that it offers a standardized mechanism through which processes can communicate without your having to hand-craft messages. In addition to interprocess communications, ToolTalk also lets developers send messages to particular objects (e.g., windows, dialog boxes, and text selections) within applications. By creating a standardized tool through which the messages pass, Sun has delivered a backbone around which loosely coupled applications can be arranged.

Open Windows provides a rich environment for both developers and users. However, the Sparcstation2's performance was disappointing. The system's benchmark scores were mediocre despite its speedy graphics: The Sparcstation2 GX was next to last running FrameMaker and came in fifth running AutoCAD.

On the positive side, there are more applications for Sun workstations than for any other Unix workstation. And there are more Sun workstations out there than any other. As with the PC, there is much value in simply being the most popular. But this broad installed base may be misleading in that there have been so many incompatible versions of Sun operating systems and GUIs that you may not be able to take advantage of the newest versions of the operating system with older software.

Unfortunately for the Sparcstation2, being the top gun has a major drawback—people are always shooting at you. The IBM Powerstation/350 beat the Sparcstation2 in speed; the Iris Indigo has a more innovative visual shell. And there are always the Mac and PC-class machines gaining from below with improving performance and much better pricing.

The Sweetest Workstation

Despite our preconception that the sweetest workstation was going to be a Unix system, we chose the Quadra 950 as our favorite. The Quadra is the winner not only because of its performance on our DTP tests, but also because there is more

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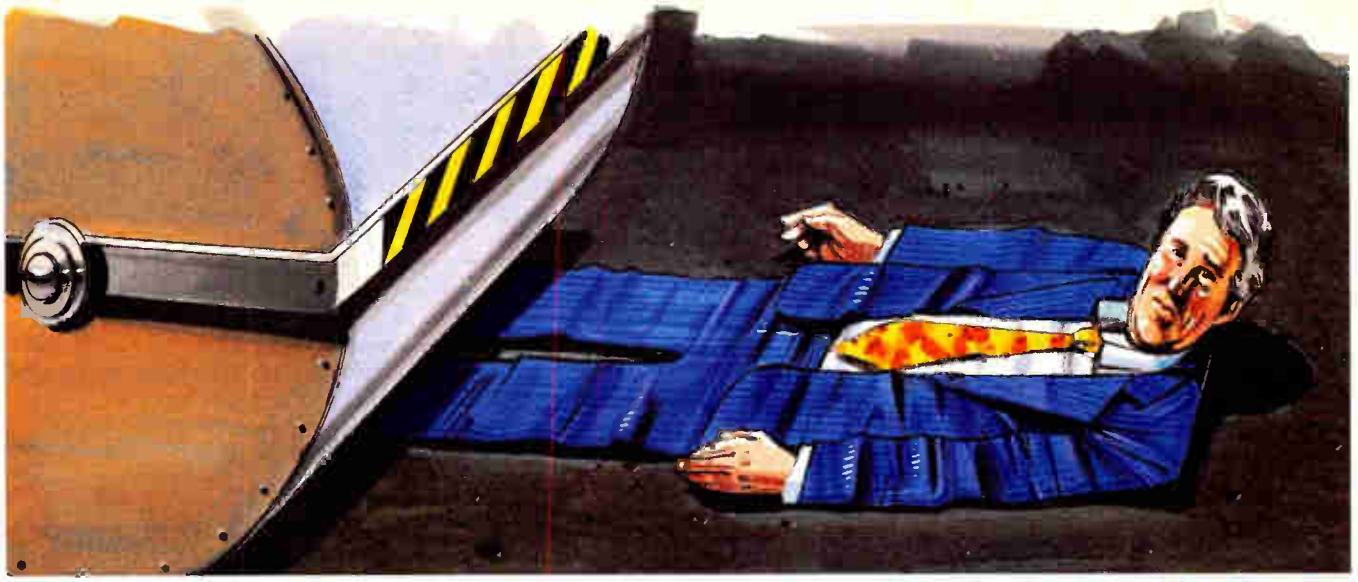

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software that is better supported and easier to install, manage, and use than for any of the Unix workstations. The Quadra is the ultimate workstation for most computer users. However, its CAD performance was weak, and engineering support is generally lacking.

Our second choice is the IBM Powerstation/350 running AIX. This is our favorite CAD system. We make this selection with some reservation, because the operating system is unusual and its GUI is far behind the others, especially HP's VUE and Silicon Graphics' Workspace. However, the performance results turned in by the Powerstation make it hard to resist.

In third place, surprisingly, is the Compaq Deskpro 50M running DOS (not Windows). Despite its shortcomings when compared to other operating systems, DOS dominates the world; while the user interface may not be the most comfortable, there is usually someone nearby who knows enough to help a new user get started. We chose this PC-class machine because of its speed and its simplicity. A lot of users simply want a machine that they can dedicate to doing one task very well. Pedrick Yacht Design (which provided our AutoCAD test file) bears this judgment out: Most of its workstation users, Unix and PC users alike, do nothing but run AutoCAD.

Honorable mention goes to the Iris Indigo. This Unix workstation has many of the user-interface attributes of the Macintosh while also offering the best features of Unix. It delivers true multitasking with correspondingly sophisticated memory management, integrated networking, client-server-based applications, and classic Unix shells as command-line interfaces (to simplify complex file management operations and automate multistage file processing). Silicon Graphics' new R4000-based Indigo, which should be out by the time you read this, may also offer the power of some of the faster workstations.

For us, the decision comes down to this: If you are choosing a workstation for processing power, pick a racehorse like the Powerstation despite the cost. But if you also require a rich user environment and excellent applications support, look beyond traditional Unix systems. ■

Ben Smith and Raymond GA Côté are testing editors for the BYTE Lab. Ben is the author of UNIX Step-by-Step *(Howard W. Sams, 1990); you can contact him on BIX as "bensmith" and on the Internet at ben@bytepb.byte.com. Ray has worked in industry designing interpretive languages and user interfaces. You can reach him on BIX as "rgacote" and on the Internet at rgacote@bytepb.byte.com.*

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486 Systems for a Graphical World

These 26 33-MHz 486 systems strike a solid balance between cost and performance

HOWARD EGLOWSTEIN
AND STAN WSZOLA

If you think that a shiny new 33-MHz 486 computer is out of reach, you should take another look. We did and found that $3500 buys you a lot more computer these days than it used to. And a 486 is more than a luxury. If you're planning to do any serious work with Windows, OS/2, Windows NT, or Unix, a fast 486 CPU is practically a necessity. These operating systems and environments demand fast video, large and fast hard drives, and lots of memory. A 486 CPU also is a must if you need to run multiple applications at the same time. Although 386 systems offer more than enough processing power for standard DOS office work, they simply can't handle the demands of multitasking.

Our review of moderately priced systems compares 26 machines worth considering—some from the biggest vendors in the industry. Many are brands you're sure to have heard of; others are from firms you may not recognize. The features table starting on page 218 provides background on the full complement of systems, which includes models from Advanced Logic Research, Atlas Industries, Axik, Bi-Link, Comex, Compaq, CompuAdd, CompuTrend, Daly, Dell, DFI (Diamond Flower), Duracom, Everex, Gateway 2000, Insight, Lodestar, NEC, Northgate, Packard Bell, Polywell, QSI, Tandy, Tangent, Tri-Star, Uniq, and Wyse.

What makes a good 486? We'll cover that in more detail in a moment, but in essence, we looked for a blazingly fast machine that uses standard components and comes packed in a standard case with plenty of room for upgrades. We also looked for a company that will be around for the duration of the computer's warranty.

The Criteria

All the machines tapped for review have a 486DX CPU running at 33 MHz, 8 MB of RAM, one or two floppy drives, a keyboard, a hard drive with a capacity of about 200 MB, and a Super VGA adapter capable of displaying a resolution of at least 800 by 600 pixels. Vendors that bundle in Microsoft Windows with their systems usually also include a mouse. To meet our price ceiling, the complete system with DOS and a monitor must retail for under $3500. If you consider the price that some of the big name brands sold for just a few months ago, this is no mean feat for companies that historically charge top dollar for high-end machines.

Part of what makes this target price so accessible is the ready supply of standardized parts. We discovered that many of the machines have motherboards from AMI, and high-quality hard drives from Maxtor, Conner, and Western Digital were common. The video cards varied widely, but a few systems came with boards from top-notch firms, such as Orchid, Diamond, and ATI. A few vendors shipped us machines with local bus video and disk-caching controllers.

By our reckoning, the machine you buy today must satisfy your company's needs for some time. That means it has to run not only today's software, but it also must have enough flexibility to run new software coming down the pike. Programmers will continue to write software that consumes ever-increasing amounts of disk space and RAM, and you don't want your new machine to become obsolete overnight. The best way we've found to ensure longevity is to compare machines operating system by operating system, benchmark by benchmark, and component by component.

continued

World Radio History

Three of our favorites: the Lodestar 486 LB Data Master, the Compaq Deskpro 4/33i Model 210, and the Axik Ace Cache 486All-33.

BYTE ACTION SUMMARY

■ WHAT 33-MHz 486DX SYSTEMS ARE

Complete computer systems that are based on Intel's 486DX chip and run at 33 MHz. Many systems reviewed here are priced under $2500.

■ LIKES

Competitive pricing has reduced the cost of a powerful 486DX machine to an affordable level.

■ DISLIKES

Price reductions in faster 50-MHz 486s may quickly make 33-MHz machines obsolete.

■ RECOMMENDATIONS

Standard desktop and tower cases offer the most flexibility. Axik's Ace Cache 486All-33 and Lodestar's 486 LB Data Master are two such systems. Both offer excellent performance. Among the proprietary machine designs, the Compaq Deskpro 4/33i Model 210 is our favorite.

The Sum of Their Parts

To start the testing, we installed MS-DOS 5.0 and Microsoft Windows 3.1 on each of the machines and then ran BYTE's low-level CPU, FPU, disk, and video benchmarks (see the graphs on page 224). The next step was running our DOS and Windows applications suite. Finally, we installed The Santa Cruz Operation (SCO)Unix version 3.2.4 and fired up our Unix test suite. Running Unix provides us with a third method of exercising the disk subsystem and checking for any system design faults that may make the machine incompatible with alternative operating systems.

The tests dealt us a few surprises. We expected that because all the systems use a 33-MHz CPU, the results for the CPU and FPU benchmarks would be similar. The sometimes wide gaps that surfaced point out the positive effect that disk-caching controllers, high-speed drives, and accelerated video can have on performance. The DOS and Windows applications suites also were revealing. Machines with especially speedy disk drives and fast video have a definite advantage here. The database and desktop publishing portions of the tests, in particular, take full advantage of these features.

For judging the compatibility of the primary computer component—the motherboard—the best test we have is our low-level benchmarks (which directly analyze both a machine's hardware and ROM BIOS) and the applications test suites. Machines are, for the most part, fully compatible if they can run a good selection of the most popular software. Our test suites do a good job of ferreting out a computer that may have future incompatibilities.

If you're planning to run DOS or Windows, a good quality BIOS is a must. We prefer to see ROM BIOSes from companies with sufficient resources to test them carefully—companies such as AMI or Phoenix or large manufacturers, such as Compaq, that write their own BIOS code. Another advantage of using a machine that accepts a standardized BIOS is "upgradability." It's likely (although not guaranteed) that you can upgrade an AMI or Phoenix BIOS ROM at a later date, if the need arises.

The ability to add more RAM—as much as 16 MB and preferably in standard SIMM or SIPP (single in-line pin package) configurations—is another primary consideration. Be wary of machines that require special proprietary memory configurations, unless you know you can get memory if you need it. Otherwise, you may be locked into buying the RAM from the computer's vendor, which can prove expensive. Happily, numerous third-party vendors traditionally support Compaq's proprietary memory configurations.

continued

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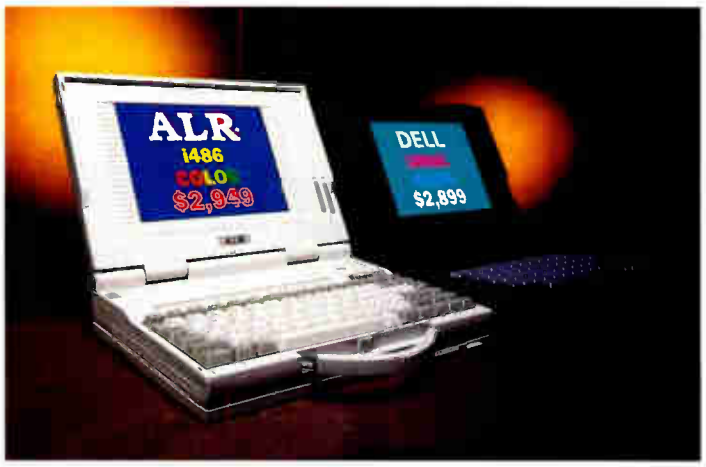

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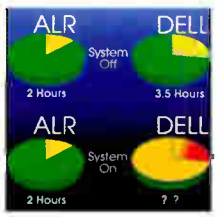
They say you can't get good chili in Hong Kong. Apparently Dell® couldn't find a 486™ color notebook there either. But just because they settled for 386SL™ power is no reason for you to. Especially when there's the American-built ALR® Ranger MC486. The ALR Ranger MC486SX/20 gives you 20-MHz i486SX™ power for only 50 dollars more than Dell's system. And that's just the beginning of the ALR advantage.

RANGER'S SUPERIOR PERFORMANCE

RANGER'S EXPANDABILITY
ALR includes a variety of internal expansion options. You can plug in FAX/Modem modules, SCSI adapters, even Ethernet network interfaces. Some desktops don't offer this much expandability! Dell, on the other hand, has just one internal modem slot. Likewise, the ALR Ranger MC486 has room for up to 16-MB of memory. Dell tops out at 12.

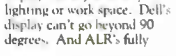
RANGER'S UPGRADEABILITY
The ALR Ranger MC486 is modular. By simply swapping CPU modules, you can quickly upgrade to 25-MHz i486SX or i486DX™ power. Dell, unfortunately, doesn't offer a modular upgrade path. Of course, there is one way to upgrade the Dell notebook; sell it and buy an ALR Ranger MC486.

RANGER'S POWER MANAGEMENT
ALR's Advanced Control™ software works with a dedicated power management microprocessor to give the Ranger MC486 over four hours of possible battery life. A detailed on-screen status display provides accurate, up-to-the-minute battery information. Dell's monitoring system (a warning beeper), is considerably less sophisticated.



RANGER'S BATTERY RECHARGE TIMES
The ALR Ranger MC486 recharges in about two hours, whether or not you're using the system. The Dell takes 3-and-a-half hours to recharge with the system off. And you can pretty much forget about recharging the Dell system while it's running. So much for working efficiently.

RANGER'S HUMAN INTERFACE
When you're on the road, you need to be flexible. The Ranger MC486's full-tilt display can adjust to any lighting or work space. Dell's display can't go beyond 90 degrees. And ALR's fully



sculpted and spaced keys help make typing easier too.

RANGER'S DOCKING STATION
With the optional ALR Ranger Docking Station, you can quickly turn this powerful notebook into a full-featured desktop PC - complete with three ISA expansion slots and four drive bays. We'd like to compare our docking station to Dell's, but we can't. Unfortunately, Dell doesn't build a docking station.

The ALR Ranger 20-MHz i486SX MC4SX/20 Model 80

Standard Features: Intel 20-MHz i486SX CPU • Integrated 8-KB cache • Processor sleep/resume mode • Upgradeable to 25-MHz i486SX or 25-MHz i486DX • 4-MB RAM (expandable on board and page mode • Up to 16-MB RAM on the system board using ALR RAM • VGA graphics featuring 800 x 600 resolution • Passive 8-bit color LCD Dragon's 8.4" diagonal size • Floppy and hard drive II (2 modules) • 80-MB internal IDE hard disk • 1.44-MB 3.5" floppy drive • 82-key embedded keypad with 10 function keys, inverted T cursor, home and end, 12 function commands • One serial port, one parallel port, one mouse port, external video port, external keyboard port and audio line-in/line-out port • ALR MS-DOS 5.0 • ALR Advanced Control™ power management software • 3.25-lb (1.5 kg) with 2.5-lb (approximately) • Card 4 hours portable life with ALR Extended Battery • Battery recharge on or off hook with system on or off • ALR Advanced Control Power Management Interface • User-selectable arrangement (system hard drive shutdown), system sleep, resume modes • 45-Watt Power Supply • Embedded quick release docking handle • ALR Quick Snap Build/Port dock or external printing device • FCC Class B, VDE, CSA and TUV • Limited 12-Months, parts and service and upgrade premium

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ISA or EISA bus? The benchmarks don't have much to tell in this regard, because this choice doesn't make as much difference as vendors may tell you. Most of a 486's functions are integrated onto the motherboard; video, disk-caching controllers, and network adapters are the only cards that usually take advantage of the EISA slots. With local bus video cards and a disk-caching controller, you'll get plenty of performance. Whether the extra boost EISA gives you on a network adapter is worth the money is something you must decide. In our view, people who really need this level of speed probably should buy something beefier than the systems reviewed here. A 50-MHz machine isn't that much more expensive, and it provides the raw horsepower needed to take full advantage of EISA's throughput.

Of course, you'll want a good monitor and keyboard. Luckily, keyboards are inexpensive enough that, for well under $100, you can replace a poor one with something respectable. Monitors are a bigger problem, because many bundled ones are barely usable, even at 640- by 480-pixel resolution. If possible, look for machines that offer name-brand tubes from larger third-party companies, such as NEC or Viewsonic. Another good test is to ask how much you can save on the system price by omitting the bundled monitor. If the vendor subtracts only $250 or $275, chances are that the monitor is of poor quality. You may want to buy the system anyway but plan on buying another display.

In general, local bus video or accelerated video cards will greatly improve a system's performance on graphics-intensive applications, *if* you have the right drivers. Card manufacturers almost always provide drivers for Windows and AutoCAD. Check with the vendor to make sure your fancy new card supports your application.

Finally, consider your disk storage needs. Do you need a disk-caching controller? Some operating systems require you to disable the cache if you have it. DOS and Windows can use some of your system's memory as a disk cache (sometimes more effectively than a caching controller can), and if you're putting together a file server, Novell NetWare does plenty of its own caching in software. On systems with slower CPUs, putting a cache on the controller makes sense; it's not so clear-cut on 486 machines.

One last thing: You may need some help with your new machine or want some help debugging that big scary card you add next year. If you buy a machine with proprietary parts or case designs, you're locked into that vendor for support and upgrades. Ask yourself whether the firm will be around when you need it. Will the company still support your machine in a few years? All other things being equal, we prefer machines that use standard "clone" cases and motherboards. If your vendor can't—or won't—support you in the future, you can call any local computer dealer for parts or service. Proprietary designs may give you smaller footprints or a lower profile, but you'll have to weigh for yourself whether small really will prove beautiful in the long run.

A Look at the Numbers

The BYTE low-level benchmarks isolate specific parts of the system and test each

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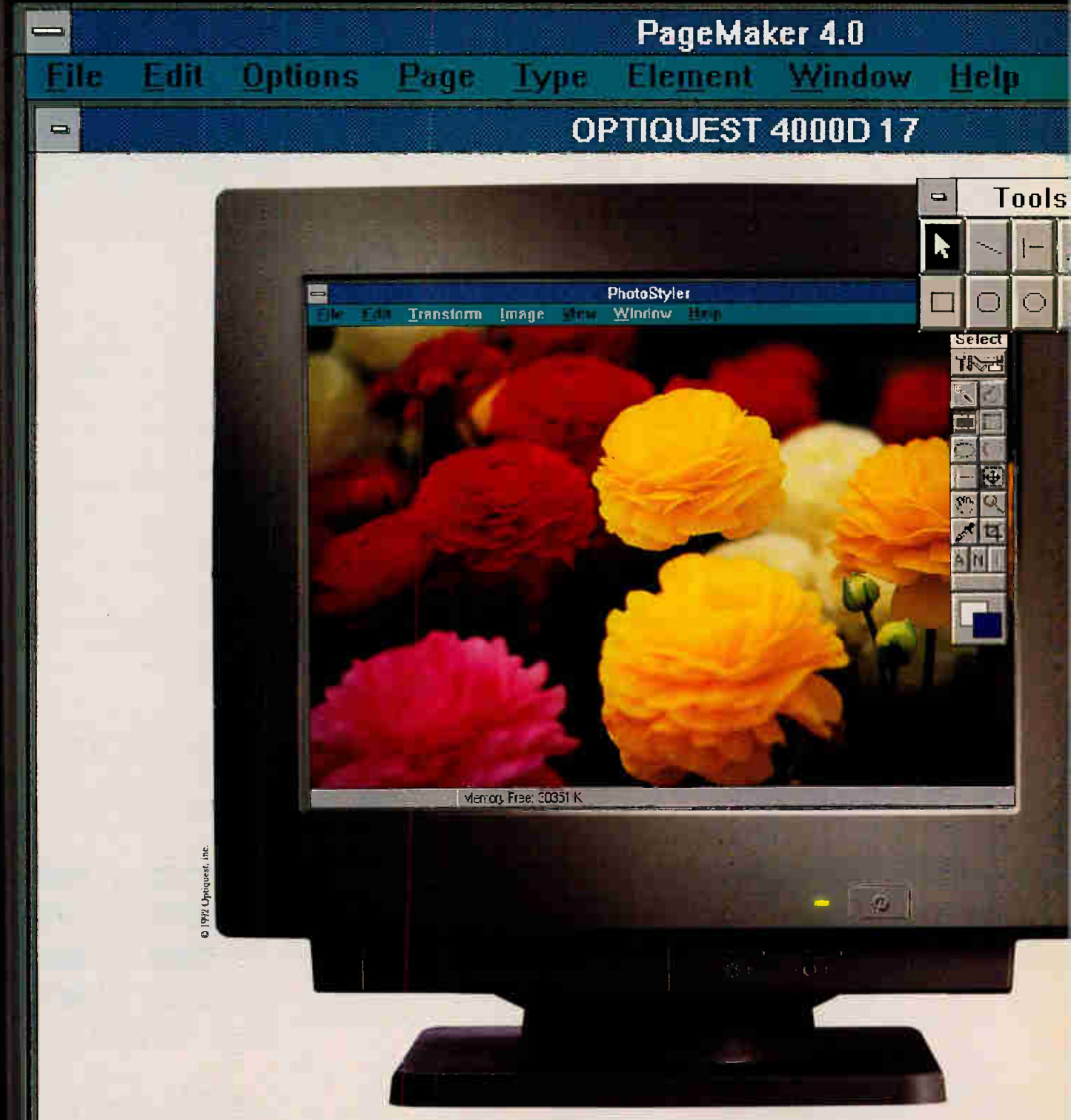

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separately. The CPU tests perform integer math functions and memory movement. By shuffling 8-, 16-, and 32-bit pieces of memory, the CPU test can pick out motherboards designed with crippling memory configurations or equipped with large external caches.

The FPU tests don't mean much on a 486DX. The FPU always is the same built-in coprocessor that all other 486 chips have. Because, on these machines, the coprocessors all run at the same clock speed, we expect the performance to be essentially the same. Disk performance is greatly improved by caching controllers; likewise, a good on-board or local bus video design provides better performance on the video tests.

The applications and Unix tests provide an extra measure of compatibility and performance in real-world situations. The DOS and Windows tests are broken down into word processing, spreadsheet, database, CAD, and scientific areas. Because most users run a variety of these applications, we've combined the benchmark results into two overall indexes: one for DOS and one for Windows.

As noted earlier, the low-level benchmark results followed a pattern. Machines that incorporate fast disk systems turned in the best disk performances. In particular, the Northgate Elegance ZXP and the Uniq UTI 486DX-33 easily led the pack. The Tandy 4833 LX/T had a very sprightly video performance—something we usually don't see in Tandy machines. The CPU performance varied depending on memory configuration and cache size. A few machines—most notably the Dell 486D/33, DFI Diamond Series Model 433D, and Everex Tempo M Series 486/33—had lower CPU ratings than our reference machine, a Compaq 386/33L. The Compaq is a speedy 386, but we didn't expect it to beat any 33-MHz 486es. Except for the Dell, the systems' FPU performances were much faster than the Compaq 386's 387 coprocessor. We've seen similarly slow performance on other Dell machines, so this didn't surprise us. The Dell, however, did manage to hold its own on the applications tests, where it counts most.

On the DOS and Windows applications tests, those machines with the best DOS performances also turned in shining Windows results. Axik's Ace Cache 486All-33 and Lodestar's 486 LB Data Master were clear standouts in the applications suites. The Unix tests were less conclusive. The machines from Comex, Lodestar, Northgate, and Tangent all earned an impressive score of 1.6.

The Last Detail

After running the performance tests, we factored in the other considerations and found three machines worth recommending. The Axik Ace Cache 486All-33 performed well and shipped with a 14-inch Viewsonic 6e display. The Axik's case is a baby tower configuration that provides easy access to the system's vital parts and easy upgradability. Similarly, the Lodestar did well on our tests and comes in a baby AT case.

Neither the Axik nor the Lodestar comes in the popular "low-profile" styling. If you have to put the machine on your desk, and you *need* a low-profile case, the Compaq Deskpro 4/33i is a better-than-average performer. The Deskpro's display and keyboard are

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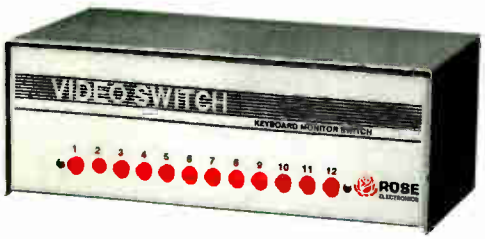

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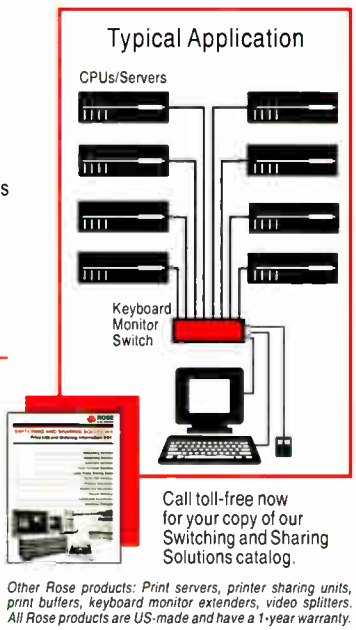

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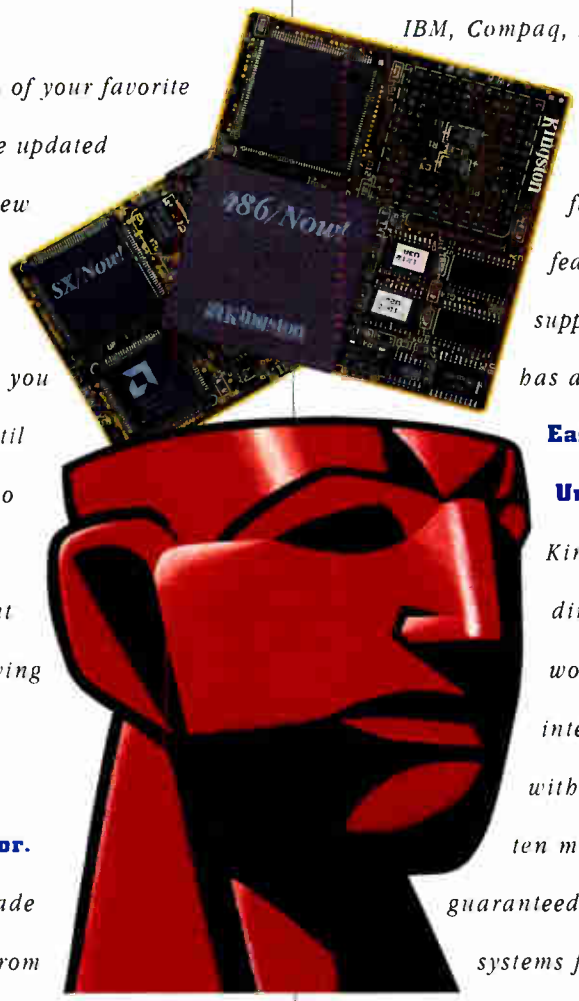
A better alternative is to upgrade only the processor. 486/Now! from Kingston is a great way to get the processing power you need for business applications, network file servers, graphics programs and CAD/CAM. 486/Now! is available with either a 486DX 33MHz or a 486SX 25MHz, and has an on-board clock for optimum processor performance.



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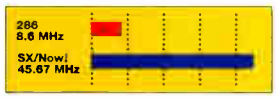

Comparison of native Compaq Deskpro 386/20e and same system with 486/Now! 486DX-33MHz Landmark Speed Test 2.02. Comparison of native IBM PS/2 Model 50 and same system with SX/Now! 386SX-33MHz Landmark Speed Test 2.03. All trademarks are of their respective owners.

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Because painfully missing from many competitors offerings is the option for a secondary cache. With ZEOS you can add a secondary cache of 128K or 256K. This speeds up many memory-intensive applications. Take it now or add it later if you wish. ZEOS gives you the option. And that's just for starters.

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COMPANY MODEL	Advanced Logic Research, Inc. Flyer 32LCT Model 340DW	Atlas Industries, Inc. Atlas-DX33	Axik Computer, Inc. Ace Cache 486All-33	Bi-Link Computer, Inc. DT 433	Comex Computer Corp. Comex 486DX/33	Compaq Computer C Deskpro 4/33i Model 210
CHIPS						
Processors supported (chip/speed)	486SX/25; 486DX/33 and 50; 486DX2/66	486DX/33; 486DX2/66	486DX/33; 486DX/50; 486DX2/66	486DX/33; 486DX2/66	486DX/33	386DX/33; 486SX/25; 486DX/33
Uses cache	●	●	●	●	●	●
CPU upgrade available	●	●	●	●	○	●
External coprocessor supported	Weitek 4167	Weitek 4167	Weitek 4167	Weitek 4167	Weitek 4167	None
Brand of motherboard chip set	ALR	UMC	Contaq	UMC	Micronics Gemini	Intel
Brand of BIOS	Phoenix	AMI	AMI	AMI	Phoenix	Compaq
MEMORY						
Standard RAM (MB)	8	4	4	4	4	4
Maximum RAM (MB)	64	32	32	32	64	32
No. of wait states	None	None	None	None	None	None
Standard cache (KB)	0	64	64	64	256	64
Maximum cache (KB)	256	256	256	256	256	64
STORAGE MEDIA						
Standard floppy configuration Drives and types	1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.44-MB 3½-inch
HARD DRIVE CONFIGURATION						
Standard capacity (MB)	Varies	213	130	120	120	210
Brand and model	Varies	Maxtor XT7213AT	Maxtor 7120AT	Conner CP30104H	Lanstar 330 MB	Compaq 210
Interface	IDE	IDE or SCSI	IDE (SCSI opt.)	IDE (SCSI opt.)	SCSI	IDE
Includes caching controller	●	○	●	○	●	○
No. of internal and external drive bays	12	6	8	8	8	3
Range of hard disk capacities available	120 MB to 535 MB	213 MB to 2 GB	80 MB to 1 GB	120 MB to 530 MB	120 MB to 330 MB	60 MB to 210 MB
MONITOR						
Brand	ALR FlexView 3X	CTX 5468NI	Viewsonic 6e	TVM 4A	AAmazing	Compaq
Color (C)/Monochrome (M)	C	C	C	C	C	C
Maximum resolution	1024 x 768	1024 x 768 (noninterlaced)	1024 x 768	1024 x 768 (noninterlaced)	1024 x 768	1024 x 768
Provides dual voltage (115/60Hz-220/50Hz):	●	●	●	●	○	●
EXPANSION SLOTS						
No. of ISA slots	10	8	8	8	6	3
No. of EISA slots	None	None	None	None	None	None
Proprietary slots	Two 32-bit bus slots	One 32-bit local bus video	One 32-bit local bus video	One 32-bit local bus video	None	None
STANDARD INTERFACES						
No. of serial ports	2	2	2	2	2	1
No. of parallel/printer ports	1	1	1	1	1	1
Video adapter/Resolution	SVGA/1024 x 768	SVGA/1280 x 1024	SVGA/1280 x 1024	SVGA/1280 x 1024	SVGA/1024 x 768	SVGA/1024 x 768
Standard VRAM (MB)	1	1	1	1	1	0.5
Brand of video adapter	Western Digital	Orchid Fahrenheit	Diamond Stealth	ALR	Trident	Qvision 1024i
Mouse included	●	●	●	○	●	○
Serial mouse (S)/Mouse port (MP)	MP	S	S	S	S	MP
Game port included	○	●	●	○	○	○
POWER SUPPLY						
Watts	300	230	250	300	250	145
Provides dual voltage (115/60Hz-220/50Hz)	●	●	●	●	●	●
COMPATIBILITY						
MS-DOS 5.0	●	●	●	●	●	●
Windows 3.1	●	●	●	●	●	●
OS/2	●	●	●	●	●	●
NetWare 386	●	●	●	●	●	●
Novell certified	●	○	○	○	○	●
SCO Unix	●	●	●	●	●	●
MPX	○	○	○	○	●	○
Interactive Unix	●	●	●	●	●	○
Other operating systems	Microport Unix	None	AT&T Unix, Xenix, pc/MOS	None	Concurrent DOS	None
BUNDLED SOFTWARE						
MS-DOS 5.0	●	○	●	●	●	●
Windows 3.1	●	○	●	○	○	●
Other	None	None	None	None	None	Utilities
WARRANTY	1 year parts and labor; opt. on-site service	1 year parts and labor	30-day money-back; 13 months parts and labor	1 year parts and labor	2 year parts and labor; 1 year on-site service	1 year parts and labor; 1 year on-site service
Technical support	●	●	●	●	●	●
LIST PRICES						
Standard configuration	$3195	$2850	$2080	$1685	$3395	$2549
Review unit	$3993	$2850	$2648	$2655	$4595	$3597
Review unit options	512 KB VRAM, SVGA color monitor, IDE caching disk controller	None	Caching controller, Diamond Stealth SVGA monitor, upgrade to 8 MB RAM, 256-KB cache	Upgrade to 8 MB RAM, 210-MB hard drive, SVGA adapter, mouse and Windows 3.1, tower case	4 MB RAM, 330-MB hard drive, SCSI caching controller, SVGA color monitor, 256-KB cache, SVGA adapter	4 MB RAM, 210-MB hard drive, Compaq monitor

World Radio History

Take a good look at the system's monitor; it can be an expensive item to replace. (● = yes; ○ = no)

CompuAdd Computer Corp. CompuAdd 433	**CompuTrend Systems, Inc.** Premio 486-33	**Daly Computers, Inc.** DC486/33C	**Dell Computer Corp.** Dell 486D/33	**DFI, Inc.** Diamond Series Model 433D	**Duracom Computer Systems** DeskSaver 486/33	**Everex Systems, Inc.** Tempo M Series 486/33
486DX/33; 486DX2/66	486DX/33; 486DX2/66	486DX/33	486DX/33; 486DX2/66	486DX/33; 486DX2/66	486SX/20 or 25; 486DX/33 or 50; 486DX2/50 or 66	486DX/33; 486DX2/50 or 66
●	●	●	●	●	●	●
●	●	○	●	●	●	●
Weitek 4167 OPTI Phoenix	Weitek 4167 Contaq AMI	Weitek 4167 OPTI AMI	None VLSI Phoenix	Weitek 4167 UMC AMI	Weitek 4167 UMC AMI	Weitek 4167 EG66/67 AMI
4	4	4	4	4	4	4
64	32	64	64	64	64	32
None	None	None	None	None	None	None
64	64	64	None	256	128	128
128	256	512	None	256	256	256
1.2-MB 5¼-inch, 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch;	1.44-MB 3½-inch 5¼-inch;
200	212	212	84	210	Varies	Varies
Western Digital Caviar	Varies	Conner CP-3200F	Quantum LPS 84AT	Western Digital	Maxtor	Varies
IDE	IDE	SCSI	IDE	IDE	IDE (SCSI opt.)	IDE
○	○	○	○	○	○	○
5	5	5	5	5	6	5
40 MB to 660 MB	42 MB to 212 MB	200 MB	120 MB to 500 MB	Varies	80 MB to 545 MB	80 MB to 245 MB
CompuAdd	Premio	NEC 4FG	Dell	ADI	Duracom	Everex MON500
C	C	C	M	C	C	C
1024 x 768	1024 x 768	1024 x 768	640 x 480	1024 x 768	1024 x 768 (noninterlaced)	1024 x 768
●	●	○	○	●	●	●
8	8	8	6	7	8	7
None	None	None	None	None	None	None
None	None	None	None	One for 32-bit memory board	One for 32-bit memory board	One for CPU card
2	2	2	2	2	2	2
1	1	1	1	1	1	1
SVGA/1024 x 768	SVGA/1280 x 1024	SVGA/1024 x 768	SVGA/1024 x 768	SVGA/1024 x 768 Integrated local bus	SVGA/1024 x 768 Integrated local bus	SVGA/1280 x 1024
1	1	1	1	1	0.5	0.5
CompuAdd	Paradise	ATI 8514 Ultra	Western Digital	Tseng Labs ET-4000	Tseng Labs ET-4000	Integrated Tseng Labs ET-4000
○	●	●	●	●	○	●
S	S	S	MP	S	S	S
○	○	○	○	●	●	○
200	230	220	225	200	200	200
●	●	●	●	●	●	●
●	●	●	●	●	●	●
●	●	●	●	●	●	●
●	●	●	●	●	●	●
●	●	●	●	●	●	●
○	○	●	●	○	○	●
●	●	●	●	●	●	○
○	○	●	○	●	○	○
●	○	●	○	●	●	○
None	None	None	None	None	Banyan Vines	None
●	○	●	●	●	○	●
●	○	○	●	●	○	●
Utilities	None	None	Utilities	None	None	None
1 year parts and labor; 1 year on-site service	1 year parts and labor; opt. on-site service	1 year parts and labor; 1 year on-site service	1 year parts and labor	1 year parts and labor; 1 year on-site service	1 year parts and labor; 1 year on-site service	1 year parts and labor; 1 year on-site service
●	●	●	●	●	●	●
$2355 $2875 4 MB RAM, 200-MB hard drive, mouse kit	$1899 $1899 None	$1799 $3475 4 MB RAM, ATI Ultra Graphics card, NEC 4FG monitor, 200-MB SCSI hard drive, SCSI controller	$2199 $3019 4 MB RAM, 230-MB hard drive, SVGA color monitor, 1.44-MB floppy drive	$2495 $3659 4 MB RAM, 210-MB hard drive, SVGA color monitor	$1299 $2495 4 MB RAM, 1.44-MB floppy drive, 256-KB cache, MS-DOS 5.0, Windows 3.1, mouse, SVGA color monitor, 200-MB hard drive, 1 MB VRAM	$1869 $2499 4 MB RAM, 200-MB hard drive, SVGA color monitor

continued

World Radio History

33-MHZ 486DX DESKTOP COMPUTERS

(● = yes; ○ = no)

COMPANY	Gateway 2000, Inc.	Insight Distribution Network, Inc.	Lodestar Computer	NEC Tecnologies, Inc.	Northgate Computer Systems, Inc.	Packard Bell
Model	486DX/33	Insight 486-33 Cache	486 LB Data Master	PowerMate 486/33i	Elegance ZXP	PB 486DX/33
CHIPS						
Processors supported (chip/speed)	486DX/33	486DX/33; 486DX2/66	486SX/20 and 25; 486DX/25, 33, and 50; 486DX2/50 and 66	486DX/33; 486DX2/50 and 66	486SX/20 and 25; 486DX/25 and 33; 486DX2/50 and 66	486DX/33; 486DX2/66
Uses cache	●	●	●	●	●	●
CPU upgrade available	○	●	●	●	● (ZIF socket)	●
External coprocessor supported	Weitek 4167	Weitek 4167	Weitek 4167	None	Weitek 4167	None
Brand of motherboard chip set	Intel	OPTI	UMC	OPTI	OPTI	Intel
Brand of BIOS	Phoenix	AMI	AMI	Phoenix	Northgate	Phoenix
MEMORY						
Standard RAM (MB)	4	4	4	4	4	4
Maximum RAM (MB)	32	32	32	36	32	20
No. of wait states	None	None	None	None	None	None
Standard cache (KB)	None	64	64	None	64	None
Maximum cache (KB)	None	256	256	128	256	256
STORAGE MEDIA						
Standard floppy configuration						
Drives and types	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch
HARD DRIVE CONFIGURATION						
Standard capacity (MB)	200	213	120	120	240	130
Brand and model	Western Digital Caviar	Western Digital	Maxtor XT7120A	Quantum Prodrive	Seagate	Seagate ST3144A
Interface	IDE (SCSI opt.)	IDE	IDE (SCSI opt.)	IDE	IDE	IDE
Includes caching controller	●	●	●	○	○	○
No. of internal and external drive bays	2	8	6	4	5	4
Range of hard disk capacities available	80 MB to 1.2 GB	40 MB to 4 GB	42 MB to 1.2 GB	120 MB and 240 MB	40 MB to 1.5 GB	130 MB to 400 MB
MONITOR						
Brand	CrystalScan	Viewsonic or TVM	StarView 2000	None	Panasonic	Packard Bell
Color (C)/Monochrome (M)	C	C	C	None	C	C
Maximum resolution	1024 x 768	1024 x 768	1024 x 768	None	1024 x 768	1024 x 768
Provides dual voltage (115/60Hz-220/50Hz):	●	No, Viewsonic; yes, TVM	●	○	○	●
EXPANSION SLOTS						
No. of ISA slots	8	8	6	4	7	4
No. of EISA slots	None	None	None	None	None	None
Proprietary slots	None	None	Two 32-bit local bus slots	None	None	None
STANDARD INTERFACES						
No. of serial ports	2	2	2	1	2	1
No. of parallel printer ports	1	1	1	1	1	1
Video adapter/Resolution	SVGA/1024 x 768	SVGA/1280 x 1024	SVGA/1280 x 1024	SVGA/1280 x 1024	SVGA/1024 x 768	SVGA/1024 x 768
Standard VRAM (MB)	1	1	1	1	1	0.5
Brand of video adapter	ATI Graphics Ultra	Diamond Speedstar	Lodestar local bus SVGA	Tseng Labs ET-4000	STB Ergo	Oak Tech. OTI-077
Mouse included	●	●	●	●	●	●
Serial mouse (S)/Mouse port (MP)	S	S	S	MP	S	S
Game port included	○	○	●	○	○	●
POWER SUPPLY						
Watts	200	250	230	110	220	150
Provides dual voltage (115/60Hz-220/50Hz)	●	●	●	●	●	●
COMPATIBILITY						
MS-DOS 5.0	●	●	●	●	●	●
Windows 3.1	●	●	●	●	●	●
OS/2	●	●	●	●	●	○
NetWare 386	●	●	●	●	●	●
Novell certified	○	○	●	●	○	●
SCO Unix	●	●	●	●	●	○
MPX	○	○	●	○	○	○
Interactive Unix	○	●	●	○	●	○
Other operating systems	None	None	None	None	DR DOS 6.0	None
BUNDLED SOFTWARE						
MS-DOS 5.0	●	○	●	●	●	●
Windows 3.1	●	○	●	●	●	●
Other	Choice of one of seven applications	None	None	None	Diagnostic utilities	Utilities, tutorials, Lotus Write, Lotus 1-2-3 for Window
WARRANTY	30-day money-back; 1 year parts and labor; 90-day limited upgrade policy	30-day money-back; 1 year parts and labor	30-day money-back; 2 year parts and lifetime labor; 1 year on-site service	1 year parts and labor; 1 year on-site service	30-day money-back; 1 year parts and labor	1 year parts and labor; 1 year on-site service
Technical support	●	●	●	●	●	●
LIST PRICES						
Standard configuration	$2395	$1999	$1979	$2099	$1999	OEM pricing
Review unit	$2682	$3069	$2599	$3098	$2919	Approx. $2200
Review unit options	4 MB RAM	4 MB RAM, SVGA color monitor, 213-MB hard drive, caching hard drive controller	256-KB cache, 4 MB RAM, 210-MB hard drive, SVGA color monitor, programmable keyboard, 2-MB cache RAM	240-MB hard drive, 4 MB RAM	4 MB RAM, 240-MB hard drive, SVGA color monitor, Omnikey keyboard	4 MB RAM

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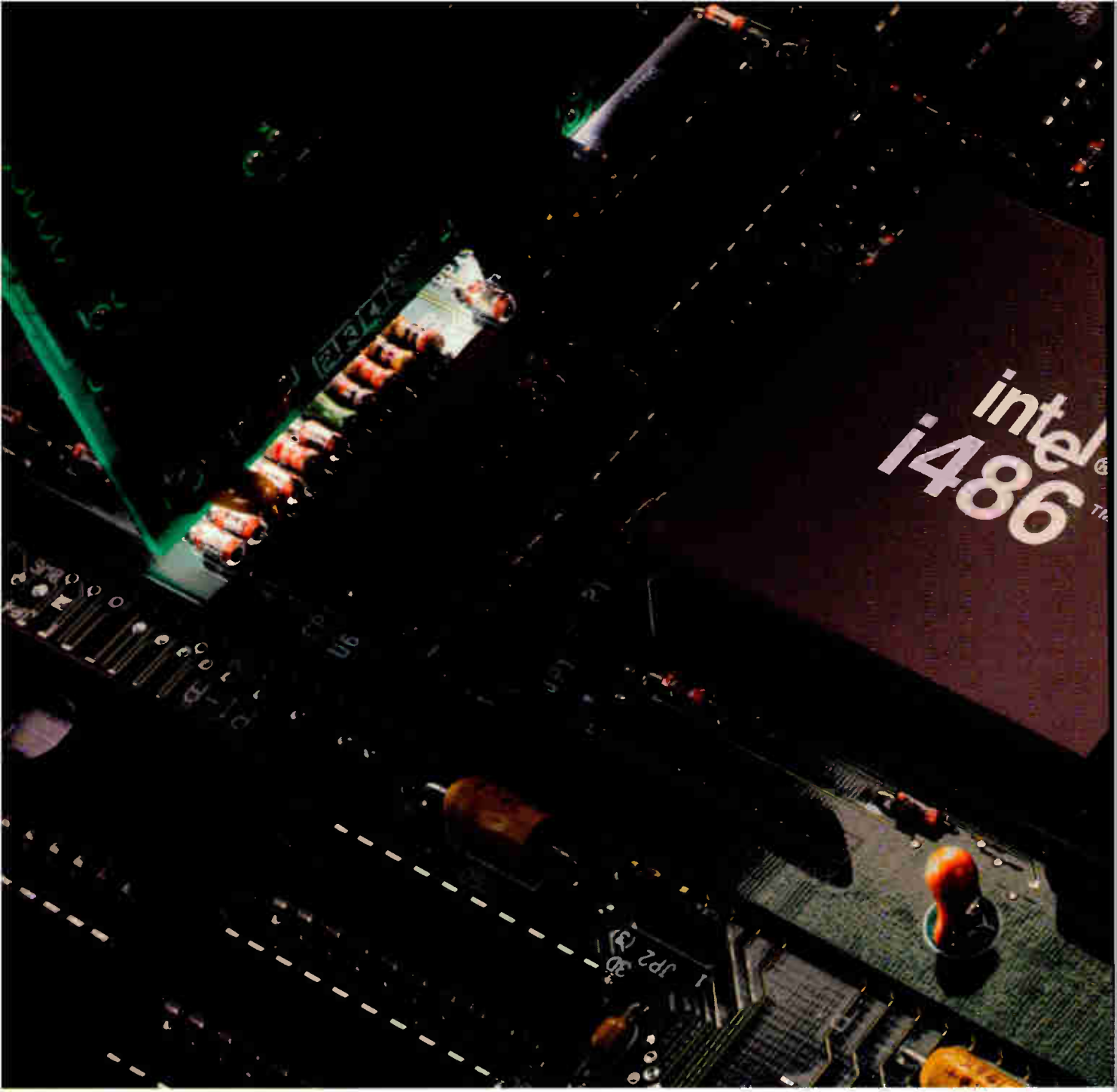
Polywell Computers, Inc. Poly 486/33VF	QSI Corp. Klonimus 486/33	Tandy Corp. Tandy 4833 LX/T	Tangent Computer, Inc. Tangent Model 433i	Tri-Star Computer Corp. Tri-WIN 486DX/33 EISA	Uniq Tech, Inc. UTI 486DX-33	Wyse Technology, Inc. Decision 486si
486DX/33; 486DX2/66	486DX/33	486DX/33; 486DX2/66	486DX/33; 486DX2/66	486DX/33; 486DX2/66	486DX/33; 486DX2/66	486SX/16, 20 and 25; 486DX/20, 25 and 33; 486DX2/50 and 66
●	●	●	●	●	●	●
●	○	●	●	●	●	● (ZIF socket)
Weitek 4167 OPTI AMI	Weitek 4167 Contaq AMI	None VLSI/Topcat Phoenix	Weitek 4167 SIS AMI	Weitek 4167 Intel AMI	Weitek 4167 OPTI AMI	Weitek 4167 OPTI Phoenix
4 32 None 64 256	8 32 None 64 256	4 64 None None None	4 64 None 128 256	8 64 None 256 256	4 32 None 64 256	4 64 None 8 256
1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.44-MB 3½-inch	1.2-MB 5¼-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch	1.2-MB 5¼-inch; 1.44-MB 3½-inch
120 Maxtor XT7120A IDE (SCSI opt.) ● 8 130 MB to 2.5 GB	80 Varies IDE ○ 6 40 MB to 4 GB	Varies Varies IDE ● 4 40 MB to 440 MB	100 HP hpc2233 IDE ○ 5 100 MB to 510 MB	384 Maxtor LXT2135 SCSI ● 8 210 MB to 1.2 GB	80 Conner CP2084E IDE ○ 4 80 MB to 1.2 GB	120 Quantum, Maxtor, or Seagate IDE ○ 5 120 MB and 200 MB
Viewsonic 4e C 1024 x 768 ●	CTX 5468A C 1024 x 768 ●	Tandy VGM 441 C 1024 x 768 ○	Relisys C 1024 x 768 (noninterlaced) ○	MAG MX14H C 1280 x 1024 ●	Axion C 1024 x 768 ○	Wyse WY-670 C 1024 x 768 ●
8 None None	8 None None	7 None None	8 None One for 32-bit memory board	2 6 None	8 None None	6 None None
2 1 SVGA/1024 x 768 1 Trident ○ S ●	2 1 SVGA/1024 x 768 1 STB ● S ●	2 1 SVGA/1024 x 768 0.5 Western Digital ○ MP ○	2 1 SVGA/1024 x 768 1 Diamond ● S ●	2 1 SVGA/1280 x 1024 1 Diamond Speedstar Plus HiColor ● S ●	2 1 SVGA/1024 x 768 1 ATI ● S ●	2 1 SVGA/1024 x 768 Integrated local bus 0.5 Wyse Hyper16 ○ MP ○
250 ●	200 ●	300 ●	300 ●	230 ●	220 ●	200 ●
● ● ● ● ○ ● ○ ● None	● ● ● ● ○ ● ○ ● None	● ● ● ● ● ● ○ ● None	● ● ● ● ○ ● ○ ○ None	● ● ● ● ○ ● ○ ○ None	● ● ● ● ○ ● ● ● None	● ● ● ● ○ ● ○ ○ USL Unix Banyan Vines
○ ○ None	○ ○ None	● ● None	● ● OS/2 (opt.)	○ ○ AutoCAD tutorial	● ● None	● ● None
30-day money-back; opt. 1 year on-site service; 2 years parts and 5 years labor ●	1 year parts and labor; 1 year on-site service ●	1 year parts and labor ●	1 year parts and labor; 1 year on-site service ●	2 year parts and lifetime labor; 1 year on-site service ●	1 year parts and labor; 1 year on-site service ●	1 year parts and labor; opt. 1 year on-site service ●
$1880 $3475 6 MB RAM, 240-MB SCSI hard drive, caching controller, 250-MB tape drive	$2128 $2840 340-MB hard drive, SVGA color monitor	$3299 $4998 SVGA color monitor, 240-MB hard drive, upgrade to 8 MB RAM	$2595 $2945 4MB RAM, 128 KB cache RAM	$3695 $3135 Equip. downgrade: 210-MB hard drive, caching controller, SVGA board	$1989 $2469 4 MB RAM, 200-MB hard drive	$1709 $2928 CPU upgrade, 4 MB RAM, 200-MB hard drive, SVGA color monitor

continued

World Radio History



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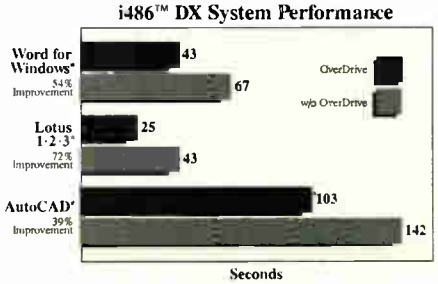

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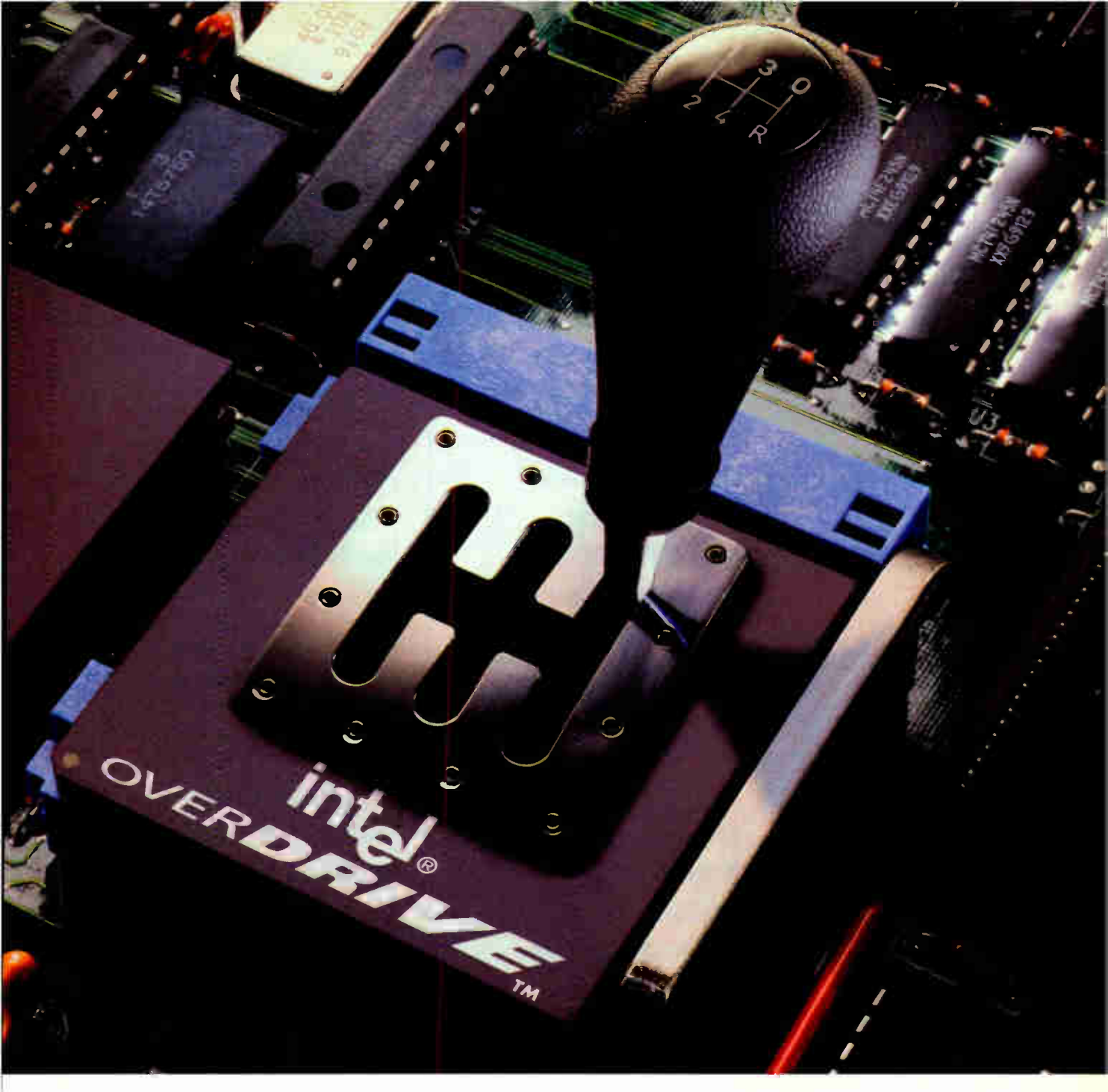
†In cases where there is no OverDrive socket, Intel recommends installation by a qualified technician.

World Radio History



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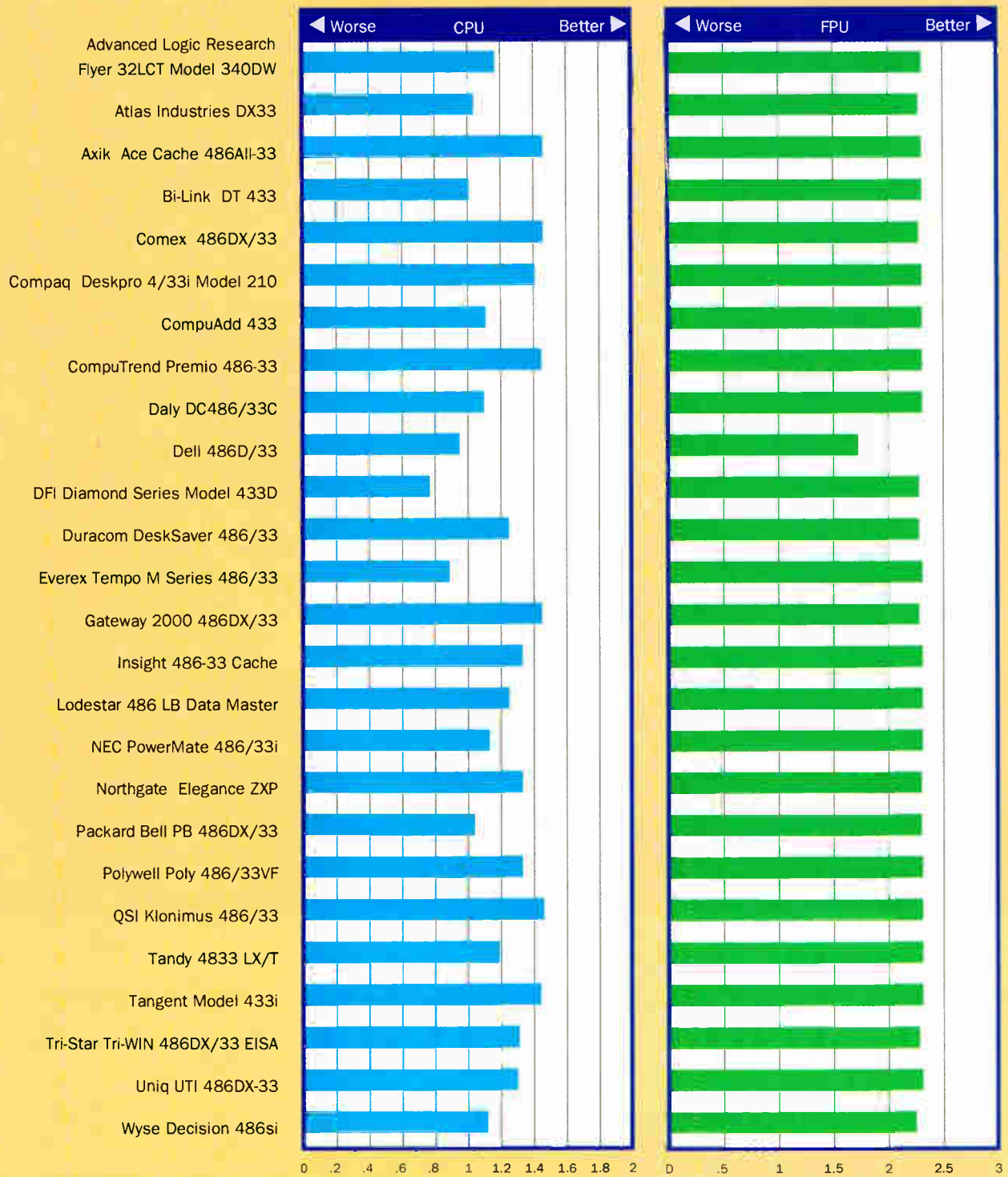
BYTE LOW-LEVEL BENCHMARKS



The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990. Version 2.2 of the BYTE low-level benchmarks is available in the byte.bmarks conference on BIX, or you can contact BYTE directly. All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 is assigned a value of 1. For each index in the Unix tests, the performance of a Sun Sparcstation IPC is assigned a value of 1. The overall index is the average of all tests.

continued

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Hard drive depicted is the Maxtor LXT535 IDE drive. Provided courtesy of Maxtor Corporation.

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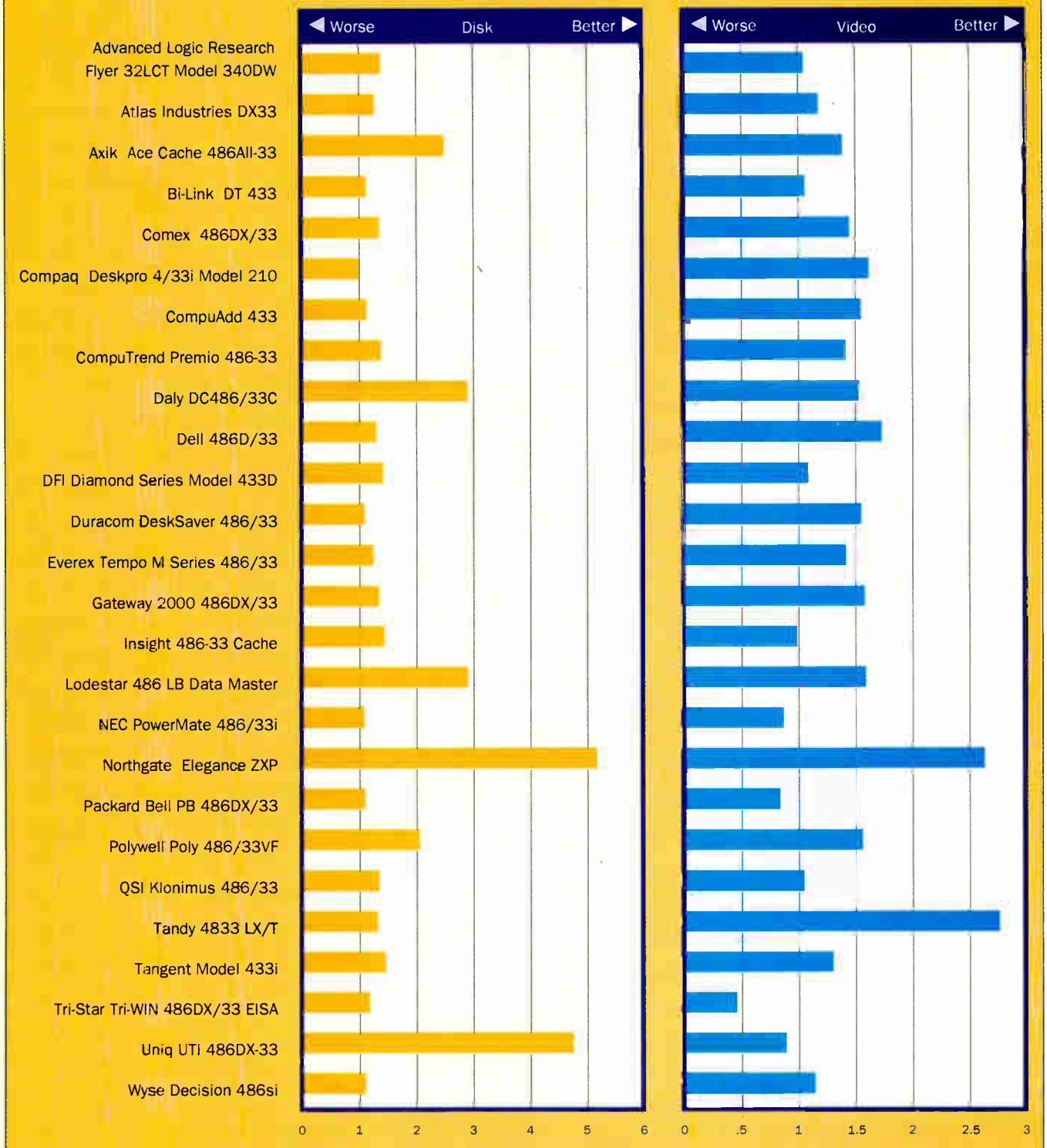
World Radio History

BYTE LOW-LEVEL BENCHMARKS



The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you identify the relative performance of a given subsystem and determine where bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990. Version 2.2 of the BYTE low-level benchmarks is available in the byte.bmarks conference on BIX, or you can contact BYTE directly. All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 is assigned a value of 1. For each index in the Unix tests, the performance of a Sun Sparcstation IPC is assigned a value of 1. The overall index is the average of all tests.

continued

World Radio History

A monitor touched by Michelangelo

Buy an IOcomm ThinkSync 7A 17" color monitor with a Michelangelo VRAM 1280 Graphics Accelerator and you've got a graphics subsystem that delivers unmatched performance for large screen, high resolution users (up to 1280 x 1024 non-interlaced resolution). All for the unbeatable price of **$1295***.

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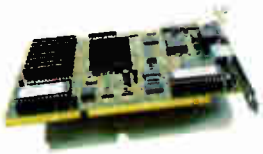

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NB67432	K101	101-key enhanced keyboard (90-day warranty)	49.95

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NB19465

- One-year warranty

Part No.	Product No.	Description	Price
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NB67467	JE1030A	200 watt 8088	89.95
NB19545	JE1036	200 watt 286/386/486	89.95
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NB65728	JE1039A	300 watt 286/386/486	149.95

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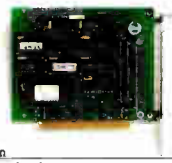
NB14120	CP3204	200MB	16ms	699.95

Controllers

IDE Disk Drive Adapter Cards



NB10268

- Interfaces two IDE hard drives to system
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NB10276	ADP60	16-bit hard adapter with BIOS	79.95
NB10284	ADP60F	16-bit hard/floppy adapter with BIOS	99.95
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- Maximum spike volts: 6,000V
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- Color: beige

Part No.	Product No.	Price
NB20159	JE1190	$29.95

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- Master switch with pilot light
- Three-prong, 6-foot power cord
- UL listed

Part No.	Product No.	Price
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- One-year warranty

Part No.	Product No.	Price
NB40774	356KU	$99.95

*Requires JE1043 o. JE1049 floppy controllers for 8088 machines.

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- One-year warranty

Part No.	Product No	Description	Price
NB17099	FD55B	5.25" TEAC 360KB	$89.95
NB17101	FD55G	5.25" TEAC 1.2MB	99.95

Floppy Controllers

- One-year warranty

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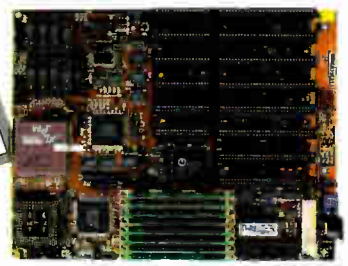

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NB75627	80386DX 40Mhz	4MB	585.95
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NB75651	80486DX 50Mhz	16MB	2,749.95

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NB42251	511000P-80	18	1MB	80ns	5.99
NB42219	511000P-10	18	1MB	100ns	5.49

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NB41718	421000A9A-80	1MB SIPP	80ns	54.95

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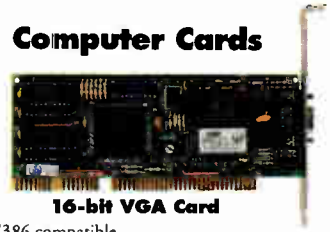
Computer Cards



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- Capable of 640 x 480 with 256 colors, 800 x 600 with 256 colors, 1024 x 768 with 16 colors (512KB RAM required for all modes)
- One-year warranty

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Part No.	Product No.	Function	Price
NB19596	JE1040	8088 floppy controller	$19.95
NB19705	JE1050A	8088/286/386/486 monochrome graphics adapter	49.95
NB19781	JE1058S	8088/286/386/486 Super VGA	159.95
NB19801	JE1060	8088 I/O	59.95
NB19828	JE1062	8088/286/386/486 RS232 serial (16450 UART)	29.95
NB67053	JE1062A	8088/286/386/486 RS232 serial (16550 UART)	39.95
NB19844	JE1065	80286/386/486 I/O	49.95
NB19895	JE1075	8088 multi I/O w/floppy controller	69.95
NB19908	JE1076	80286/386/486 multi I/O w/floppy controller	69.95
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NB20757	JE24	6.50 x 3.125	1,360	2	12.95
NB20773	JE25	6.500 x 4.25	1,660	3	17.95
NB20790	JE26	6.875 x 5.75	2,390	4	24.95
NB20811	JE27	7.250 x 7.50	3,220	4	32.95

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- Handheld, high accuracy
- Measures AC/DC voltage, AC/DC current, resistance, diodes, continuity, and transistor current gain (except 27140)
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- Also measures frequency and capacitance

Part No.	Product No.	Description	Price
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NB27140	M3900	3.5 digit multimeter with tach/dwell	59.95
NB27086	M3650	3.5 digit multimeter w/frequency & capacitance	74.95
NB27158	M4650	4.5 digit w/frequency & capacitance & data hold switch	99.95

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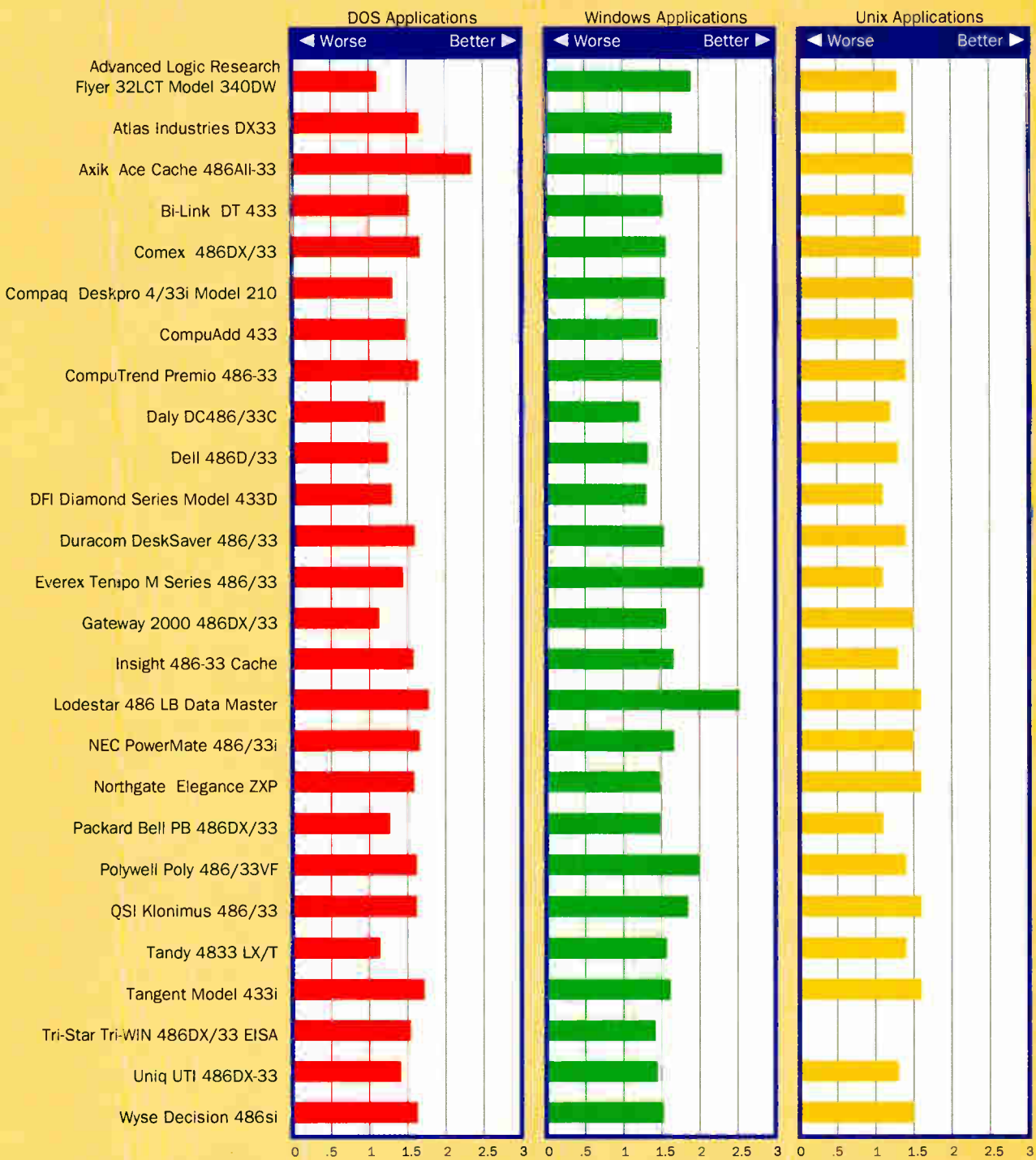
BYTE SYSTEM BENCHMARKS



BYTE's applications performance suite measures the performance you can expect to achieve running a given applications category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.1. We test six applications categories for each environment, running test scripts with the programs listed in the following software categories: Word Processing (WordPerfect 5.1 and Lotus Ami Pro 2.0); Spreadsheet (Lotus 1-2-3 release 3.1+ and Microsoft Excel 3.0a); Database (Software Publishing Superbase 4 1.3 and Borland dBase IV); Development (Borland Turbo Pascal for Windows and Microsoft C 6.0); Scientific/Engineering (MathSoft MathCAD for Windows 3.0, The MathWorks MathLab 3.5k, and Computing Resource Center Biturbo Stata 2.1); CAD (Autodesk AutoCAD release 11); Desktop Publishing (Aldus PageMaker 4.0). The data files and test scripts are available from BYTE.

Our Unix tests show relative performance for double-precision arithmetic, the Dhrystone 2 benchmark, spawning a process (execl()), file-copy throughput, pipe-based context switching, and running a shell script with eight concurrent scripts running. Unix benchmarks are available on Usenet, in the listings area on BIX, or on disk.

continued

World Radio History

Why do they call it a dongle?

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

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

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

The Most Powerful Program in the World

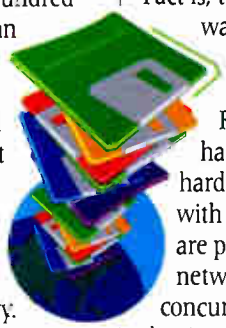
Determined to make those long years pay off, he called on every distributor, VAR and dealer in the world. He drove from Beantown to San Diego. Flew from Dublin to Borneo. Everyone loved the program.

So he sold a few. Only a few.

Back in Boston he waited. After a long year with only 13 orders he set out to see what happened. As he drove across the country and flew around the world he discovered everyone knew about his program. Everyone had it too.

The Global Marketplace

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



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

Call It What You Like

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

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

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

You've Come A Long Way, Baby

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

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Truth is, more and more developers are using keys. And the Sentinel Family is the most widely used in the world. In fact, over 6,000 developers use Sentinel from Rainbow. Why? They are simply the most effective, reliable and easy to implement keys on the market.

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quite good, and it's a safe bet that its parts will be available for some time to come.

Considering that the price of most of these machines hovers right around $2500, it's hard to think of any reasons to buy anything less than a 486. For word processing, maybe. But that justification may not hold for long, because most word processors are moving to Windows. The way the tides are flowing, it's probably better to opt for the most power you reasonably can afford. ■

Howard Eglowstein and Stan Wszola are BYTE Lab testing editors. You can reach them on BIX as "heglowstein" and "stan," respectively.

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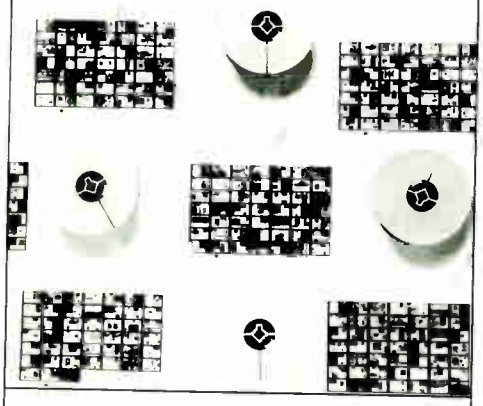

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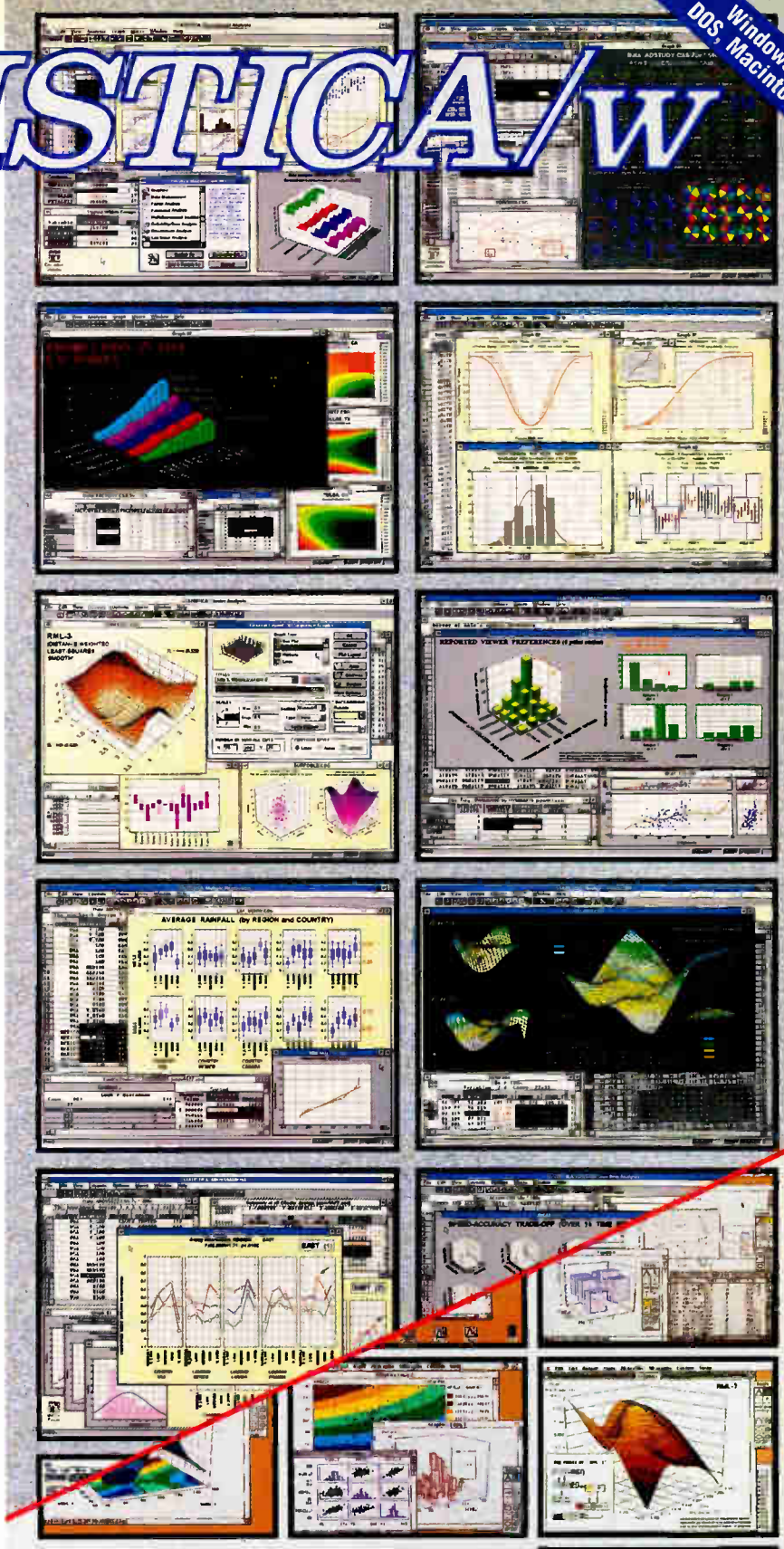

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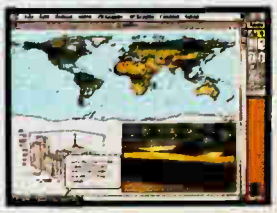

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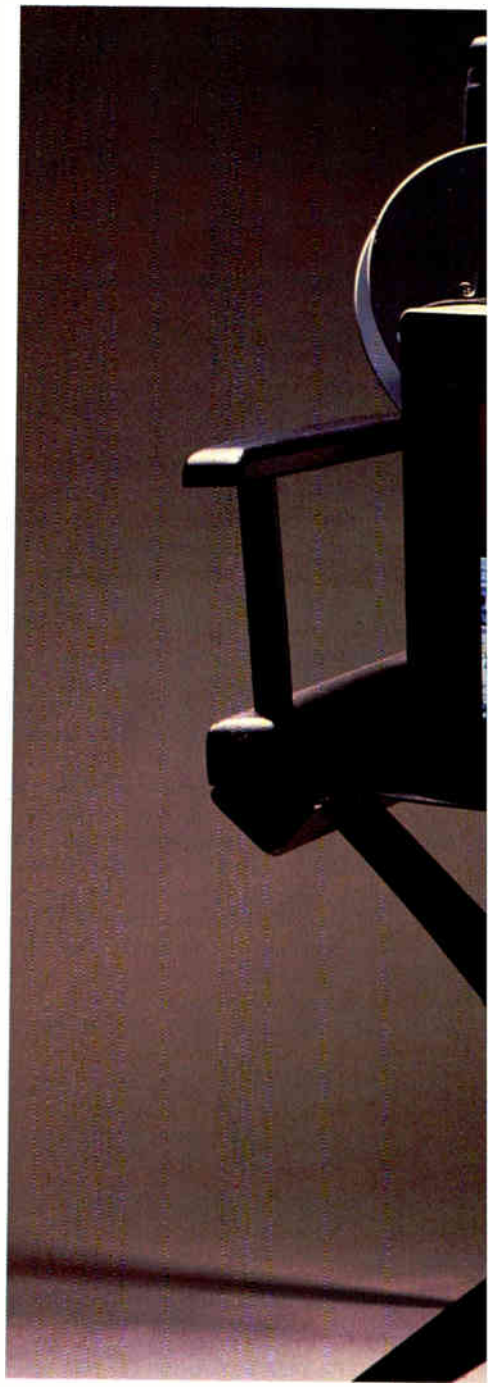
SOFTWARE

Cut to Video: Four Programs for Moving Presentations

TOM YAGER



Business presentations boil down to one thing: You're selling something. Be it a product or a service, an idea, or even yourself, the challenge is to win over others' minds. Make an effective presentation and you could be on your way to your own parking spot. Make a bad presentation and you could be on your way to a career in Fryolator operation.

The most persuasive selling tool multimedia offers is the moving image. For this roundup, I have selected products that share a broad purpose: They integrate video into business presentations. For the Macintosh, I looked at Adobe Premiere and Diva VideoShop. For PCs, I took a look at Mathematica's Tempra Show and AT&T Graphics Software Labs' Panorama. These products use either digital or analog technology to get video into presentations.

There are other programs (e.g., AimTech IconAuthor, HSC Interactive, and Macromedia Authorware Professional) that let you mix moving pictures with other types of media, but they are designed more for developing interactive applications, such as information kiosks and automated product demonstrations, and less for presentations you give in front of an audience. These programs can certainly be used to put together slick business presentations, but that isn't their primary application.

QuickTime and the Digital Route

Apple's QuickTime provides a foundation for the acquisition, storage, and playback of digitized moving video and sound. Both Premiere and VideoShop give you the tools to assemble and edit video and sound into QuickTime movies.

Apple is mounting a campaign to take QuickTime beyond the Mac and have it adopted as the prevailing desktop digital-video standard. If successful, it will become the first widely accepted method for passing digital video between different types of computers.

Two benefits of the QuickTime video are that it's inexpensive and easy to use: A $500 board, such as SuperMac's Video-Spigot, and the software that comes with it, are all it takes to turn video into a digital file. QuickTime files, called *movies*, can be played back on other Macs without special equipment.

The QuickTime video, and digital video in general, is not without its cost. Video files are huge, even when compressed, so a few seconds of video can occupy several megabytes of disk space. That's costly, especially once you start thinking about moving that data through networks or modems. The other drawback is that digital video, except in high-end, disk-hogging implementations, delivers material of a lesser quality than the original.

The Analog Alternative

These drawbacks have boosted analog video combined with two other technologies: video overlay boards and computer-controlled video players. These make use of existing analog video equipment to add video to computer-based presentations.

Video overlay, and the similar video-in-a-window boards, typically accept input from external analog video sources (including videotape, laserdisc, and TV) and display it on a computer's monitor. A special class of video overlay boards display their output on ordinary TV sets or video monitors instead. Either way, these boards allow you to combine computer-generated graphics with moving video. Since that video is never digitized to disk, its quality does not suffer nearly as much, and the higher-quality hardware can actually make video look *better* as it passes through your computer.

A relatively recent development—computer-controlled video recorders—is bringing new capabilities to presenters. Once you hook your computer's serial port into a specially equipped video deck, the same program that sequences your computer graphics for you can position

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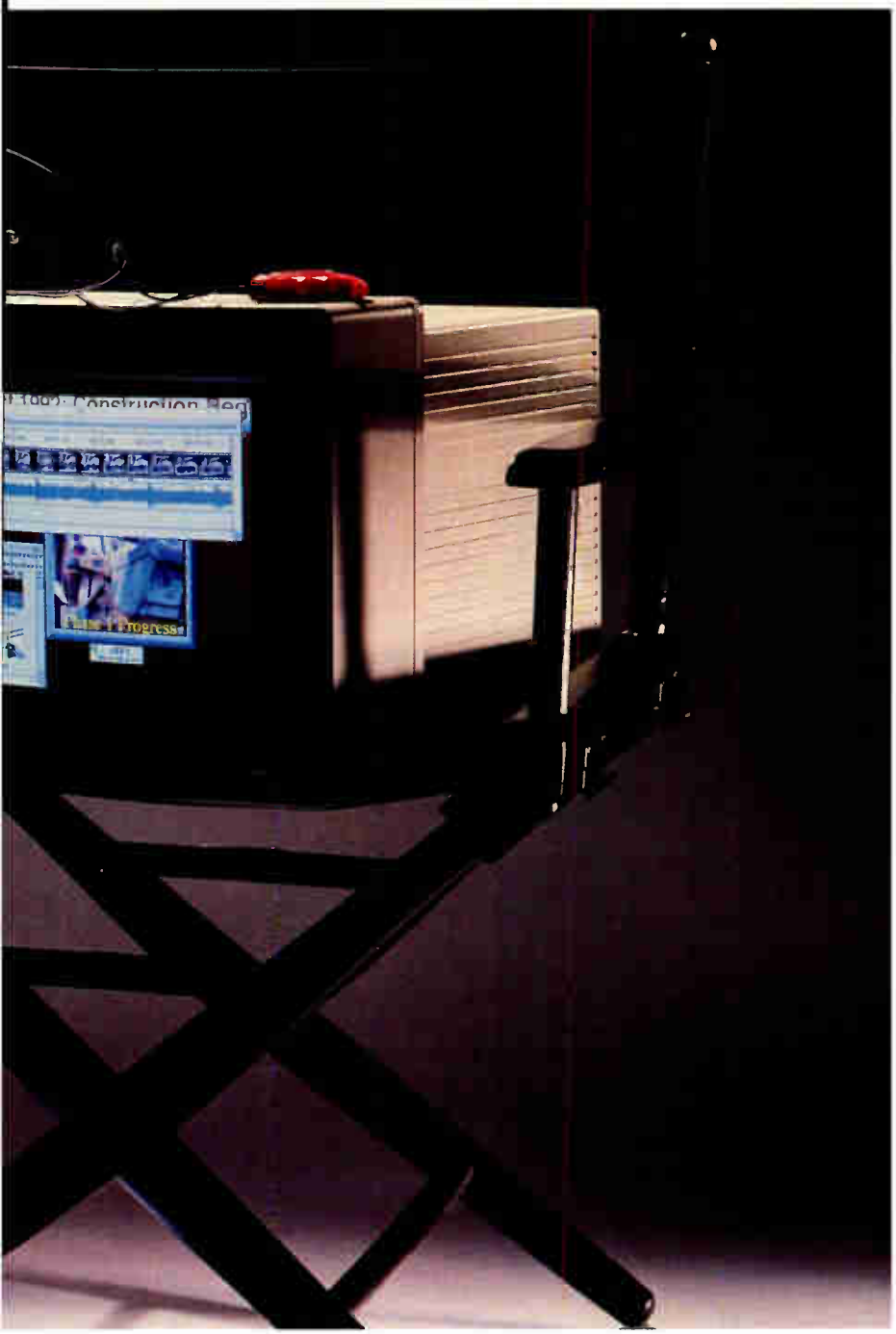

BYTE ACTION SUMMARY

- **WHAT VIDEO-PRESENTATION SOFTWARE DOES**
  These programs enable you to edit and arrange motion video clips for use in business presentations.
- **LIKES**
  Being able to manipulate video and audio sequences, relatively easily, on the desktop.
- **DISLIKES**
  Digital video occupies huge amounts of disk space; the analog approach requires expensive equipment.
- **RECOMMENDATIONS**
  For editing QuickTime movies, Premiere is the premier choice. Under DOS, Tempra Show is inexpensive but capable. Panorama is recommended for PC users who want video output of very high quality.
- **PRICE**
  Premiere, $495
  VideoShop, $599
  Tempra Show, $199
  Panorama: Targa version, $995; ATVista version, $1195

and play video clips on command. This provides a level of convenience similar to that offered by digital video, but with a far better quality-to-cost ratio.

Computer-controlled video decks are still expensive—in the $2000 range. The big drawback to analog video is that it has to come from somewhere. You can produce QuickTime movies, combining material from several sources, right on your Macintosh. You can produce analog videos using your computer, but it costs a lot more and requires additional equipment.

Making Mac Movies

The two QuickTime editing programs I looked at string captured video clips together, letting you add digital audio and computer-generated graphics. Both give you the freedom to carry out complex edits, including transitional special effects that bridge video clips or graphics with computer-generated animated transitions.

To test the Mac products, I used the BYTE Multimedia Lab's Mac Quadra 700 with 20 MB of memory and a 400-MB hard drive (you need at least 4 MB of RAM in your Mac). It was equipped with a VideoSpigot QuickTime acquisition board from SuperMac Technology. This board has an RCA jack for a single composite video input.

To record audio with your video, you need either an external audio digitizer (like the MacRecorder) or a newer Mac, such as a Quadra, with a built-in audio input. The Quadra 700 has a microphone jack. An attenuating patchcord from Radio Shack allowed me to hook the line-level output from the video decks directly into the Mac. For video input, I used a Panasonic AG-7650 professional Super-VHS player and a Sony CVD-1000 VDeck, a compact Hi-8 VCR. Neither deck was placed under the Mac's control, although both decks support it.

continued

World Radio History

Adobe's Newest Premiere

The latest version of Adobe Premiere, version 2.0, was in beta testing at the time of this review and was slated for an early autumn release. This new software is a major upgrade, showing that Adobe is serious about making Premiere what a colleague of mine called "the Photoshop for video."

In addition to incorporating its own QuickTime movie-capture facility, version 2.0 has a new titling module. Titles can be animated and can be rendered with transparency and smoothed edges. There's also room for vendors to add device-control software to Premiere. With that, you can arrange precise, automated capture and "print to video" using computer-controllable video decks.

Anticipating the availability of higher-quality video capture and playback hardware, Premiere 2.0 has some features that make it a useful tool for serious video production. If your hardware supports it, Premiere will now handle digital audio at rates as high as 44 kHz, with 16-bit resolution (1.0 is limited to 8-bit resolution). Movies can be turned into, and created from, numbered PICT files. Those who plan to use Premiere as a component of an existing video-editing suite will appreciate 2.0's support for SMPTE time code and EDLs (edit decision lists). With these, producers can use Premiere to define their edits and then export EDL files to professional editing systems. These files execute the edits using the original tapes and produce broadcast-quality results.

Overall, Premiere 2.0 addresses many needs of QuickTime producers. It has the potential to appeal equally to the dabbler and the pro.

Adobe Premiere

Screen 1: *Adobe Premiere uses a "collection and storyboard" approach to acquiring and editing video. You assemble and edit clips in the construction window, shown here in the upper right corner.*

Adobe's Premiere was one of the first QuickTime tools to appear (see "Two Tools of the QuickTime Trade," June BYTE), and so it has come to be the embodiment of QuickTime itself for many people. The text box "Adobe's Newest Premiere," above, offers a preview of Premiere 2.0, which at first blush is impressive indeed. But its predecessor certainly deserves top consideration when you're looking for a video-editing program.

Premiere, like most digital (and some analog) video-editing applications, employs a "collection and storyboard" interface (see screen 1). Using a utility external to Premiere (QuickTime acquisition boards come with simple capture programs), you acquire your video clips. The program displays them as little icons in a tidy collection window (in Premiere parlance, a *project* window). Digital audio files and still graphics are collected here as well.

You edit movie and audio clips by setting In and Out points. These points determine what portion of a clip will play. If a clip is too long or too short, you can simply adjust the In and Out points.

To create the most basic kind of presentation, you drag movie icons from the project window and lay them end-to-end in the storyboard. Premiere's storyboard is a series of rows, with each row dedicated to a specific type of data. There are three video rows, including one for transitional effects, and three audio rows. The "Super" row in the storyboard is reserved for videos and still graphics that you want to superimpose over playing videos. This lets you add titles, animation, and even video as layers above the rest of your material.

If you lay movie clips end-to-end on the same row in the storyboard, you get an instant transition between scenes, called *cut edits*. If you have a yen for something more visually exciting, Premiere has a library of digital transitional effects. These are cataloged in a floating window, with animated icons that clearly show the effect of each transition. Premiere sports an excellent mix of traditional and eclectic transitional effects, ranging from fairly sedate wipes and dissolves to wilder page turns.

Premiere's video filters have a practical side, adding antialiasing, brightness/contrast control, color balancing, and tinting effects to selected video segments. These filters help you enhance your video by compensating for problems in the original material.

Audio in Premiere is mixed using controls that rest under each audio clip in the storyboard. The level controls are single horizontal lines (one line controls each clip) that represent the audio playback level. The line is initially anchored on both ends by movable points. You can vary the audio playback level over time by moving the points around (they move in all directions). The result is a graph that represents your requested audio mix.

I'm struck by how Adobe has managed to craft a simple interface for such a complex idea. There is very little in Premiere that doesn't feel perfectly natural after its first use. I was initially surprised to find the program accompanied by a very thin manual, but now I get it: A program this well-written requires very few trips back to the documentation.

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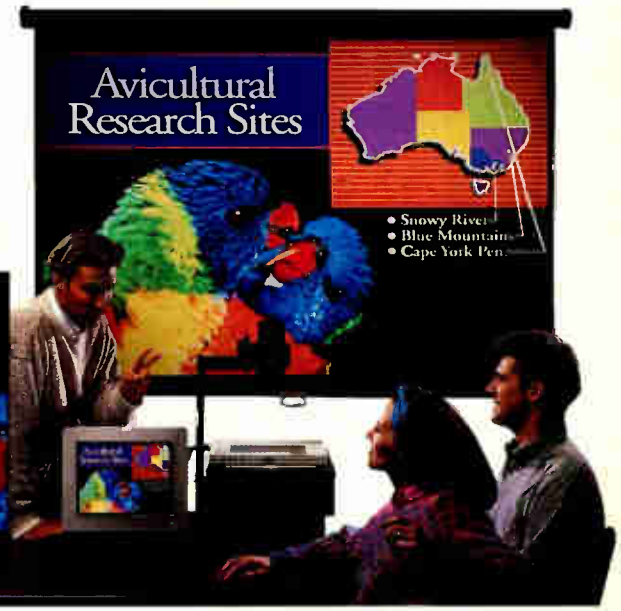

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World Radio History

Diva VideoShop

Screen 2: *Diva's VideoShop, like Premiere, uses a storyboard approach, with clips laid out in sequence. VideoShop adheres to a methodology that's more like traditional film editing.*

I was pleased to find that, despite the same basic collect/storyboard interface, Diva's VideoShop program incorporates many unique attributes that make it a worthwhile alternative to Premiere. VideoShop uses HyperCard to create a complete environment, even to the extent of providing Finder-like menu options like Find and New Folder. These are all part of VideoShop's desktop, intended to be a Mac-like environment tuned specifically for video (see screen 2). QuickTime movie files are optionally shown in VideoShop's collections, called folders, as animated icons that play the first several frames of the movie contained there. These "micons" (movie icons) animate only when you select them, so CPU time is not consumed needlessly.

Another VideoShop specialty is its constant preview window. In Premiere, previews are played in a tiny window and can be played only forward, and they are jerky, rough approximations. VideoShop's preview window allows you to play the current storyboard (called a *sequencer*) forward, backward, and at variable speeds, simply by clicking on the preview window's controls.

VideoShop's sequencer window supports an arbitrary number of video and audio tracks; you add more as you need them. To edit a clip, you click on a magnifying-glass icon and then double-click on a clip in the sequencer. This opens a window with an expanded view of the selected clip, giving you a visual that looks and handles remarkably like film. This metaphor is used effectively throughout VideoShop. To trim a clip, you drag over a portion of it with the mouse and press Delete. You can undo edits, but unlike with Premiere, when you make a cut in VideoShop, it stays. It does not, however, affect the original clip; you can always revert back to the original by dragging it in again.

Perhaps the most unique quality of VideoShop is its support of an arbitrary number of video channels. The multiple video channels can effectively create complex effects like video-in-a-window and title overlay. While Premiere supports the notion of a fixed-size master playback window in which all elements, unless modified by effects, play back at the master window's size, VideoShop uses a resizable playback window in which you can position and size multiple video clips. The clips can play in sequence, simultaneously, or any way you like. Video channels can include still graphics, which VideoShop (oddly) converts into QuickTime movies while importing them.

As with Premiere, VideoShop supports both transitional effects and video filters. But there's a difference in how each program has you apply effects. In Premiere, effects and clips are all distinct, movable pieces, laid out in separate rows in the storyboard. VideoShop applies transitional effects to video clips laid end-to-end on the same line in the sequencer. Transitional effects take place within a channel rather than between channels. This feels a little strange at first, but it's not without its merits. Each video channel can have its own effects, and it's OK for those effects to overlap, which is not the case with Premiere.

VideoShop doesn't offer a very extensive selection of effects. It sticks with basics, like the requisite dissolve (cross-fade) and wipe effects. And VideoShop doesn't provide either Premiere's animated effect icons or Premiere's depth of control over the effects.

Compared with Premiere, VideoShop gives you less power to manipulate effects. You get one chance to preview the effect on your own video, a very nice touch that makes up for the lack of the animated icons, and one chance to press Undo after you commit to the effect. After that, you're stuck with your changes unless you choose to rebuild the affected portion of your video. That's the one serious drawback of the film metaphor. While VideoShop provides you with constant, high-quality previews, that comes at the price of some changes (like effects) being difficult to undo.

While I found that trade-off acceptable, I could not accept VideoShop's inability to manage audio tracks. Except for a "Set audio level" menu option (which never worked for me), there is no control over the mixing of audio. Video transitional effects don't touch the audio, which abruptly shifts from one clip to the next. I also found disconcerting the program's inability to automatically scale video clips to fit the playback window.

VideoShop does let you record new clips from within the program. I had some trouble with that, however, probably because VideoShop (and Premiere 2.0) requires the use of a special driver, called a video digitizer, that SuperMac still had in beta testing at the time of this writing.

In general, I find Premiere to be the more useful of the two QuickTime tools. I like the film metaphor and the WYSIWYG emphasis in VideoShop, but the lack of audio handling and automatic scaling are enough to keep me running back to Premiere. I have no misgivings about recommending VideoShop for those projects that suit it, such as presentations that need multiple video sequences running simultaneously, but I think Premiere is the better choice for most uses.

Yes, You Can Do This Under DOS

Multimedia development is usually associated with graphical environments, but there are a couple of very capable presentation-making programs that run under plain old MS-DOS. You do not have to be using Windows or hefty Windows applications to build video into your presentation.

Both of the DOS packages I cover here use analog video input. To evaluate the PC products, I used two systems: an ALR Flyer 32LCT multimedia PC and a Uniq 486/50 server. The ALR was equipped with a Cardinal Technologies SnapPlus combination VGA/video-overlay board, while the Uniq had a Truevision ATVista 24-bit video board. With this hardware, both systems were equipped to handle incoming analog video.

The SnapPlus displays the video in a window on a VGA monitor, and the board also has the benefits of on-board VGA and recordable video output. The ATVista displays incoming video, combined with graphics, on a dedicated TV monitor.

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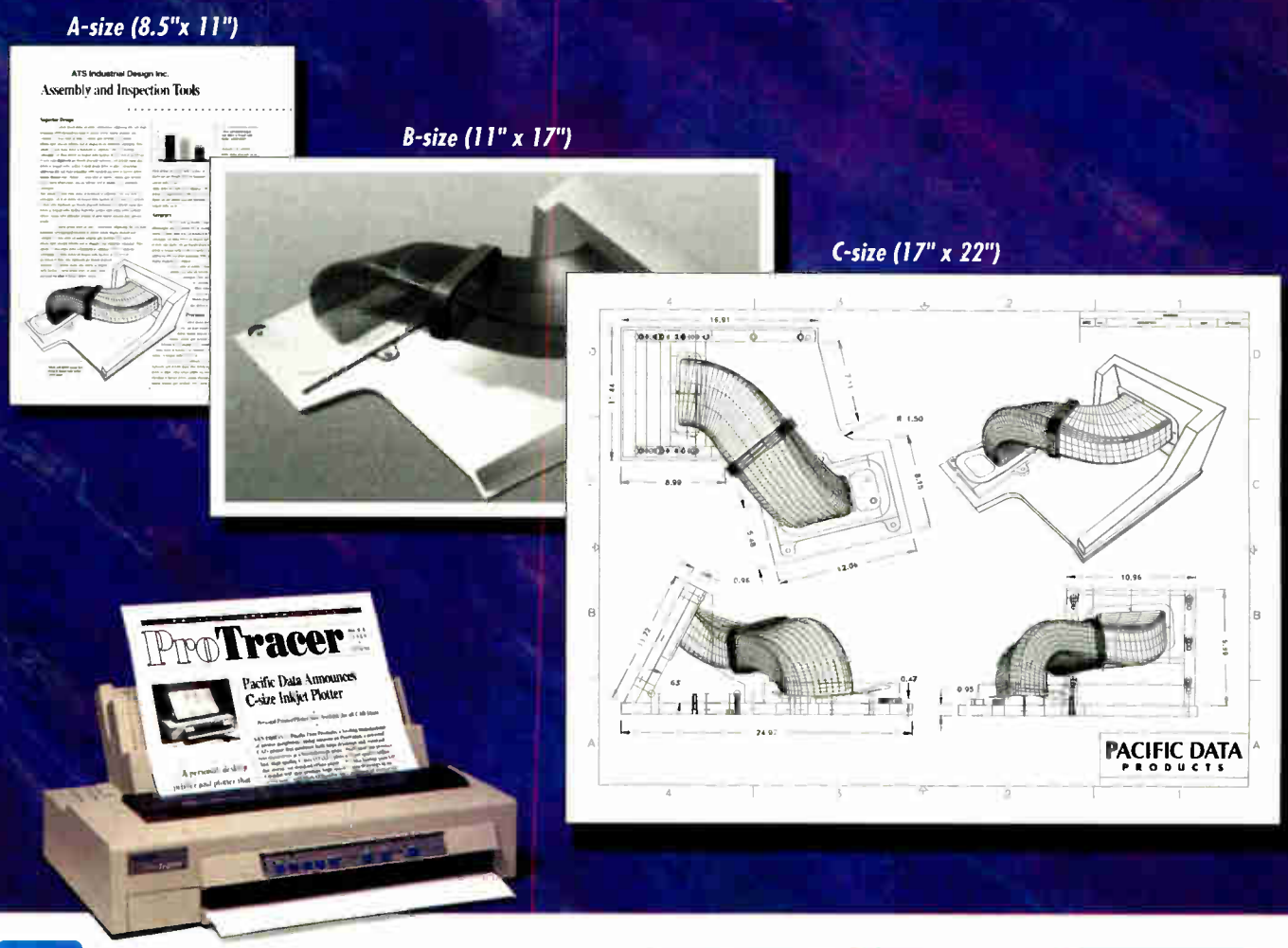
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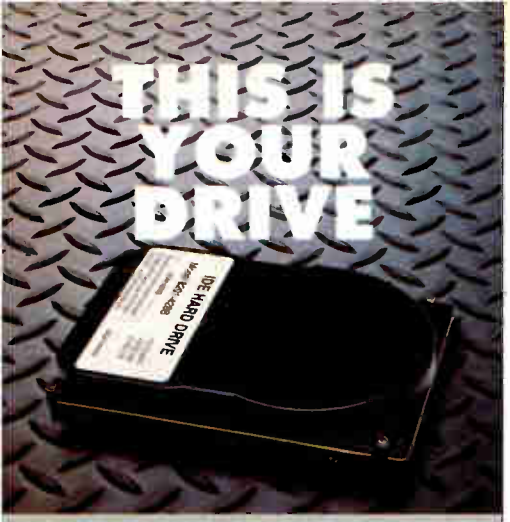

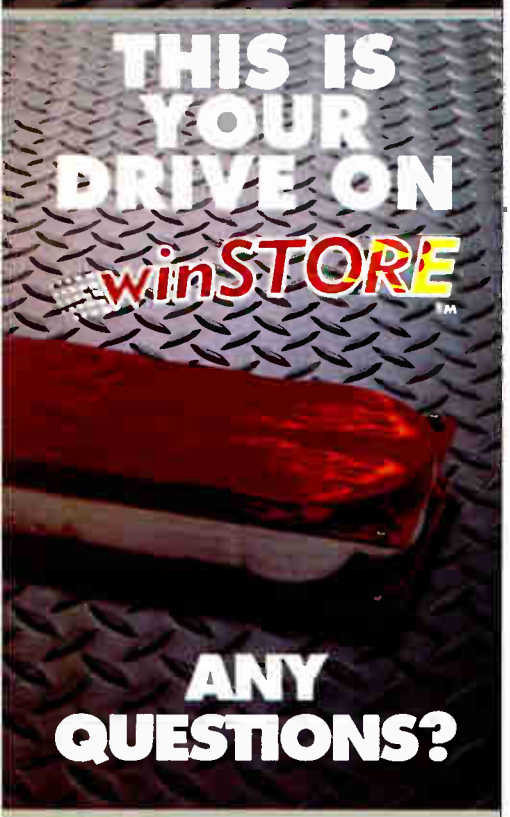

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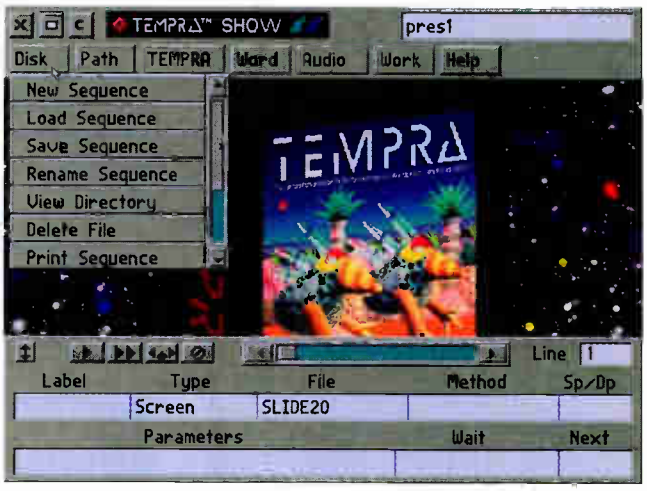
Tempra Show



Screen 3: *Mathematica's Tempra Show, an easy-to-use presentation package, puts a graphical interface over DOS to walk you through the process of putting events in sequence.*

Mathematica's Tempra Show is a DOS (not a Windows) program that has a GUI wrapper. Presentations created with Show can be played back on any properly equipped DOS machine (a PC with at least a 286 processor, 540 KB of main memory, and 5.5 MB of disk space). This is a very capable but easy-to-use presentation package, and I like its results.

I call Tempra Show a "presentation sequencer." You can't create any new material with it. Its function is to string together various types of multimedia data, generated from other sources, into a self-running presentation. Show can incorporate all sorts of data into presentations: still images (PCX and TGA formats); Autodesk Animator/3D Studio FLI and FLC files; digitized audio, MIDI, and CD audio; text; and, of course, video.

Bringing these data types together in Tempra Show is the script's job. Using the graphical interface, you build the script one event at a time; dialog boxes pop up to prompt you for additional information when needed. The GUI walks you through the parameters associated with each event, such as Screen (to load and manipulate graphics). Once you get used to what some of the cryptic button labels mean (e.g., 80Butn is a Button event in 80-column format), it's not a bad way to navigate (see screen 3).

Building a presentation one line at a time makes it difficult to maintain continuity. You can dismiss the GUI and go down one layer to the text-based interface underneath, but that's a little bewildering. You will, however, be able to see more than one event's worth of the script on the screen, and you can switch back to the GUI very easily.

Tempra Show's handling of the SnapPlus board's video-window capability couldn't be simpler: All you have to do is drag out a rectangle at the size and position you want the video window to appear, and when that event plays back, the video window pops up. With the SnapPlus, video windows popped up, disappeared, and resized rapidly in response to script events, making it easy to maintain a smooth flow. (Show also supports the Creative Labs Video Blaster.)

Tempra Show supports computer-controllable video decks, including the Sony Vdeck, which Show controls through a serial port. The program has a set of VCR events (e.g., play, forward, and rewind) that simulate pressing remote-control buttons. These controls allow for precise seeking and automatic segment playing on time-code-striped tapes. The combination of Show, Vdeck, and the SnapPlus board is one of the most painless and efficient setups I have used for video presentations. While Show's scripts can't rival the programmability of more advanced tools such as Asymetrix's ToolBook and Aimtech's IconAuthor, neither of these can match the ease with which Show compiles even fairly demanding presentations.

The package deserves extra credit for its Build Demo function. Build Demo provides an easy way to let you package your presentation and share it with other people. This part of the program loads a floppy disk or a hard disk directory with a distributable run time of Show, your script, and all the files needed to run the presentation on another machine. It even creates a batch file that launches everything from the command line. This is a simple touch, but it shows that Mathematica realizes that people don't build presentations to show them to themselves.

Tempra Show, even with its couple of quirks, is an excellent solution for many kinds of presentations that incorporate video. Mathematica's program is unique and is an ideal choice for PC users who don't have lots of time or money to invest.

continued

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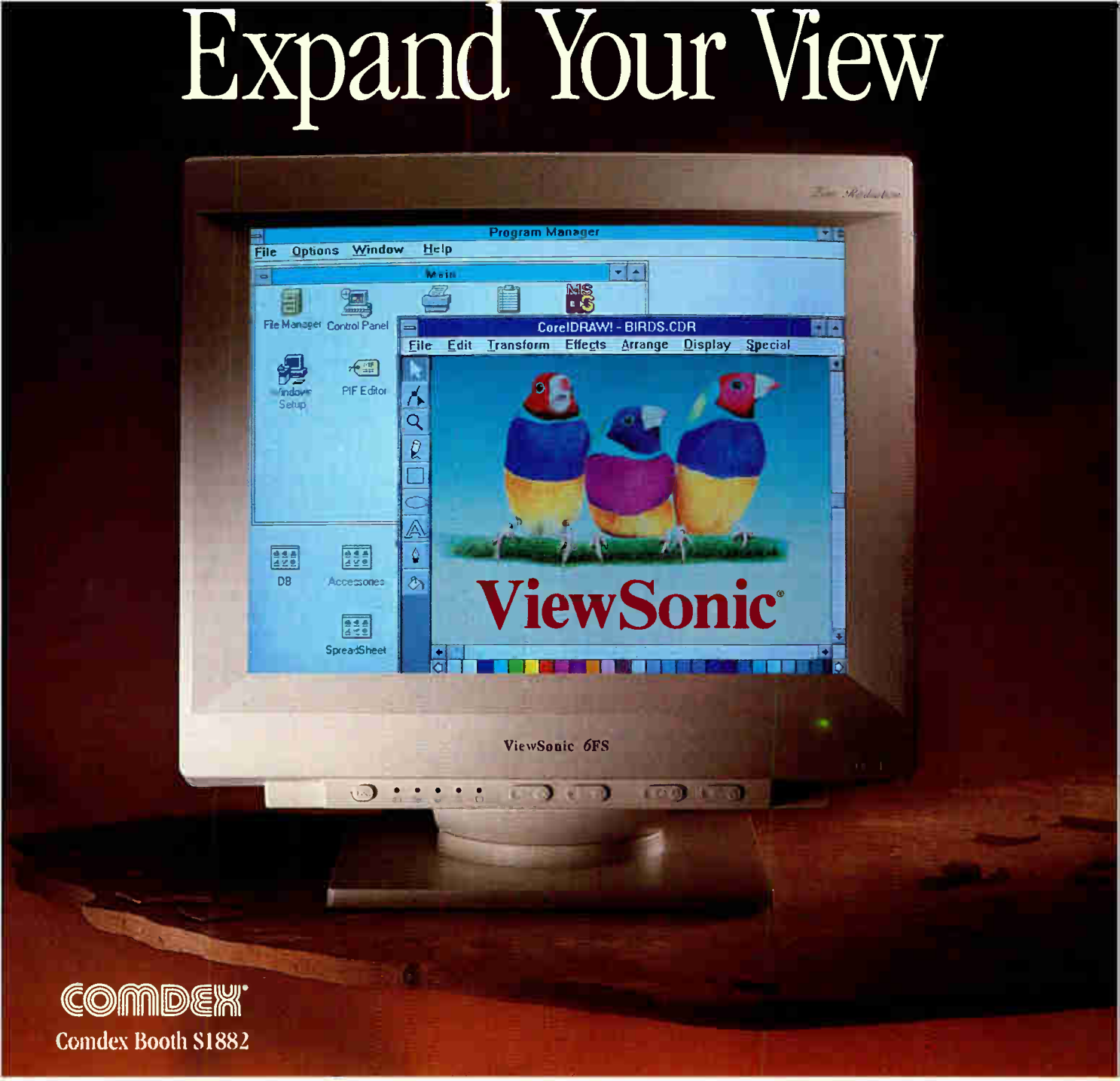

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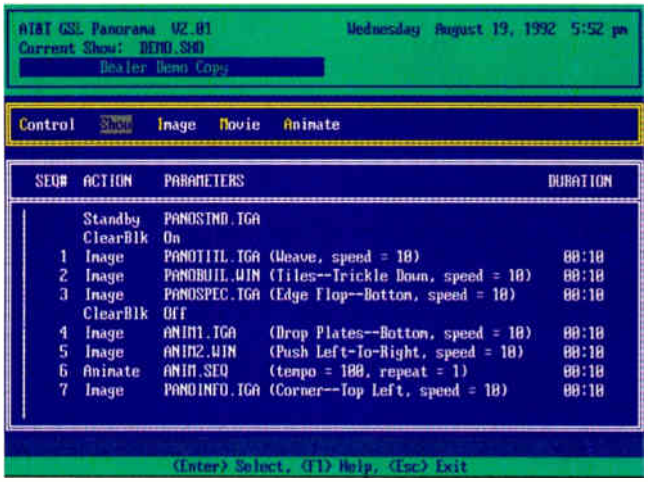
Panorama



Screen 4: *AT&T GSL's Panorama is a script-oriented sequencing program. Components of a presentation are shown in a list rather than as visual movie icons.*

The second DOS program I looked at is a fairly high-end solution: Panorama from AT&T Graphics Software Labs (see screen 4). It's the only one I reviewed that is specifically geared toward creating presentations intended for output to video (or a TV monitor or video projector). It uses the combined video I/O capabilities of Truevision Targa and Vista video boards to bring in video from an external source, combine it with graphics, and send the result back out as recordable video. The quality of the graphics output, thanks to the ATVista's 24-bit color, is superb. What Panorama offers is professional-looking output, suitable for trade show booths, presentations before large crowds, and other situations where image is everything.

Like Show, Panorama is a script-oriented presentation sequencer. The simplest Panorama presentation consists of a string of TGA-format graphics files. Truevision Targa and Vista boards have the ability, rarely tapped, to perform impressive special effects, and Panorama makes use of this power for creating transitions between graphics slides. All the effects are tasteful and suitable for professional applications, but there are some (e.g., squeeze, roll up, and pour) that are custom-made for turning heads.

You build a Panorama script on your PC's main monitor, and the script, along with running status and error messages, is always visible, since the Truevision boards typically use a separate TV monitor for display.

Panorama incorporates video through two Video event types. The Video Live event removes all graphics from the display and shows only video, while the Video Overlay event uses the *live* bit in a graphics file, showing the video through those pixels that have their live bit set. Pixels that are not set live create a graphical overlay.

You can capture and save video still frames from within Panorama for use in your presentations. The program also supports capturing motion video. You can capture as many frames as will fit in your video board's memory at once. For example, with a 4-MB ATVista, I could capture 64 frames. At full speed, this movie would play back in 2 seconds, but by specifying frame delays you can lengthen the movie's time by reducing the frame rate. Panorama movies aren't meant to be substitutes for video, and at the 64-frame resolution the images look pretty horrid close up. Still, for material that doesn't call for great detail, the movie feature comes in handy.

You can also add motion to a Panorama show through animation. It supports simple path-based animation of any graphics, but it is tuned for *clips*, images that are some fraction of the display size. A simple interface lets you set key points along the animation path and adjust the spline tension of the lines running between the key points. When you play the script, the animation event moves the clip along the path you specified.

Targa and Targa+ owners benefit from additional features in version 3.0 of Panorama, which is not available for the ATVista board. Version 3.0 adds the ability to play back digital audio files (through Sound Blaster and Pro Audio Spectrum boards), as well as interactivity for kiosk-style applications, more transitional effects, and the ability to animate multiple graphics clips at once.

I'm put off by GSL's failure to release Panorama 3.0 for the ATVista, but the Targa boards are more popular. The quality of Panorama's output sets it a bit above the rest of the pack, and the enhancements in version 3.0 widen that gap even more. For presentations that require video output, Panorama is an excellent choice.

A More Elegant Solution

The tools described here are good representatives of the kinds of practical applications that exist today. They are all good, solid packages. For editing QuickTime movies, Premiere is a cut above VideoShop because it gives you better control of effects and has slick audio-handling facilities. Tempra Show is inexpensive and easy to use; it's an ideal solution for people who don't have lots of time or money to invest. Panorama stands out for the superb quality of its output.

Using video in presentations used to mean setting up a VCR next to an overhead projector. Computers offer tight integration of video with other data, making for presentations that flow smoothly and leave a strong impression. Only video can transport audiences to another place. ■

Tom Yager is a BYTE technical editor and director of the Multimedia Lab. He's working on his second book, The Multimedia Producer's Handbook *(Academic Press, forthcoming). You can reach him on BIX as "tyager" or on the Internet at tyager@bytepb.byte.com.*

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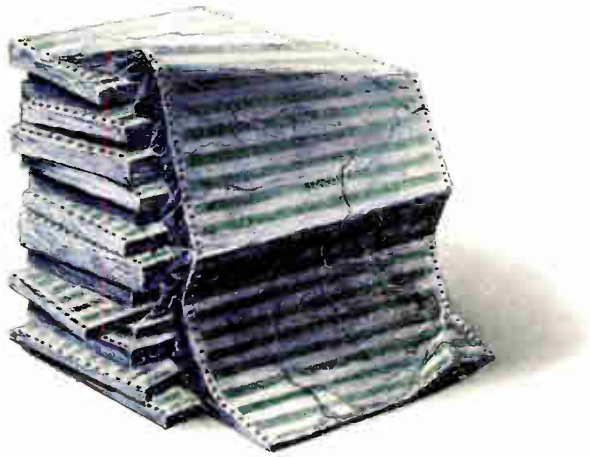

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HARDWARE

Compaq Unveils a New Network Printer

GREG LOVERIA

The importance of any printer's standard features—paper handling, performance, reliability—is magnified when you place the printer on a large network. Even a feature such as emulation sensing, which seems like a luxury on a stand-alone printer, becomes a necessity on a printer handling numerous jobs from multiple platforms. Any new network printer must measure up to some very demanding expectations.

New to the printer market, Compaq Computer has designed a couple of network printers poised to meet those high expectations. The most striking feature of the new Pagemarq line of network printers is affordability.

Compaq's speedy Pagemarq 20 offers enhanced resolutions of up to 800- by 400-dpi, automatic port switching, and emulation sensing.

A Network of Printers

The Pagemarq network laser printers offer a long list of standard features and options that should appeal to discerning LAN administrators. Based on a Fuji/Xerox print engine, Compaq's Pagemarq 15 ($3999) and Pagemarq 20 ($5499) offer output speeds of 15 and 20 pages per minute, respectively. Options on the Pagemarq 20 that I tested included 8 MB of RAM, NICs (network interface cards; AppleTalk for $269, Token Ring for $799, and Ethernet for $599) for connecting directly to a LAN, a 9600-bps Group 3 internal fax ($659), a 1-MB font module ($259), and a 60-MB internal hard drive ($659). These are list prices, and they'll probably be discounted through dealers.

An on-board AMD 29000 RISC processor, operating at 20 MHz on the 20-ppm unit and 16 MHz on the 15-ppm model, along with Compaq proprietary ASICs (application-specific ICs) and transmission data compression, work in conjunction to speed printing. Both units ship with 4 MB of RAM. The Pagemarq 20 can be expanded to 20 MB, and the Pagemarq 15 can go to 18 MB with convenient SIMM upgrades. One parallel and one serial port are included; both printers can receive and process print data simultaneously from either port. The Pagemarq supports the latest versions of the two industry-standard PDLs (page-description languages), version 5 of Hewlett-Packard's PCL (Printer Control Language) and Adobe PostScript Level 2.

I used to share a standard HP LaserJet Series III printer networked with other writers and illustrators. We had to generate lengthy aerospace technical manuals, and problems often arose when switching between PCL and PostScript. Since the LaserJet III was a PCL printer, we would install a PostScript emulation cartridge to print from Windows applications; however, for CAD plots, most of us printed without the cartridge using PCL. Checking the printer cartridge's installation status was mandatory before each print job. Anyone who has ever inadvertently printed a single page of PostScript data to a printer in PCL mode knows of the reams of paper—and time—wasted when a printer is improperly configured.

Emulation sensing solves this problem. The Pagemarq automatically determines the language required to service a print job and routes the job to the proper interpreter. No user intervention is required. I tested the automatic-sensing feature between PCL and PostScript emulations from both DOS and Windows applications. In both environments, I first used an HP Series II driver, and then I switched to a PostScript device driver (an Apple LaserWriter IINTX). The feature worked flawlessly, and print speeds between the two modes were almost identical.

In addition, multiple computers and networks can access the printer at the same time, thanks to the port-switching feature that can simultaneously service jobs from all active ports (i.e., serial, parallel, fax, AppleTalk, and the NICs). In a diverse computing environment, emulation sensing and port switching are mandatory features.

Paper Handling

The Pagemarq 20 arrived with three front-mounted, 500-sheet, 8½- by 11-inch motorized paper trays as standard features. Unfortunately, you cannot tell visually whether the paper is low. Even though the printer beeps loudly when all trays are emptied, most administrators would prefer a better way to keep track of the paper load. Single sheets and envelopes can be fed manually into the printer, but only via a rear-access flip-down panel. If you work with a lot of envelopes, you'll want the optional multipurpose feeder.

For print runs longer than 500 pages, you can configure the trays for auto-selection; when one tray empties, the next one loads. The only hitch here is that you will still have to empty the paper-output receptacle after 500 sheets have come through.

You can select individual trays from the front panel or on-screen using a remote printer control utility (more on this later), allowing different paper weights or colors to be selected from separate trays without reloading. I tested a variety of papers in

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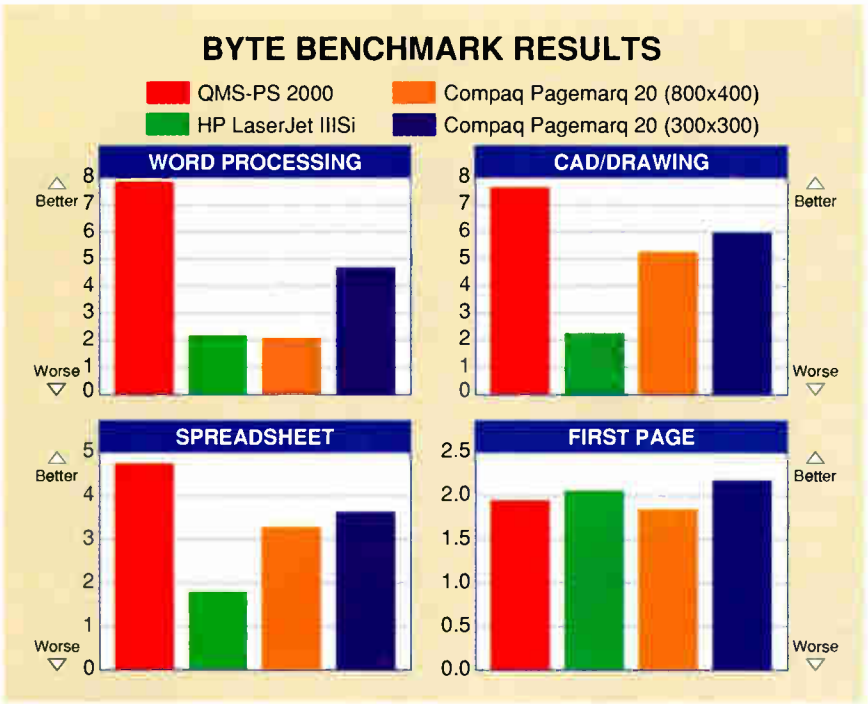

The Pagemarq 20 compared favorably to the HP LaserJet IIISi in the BYTE PostScript tests.

the 16- to 28-pound weight range and the output was identically crisp, with deep unstreaked blacks, on all paper stocks in my arsenal.

For CAD/CAE applications, both Pagemarq units can also print to 11- by 17-inch paper, using the optional B-size tray ($99). In my print tests from AutoCAD release 12, in both PCL and PostScript modes at 800 by 400 dots per inch, 11- by 17-inch plots were outstanding and, at this resolution, rivaled some of the best electrostatic and plotter output I've seen.

Getting Directions

A small 2-row by 15-column LCD and a slick little eight-button control panel provide convenient access to the printer's setup attributes and menus. The Pagemarq uses "on-line" documentation: Four extensive printer-setup menus are built into the unit's control ROM. Each menu is loaded with submenus and branches that take you to a specific printer-setup function, such as emulation sensing (on or off), lines per page, and page orientation.

You can access all menus easily via the front control panel, but it helps to know where you're heading. At any main or branch menu display on the LCD, you can get a hard-copy "road map" for that particular menu, complete with every subbranch and current printer setting.

In a network environment, some users will output only text documents while others will print documents with embedded line art and halftone graphics. The Pagemarq has multiple dpi resolutions (up to 800 by 400 dpi) that can satisfy all these needs. At 300 dpi, both text and graphics using PostScript Level 2 look great, but 800- by 400-dpi printing is where the Pagemarq really shines. Halftoned images output using Aldus PhotoStyler and PageMaker 4.0 look almost as good as results from a high-resolution typesetter.

The Administrator utility is a point-and-shoot GUI invoked from DOS (it can also be called as a full-screen application within Windows). With it, any authorized user can access most printer-setup and configuration parameters directly from a network node.

Typefaces and Other Fax

Both Pagemarq printers ship with 15 PCL fonts and the 35 standard Adobe Type 1 typefaces. Using the Administrator utility, you can download additional Type 1 or PCL typefaces directly to printer RAM or, for permanent storage, into the optional 1- or 2-MB ($259 and $399) programmable font module, a nonvolatile EEPROM. Once downloaded to the printer module, the typefaces are automatically available from your application. You no longer need to worry about downloading fonts. Typefaces can also be downloaded and stored on the optional $659 60-MB internal hard drive.

Downloading typefaces through a parallel connection is relatively slow, but once accomplished, you can delete typefaces from your system's hard disk, freeing up valuable space. It took 6½ minutes to download 27 Type 1 faces (2.2 MB) from my Zeos 486/25 system to the printer's hard drive. Times were identical for downloading to the module. The optional hard drive is expensive, but it can also be used as a print and fax document-caching device to enhance performance. Using Compaq's Administrator utility, or from the printer's LCD control panel, you can remotely output printed reports detailing all faces stored in printer RAM, ROM, or on the printer's hard drive.

continued

BYTE ACTION SUMMARY

- **WHAT THE PAGEMARQ 20 IS**
  A 20-page-per-minute laser printer designed for large networks.
- **LIKES**
  Reasonably fast performance, good print quality, and a relatively low price.
- **DISLIKES**
  No way to monitor a low-paper condition. Printouts on 11- by 17-inch paper require an optional tray.
- **RECOMMENDATIONS**
  The Pagemarq 20 is an exceptional network printer. It's a recommended solution for most network printing needs.
- **PRICE**
  $5499
- **FOR MORE INFORMATION**
  Compaq Computer Corp.
  P.O. Box 692000
  Houston, TX 77269
  (713) 370-0670
  fax: (713) 374-4583
  Circle 1228 on Inquiry Card.

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COMPAQ NETWORK PRINTER

The internal 9600-bps send/receive fax modem ($659) is CCIT Group 3–compatible and allows any networked user to generate and send fax documents from within Windows or DOS applications using pop-up utility menus. When you print a document from within any DOS or Windows word processor, a pop-up window asks whether you want to print or fax the document. If you choose fax, a cover page is generated and the document is sent down the network to the Pagemarq for fax transmission. You can even send PostScript files directly to another Pagemarq. It's an elegant fax implementation.

To the Test

In straight parallel tests of the Pagemarq 20 unit, print speeds were compared with those of network printers previously tested by the BYTE Lab (see the figure). The tests are a customized subset of the industry-standard Genoa Technology test suite. The First Page test indicates how fast a printer can pump out short memos or business letters. The Spreadsheet test prints pages from different versions of Lotus 1-2-3 and Microsoft Excel, including heavily formatted text and 3-D graphs. The CAD/Drawing test uses samples from AutoCAD, several illustration packages, and desktop publishing software. The Word Processing test generates formatted documents with numerous font changes.

Although the Pagemarq posted median-to-swift print speeds in these tests, note that the unit was compared against a network printer almost three times more expensive (the QMS-PS 2000) and in a parallel environment. In the end, your network print times will be increased or decreased by network server speeds and interface cards. Data transmission times using NICs, dependent on the network and how it is tuned, can be much faster than a straight parallel connection, with rates up to 16 MIPS. For a description of the LaserJet IIISi and the QMS-PS 2000, as well as descriptions and test results of some other major network printers, refer to the network printer roundup "Laser Muscle: Five Printers Built to Handle Networks" in the February BYTE.

Compaq's Pagemarq printers should be viewed as total network print solutions rather than just laser printers. The Pagemarq 20 can do everything the LaserJet IIISi can do—for less money. It's a good value and a recommended solution for your network printing needs. ■

Greg Loveria is a computer graphics and desktop publishing consultant, animator, and writer in Binghamton, New York. He can be reached on BIX as "loveria."

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5 ❑ Engineer/Scientist
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13 ❑ DOS + Windows 16 ❑ MacOS
14 ❑ OS/2 17 ❑ VAX/VMS

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Fax Boards/Machines	9
Graphics Tablets/Mice/ Pen Input	10
Keyboards	11
LAN Hardware	12
Laptops & Notebooks	13
Mail Order	14
Memory/Chips/Upgrades	15
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia	19
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
Tape Drives	23
UPS	24

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Business	25
CAD/CAM	26
Communications/Networking	27
Data Acquisition	28
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Macintosh	34
Mail Order	35
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Miscellaneous Software	37
On-Line Services	38
Operating Systems	39
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56	82	108	134	160	186	212
57	83	109	135	161	187	213
58	84	110	136	162	188	214
59	85	111	137	163	189	215
60	86	112	138	164	190	216
61	87	113	139	165	191	217
62	88	114	140	166	192	218
63	89	115	141	187	193	219
64	90	116	142	188	194	220
65	91	117	143	169	195	221
66	92	118	144	170	196	222
67	93	119	145	171	197	223
68	94	120	146	172	198	224
69	95	121	147	173	199	225
70	96	122	148	174	200	226
71	97	123	149	175	201	227
72	98	124	150	176	202	228
73	99	125	151	177	203	229
74	100	126	152	178	204	230
75	101	127	153	179	205	231
76	102	128	154	180	206	232
77	103	129	155	181	207	233

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234	259	284	309	334	359	384
235	260	285	310	335	360	385
236	261	286	311	336	361	386
237	262	287	312	337	362	387
238	263	288	313	338	363	388
239	264	289	314	339	364	389
240	265	290	315	340	365	390
241	266	291	316	341	366	391
242	267	292	317	342	367	392
243	268	293	318	343	368	393
244	269	294	319	344	369	394
245	270	295	320	345	370	395
246	271	296	321	346	371	396
247	272	297	322	347	372	397
248	273	298	323	348	373	398
249	274	299	324	349	374	399
250	275	300	325	350	375	400
251	276	301	326	351	376	401
252	277	302	327	352	377	402
253	278	303	328	353	378	403
254	279	304	329	354	379	404
255	280	305	330	355	380	405
256	281	306	331	356	381	406
257	282	307	332	357	382	407
258	283	308	333	358	383	408

Inquiry Numbers 409-590

409	435	461	487	513	539	565
410	436	462	488	514	540	566
411	437	463	489	515	541	567
412	438	464	490	516	542	568
413	439	465	491	517	543	569
414	440	466	492	518	544	570
415	441	467	493	519	545	571
416	442	468	494	520	546	572
417	443	469	495	521	547	573
418	444	470	496	522	548	574
419	445	471	497	523	549	575
420	446	472	498	524	550	576
421	447	473	499	525	551	577
422	448	474	500	526	552	578
423	449	475	501	527	553	579
424	450	476	502	528	554	580
425	451	477	503	529	555	581
426	452	478	504	530	556	582
427	453	479	505	531	557	583
428	454	480	506	532	558	584
429	455	481	507	533	559	585
430	456	482	508	534	560	586
431	457	483	509	535	561	587
432	458	484	510	536	562	588
433	459	485	511	537	563	589
434	460	486	512	538	564	590

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591	616	641	666	691	716	741
592	617	642	667	692	717	742
593	618	643	668	693	718	743
594	619	644	669	694	719	744
595	620	645	670	695	720	745
596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
600	625	650	675	700	725	750
601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764
615	640	665	690	715	740	765

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
972	997	1022	1047	1072	1097	1122

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1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1162	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478
1329	1354	1379	1404	1429	1454	1479

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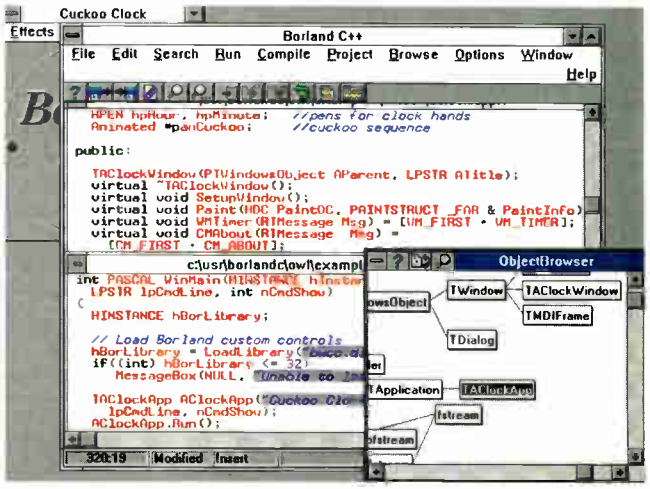
SOFTWARE

Borland Targets Windows Developers with Latest C++ Release

OTHAR HANSSON

Borland C++ 3.1 is the latest release of the best-selling object-oriented development environment. In addition to the expected support for the Windows 3.1 API, Borland C++ purports to offer "all you need" to produce Windows applications. However, what you mostly need to develop Windows applications at the moment is *patience*, and Borland's integrated browsers and editors, fast compilation, and reusable code modules are all designed to speed the process for the Windows developer.



Borland's Windows integrated development environment now provides optimization options, an object browser, and a color-coded editor. The class definition being edited uses Borland's language extension to control Windows message handling.

Development Environment

Borland has significantly extended the functionality of its Windows-hosted IDE (integrated development environment). The IDE now permits developing optimized Windows code under Windows and debugging multiple applications, such as DDE clients and servers. It also contains some of the features we've been waiting for in Windows development environments. There is a speed bar under the main menu bar, providing quick access to commonly used commands.

Most impressive is the context-sensitive editor. The editor provides cues for different elements of a program's structure, as in the screen's italic blue constant strings, boldface black keywords, and red function names. Colors and character attributes are user-defined, of course, and are available in both the DOS and Windows environments. Suitably garish colors can be assigned to catch unexpected characters and preempt some typographical errors.

In addition, the IDE features a graphical class browser, which provides an overview of the inheritance hierarchy. A double-click on a class brings up a scrollable list of class members. A speed-bar button brings up an editor window containing the class declaration. The browser is particularly useful in getting up to speed on a large body of existing code, such as the Borland ObjectWindows Library.

Language Lawyers

In contrast to Microsoft C/C++ 7.0 (see "Microsoft's Lucky Number," September BYTE), Borland C++ 3.1 is intended to comply with the AT&T Cfront 3.0 de facto standard. Microsoft C/C++ 7.0 (also known as C7) is based on the previous Cfront 2.1 release. As more publicly available code and widely read books begin to rely on Cfront 3.0 syntax and features, this will be an advantage to Borland users.

Borland also achieves better marks on C++ compiler validation suites, such as Plum-Hall and Perennial. Of course, this latest-generation compiler retains the ability to compile Kernighan-Ritchie or "classic" C code, with appropriate warnings. Borland C++ 3.1 implements the Cfront 3.0 template mechanism. Templates permit the specification and instantiation of generic classes. Common examples are the container classes: lists, queues, stacks, and so on. Templates make it convenient to declare two classes to represent lists of integers and lists of employees (assuming there is an employee class).

More important, the list template contains a single copy of the code for lists, simplifying maintenance and debugging. In contrast, Microsoft C7 provides a simple macro-preprocessor for achieving results similar to those of templates. By using a preprocessor, the Microsoft mechanism is more flexible, in that template arguments (e.g., integer and employee) can be used in preprocessor directives: This is because there are two preprocessor phases. However, this permits the development of code that is unlikely to be supported under future standardizations of templates.

Borland C++ 3.1 does not implement the exception mechanism that has been discussed by the ANSI X3J16 C++ standards committee. Microsoft C7, in a questionable implementation of the proposal, uses a simple `setjmp/longjmp` mechanism to modify the call stack when an exception arises. The problem with this is that destructors, which normally would have been called during procedure call returns, are not called as the stack is unwound. This can leave data structures in an ambiguous and volatile state.

Windows Message Handling

Language designers, as a rule, ignore I/O and other such "implementation details," as anyone who has ever internationalized a C program or handled I/O in Pascal can attest. C++ seems to be suffering a similar tale of woe in the area of GUIs. For example, one major motivation for the interest in applying object-oriented languages to the implementation of GUIs is the ability to have class-specific GUI event-handling (or message-handling) routines and to subclass by changing only a few event handlers. Sample events include mouse-clicks, window exposures, and window resize requests.

Unfortunately, because of the large number of events that must be handled, each class incurs the high space and time penalty of lookup in a large virtual-function table. Both Microsoft C7 and Borland C++ provide a way to work around this problem. Microsoft uses a clever macro

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scheme to define and implement a single message-handling routine using a sparse table. Borland provides the much simpler mechanism of annotating member function declarations with the set of messages that they will handle.

Unfortunately, this is a Borland-specific extension to the C++ language standard. Although this has enraged the language lawyers, it seems to me to be a fairly insignificant practical issue. Maybe some fear that Borland, like the proverbial 700-pound gorilla, will do whatever it wants with the language standard in the future (remember pre-Turbo Prolog?).

In addition, there are many more significant hurdles to portability: The Borland extension seems to be convertible to C7 with a simple script. Furthermore, the time spent in tying events to event handlers is minimal compared to the rest of the software development process—for example, in the X Window System toolkit, many such event "translations" can be defined by the user at run time.

Precompiled Headers

In Windows applications, which are built on deep hierarchies of type and class declarations, the unnecessary recompilation of "-h" header files is a significant overhead cost on each source file. Borland C++ 3.1 uses precompiled headers to speed recompilation, relying on the fact that declarations in header files typically change much more slowly than the corresponding definitions in source files. Headers are compiled automatically (based on a user-settable option) and recompiled when necessary. Borland does all the bookkeeping for you. Microsoft C7 requires specification of a file that contains the precompiled headers. Even though the headers may have changed, you can still use the old precompiled headers. Needless to say, this could be confusing.

Microsoft claims several other advantages in this area, which on second thought appear to be either rarely useful or achievable by other means (e.g., in-lining). Programmers may reserve the right to care about code generation and optimization, but they shouldn't have to care about how to optimize compilation at this low a level, and thus Borland's approach seems more workable. In fact, I hope that such techniques will evolve into incremental recompilation and linking, where a change to a single declaration in a header file will cause recompilation of only those functions that use that declaration (as in Lucid's Energize system for Unix C++ development).

Application Frameworks

Borland's OWL (ObjectWindows Library) provides a significantly abstracted object-oriented interface to the Windows API. There is little change from the 3.0 version of OWL. While Microsoft Foundation Classes are based directly on the structure of the existing Windows API, OWL provides building blocks such as built-in file and editor windows with automatic scrolling. If OWL is deep in some areas, then Microsoft Foundation Classes are broad.

Of course, the wonderful thing about class libraries is that one can compile and use the Microsoft Foundation Classes library within Borland C++. The Borland C++ 3.1 package also includes the Resource Workshop, an integrated tool for specifying the menus, dialog boxes, string constants, and bit maps that form the look and feel of an application, and for modifying these resources within an existing application. Also in the package are WinSight (an improvement on the Microsoft Software Development Kit's Spy program) for tracing Windows messages and displaying window hierarchies, and WinSpector (analogous to Microsoft's Dr. Watson) for trapping and analyzing UAEs (unrecoverable applications errors).

Borland continues to provide support for DOS developers. In addition, many developers will continue to build Windows applications under DOS, using either the DOS IDE or their favorite editors, make files, and the stand-alone Borland compiler. TurboVision complements OWL, providing an application framework for DOS. TurboVision provides classes to support development of event-driven, mouse-and-menu-based applications for DOS, including built-in editor windows and other modules. DOS overlay management, allowing the use of extended memory, is handled by VROOMM, as in previous versions of Borland C++.

Comparisons

There are many other differences between Borland C++ and its main competitor, Microsoft's C7. For example, Borland C++ has advantages in the area of using the power of C++ in DLLs: The OWL itself can be placed in a DLL and shared by several applications (offsetting the size of the library). Other compilers have advantages over the front-runners in 386 support, debugging, or optimization. These and other differences underscore the importance of head-to-head comparison on your project before choosing or switching among the many strong development environments out there, particularly if you have a large body of existing code that you need to work with.

Microsoft has some innovations in C7 (its first C++ compiler). But with several major releases over the past few years, Borland has been a consistent leader in innovation and ease of use in development environments. Borland C++ 3.1 continues this tradition. Its interface and ease of use make it the obvious choice for new C++ programmers, and its stability and portfolio of features make it a serious candidate for the experienced C++ programmer. ■

Othar Hansson is vice president of Heuristicrats Research, Inc., a software R&D firm in Berkeley, California. He received his Ph.D. in computer science from the University of California–Berkeley, and he has been a C++ user since 1986. He can be reached on BIX c/o "editors."

BYTE ACTION SUMMARY

- **WHAT BORLAND C++ 3.1 IS**
  The latest release of Borland's popular object-oriented development environment.
- **LIKES**
  Support for the Windows 3.1 API; integrated browsers and editors; ObjectWindows Library; extended Windows-hosted IDE functionality; and faster compilations.
- **DISLIKES**
  Borland deviates from the language standard in Windows message handling and fails to support exception handling.
- **RECOMMENDATIONS**
  Borland C++ 3.1's interface and ease of use make it the obvious choice for new C++ programmers; its stability and features make it a serious candidate for the experienced C++ programmer as well.
- **PRICE**
  $495
- **FOR MORE INFORMATION**
  Borland International, Inc.
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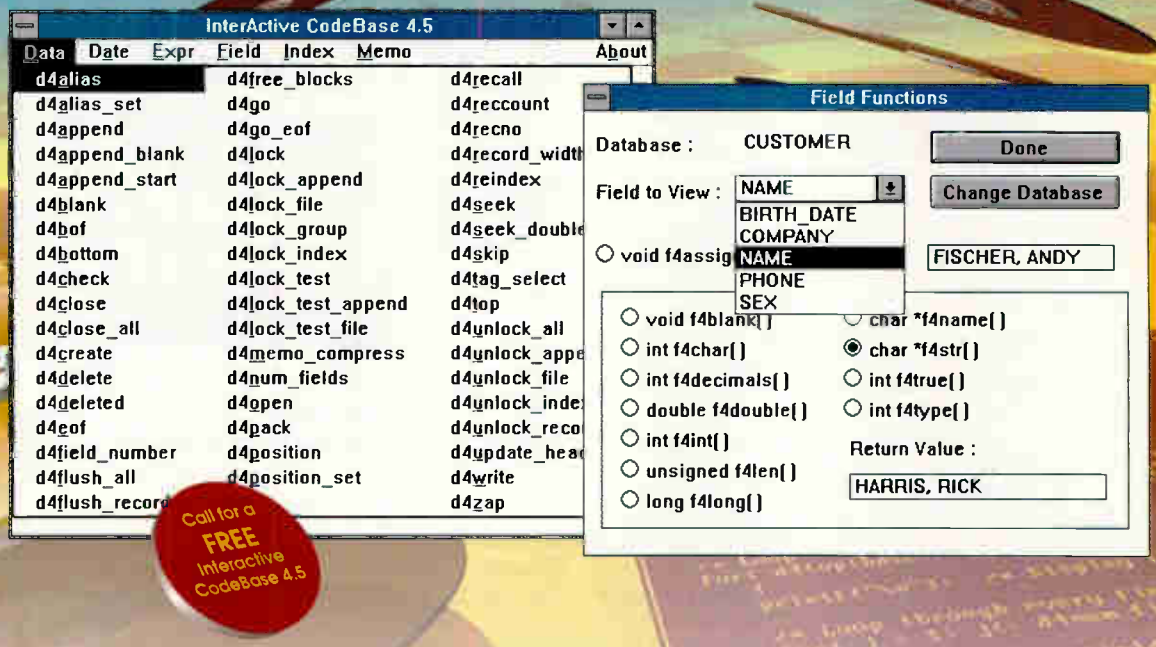

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APPLICATION

Sophisticated Graphing Under Windows

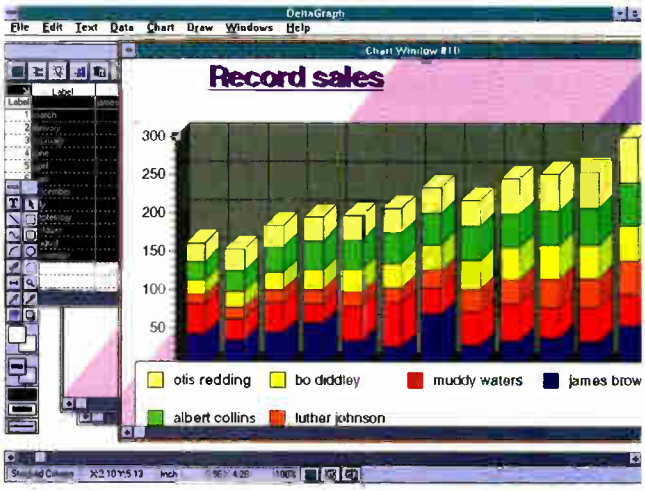
D. BARKER

If you think the charts drawn by your spreadsheet program look like something you'd find on the wall of a cave, then take a look at DeltaGraph Professional for Windows. DeltaPoint's program has been one of the finest technically oriented charting packages on the Macintosh. Now many, but not all, of these features are available to Windows users.

DeltaGraph can quickly turn a flat chart into a slick and colorful graphic suitable for presentation. The default charts are fairly mundane, but you can easily enhance them with depth, color tints, shadowed text and objects, gradients and shades, illustrations, logos, and slick backgrounds. The bar chart in screen 1, for example, took only minutes to create.

But this program is not just for people whose primary concern is snazzy visuals. Besides basic calculation functions that businesspeople need, DeltaGraph offers data analysis that can serve statisticians and others working in technical, number-intensive fields.

Nevertheless, the Windows product is not without flaws. I found it to be much slower than its Macintosh counterpart. Also, DeltaGraph for Windows had an annoying penchant for redrawing entire screens after I made only minor changes, which added even more time to the creation process. Overall, however, the package brings excellent charting capabilities to Windows users.



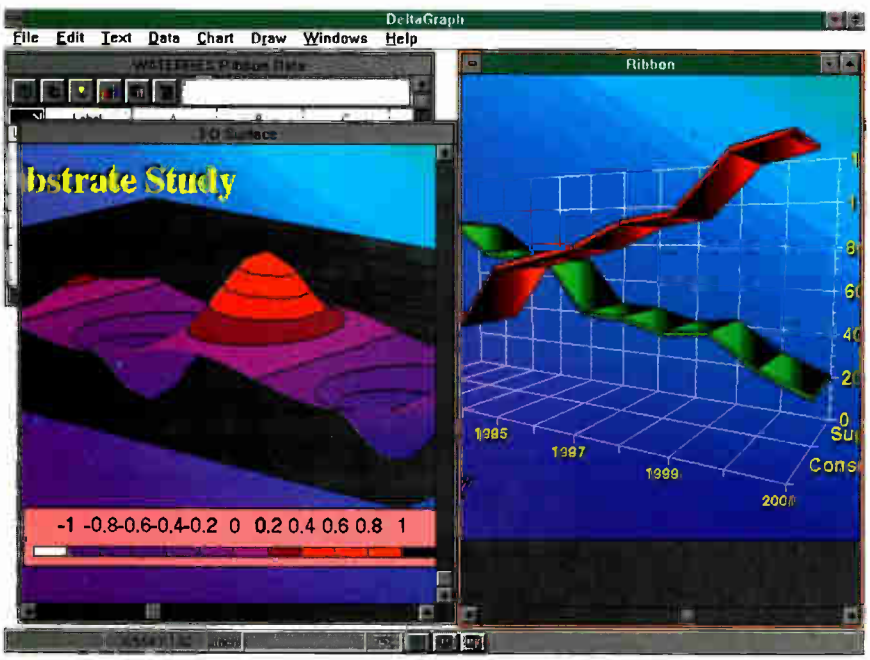
Screen 1: *It took only a few minutes to turn worksheet data into this 3-D stacked column chart. It's easy to change any of the elements, each of which is a separate object.*

The first thing that DeltaGraph Professional has over spreadsheets and presentation programs is a bigger collection of chart and graph types. Most of today's spreadsheets and slide-making programs can do 3-D charts, and a few, like Informix's Wingz and 3-D Visions Corp.'s Stanford Graphics, can do some technical-type graphs. But none has the range of options that DeltaGraph offers. (This could change with the arrival of Stanford Graphics 2.0, which wasn't yet shipping at the time of this review.)

The package comes with 40 basic chart types. These include 2-D standards like column, bar, and pie charts, in regular or stacked format; contour charts, with either two or three axes; text charts; tabular charts; and more esoteric types like bubble, spider, and triangle charts. For people in scientific and technical jobs, there are true x,y,z-coordinate charts, double-y and double-x charts, and a variety of 3-D formats, including wireframe, surface fill, ribbon, and scatterline charts (see screen 2). The program can also do curve fitting and error bars.

Getting data into DeltaGraph is easy. You can use the program's spreadsheet-like notebook window and type in the numbers yourself, or you can import numbers from another program. DeltaGraph can take in data from just about any application, including Lotus 1-2-3, Quattro Pro, and Excel, as well as common formats like dBase, DIF, SYLK, and delimited ASCII. Using DDE and OLE, you can link to other Windows programs (DeltaGraph can work as both an OLE client and server).

DeltaGraph can import just about any



Screen 2: *This 3-D surface graph and ribbon chart are examples of DeltaGraph's 40 different types of data graphics. The ribbon chart shows the program's shading capabilities.*

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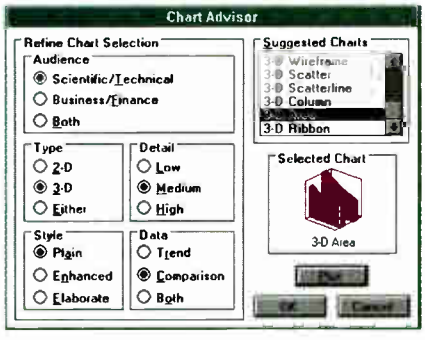
kind of common graphics file: EPS, TIFF, PICT, PCX, AutoCAD, HPGL (Hewlett-Packard Graphics Language), CGM, Windows metafiles, and Windows bit maps. Harvard Graphics charts can be brought directly into DeltaGraph. Similarly, DeltaGraph charts and objects can be exported in those formats. Everything won't necessarily look the same when opened up in another application, however; for example, HPGL does not handle perspective text.

The Windows version can swap files with the Mac version. You'll need a Mac with a SuperDrive to read the PC disks, or a network connection to ship files back and forth; I used both methods successfully. Only once did I hit a snag: A Mac file I brought in over the LAN was missing half its graphs. Somewhere between the Mac and the PC, four graphs disappeared. Otherwise, compatibility appears solid.

Want Some Advice?

After you've got the data into the notebook page, all you have to do is press the plot button and then pick the kind of chart you want. A preview of the chart shows up in a little window. By clicking on the names of different chart types, you can see what each looks like. If you're not confident that you can pick the best type of chart or graph, you can call on the Chart Advisor (see screen 3). This is a mini expert system designed to suggest the best graph according to the number of data points, whether the audience is "scientific/technical" or "business/finance," and whether you are trying to show a trend or comparison. The advisor makes reasonable suggestions; as with any advice, you can ignore it if you like.



Screen 3: *If you tell the Chart Advisor a few things about the kind of chart you want—target audience, for example—it will make suggestions.*

In DeltaGraph, every element of a chart or graph is a customizable object. In order to change the color of a bar, for example, you just select it, then call up the color palette and pick the color you want, and the change is made in the chart. The same goes for styling text, backgrounds, legends, labels, and so on. DeltaGraph's artistic capabilities are extensive—besides fancy gradient fills and color-mixing tools, the package incorporates basic Bézier drawing tools—so a person with good visual sense could use it to render very attractive data graphics.

Formulas and Functions

Besides its technical charts, DeltaGraph's calculation tools help it surpass programs like Aldus Persuasion and Harvard Graphics. If you need basic data analysis, like figuring the frequency of certain values, DeltaGraph has a component for building formulas. Working within a dialog box, you click on functions, such as Avg(), Diff(), and Freq(), select source columns, and pick operators by pushing buttons.

The program isn't meant to be a full-blown analysis package—it supports 50 data functions, compared to Microsoft Excel's more than 300—but it's got sufficient functionality to handle many types of mathematical and statistical problems. In fact, statisticians represent a prime target market thanks to the calculation capabilities and technical charts.

Good Variety of Output

DeltaGraph can send files to PostScript or GDI (Graphical Device Interface) printers, which covers just about any output device you're likely to want to use, including color laser printers, film recorders, and plotters.

You can also print a PostScript file to disk, so you could send it off to a service bureau for high-resolution printing.

A Funny Thing Happened on the Way to the PC

Despite its benefits, the Windows version of DeltaGraph isn't as good as its Mac counterpart. The most noticeable difference is speed. Generating a fairly typical graph—a 3-D stacked-column chart representing 12 months of sales for six recording artists (similar to the one in screen 1)—can take as much as 2 minutes on a 33-MHz 386. On a "comparable" Mac, the same job takes 13 seconds. In fact, the Mac version generally renders a chart in less than 10 seconds.

DeltaGraph for Windows' mania for redrawing is even more tiresome. If you make a change to a chart, the program usually redraws the whole thing, as well as anything visible in other windows. This isn't so bad with plain charts, but it gets tedious with complex graphics. The program first redraws the background, then the grid,

BYTE ACTION SUMMARY

- **WHAT DELTAGRAPH PROFESSIONAL FOR WINDOWS IS**
  A program for producing presentation-quality charts and graphs.
- **LIKES**
  Great-looking charts; wide variety of charts and graphs; ease of learning and use.
- **DISLIKES**
  Redrawing is tedious and much too frequent; performance is sometimes pokey.
- **REQUIREMENTS**
  Microsoft Windows 3.x, 2 MB of RAM, at least 5 MB of hard disk space (complete installation takes 22 MB), and EGA graphics at the least; a fast 386 or 486 is highly recommended.
- **RECOMMENDATIONS**
  If you're a Windows user and need to produce good-looking data graphics for presentations, buy DeltaGraph.
- **PRICE**
  $295
- **FOR MORE INFORMATION**
  DeltaPoint, Inc.
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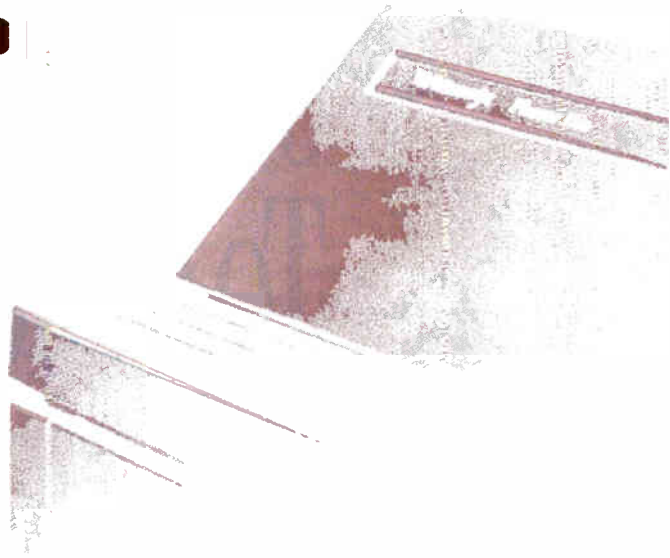

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MULTIMEDIA

Style Meets Substance in Matrox Studio

TOM YAGER

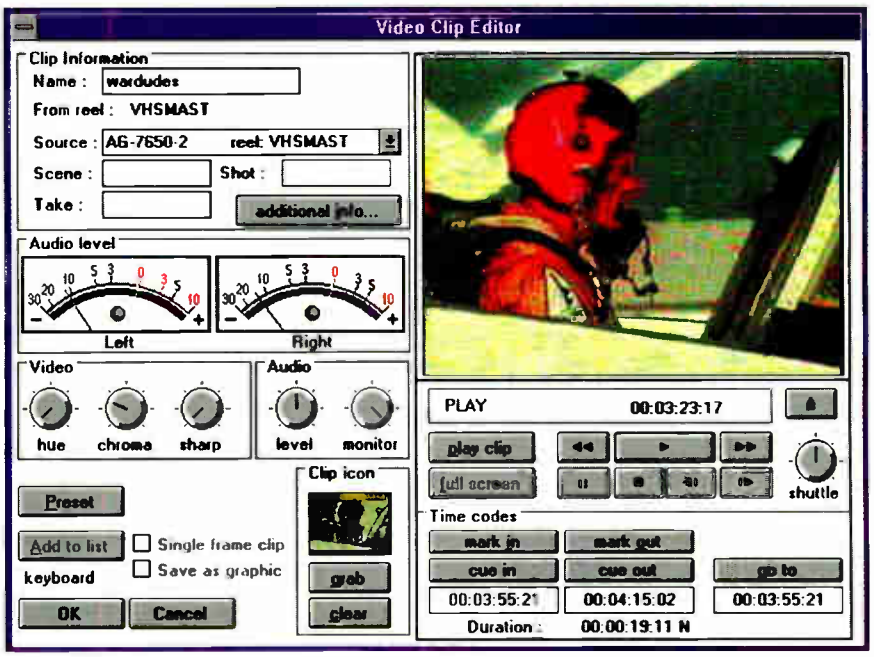
If anything typifies the business environment of the 1990s, it is that we all have more information to deal with and less time in which to deal with it. The same is true for our coworkers, managers, employees, and customers. In this rushed, competitive atmosphere, the *packaging* of ideas for efficient delivery is becoming as important as the ideas themselves.

There is no medium that combines the ideals of high information density, easy and inexpensive delivery, and image-enhancing power as well as video. One of multimedia's most exciting benefits is the spread of video capabilities from the exclusive domain of Madison Avenue types and pricey video production houses to the hands of general business users. Computers are speeding that movement by lowering costs and hiding the complexity of video technology.

A milestone was passed about two years ago when Newtek introduced the amazing Video Toaster (see "Newtek's Video Toaster Makes Professional Video Affordable," March 1991 BYTE). It established standards for value, output quality, and ease of use that stand today. Now, an exciting new product from Matrox Electronic Systems called Studio promises to raise these standards, putting professional video production power in the hands of corporate communicators, businesspeople, and all those whose livelihoods depend on having their ideas and products understood and adopted.

The abridged description of Studio calls it a PC-based video-editing system. What makes Studio unique is its incredible completeness. In one package come all the hardware, software, cables, and connectors you need to create your own professional-quality videos; all you have to add are VCRs. You can blend computer-generated graphics and titles with your video, add broadcast-quality digital video effects, and use the automated, computer-controlled audio mixer to manage the audio portion of your production. All this power comes together under an unintimidating Windows user interface; you can literally go from a blank screen to your first professional edit in 10 minutes.

I have to place some emphasis on the word *professional*. Studio's price tag of $14,000 may strike some as extravagant.



Studio's video clip editor. This interface lets you interactively mark a section of video and turn it into a "clip" that you then combine with other clips to create a finished video production. Every aspect of Studio's video and audio hardware is software-controllable, and much of that control comes together in this one densely packed but comfortable interface.

But anyone who has looked into the costs of the components of an in-house video production system knows that Studio, while no drop-dead bargain, is a good deal.

For $14,000, Studio gives you an eight-input video switcher with digital effects; a six-channel computer-controlled stereo audio mixer with DSP (digital signal processor) digital audio; a 32-bit frame buffer for computer graphics; three channels of time-base correction for video synchronization and quality enhancement; and VCR control for up to four decks. (Studio can be purchased in less expensive configurations, including a $9995 version without the audio mixer and time-base correction.) You needn't invest in costly additional components, and Studio doesn't require you to have the kind of expertise typically needed to purchase and set up a video production system from scratch. All you need is a little creativity and the desire to take control of your own presentations.

I tested Studio using a Media Resources/PC Craft 486-50 EISA system equipped with 8 MB of memory. I used two Panasonic AG-7650 Super-VHS playback decks as sources, one AG-7750 recorder, and a BT-M1310Y professional video monitor. I also used a Truevision ATVista graphics board and software from AT&T Graphics Software Labs to create some of the graphics and animation sequences used in these tests. Studio requires Windows 3.1; its drivers install under the Multimedia Extensions, and the editing software is a native Windows application.

Call 1-800-Cable-Me

Studio's hardware side consists of five PC boards (four ISA and one EISA), three of which are tied together with a rigid bus connector (see the photo). You'll also find an astonishingly complete collection of cables, connectors, and adapters. Having configured video systems with makeshift cables many times, I cannot overemphasize the value of having everything included, complete with labels.

Studio's video inputs are versatile. The cable set has four S-Video (most often associated with the higher-resolution Super-VHS and Hi-8 video formats) inputs. One or more of these can be converted, using

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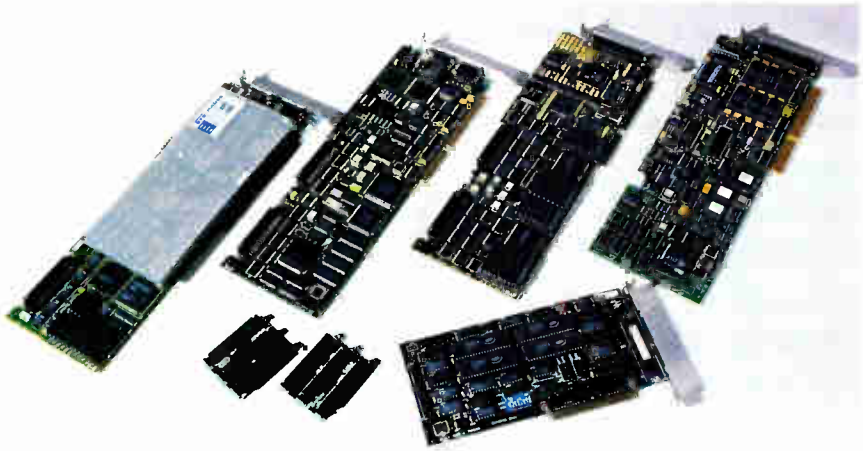

Studio's hardware consists of five boards (four ISA and one EISA). The first three (working from left to right) handle video, and they communicate with each other via a set of bus sockets along the top of the boards. The fourth is the DSP-based audio processing board. The smaller board below the others is the four-port RS-422 VCR controller.

supplied adapters, to transform a single S-Video connection into two composite video connections. In that way, Studio supports four to eight inputs; you can mix S-Video and composite inputs however you like. It's most beneficial to use S-Video inputs for those devices that support it and to run your entire system on S-Video if possible, since that improves the overall quality. Four external S-Video sources are enough for the most demanding projects.

The VCR control runs through a four-port RS-422 serial card. You don't have the option of using a camcorder or an inexpensive consumer deck; Studio requires high-quality editing decks, but with the cost of this gear declining, it's hardly a heavy burden. Besides, you wouldn't want to hobble Studio with consumer video equipment; you can only expect professional results if *all* your components measure up.

Studio's Triplecast

Studio takes advantage of brand-new application-specific-IC technology, developed at Matrox, Philips, and elsewhere, to create something that's never existed in a PC before. This technology gives you three independent channels of video that you can combine virtually any way you like. You can switch any of the eight video inputs into this three-channel virtual bus, and you can also use Studio's internal graphics frame buffer as a video source.

Obviously, you can't just throw three video signals onto a screen at once. Each channel has its own digital processing unit. Each unit operates independently of the others, contributing to your output in the way you define. Video can be resized in real time. Making video smaller creates window or picture-in-picture effects, while making video larger than full-screen creates a zoom effect. A video channel can be positioned anywhere, regardless of its size—even completely off the screen.

To get to the screen, the video must pass through Studio's effects unit. This decides which of the three channels actually shows on the screen, and how. For transition between two full-screen video sources, you can wipe, dissolve, or slide one source over another. Video windows can be transitioned in and out without disturbing the underlying video. Among the most intriguing of the effects are those that apply the digital keyer.

Studio's keyer lets you "stack" video channels, with the content of the image in selected channels determining what the output will look like. For a simple example, let's say you wanted to add a quick title to some video. You'd create a simple title graphic: white characters on a black background. You would then switch Studio's keyer into luminance (brightness) mode. A luminance keyer analyzes a video signal and turns everything within a certain brightness range transparent. With a little adjusting, the black background would become transparent, leaving the white title characters in the foreground, "floating" above the video underneath. You just created a video overlay.

If you wanted to use a graphic that had more color, you might use Studio's chroma (color) keyer. This lets you choose a range of colors (instead of brightnesses) that will become transparent. Alpha keying works with still graphics created in software that uses Studio's 8-bit alpha channel. This allows portions of a still image to take on any of 255 degrees of transparency, from opaque to filmy to invisible.

Studio's Ultimatte key mode uses the blue component of a graphic to determine transparency, useful for creating semi-transparent graphical effects in software that doesn't support the alpha channel. While I used still images as examples, most of Studio's key modes can be used with moving video as well.

Finally, a quick note or two on the audio board (referred to as the Virtuoso board).

continued

BYTE ACTION SUMMARY

WHAT MATROX STUDIO IS
A combination of PC hardware and Windows software for professional-quality video editing.

LIKES
Includes everything but the video decks and monitors; comfortable interface; ingeniously versatile hardware design.

DISLIKES
The keyframer used for nontransitional video effects should be easier to use and more automatic.

RECOMMENDATIONS
A well-engineered, well-executed video-editing package. It gets my whole-hearted recommendation for those who do their own video production and who care about the quality of the results.

PRICE
$14,000

FOR MORE INFORMATION
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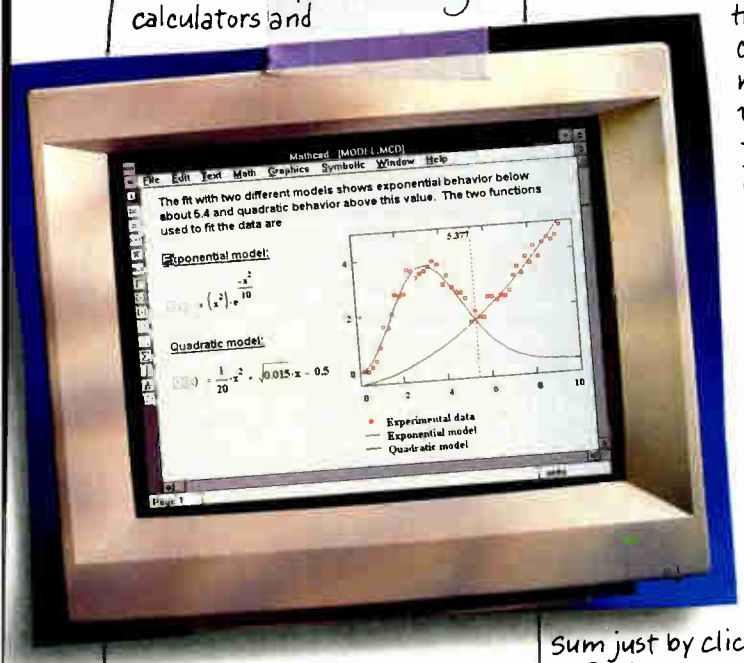

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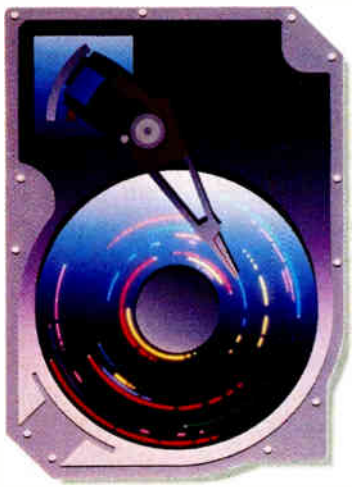

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It's an MPC-compliant board, capable of digitizing and playing back audio at up to 44.1 kHz in 16-bit stereo. It also has an on-board music synthesizer and supports external MIDI devices. Virtuoso's mixer controls up to six stereo audio sources, with volume, balance, bass, and treble controls for each channel. Matrox used a general-purpose DSP, which will later bring digital audio effects to Studio.

The Soft Side

For all Studio can do, Matrox's programmers have done a marvelous job of wrapping that complexity in a friendly but not condescending application.

The main interface is the now-familiar collection/storyboard combo. Video segments, graphical images, and digital audio files are organized into "clips" and added to a collection by built-in Studio tools. The video clip editor (see the screen) puts up a comfortable interface on your VGA monitor that includes VCR controls, video and audio adjustment controls, audio VU (volume unit) meters, and a live video window. Creating a video clip is as simple as using the graphical VCR controls to find the segment you want and marking its beginning and end. Studio digitizes a frame of the video and turns it into an icon, displaying it in the collection.

Once you have clips in your collection, you create your video by dragging and dropping the clips onto the storyboard's time line. A graphic depicts the start, end, and duration of each clip. There are separate time lines for graphics, audio, and multiple video channels. Two special time lines—Audio M/E (mix/effects) and Video M/E—are automatically filled in as you drop clips onto the storyboard. You double-click on the icons on the M/E lines to change the default audio or video mixing. In the case of video, it's the Video M/E time line that controls the type and duration of transitional effects and determines which video channels get displayed.

You can take minute control over each video channel's processing unit through Studio's keyframe effects. These allow you to set starting and ending attributes and then have the software interpolate between them automatically. You could, for example, have a one-quarter-screen video window appear and then gradually grow to occupy the entire screen. You would only have to set keyframes for the size and position of the one-quarter-screen window and the full screen that followed it. Studio would determine the intermediate size and position changes needed to make the window grow as you requested.

The only unpleasant part of Studio for me was that the keyframe effects weren't more automated. For example, you can create the effect of a video frame tumbling end-over-end into oblivion by using the keyframer, but it's an ordeal. A library of common keyframe effects, along with the ability to load and save new ones (a feature presently lacking), needs to be added.

At any point in the process, you can ask Studio to preview a portion of your storyboard. In fact, Studio is loaded with "preview" buttons so you can see how your choices will affect your finished video long before you commit them to tape. When you are ready to record, Studio lets you send either the entire storyboard or a selected portion of it to your recorder. If your production calls for tape changes, Studio will prompt you for them as needed. This means that you can get more mileage out of the equipment you have: Two source decks, with media changes, can serve the purpose of three or more.

Rewind and Eject

Studio is not the Video Toaster killer some might have been expecting. The Toaster still has the advantage of being usable in a live environment; Studio (its software, that is) can only deal with videotape and still images. The Toaster also includes 3-D animation, and its library of transitional effects is much larger than Studio's.

On the other hand, Studio has some things the Toaster doesn't: S-Video input and output, built-in time-base correctors, audio processing, VCR control, editing software, and video scaling top the list. Some of these can be added to the Toaster at no small cost (about $9000). Prior to Studio's introduction, I did just that, and I'm very pleased with the results. Studio does not obsolete the Toaster; in the BYTE Multimedia Lab, they complement each other nicely. But of the two, Studio is clearly the better *editing* system, requiring less external gear, fewer connections, and fewer steps to a finished video.

If you're serious about doing your own video production, and you care about the quality of the results, Matrox Studio stands out as a well-engineered, well-executed video-editing solution. Software vendors are seeing this, too, since graphics packages like AT&T Graphics Software Labs' Topas and Rio and Autodesk's 3D Studio are being updated to include Studio support. I have no trouble giving Studio my most enthusiastic recommendation. ■

Tom Yager is director of the BYTE Multimedia Lab and author of The Multimedia Producer's Handbook *(Academic Press, forthcoming). He can be reached on BIX as "tyager" and on the Internet at tyager@bytepb.byte.com.*

World Radio History

APPLICATION

LANlord Evicts LAN Problems

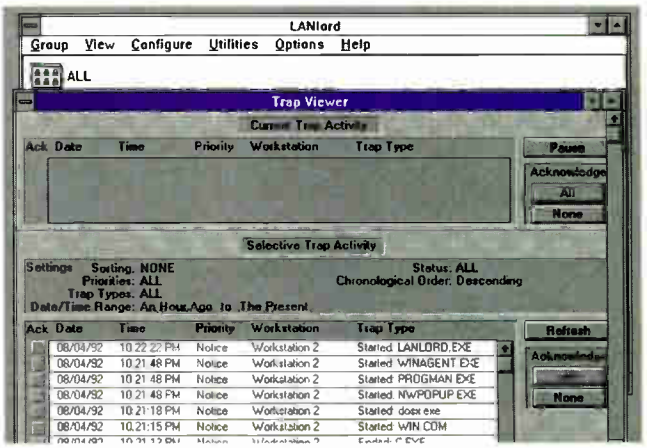
BARRY NANCE

LAN administrators sometimes need to handle problems that require knowing more than just the contents or destination of packets flying over the wire. Application-layer management involves topics that are so high-level they hardly seem to involve the network at all: tracking workstation hardware configuration, determining how many (or which) users are running a certain limited-license application, and making changes to system and Windows configuration files at selected workstations, to name a few.

All of these are tasks that can best be carried out by an administrator working from a central management console—the same network administrator who handles low-level cable management. But while there are a host of management packages that will give you all the physical-layer information you require, there are relatively few that provide the high-level (i.e., transport layer through application layer) data required for configuration and asset management.

Microcom's LANlord 1.0 is the newest of these packages for NetWare 2.15, 2.2, and 3.11 LANs, and it's probably the most complete. In a single bundle, it gives you a software-metering module, a workstation-hardware-inventory module, a program-activity module, an alert-generating module, an alert-viewing module, and a remote-configuration module. In addition, Microcom promises to send you a virus detection and repair utility when you send in your registration card.

LANlord provides critical information, central management, and remote-editing capabilities, but unfortunately not without a little pain along the way. There are numerous configuration requirements and restrictions that make LANlord more difficult and less complete than such a package needs to be.



LANlord's Trap Viewer (Alert display) is part of the Windows-based LANlord Manager, LANlord's primary user interface.

LANlord Architecture

LANlord is a client/server design. The server is an OS/2 machine that maintains a MIB (management information base) of over 200 objects detailing configuration and software-use information for each of its network clients. If the OS/2 server has to manage fewer than 20 or 30 clients and has enough horsepower, the LANlord server module can run as a nondedicated task under OS/2. However, the OS/2 machine must be dedicated to LANlord on busy networks.

The server's clients are LANlord agents that run on DOS and Windows PCs. These agents are the components that determine hardware configurations and monitor software usage. Clients communicate configuration information to the LANlord server at timed intervals over SNMP protocols.

The last component is the administrative module (LANlord Manager), which can run on any Windows 3.0a client on the network (see the screen). LANlord Manager is the administrator's "front end" to the LANlord server; it's where the administrator can monitor configuration information or perform administrative tasks.

Because of LANlord's structure, you need an interesting mix of hardware and software to get it up and running. The server requires a system running OS/2 1.21 or higher (I used OS/2 2.0). At least one workstation must run Windows 3.0a or higher (I used version 3.1). DOS workstations that you want to monitor must run a 19-KB agent TSR program, and Windows clients must also run a WinAgent program for monitoring Windows activity.

What LANlord Can Do

LANlord can track software usage, maintain an inventory of installed hardware and software, and give the administrator remote access to configuration files on each workstation. You access all these capabilities through LANlord Manager at your Windows management console; the information you work with is constantly updated by the clients in real time.

Software tracking meters software for licensing purposes and maintains a history of program usage for each workstation. After you tell LANlord about the software licenses in effect for your site, LANlord monitors the number of concurrent users of that software. You give LANlord the title of the software, the drive letter and path, the number of licenses, and the time interval (in minutes) LANlord should use for recording concurrent access. LANlord generates an alert when someone on the LAN exceeds the license limit. If you don't specify the drive letter and path, LANlord tracks the usage of all copies of the specified application.

Besides showing usage statistics in numeric form, LANlord can display a graph of software usage. You can see at a glance if you need to buy additional licenses or, conversely, if you've bought software that no one uses. LANlord also shows the network administrator a history of programs run on each workstation. You can see this information for all workstations (sorted by workstation or by application) or for a single workstation; you can also specify a single application to keep track of where and when that application has been run.

LANlord's detection of installed hardware and software is thorough and provides useful information. You get the sort of information at the management console that you would see if you ran a utility such as Norton's SysInfo at the workstation. A Summary screen shows the workstation's basic hardware configuration. A Volumes screen gives information about the workstation's hard drives. The System Files screen lets you view configuration files. The Versions screen tells you whether the workstation's DOS and network software are up to date. You also get detailed

World Radio History

pictures of Windows activity (if appropriate), memory utilization, DOS open files and environment information, adapters (including I/O-port, interrupt-request, and DMA-channel assignments), and IPX/SPX network statistics.

Finally, the administrator can remotely edit a workstation's AUTOEXEC.BAT, CONFIG.SYS, WIN.INI, SYSTEM.INI, and SHELL.CFG files. In addition, the administrator can, at his or her discretion, reboot the workstation after making these changes.

Alerts

LANlord provides configuration and usage information whenever you ask for it, but it can also generate alerts when certain conditions occur. A LANlord alert (Microcom calls them traps) can be critical, a warning, or just a notice. You can customize the category of each event and the color scheme LANlord uses for each category.

Alerts include a workstation joining or leaving the LAN, an unknown or incorrect workstation ID, a change in a workstation's configuration files, a workstation accessing a particular file, a workstation exceeding software license limits, the execution of a particular program, a user signaling for help, the detection of a virus, or the exceeding of a threshold you've set for that workstation. You can set threshold limits on quantities, including free disk space; available Windows GDI (graphics device interface) Heap or User Heap; or IPX or SPX errors.

LANlord in Action

Installing LANlord can be quick and easy if you already have OS/2 and Windows workstations on your LAN. As you set up LANlord, you can assign workstations to various logical groups; these groups may match the network's physical layout (e.g., the third-floor group) or more intangible organizational quantities (e.g., authorized Excel users). You can establish different monitoring parameters for each LANlord group.

I exercised LANlord on my LAN at home and at the office. Both networks are NetWare 3.11 environments with a mix of OS/2, pure DOS, and DOS-and-Windows workstations—both perfect matches for LANlord. I put all my applications, even shareware registrations, under the scrutiny of LANlord's software metering. I was able to verify over the course of several days that I'm not using unlicensed software. Before I updated the licensed-software list, LANlord dutifully alerted me to the supposed transgressions as I used each unlisted software product.

I found the hardware and software inventory supplied by LANlord complete and accurate. LANlord supplies a wealth of information, including even such things as CMOS configuration. I kept a log to check LANlord's program-monitoring functions; LANlord's history of programs run at each workstation echoed my handwritten list exactly. I also found LANlord's remote configuration and alert features very convenient.

Early Quirks

This is LANlord's initial release; the first version of any software product is bound to suffer from restrictions and limitations that disappear in later versions. But LANlord imposes some restrictions on your LAN that you may not be willing to live with. To Microcom's credit, the developers know about these drawbacks; the README file mentions many of them.

LANlord uses a SAP (service access point) provided by the Novell OS/2 NetWare Requester. The current OS/2 NetWare Requester doesn't support multiple SAPs, so you can't run any other SAP application on your LANlord server. In particular, the OS/2 machine can't be both a named pipes server and a LANlord server. If you have an intelligent hub, bridge, or router on your network that filters NetWare SAP packets, the LANlord packets will fall into the bit bucket. You need to configure such devices to pass NetWare SAP packets, if the device can be so configured.

Microcom says LANlord may fail in the presence of Novell's NMS (Network Management System). The problem seems to be one of misdirected packets between the two management systems. Microcom also says it is working closely with Novell to fix the incompatibility.

Restrictions aren't limited to the LANlord server. The workstation on which you run LANlord Manager needs at least 8 MB of RAM. You can't run SHARE.EXE on a 286 DOS workstation and also run LANlord Manager on that workstation. Unfortunately, SHARE enables file sharing on a LAN, and many applications, such as Paradox for Windows, require that SHARE be loaded.

Agents, too, show a few quirks. The agent TSR program sometimes fails to respond to server requests when enhanced-mode Windows is running on top of the agent TSR and a DOS session is active. And the LANlord Windows Agent, which monitors Windows program activity, runs in standard or enhanced mode but not in real mode.

LANlord loads agent functions into memory from the disk as necessary to keep the size of the resident agent down to about 19 KB. Floppy drive–based computers will feel the slowdown as agent functions swap in and out of RAM. Finally, LANlord agents are compatible with the EMM386.EXE memory manager that comes with DOS 5.0, but not with the version of EMM386.EXE shipped with Windows.

The LANlord Verdict

I found that LANlord did a good job of living up to its promise. The information it displays makes network configuration and control easy. Basically, LANlord keeps a network administrator from having to continually walk around the office fixing things, noting workstation hardware and software configurations, and watching who runs what software.

I recommend LANlord for medium and

BYTE ACTION SUMMARY

WHAT LANLORD 1.0 DOES
It monitors high-level NetWare LAN usage, keeping track of configuration and application program use of DOS and Windows clients.

LIKES
LANlord is a useful collection of networking tools and a good complement to low-level protocol monitoring tools.

DISLIKES
LANlord requires both OS/2 and Windows and has restrictive requirements on network software configuration. It lacks support for OS/2 and Mac clients.

RECOMMENDATIONS
LANlord is a good investment for configuration management if your network matches LANlord's requirements.

PRICE
One to 10 users, $999
101 to 250 users, $8999
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FOR MORE INFORMATION
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LANLORD EVICTS LAN PROBLEMS

large LANs whose hardware and software configuration is already close to what LANlord needs to run. You can compare the cost of LANlord, at about $100 per node, with the cost of a network administrator's time spent walking around the office; LANlord will pay for itself over the course of a few months if you have an active administrator.

I'd like to see LANlord expanded or included in a more complete network management tool.

There are a few gaps, however: Since an OS/2 system is required for the server, I wondered why the developers decided to release the product with a Windows interface. For LANlord, a Presentation Manager interface would make more sense. Macintosh and OS/2 agents will be a welcome addition in a future version of LANlord. And I'd like to see LANlord incorporate a software-distribution facility to help manage the dissemination of new files and updates.

Most critically, LANlord is only a partial solution; I'd like to see it expanded or included in a more complete network management tool. If LANlord included lower-layer diagnostics as well as the top-layer features, I'd buy it in a heartbeat. As it is, I'm currently extending the functionality of our homegrown management solution to include a wider range of monitors—from Token Ring beacon detection to available server disk space—because my office needs soup-to-nuts tools. I could buy LANlord, Madge's Ring Manager, and maybe another product, but, considering all the licenses, the complete solution is just too expensive. ■

Barry Nance, a programmer for the past 20 years and a BYTE contributing editor, is the author of Using OS/2 2 *(Que, 1992),* Network Programming in C *(Que, 1990), and* Introduction to Networking *(Que, 1992). He is the editor for the IBM Exchange on BIX, where you can reach him as "barryn."*

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HARDWARE

Network Modems Dial in, Dial out, and Route Packets

STEVE APIKI, TOM THOMPSON, AND JON UDELL

A modem is a modem, but a shared network modem is more like three devices in one: It can act as a connection point for remote users who need LAN access, a shareable resource for LAN clients that need to reach dial-up services, or a LAN-to-LAN router.

In merging these three functions, the network modem combines many capabilities of communications servers and routers into a single, easily configured box. Naturally, a network modem won't replace a dedicated router or communication server; what you gain in ease of setup and configurability you'll pay for in power and scalability. But for many smaller businesses, or workgroups within large organizations, a network modem provides an attractive, all-around solution to dial-up communications requirements.

In this review, we'll look at two LAN-based modems, the Microtest Lanmodem and the Shiva NetModem/E (see photos 1 and 2). Both are high-speed V.32bis modems that connect directly to Ethernet networks. Both will carry out all the tasks listed above, but the NetModem/E runs both AppleTalk and NetWare protocols, while the Lanmodem works exclusively on NetWare LANs.

On the Wire

Network modems sit directly on the wire, communicating with clients via LAN protocols. Both of the devices we tested are designed for Ethernet connections, but Microtest and Shiva offer versions for other physical topologies, including Token Ring and LocalTalk.

The Lanmodem is a dedicated NetWare device—it communicates via SPX/IPX, requires a NetWare server to maintain its boot files, and routes NetWare packets. The more versatile NetModem/E runs on both NetWare and AppleTalk LANs and in mixed-network installations.

Both the Lanmodem and NetModem/E are V.32bis modems, handling communication rates of up to 14.4 Kbps. Both support V.42 error correction and V.42bis data compression, which can yield speed gains of up to 4 to 1 when communicating with other V.42bis modems. The Lanmodem also includes a serial port to which you can connect a second modem for sharing on the network.

These products provide dial-out and dial-in capability through client software bundled with each product. Dial-out client software takes three forms, depending on environment. Under DOS, it consists of an INT14 or other standard communications protocol redirector. Windows clients get a new communications driver that replaces COMM.DRV. Finally, Macintosh clients get a communications driver that can be activated through the Chooser. Dial-in software is similarly dependent on environment, but in every case each remote client requires some software in order to connect to the host LAN.

In addition to the dial-in and dial-out utilities, the Lanmodem and NetModem/E also provide software for administering configuration and security. Typically, these utilities let administrators assign access permissions and configure the modems for LAN-to-LAN connection. One nice feature that both modems support is dial-back, which provides an extra level of security and the convenience of billing your office directly for the connect charges you accrue while working at home.

Microtest Lanmodem

Lanmodem's Novell-only orientation restricts the networks on which it can be installed, but it makes setup, administration, and use conceptually simple. However, the eccentricities of the user interface common to all the Lanmodem's utilities can cause a little frustration.

Once the Lanmodem is running, the network administrator sets up communication parameters and user-access privileges. You can set configurations for both

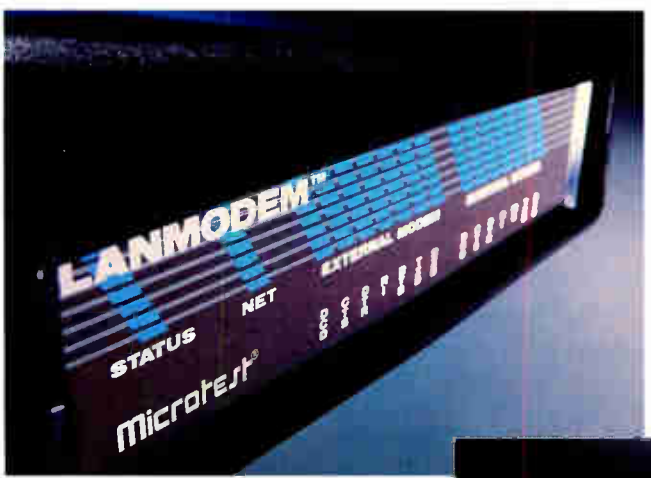

Photo 1: *The Lanmodem displays a full set of status lights for both internal and external modems if you've connected an external unit to its serial port. On the back, the Lanmodem has ports for thin-wire, AUI, and 10Base-T Ethernet.*

Photo 2: *Shiva's NetModem/E supports AppleTalk and NetWare LANs and has modules for connecting to different types of Ethernet networks.*

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A Message To Our Subscribers

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internal and external modems, if an external modem is connected to the serial port. External and internal modems are completely independent, so you can make one available for dial-in and the other available for dial-out, if you wish. You set user-access parameters (e.g., dial-in, dial-out, and dial-back) by checking a box for each NetWare user or NetWare group. Because Lanmodem reads the NetWare bindery directly, you don't have to key in any user names or maintain another group of users—a handy administrative feature.

All the tools for Lanmodem, both administrative and user, run under a GUI created using Zinc Software's interface library. Microtest's GUI was a little hard to work with, because it doesn't quite follow familiar Windows and Mac conventions.

Dialing out with the Lanmodem provided stable, reliable connections, and at 9600 bps it was hard to tell we were using a redirected modem at all. As with all network communications devices, you need to load a DOS redirector in order to access the Lanmodem. You also need a communications program (e.g., the networked version of Procomm Plus) that supports INT14 or NASI (Novell Asynchronous Services Interface) redirectors. Dial-out communications seemed a little hard to use at first, as the documentation didn't make it clear that you could load the redirector without running the graphical shell. However, Microtest's knowledgeable technical-support staff set us straight, and we were able to include loading and unloading the redirector in a batch file that launched Procomm Plus.

On the other hand, dial-in access to NetWare could hardly be easier. Microtest provides a dial-in package called FastLink that includes a full remote IPX stack. When you launch FastLink, it dials up the host you specify in a configuration file. Once the modems negotiate a connection, FastLink loads a packet driver, IPX, and NETX (a total of 69 KB), leaving you at a DOS prompt attached to a remote server—just as if you had loaded a local shell. Note that the packet driver you get with Lanmodem is not generic; you can't run other protocols (e.g., TCP/IP—we tried) through FastLink's packet driver. The only connection problems we had during dial-in were when using the dial-back feature, and those we solved by tweaking remote modem parameters.

When connecting with 2400-bps modems, we found dial-in access was just too slow to be practical. However, connections of 9600 bps and up were perfectly reasonable and gave a pretty good illusion of local access. That illusion dissolves the instant you try to run a remote program, which requires loading the entire executable file into memory across the wire. FastLink traps remote execution attempts and asks you whether you want to continue or whether FastLink should instead download the file to a local disk for faster future access. FastLink also handles unexpected disconnects, attempting to redial lost connections.

With dial-in, you cannot be a client on both the remote LAN and the local LAN simultaneously. For that kind of access, you need to configure Lanmodem as a router. In its routing mode, Lanmodem routes IPX packets from the local LAN to another Lanmodem or Novell Asynchronous Router on a second network.

continued

BYTE ACTION SUMMARY

- **WHAT NETWORK MODEMS DO**
  They provide a dial-in LAN connection for remote users, a shared dial-out resource for LAN clients, and an asynchronous LAN-to-LAN connection.
- **LIKES**
  Mixed network support of NetModem/E; tight NetWare integration and additional serial port on Lanmodem.
- **DISLIKES**
  Lanmodem's user interface; some difficulty making high-speed connections with both products.
- **RECOMMENDATIONS**
  For mixed-LAN and AppleTalk support, the NetModem/E is your only choice; NetWare-only shops should choose the Lanmodem.
- **PRICE**
  Microtest Lanmodem, $1995
  Shiva NetModem/E, $1699
- **FOR MORE INFORMATION**
  Microtest, Inc.
  4747 North 22nd St.
  Phoenix, AZ 85016
  (800) 526-9675
  (602) 957-6400
  fax: (602) 971-6963
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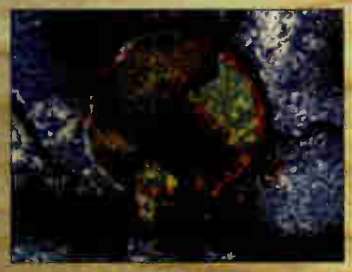

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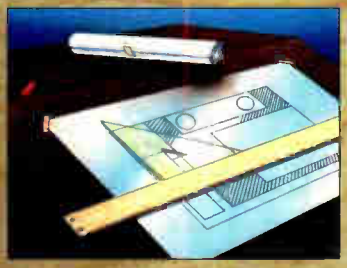

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Every client on one LAN then has access to resources on the other, given sufficient NetWare access rights. We tested out the Lanmodem routing between our LAN and Microtest's demonstration network, which ran a second Lanmodem router. The connection was very quick, robust, and easy to set up.

Shiva NetModem/E

The NetModem/E offers connection services to both AppleTalk and NetWare LANs. Mac users can run NetModem/E software on System 6.x and System 7.0 Macs. As with the Lanmodem, you can use the NetModem/E for 14.4-Kbps dial-out, dial-in, or routing.

For Mac dial-out, you use the Shiva Config Control Panel to select what serial port (either modem or printer) gets redirected via the AppleTalk driver to the NetModem/E. You also set time-out intervals here; if no I/O activity takes place on the redirected port for a certain amount of time, the software automatically disconnects the modem. This is handy for occasions when you might leave the Mac unattended during a lengthy download, yet you want the long-distance connection broken after the transfer completes.

You select the NetModem/E from the Chooser, as you would with printers or file servers. One nice interface feature: If the selected NetModem/E is being used by another user—whether it's a Mac or a Windows PC—you get an alert that tells you who's tying it up. You can opt to cancel the connection attempt or try to connect later. In the latter case, you'll get another alert when the NetModem/E becomes available.

You can dial out from a NetWare LAN using either a DOS INT14 redirector or a Windows COMM.DRV replacement. Shiva provides a Mac-like "Chooser" for Windows and DOS that scans for NetModem/E units and pools and attaches them to COM ports. As in the Mac version, a simulated modem display appears onscreen when you launch a communications program. Under DOS we ran the INT14 version of Procomm, and under Windows we used Terminal and Dynacomm. The modem display, naturally, is much nicer in Windows than in DOS. Yet Shiva's trademark digitized modem sounds work only in DOS—oddly, there's no sound support for Windows.

The NetModem/E administrator can establish a list of authorized users but must manually synchronize that list with NetWare and AppleShare servers. We used the NetModem/E to call a variety of services from both DOS and Windows at speeds up to its peak 14.4 Kbps.

Dial-in also supports remote Mac and PC clients. From a Mac, you make a remote connection by double-clicking on an icon in the Network Control Panel. You can also set up dial-in names, phone numbers, and baud rates. Once connected, you appear as a node on the remote network. PowerBook users will recognize this as the same capability provided by Apple's AppleTalk Remote Access software. While ARA comes bundled with PowerBooks, it isn't provided with desktop Macs, so Shiva's Dial-In Access software will be handy for those connecting from home desktop Macs to the office network.

We tested Dial-In Access from a PowerBook 170 using a Global Village PowerPort/Gold 14.4-Kbps modem. We were able to make reliable connections only at 9600 bps. Dial-In Access doesn't use Apple's CCL (Command Connection Language) files. CCL files let you select a

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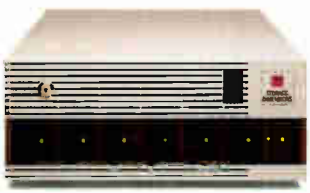

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modem by name instead of dealing with AT commands and S-register settings. Shiva's LanRover/L uses CCL files, but Dial-In Access users must use a Shiva application to configure new modems; we had to do this for the PowerPort/Gold.

For dial-in access to NetWare LANs, Shiva provides an ODI (Open Data-link Interface) driver that sends Ethernet packets from your remote PC through a phone line to a NetModem/E sitting on the LAN. You build connection scripts interactively or by editing the sample Shiva provides. Once connected, you load the NetWare shell (IPX and NETX) and log in. You can just call the NetModem/E or arrange to have it turn around and call you back.

You can, and should, also load the optional LaunchGuard TSR program. Like Microtest's FastLink, LaunchGuard keeps you from accidentally running remote programs. The idea, of course, is to maintain copies of all your programs on the remote PC and use the asynchronous connection to link those programs to LAN-resident data and services. This setup is perfect for client/server applications like Shiva's own ShivaNet Manager.

However, even with LaunchGuard you can find yourself in an unintentional file transfer. When we fired up the Epsilon text editor from the C drive, for instance, it began loading the first copy of its 70-KB configuration file that it found on the path—which happened to be on the remote network. Fortunately, Shiva provides an escape mechanism—Ctrl-Alt-E—so you don't have to wait out the transfer or reboot.

Dial-in and dial-out are nifty features, but network-to-network routing is simply stunning. Using ShivaNet Manager, we told the NetModem/E on BYTE's LAN to call its counterpart on Shiva's technical-support LAN. Once IPX routing was under way, we could fire up File Manager and literally drag files between Cambridge, Massachusetts, and Peterborough, New Hampshire. With matched NetModem/E's in the circuit, transfers were really fast. After breaking down the connection, we repeated the same experiment from a Mac. The NetModem/E obligingly set up AppleTalk routing between the two LANs. It worked so seamlessly that we dialed out to MCI using another NetModem/E attached to the remote LAN. (Don't worry, Shiva, we used MCI's 800 number.)

Excellent Choices

Network modems are excellent choices for smaller networks that don't require a full-fledged router or communications server. The most significant problems we had with both the Lanmodem and NetModem/E were in configuring remote modems for consistently negotiating high-speed connections.

Selecting between the two will depend mainly on your network. The Lanmodem is more expensive than the NetModem, but it offers a second port for easy expansion. If you run AppleTalk or a mixed environment, the NetModem/E is your only option. For NetWare-only LANs, the NetModem/E is also a good choice, but we found that the Lanmodem's tight integration with NetWare made it easier to work with, despite its quirky interface. ■

Steve Apiki is a BYTE technical editor, and Tom Thompson and Jon Udell are BYTE senior technical editors at large. You can contact them on BIX as "apiki," "tom_thompson," and "judell," or on the Internet at apiki@byteph.byte.com, tomt@byteph.byte.com, and judell@bytepb.byte.com, respectively.

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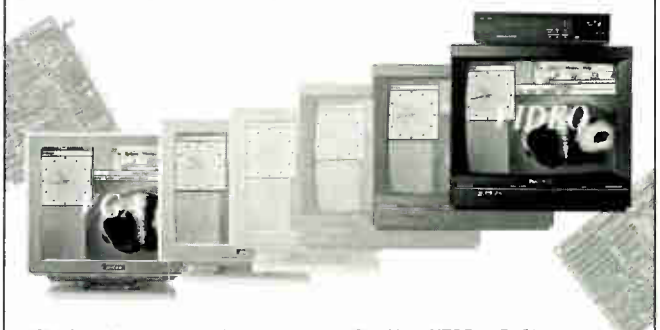

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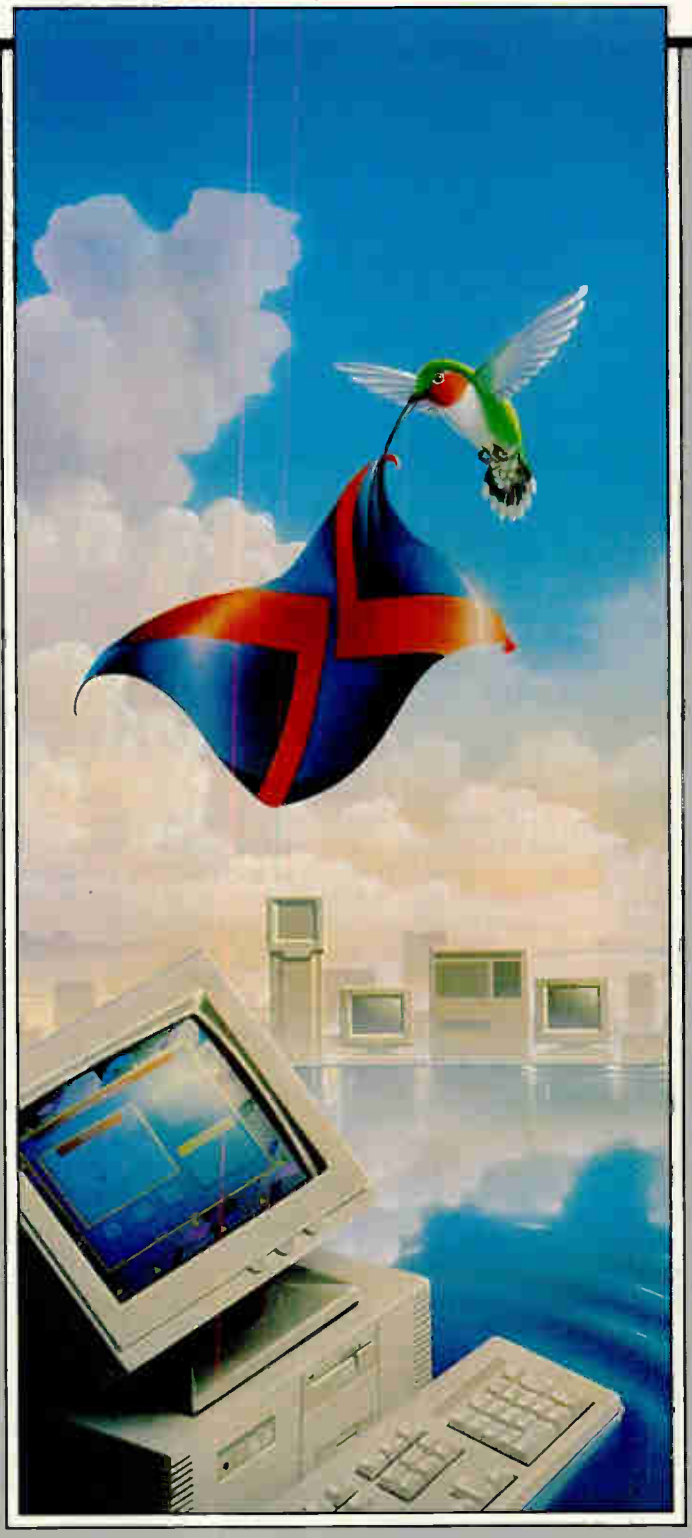

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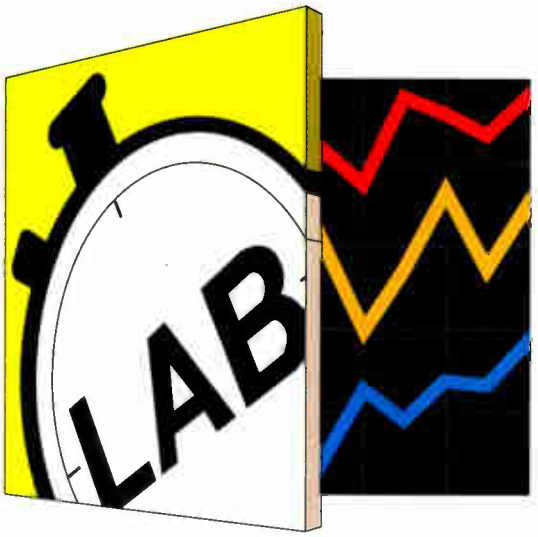
The BYTE Lab, Behind the Scenes

ALAN JOCH

Testing today's hardware and software is more challenging than ever. Here's a look at how the BYTE Lab will be meeting that challenge.



The forward march of processing power combined with dropping prices continues to have a dizzying effect on PCs and workstations. This month, the BYTE Lab is filled with 486 systems that rank near the top of the performance curve. That so many systems meet this classification indicates that high-performance hardware lies within the reach of more people than ever. As the BYTE Lab Product Report makes clear, you can spend less than $3500 today and walk away with a 486 that runs everything from basic word processing programs to Unix. The Solutions Focus, which heads up the reviews section, shows that the PC environment stands head-to-head for price and performance with leading RISC-based workstations.

This doesn't mean that PCs can do it all, of course, but 10 years after the XT legitimized the microcomputer, the platform continues to flourish.

The bottom line is that the development of more-sophisticated hardware and software products is stronger than ever. So, too, are the challenges for those in the BYTE Lab who must learn new technologies and develop appropriate test methodologies to gauge a product's usefulness.

The significance of this hit home recently when we spent an afternoon with representatives of BYTE Brasil, the São Paulo–based computer magazine that publishes original material along with editorial from the flagship BYTE. This year's lifting of local trade restrictions will mean a legal flood of computers into that country. For BYTE Brasil, product evaluations will become an important service to its readers. How we built a testing facility and conduct evaluations on an ongoing basis became the foundation for many of the questions that afternoon.

Our Benchmarks

We're proud to have been the first computer magazine to develop benchmarks to rate computer performance. Our benchmark development continues: We've just finished expanding our Windows benchmarks, and we're working on new versions of Macintosh, Unix, NetWare, and DOS test suites. Over the next few months, we'll unveil these upgrades in evaluations that appear in these pages. We'll continue to publicly distribute the benchmarks, and we invite you to use them when you make buying decisions. We'd also like to hear your ideas for how we can improve our next generation of tests.

But while we believe in indexes and charts to quickly show how, for example, one 50-MHz 486 system ranks in performance against a competitor, readers demand more than simple numbers to understand the products we write about. Our testing editors have the technical expertise of some of the most talented programmers and engineers in the computer publishing field. They're also communicators. The same people who conduct BYTE Lab evaluations write the reviews that you see every month. That's the only way to get the hands-on insights that add power to benchmark numbers. This may sound obvious, but until recently, few magazine testing labs used the approach the BYTE Lab has been using all along.

Application-level tests have always been important in our testing, and in the future we'll emphasize them even more. The venerable BYTE Lab application-level benchmarks use commercial software to test how effective a particular product is for database applications, graphics, or word processing. We'll also spend more time doing field work, learning how professionals use a particular genre of products and what questions they'd like answered.

Looking at the BYTE Lab

This month's installment of Reviewer's Notebook launches a new format designed to keep you up to date with the BYTE Lab as it evolves. We'll take you behind the scenes as we develop new testing methods and discuss important technological issues.

The reason for this new format is threefold. Through phone calls, E-mail, and letters, many readers have expressed the desire to look over the shoulders of BYTE Lab editors. Usually, these questions center on two important areas: how to decide if a particular product is right for your needs, and how to use the product most productively. Each month, those are the two primary issues we address as we develop a Solutions Focus, a roundup, and stand-alone reviews. This new format does not change the other way you have to get answers from the BYTE Lab: Ask BYTE, which has been addressing product and productivity problems for many years, will continue to field your specific questions.

By using this page to invite you into the BYTE Lab each month, we'll address specific issues relating to hardware and software testing. We also hope that you'll come to understand who we are and how we do our jobs, and develop greater trust in our recommendations. Finally, we'll provide a window to the future as we look at the latest technologies hitting the market.

Of course, this will work best if it's interactive: Let us know your questions, concerns, and insights about the subjects we deal with each month. Together, we'll advance the art of product evaluations. ■

Alan Joch is senior editor and director of the BYTE Lab. You can reach him on BIX as "ajoch."

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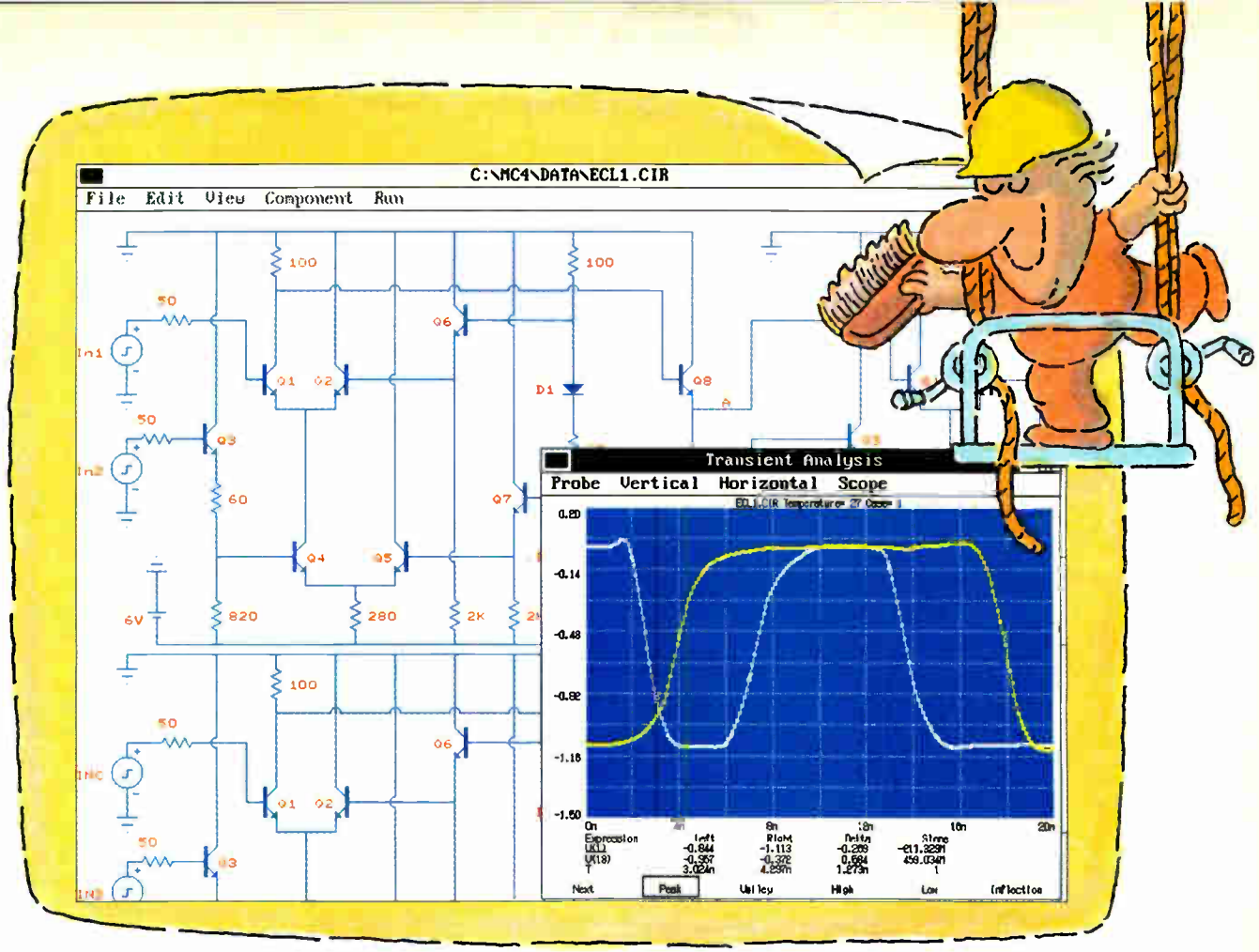

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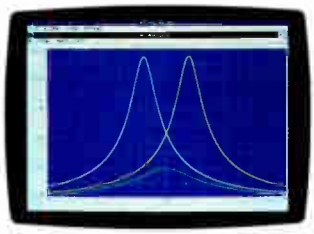

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BOOK AND CD-ROM REVIEWS

HUGH KENNER

AMOK IN CYBERSPACE

The Hacker Crackdown: Law and Disorder on the Electronic Frontier
Bruce Sterling
Bantam Books, $22.50,
ISBN 0-553-08058-X

A sequence to ponder: 1876 ("Mr. Watson, come here; I want you"), and then 1878 ("First teenage males flung off phone system by enraged authorities"). The teenagers were Bell's first telephone operators, and the litany of their misdeeds resounds down the decades. They talked back to subscribers, took Saint Patrick's Day off without getting permission, but worst of all, "played clever tricks with the switchboard plugs, disconnecting calls, crossing lines so that customers found themselves talking to strangers."

"This combination of power, technical mastery, and effective anonymity seemed to act like catnip on teenage boys." In *The Hacker Crackdown: Law and Disorder on the Electronic Frontier*, Bruce Sterling next adduces the hacker culture of the 1990s. Verily, some things never change.

Sterling was coauthor, with William Gibson, of last year's novel *The Difference Engine*, about a Victorian England in which Babbage's machine has succeeded (and John Keats lives, a wizard programmer). Gibson, in 1982, had coined the word *cyberspace*, the sort of word that can annoy in the absence of firm agreement about its scope. Here's Sterling to the rescue: Cyberspace is "the 'place' where a telephone conversation appears to occur." Not inside one phone or another; no, "the place between the phones. The indefinite place out there, where the two of you, two human beings, actually meet and communicate."

For decades, cyberspace was a darkness defined by sound. Today, awash in light from computer screens, it's routinely inhabited by "quite normal people," even civil servants. "We do not really understand how to live in cyberspace yet," and *The Hacker Crackdown* is about "certain strange events in the year 1990," when cops carried seized computers out of dozens of doors and some owners never did find out what, if anything, they were charged with.

There's a surreal interlude when a registered Republican (and Grateful Dead lyricist) finds himself, on his ranch in Wyoming, explaining "the very nature of computer crime to a head-scratching local FBI man who specialized in cattle rustling." And there's a wry subclimax when a young man is on trial for stealing from Southern Bell a document valued at $79,449, and after pages of skillful narrative foreplay, our author spreads before us nothing less than the radioactive document itself: mere grim lists of who's responsible for what in the 911 number system. And for this, jail impends? (Moreover, there was nothing to steal. The document was in the public domain.)

What makes the book work much better than such lurid details suggest is the third of its four parts, "Law and Order." There, Sterling spends time with the Bad Guys, those who seize the equipment of innocents and scare the guts out of bewildered teenagers. And they're feisty, and they talk sense, and it's not a black-and-white world. It's riven by conflicting coordinate systems.

Gail Thackeray, "a trim blond Baby Boomer who favors Grand Canyon white-water rafting to kill some slow time, is one of the world's most senior, most veteran hacker-trackers." She shares computer fever with her targets, longing for access to "an Amiga 2000 with IBM card and Mac emulation!" And four pages from the end, we are privy to a moving moment in San Francisco.

Ms. Thackeray is at the same party as the kid who was almost jugged over that Southern Bell document. She turns on him "the full lighthouse glare of her attention and begins a determined half-hour attempt to win the boy over." His future should be with her! His skills should be Prosecuting Computer Crime! He's listening with unfeigned attention, saying yes, ma'am.

Too soon yet for a symbiosis. But give both camps, say, another decade.

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. His recent books include Mazes *and* Historical Fictions. *You can contact him on BIX as "hkenner."*

INSIDE GRAPHICS FILES

Graphics File Formats, David Kay and John Levine, Windcrest, $24.95, ISBN 0-8306-3059-7.

Graphics File Formats won't keep you glued to your seat, nor will it provide you with masterful insights into the inner workings of graphics applications. It will, however, come in handy if you ever need to decode or understand any of the common graphics file formats. The book helps developers decide which graphics standards are most appropriate for their applications. Each format description is accompanied by a section listing the format's advantages and disadvantages.

CompuServe's GIF, for example, can be used to exchange images between widely differing input and output devices. It's widely supported on numerous platforms, and it supports 24-bit color and images of up to 65,536 by 65,536 pixels. On the downside, GIF can have only 256 24-bit colors and cannot store gray scales or color-correction data. Also, it does not store CMYK or HSI model data. Similar feature lists are provided for all formats.

Exploring the depths of graphics file formats is probably not on your daily task list. However, after reading this book, you'll understand the appropriate uses of each format, and the detailed description is sufficient for you to rummage around inside many of the graphics files and determine how they operate. This is the type of voyage of discovery I enjoy.

—Raymond GA Côté

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LITERATE LISTINGS

Literate Programming, Donald E. Knuth, University of Chicago Press, $24.95, ISBN 0-937073-80-6.

While you're waiting for Donald Knuth's fourth volume of *The Art of Computer Programming*, pass the time reading this new collection of Knuth classics. *Literate Programming* gathers an even dozen pearls, ranging from his 1974 Turing Award address titled "Computer Programming as an Art" to contemporary works on Web and Tex.

The title refers to Knuth's current quest for readable programs. "All of the major problems associated with computer programming—issues of reliability, portability, learnability, maintainability, and efficiency—are ameliorated when programs and their dialogs with users become more literate." In short, computers are fully capable of properly deciphering the most amazing mélange of uncommented, poorly spaced code with indecipherable variable names. If, however, the focus changes from writing code for the computer to writing code for other programmers, the result becomes like literature rather than programming.

While the first half of the book presents the whys and wherefores of Knuth's move to literate programming (and includes one of my favorite Knuth essays, "Structured Programming with `go to` Statements"), the second half consists of views into Tex, a typesetting program, and Web, a literate programming environment in which Tex is written.

Reading others' code is a learning experience. By doing it, you can increase your own repertoire of algorithms and solutions. The key is that the reading should be enjoyable as well as educational. Much less is learned from having to wade through turgid code than by sitting down with a good algorithm in front of a warm fire.

—Raymond GA Côté

MORE MAC SECRETS

Macintosh Programming Secrets, 2d ed., Scott Knaster and Keith Rollins, Addison-Wesley, $29.95, ISBN 0-201-58134-5.

Scott Knaster wrote the original *Macintosh Programming Secrets*, an enjoyable amalgam of loopy humor and little-known Mac programming techniques. Now he teams up with Keith Rollins to write a second edition. Most of the material is new. And it is the good stuff.

It includes sample code for a movable modal dialog box, a progress indicator (like that used by the Finder during a file copy), intelligent window redrawing using off-screen buffers, and a file copy program that illustrates use of the File Manager. There's also a discussion of stand-alone code (the stuff of INITs, XCMDs, and WDEFs) with sample code, and a nifty Command-period abort dialog box that gives you control of the computer no matter what by sneaking a look at the Mac's event queue. The Knaster humor is still there, making an esoteric subject interesting. This is a must for the Mac programmer's bookshelf.

—Tom Thompson

DIAL SOS FOR SUPPORT

Support on Site, $1295 from Computer Library (1 Park Ave., New York, NY 10016, (212) 503-4400; fax (212) 503-3695).

Unless you have had firsthand experience as a technical-support professional, you can never imagine how wide-ranging, challenging, esoteric, and downright flaky some support requests can be. Supporting a large group of users requires a broad knowledge of applications and hardware, a shelf full of reference materials, and personality traits such as patience, persistence, and a sense of humor.

The new Support on Site series from Computer Library puts all the reference materials in one place. The first title to be released, SOS for Applications, packs a large reference set onto a single CD. Computer Library updates it monthly with material from software manuals, technical notes, newsletters, and even program code fixes and software drivers. An annual subscription sells for $1295 (single user) or $4995 for the LAN version (five concurrent users).

Computer Library is still building up the product's content, but it has already covered many popular programs, including Windows 3.1 and OS/2; dBase for the PC; and the PC and Mac versions of Lotus 1-2-3, WordPerfect, and Excel. As of the August edition, coverage of PC applications far outnumbered Mac product references.

SOS is packed with valuable tips, fixes, and workarounds, but organizationally it appears as a hodgepodge of technical data from divergent sources. As such, it's less accessible than other reference works. Although each document contains a header of descriptive fields, much of the information just doesn't lend itself to simple classification.

Accessibility of information is crucial in support work, where you rarely look for a clearly defined subject. You usually research complex problems involving many hardware and software elements, and it's hard to encapsulate such problems in a simple search.

The search-and-retrieval software starts with a field template to narrow your search to a particular application or publication. From there, you can use Boolean operators (i.e., AND, OR, and NOT) to create search expressions. You can also negotiate proximity searches, looking for *Windows* within 10 words of *network*, for instance. Anyone familiar with the interface of Computer Library's Computer Select CD-ROM will feel right at home with SOS.

This is not a CD for browsers or nontechnical users. The structure and content are not accessible enough to accommodate casual use. However, technical-support professionals will find SOS useful as a comprehensive reference tool and a way to keep up with the steady stream of technical updates. ■

—Stanford Diehl

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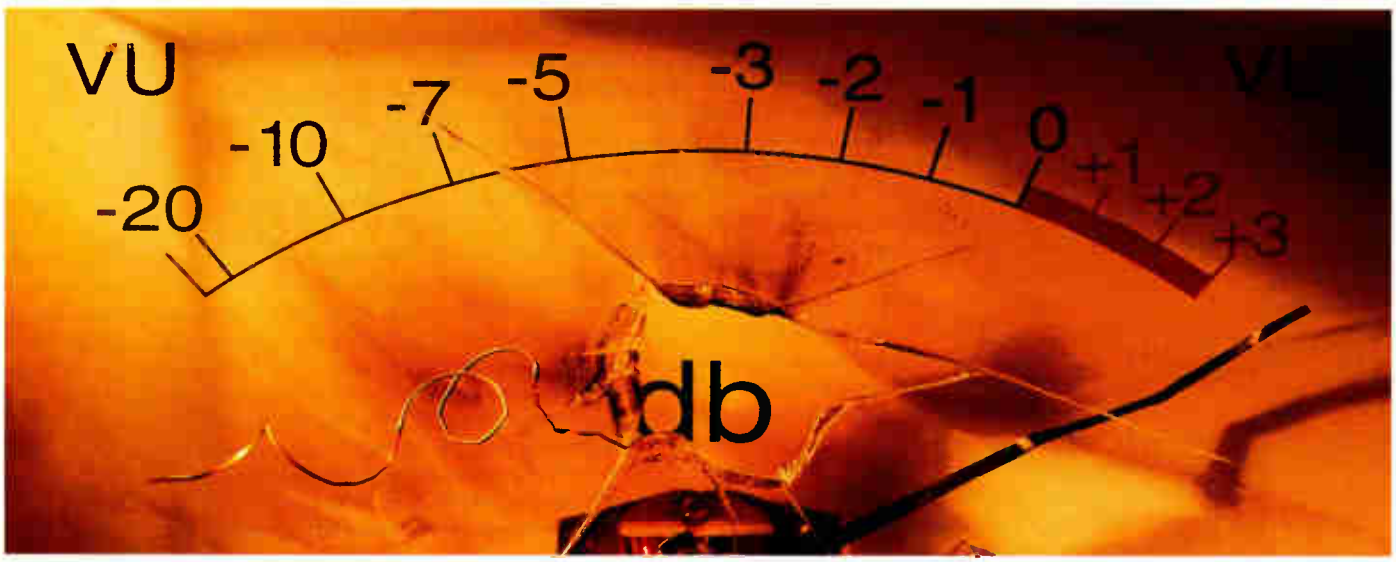

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UDI MANBER
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APPROXIMATE PATTERN MATCHING

The meeting with the famous Dr. Kruschel was two months ago, and you distinctly remember writing down an important idea and filing it under *Kruschel*. Or was it *Krushel*? No, *Kruchell*. Can't find it. How about *Kruchal*? Oh, no, this idea is crucial now, and there are just too many spelling possibilities!

If the amount of data you have is small, you may be able to look everywhere (e.g., you can look at all names that start with *K*). But if you have megabytes' worth of text and the only way to find something is by searching for names, technical terms, or other keywords or patterns, a typo may be equivalent to dropping a folder behind the filing cabinets—it's virtually lost.

Searching text through pattern matching is a common operation in many applications, ranging from word processing to molecular biology. But sometimes the pattern does not appear in the text exactly, and errors in the text or in the query can result from problems like misspellings or transmission errors. Most text editors and search programs do not support approximate searches because of the complexity involved in implementing such a procedure. But some new algorithms may change that.

Below, we describe one such algorithm in sufficient detail to enable you to include it in your own programs. We also describe `agrep`, a Unix software tool for approximate pattern matching that we developed. `Agrep` includes many options that make searching powerful and convenient.

Imagine how nice it would be if you didn't have to write down the exact spelling of everything. Instead of guessing all the possibilities every time you need to spell *Kruschel*, you can just try something similar and let the program find out the right spelling. If you use `agrep`, you can search approximately for *Kruchel* in a whole directory (or even several directories), and instead of getting `No match`, you might get `The best match has 1 error; there are 4 such matches; do you want to see them?`

Agrep finds patterns even when you can't remember the exact spelling

Think of a system that automatically suggests alternatives every time it sees a word it doesn't understand. If you typed `cd pesonal/travel/Massashusetts/hotels`, the system would not reply `pesonal/travel/Massashusetts/hotels: No such file or directory`. Instead, it might say, `do you mean personal/travel/Massachusetts/hotels?` Such systems can't come soon enough for those of us who can't type or spell well. Approximate matching is useful, fast, and not too hard to do.

Exact String Matching

The first thing you must do when designing an algorithm is define the problem precisely. Often, it's best to start with the simplest nontrivial variation of the problem and go from there. As Einstein once said, "Make it as simple

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as you can, but not simpler than that." So we'll forget the word *approximate* for a moment and concentrate on exact string matching.

We represent the text and the pattern as sequences of *characters*. Think of the characters as English characters, but they can be any symbols, such as DNA base pairs, lines of source code, angles between edges in polygons, or music notes and tempo in a musical score.

We'll denote the text by $T = t_1 t_2 \ldots t_n$, and the pattern by $P = p_1 p_2 \ldots p_m$. Generally, n is much greater than m. The basic string-searching problem is to find all occurrences of P inside T.

The straightforward solution to this problem is to start by comparing p_1 to t_1 and continue (comparing p_2 to t_2, and so on) until we either complete the match or find a mismatch. In the latter case, we must go back to the place from which we started the match (t_1 at first), move on one character (to t_2), and try again. This process is illustrated as shown at right. The pattern is `vivid`, and the piece of text we are searching in is `vivi&dv&vivid`.

We've indicated mismatches in bold type. The first four characters match, but the fifth does not. We cannot continue matching from `&`, because the third and fourth positions in the text (`vi`) match the beginning of the pattern and may be the start of a complete match. We have to try every beginning as shown.

```
vivi&dv&vivid
vivid
 v
  viv
   v
    v
     v
      vi
       v
        vivid
```

Boyer-Moore Filtering

There are many ways to improve on this straightforward solution. The two most famous ones are the Boyer-Moore algorithm and the Knuth-Morris-Pratt algorithm (see Gonnet in the bibliography).

The Boyer-Moore algorithm is usually the fastest algorithm for exact string matching. It has many variations, but the main idea is this: The first comparison is not between the first character in the pattern and the first character in the text, but between the *last* character of the pattern and the mth (fifth in our case) character in the text.

In our example, we would compare `d` to `&`; we have a mismatch right away, so we can shift the pattern. The key idea is to look at the character in the text that caused the mismatch (in this case, `&`) and see where this character can fit in the pattern. `&` does not appear at all in our pattern; therefore, we can safely shift the whole pattern m positions to the right.

The next comparison is between the last character in the pattern and the tenth character in the text (moving m steps from the fifth position). The tenth character is `i`, which does appear in the pattern in the second and fourth positions. The only safe shift is by one, because the `i` in the text may match the fourth position in the pattern; so now we look at the eleventh character in the text, `v`, which appears in the pattern in positions 1 and 3.

The safe shift now is by two (which is the size of the pattern minus the last position of the text character in the pattern). That gets us to the thirteenth character, `d`. Now we have a match of the `d`s, and we continue, backward, to check whether the

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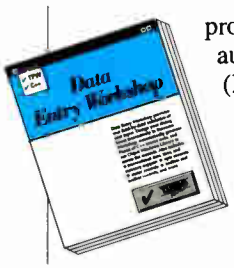

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whole pattern matches (which it does, in this case). If there is a match of the last few characters and a mismatch in the middle, we can shift by one, as in the straightforward algorithm, or use other techniques for determining a better shift.

The main advantage of this method is that most of the time there will be mismatches that will lead to large shifts. In our example, only eight character comparisons are used, versus 20 comparisons for the straightforward method. We recently extended the Boyer-Moore approach to approximate matching, and it is used in some parts of the latest version of `agrep`. But other parts use a much more general and elegant algorithm, based on a remarkable algorithm by Baeza-Yates and Gonnet (see the bibliography).

The Shift-AND Algorithm

Assume for the moment that you're looking not only for all matches of the pattern, but also for all matches of all prefixes of the pattern. This requires much more information; but, as is sometimes the case in algorithm design, more is easier to obtain.

In our example, we are looking for all occurrences of five patterns: `v`, `vi`, `viv`, `vivi`, and `vivid`. We build a table that will indicate, for each position in the text, whether this position is the end of any of these five patterns. For each text position, we will have a bit array of size 5, such that the kth bit is 1 if this position is the end of a match to the kth prefix. Overall, the table will consist of m rows and n columns of bits:

```
   vivi&dv&vivid
v  1010001010100
i  0101000001010
v  0010000000100
i  0001000000010
d  0000000000001
```

We are mainly interested in the last row, which indicates a match to the whole pattern, but the other rows will become important shortly.

Let's formalize what we've done so far. We denote by R_j the jth column of the table. R_j is a bit array of size m, such that $R_j[k] = 1$ if the first i characters of the pattern exactly match the k characters preceding and including t_j in the text (i.e., if $p_1 \ldots p_k = t_{j-k+1} \ldots t_j$). The question is how to evaluate this table quickly. The first observation is that the $j+1$st column depends only on the jth column, the pattern, and t_{j+1}. For example, there is a match for `viv` at $j+1$ only if there was a match for `vi` at j and $t_{j+1} =$ `v`. In other words,

$$R_{j+1}[k] = \begin{cases} 1 \text{ if } R_j[k-1] = 1 \\ \quad \text{and } p_k = t_{j+1} \\ 0 \text{ otherwise} \end{cases}$$

Initially, $R_0[k] = 0$ for all k, $1 \le k \le m$, and $R_j[0] = 1$ for all j, $0 \le j \le n$.

The recurrence above can be translated directly into a program that requires one IF statement to compute each entry in the table. But we can do much better. If the pattern's size is no more than 32, we can represent each column (which is just a bit array) as one computer word. As we show next, a whole column can be computed quickly.

Look at columns 1 and 2 in the example above. There are two conditions to have 1s in column 2: (a) 1s can be only at positions where there is an `i` in the pattern (because $t_2 =$ `i`), and (b) a 1 can be at a given position in column 2 only when the previous position in column 1 was a 1. Condition a ensures that the last character (t_2, in this case) matches, and condition b

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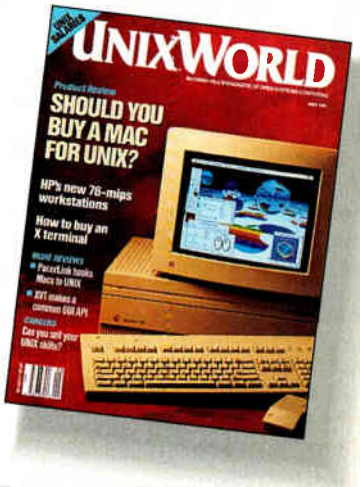

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Listing 1: *The* `shift-AND` *algorithm for exact string matching.*

```
#define WORD_SIZE 32        /* the size of a
                               computer word      */
#define MAX_SYM   256       /* the size of
                               the alphabet       */
unsigned int CV[MAX_SYM];   /* the characteristic
                               vector table       */
char pat[WORD_SIZE];      /* the pattern (bounded
                             by WORD_SIZE)        */
unsigned int m;     /* length of the pattern     */
unsigned int bit[WORD_SIZE];  /* bit[i] has a 1
                                 in the ith
                                 bit only         */

preprocessing(pat, CV)  /* compute the
                           characteristic
                           vectors                */
char *pat;
unsigned int *CV;
{
    int i, j;
    m = strlen(pat);
    for (j=0; j<WORD_SIZE; j++) bit[j] =
        (1 << (WORD_SIZE - j - 1));
    for (i=0; i<MAX_SYM; i++) {
       CV[i] = 0;
       for (j=0; j<m; j++) {
          if (pat[j] == i) CV[i] = CV[i] | bit[j];
       }
    }
}

shift_AND(text, textend, CV)
char *text, *textend;
unsigned int *CV;       /* the characteristic
                           vector table           */
{
    unsigned int R;
    unsigned int S;
    unsigned int cv;    /* characteristic vector
                           for current character  */
    unsigned int bit_0;   /* used to store bit[0]*/
    unsigned int endpos;  /* bit mask for testing
                             for a match          */

    endpos = bit[m-1];
    R = bit_0 = bit[0];     /* initial state       */
    while(text < textend) { /* main loop           */
       cv = CV[*text++];  /* get characteristic
                             vector for the
                             current character    */
        R = ((R >> 1) | bit_0) & cv; /* shift, fill,
                                        AND       */
      /* It is possible to avoid the 1-filling by
         using 0 to indicate a match and OR
         instead of AND                           */
       if (R & endpos) report_a_match(text);
    }
}
```

Listing 2: *The new main loop for dealing with one substitution error.*

```
R = R_save = R1 = bit_0 = bit[0];
 /* R_save is needed to remember the old value of
    R; it's possible to do without it if we "double
    the loop" (see agrep's code)                  */
while(text < textend) {
   cv = CV[*text++];
   R = ((R >> 1) | bit_0) & cv;
        /* for exact matching                     */
   R1 = ((R1 >> 1) & cv) | (R_save >> 1) | bit_0 ;
   if (R1 & endpos) report_a_match(text);
   R_save = R;
}
```

ensures that the previous characters match.

To check for condition *b*, we simply *shift* column 1 downward. To quickly check condition *a*, we prepare (ahead of time, when we first see the pattern) a *characteristic vector* of size *m* for each alphabet character. The characteristic vector for character `i`, for example, has a 1 in positions 2 and 4, which are the positions in the pattern where `i` occurs, and a 0 otherwise (that is, 01010). The characteristic vector for `v` is 10100; for `d` it is 00001; for all other characters, it is 00000.

To take care of condition *a*, we match the vector obtained by shifting column 1 downward (column 1 is 10000; after the shift, it is -1000) with the characteristic vector for `i`; only the positions with 1s in both vectors are set to 1, and all others are set to 0. This is indeed the correct value of column 2. The only exception is at position 1, in which case condition *b* is trivial (there are no previous positions). So, when we shift, we always fill the first position with a 1.

Here's another example. Column 3 is 10100. After the shift (and the 1-filling), it is 11010. We then compare it—using an AND operation, bit by bit—to the characteristic vector for `i`, which is 01010, and we obtain 01010. Shifting and performing ANDs are usually just as fast in C as adding and subtracting, so the whole algorithm is very fast.

To summarize, we first constructed a table that shows all matches to all prefixes of the pattern. Next, we found a recurrence that computes all entries in the table. Finally, we discovered a way to compute each column in the table by essentially one shift of the previous column and one Boolean AND operation with a characteristic vector. Now we are ready to write the program. Although the algorithm is counterintuitive, the program turns out to be surprisingly short.

The program in listing 1 is not as fast as a well-tuned program based on Boyer-Moore filtering, but you can easily extend it to handle more complicated patterns. Suppose that instead of `vivid`, you are looking for all words that have five characters and an `i` in the second and fourth positions (which is how we searched the dictionary to find `vivid` as an example). A common way to indicate this pattern is `.i.i.`, where "." stands for any character.

The `shift_AND` program in listing 1 can handle this pattern without any modifications. The only thing we need to do is to change the preprocessing slightly. We simply add 1s in the first, third, and fifth positions to the characteristic vectors of all characters. This indicates that the first, third, and fifth positions match all characters. To exclude digits, for example, we just set their characteristic vectors to 00000.

It gets even better. We discovered that you can extend this algorithm to support approximate pattern matching in a very general way. This discovery was the basis for the development of `agrep` (although `agrep` now uses several other algorithms as well) and the ability to provide general-purpose approximate pattern matching.

Approximate String Matching

Let's try one substitution error. In our example, we want to search for all the occurrences of `vivid` with possibly one

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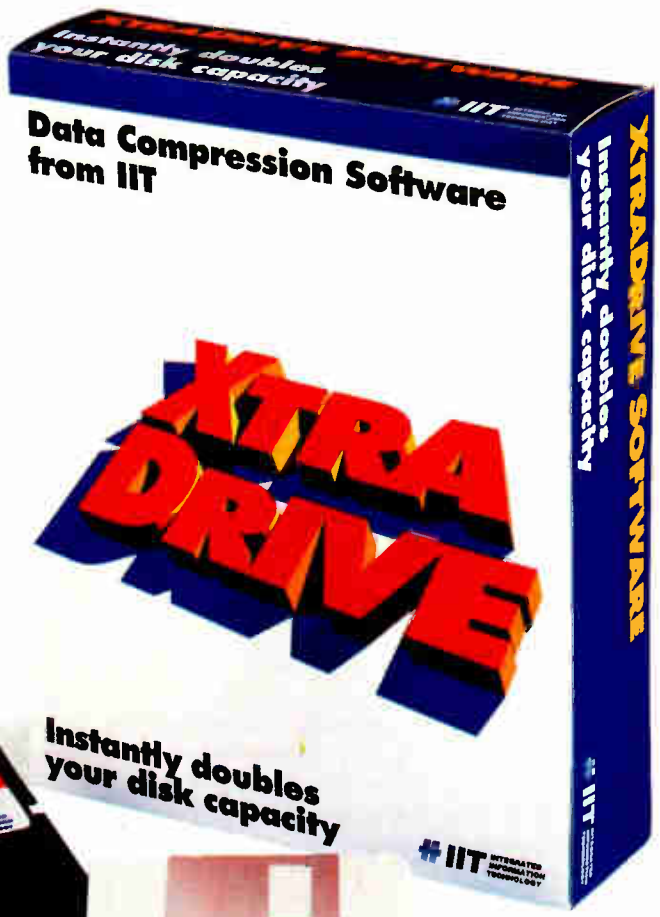

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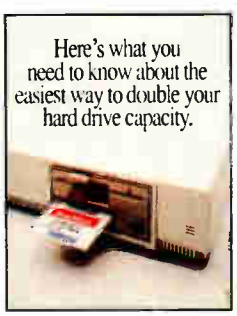

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character changed. We compute two tables. One table, R, is identical to our previous table, and it is computed in the same way. The other table, which we denote by R^1, is similar to the first table, except that it shows all matches that either are exact or have one substitution.

```
     R
   vivi&dv&vivid
v  1010001010100
i  0101000001010
v  0010000000100
i  0001000000010
d  0000000000001

     R1
   vivi&dv&vivid
v  1111111111111
i  0101000101010
v  0010100010101
i  0001000001010
d  0000100000001
```

Look first at the fifth column of R^1. This column differs from the fifth column of R in the first, third, and fifth positions. Indeed, `vivi&` matches the pattern `vivid` with one substitution, `vi&` matches `viv` with one substitution, and `&` matches `v` (the first row of R^1 is always 1).

We can discover the match with one substitution of `vivi&` to `vivid` by looking at the fourth column of R and finding the exact match of `vivi`. If there is an exact match up to the last character, then there is always a match with at most one substitution (there may be an exact match, but we don't care, because R will indicate it). So one way to add 1s to R^1 is by shifting down the previous column of R without the AND.

Now look at column 10. In R^1, column 10 is 11010. The second row is 1 because of an exact match (`vi`), which is covered by the shift. The fourth row corresponds to the match of `v&vi` against `vivi`, in which the substitution occurred earlier. We can discover that match by looking at the ninth column of table R^1, checking that there is a match (with one substitution) of `v&v`, and verifying that the last character (`i`) matches.

Overall, all possibilities can be handled with just two additional arithmetic operations. If the substitution is for the current text character or there is an exact match, then shifting the previous column of R will discover the match. If the substitution occurred earlier, then shifting (with 1-filling) the previous column of R^1 and performing an AND on it with the characteristic vector will discover the match. Listing 2 shows the new main loop that checks for one substitution error.

Now we will deal with insertions and deletions. An insertion or deletion that happened earlier is already indicated by the previous column of R^1; it can be detected by the exact same shift and AND operation that detected an earlier substitution. An insertion at the end can be detected by copying the previous column of R (without a shift). And a deletion can be detected by shifting the `current` (new) column of R.

For example, the third column of an R^1 that covers substitutions, insertions, and deletions would be 11110; the fourth 1 comes from a match of `vivi` to `viv` by deleting the last `i`, and we detect it by shifting the third column of R. The second 1 can be obtained in two ways: We can match `vi` to `viv` by inserting the last `v` (which we detect by copying the second column of R), or we can match `vi` to the `v` that starts in the third position by deleting

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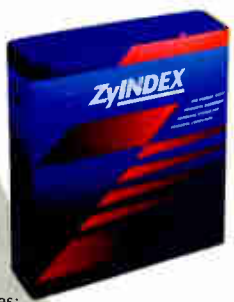

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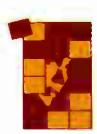

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the `i`. Overall, substitutions, insertions, and deletions can be handled with four arithmetic operations.

Furthermore, if you want to allow more than one error, it's no big deal. You simply maintain one additional table for each error and use similar transitions from one table to another. This algorithm supports arbitrary wild cards, range of characters (e.g., all digits), complements of characters (e.g., anything but blank), and a whole host of other options. In fact, you can even extend it to search for any regular expression, even with errors.

Agrep

Motivated by this algorithm, we developed `agrep` for approximate or exact pattern matching in Unix. It's as fast as any other `grep` that we know of for exact string matching (it takes about 0.1 second of user time to search a simple string in a 1-MB file on a Sparcstation II), and it can do much more.

A typical use of `agrep` is to search for patterns in text files as follows:

```
agrep [ -OPTIONS ] pattern
[ -f patternfile ]
filename(s)
```

The file or files are typically scanned line by line (but not always; see below), and all lines containing the pattern are output.

`Agrep` has three significant features not supported by other `greps`. The first is the ability to search for approximate patterns. For example, `agrep -2 Krushell ideas-file` will find *Krushal*, *Kruchel*, *Krushalle*, and any other word that can be obtained from *Krushell* with at most two substitutions, insertions, deletions, or any combination of these. (This search took 1.3 seconds of user time in a 2-MB text file on a Sparcstation II.) If you don't want to, you don't have to specify the number of errors: `agrep -B breacracy /usr/dict/words` scans the dictionary for the best match to *breacracy*, which is great for someone who doesn't know (and maybe doesn't want to know) how to spell *bureaucracy*.

It is even possible to assign different costs to insertions, deletions, or substitutions. For example, `agrep -1 -I2 -D2 555-3217 address-file` will output all lines containing numbers that differ from 555-3217 by at most one digit. The `-I` option sets the cost of insertions (`-D` sets the cost of deletions); in this case, setting it to 2 prevents insertions and deletions.

`Agrep`'s second advantage is that it's record-oriented rather than just line-oriented. A record is, by default, a line, but it can be user-defined; for example, `agrep -d '^From ' -1 Kruschel mail-file` outputs all mail messages containing *Kruschel* with at most one error (mail messages in Unix start with *From*, and the `-d` option defines records separated by the given delimiter).

`Agrep`'s third major advantage is that it supports Boolean queries. For example, `agrep -d 'XXXX' 'Kruschel;[8-9]/#/92' ideas-file` outputs all *ideas* (which we assume are separated by *XXXX*) containing *Kruschel* and a date that starts with either *8* or *9* and ends in *92* (that meeting was about two months ago, right?). The symbol # stands for arbitrary wild cards—that is, anything, of any length, can replace it.

These options can be combined with other new options to form powerful queries. Two examples follow.

`Agrep -i -d '====' -1 '<byte>;Manbr;matching;<199[1-2]>' bib-file` outputs all records (separated by

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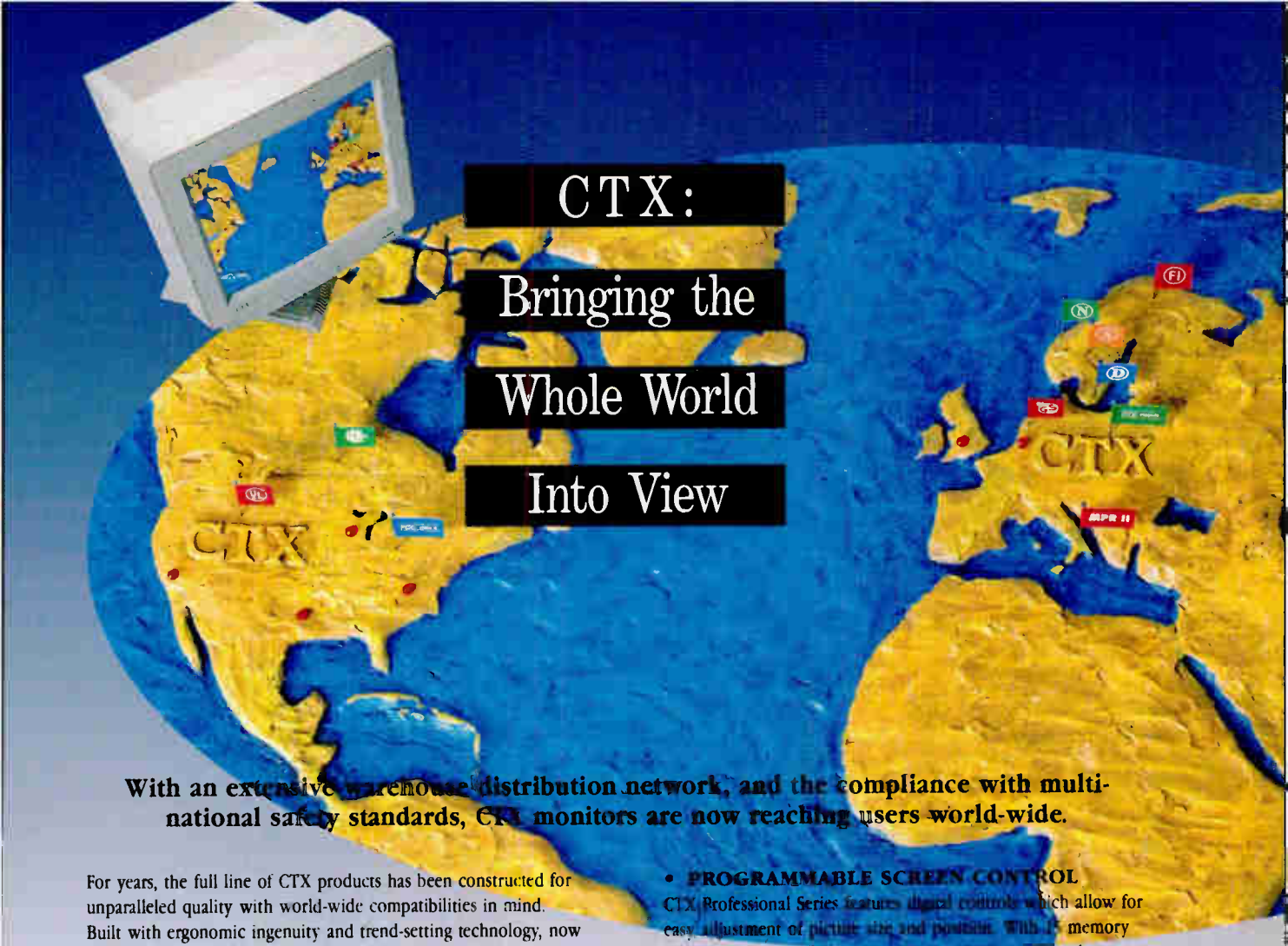

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Name	Definition
Gamma	$\Gamma(z) = \int_0^\infty t^{z-1}e^{-t}\,dt$
Sine	$\sin(x) = \frac{1}{2i}(e^{ix} - e^{-ix})$
Zeta	$\zeta(s) = \sum_{k=1}^{\infty} k^{-s} \quad (\Re s > 1)$

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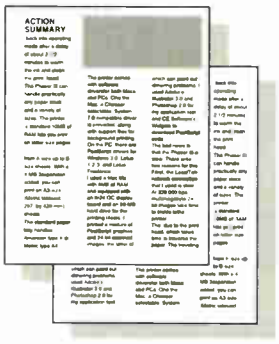

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====) referencing articles in BYTE (the -i makes it case-insensitive) in 1991 or 1992 by *Manbr* (or something like that—one error is allowed) and dealing with matching. The error cannot be in either *BYTE* or the year (the angle brackets forbid errors in the pattern between them).

`Agrep -p -5 abcdefghij /usr/dict/words` outputs all words in the Unix dictionary that have at least five of the first 10 letters of the alphabet in order. The -p option makes insertions free everywhere, so, for example, it can be used to give acronyms and find the full name. Since we don't pay for insertions, only deletions make sense, which is why the query has the meaning it has. The reply to this query (at least on our machine) starts with *academia* and ends with *sacrilegious*. We'll tell that to Dr. Kruschel the next time we see him. ■

Editor's note: *The source code for* `agrep` *is available on the Internet by anonymous ftp to cs.arizona.edu. You'll also find it on BIX in the frombyte92 listings area.*

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Udi Manber is a professor of computer science at the University of Arizona. He won the Presidential Young Investigator award in 1985 and is the author of Introduction to Algorithms—A Creative Approach *(Addison-Wesley, 1989). Sun Wu is a member of the technical staff at Bell Laboratories in Murray Hill, New Jersey. Both authors won the best paper award at the 1992 Usenix Winter Technical Conference for their work on* agrep. *You can reach them on BIX c/o "editors" or on the Internet at udi@cs.washington.edu and sw@cs.arizona.edu, respectively.*

World Radio History

DICK POUNTAIN

A CALL TO ARM

Here's why Apple and other companies are jumping on the ARM bandwagon

Apple's decision to use the U.K.-designed ARM610 CPU chip in its Newton PDA (Personal Digital Assistant)—and in future PDAs—may have come as a surprise to many people. Before Apple's announcement (see "The PC Gets More Personal," July BYTE), Advanced RISC Machines' ARM architecture was not at all well known in the U.S.

What's the attraction of the ARM610? This 32-bit RISC CPU combines fast processor speed and low power consumption in a small package. For hand-held systems such as Apple's Newton, this is an ideal combination.

The basic ARM design has been around longer than any other commercial RISC processor. I first wrote about it in the January 1986 BYTE (see "The Acorn RISC Machine"). At that time, *ARM* stood for Acorn RISC Machine, a computer from U.K. PC manufacturer Acorn Computers. Acorn designed the original ARM in 1983 (see the text box "Origins of the ARM" on page 296). Then in 1989, Olivetti bought Acorn, and in 1991 it spun off all ARM development into ARM, Ltd., a research, design, and marketing venture jointly owned by Olivetti, VLSI Technology, and Apple Computer. ARM's chips are manufactured under license by VLSI Technology in the U.S. and by GEC Plessey in the U.K.

An ARM6 Overview

ARM's commercial strategy is to design custom ASICs (application-specific ICs) based on the ARM6, a macrocell implementation of the original ARM CPU architecture with 32-bit addressing. A macro cell is the VLSI CAD equivalent of a subroutine; it's a complete predesigned (and debugged) circuit element that you can drop into a new design without modification.

The ARM6 is so simple that its CMOS implementation uses only about 33,500 transistors and occupies very little silicon area when compared to rival CPU designs; Intel's 486 requires 1,200,000 transistors. The ARM CPU element consumes less than one-quarter of a small silicon die, leaving room for other components that a customer chooses for specific jobs. For example, in the embedded controller market, a customer might specify some on-chip ROM to hold the control software, and a UART (universal asynchronous receiver/transmitter) for serial communications.

The ARM610 is one such specific ASIC design, intended especially for advanced hand-held, battery-powered computers. In addition to an ARM6 CPU core, the ARM610 contains a 4-KB instruction and data cache, a write buffer, and an innovative MMU (memory management unit) that's optimized for the needs of an object-oriented operating system (see figure 1). The instruction set is small, as you'd expect of a RISC design, and all instructions are conditionally executed (see the text box "The ARM610 Instruction Set" on page 297).

Although the ARM610 is a custom design for Apple,

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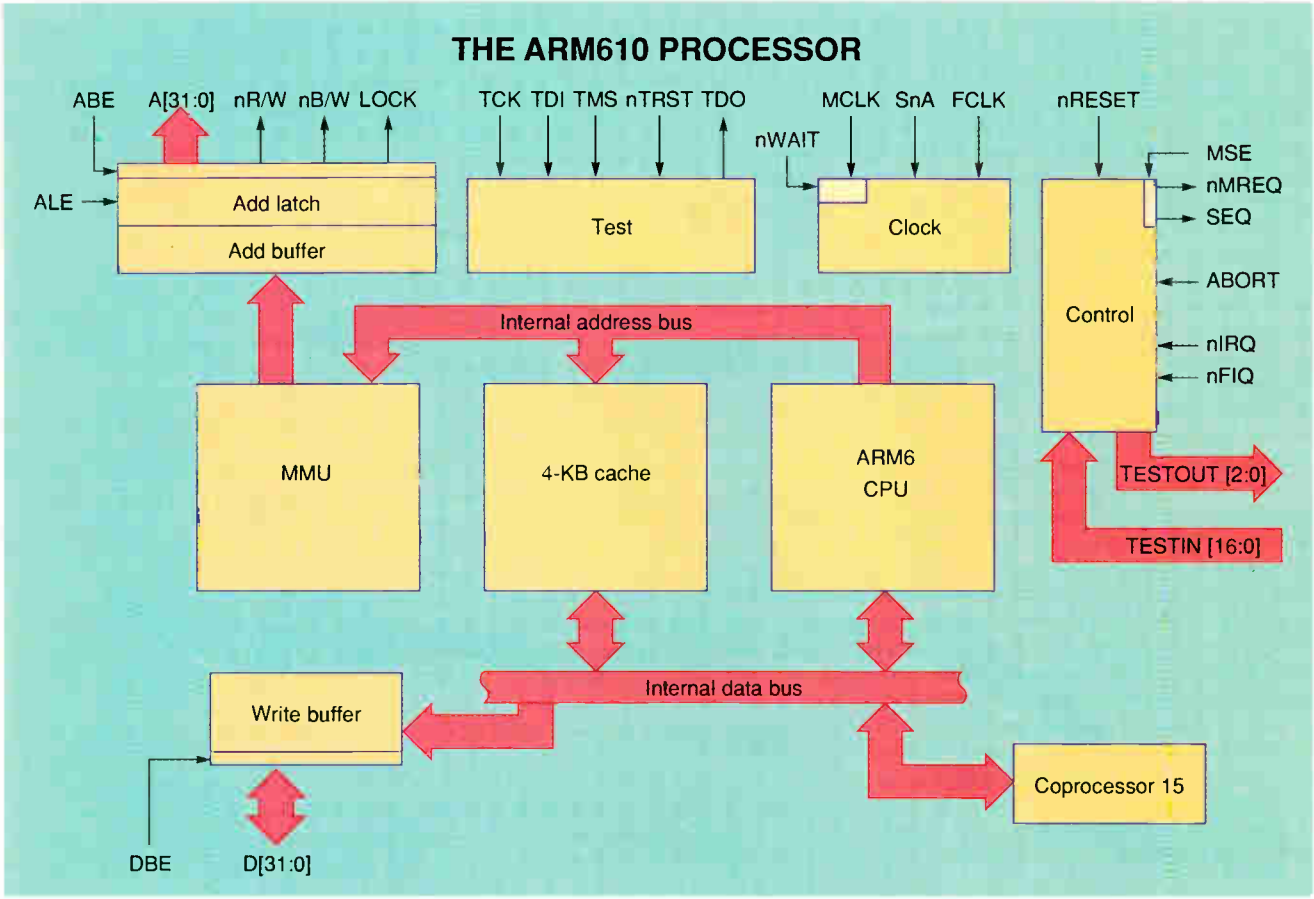

Figure 1: *The ARM610 RISC CPU contains a 4-KB instruction and data cache, a write buffer, and an innovative MMU that's optimized for the needs of an object-oriented operating system.*

which holds a patent on the MMU, any computer company can buy the chip. The fact that a small U.K. company succeeded in supplying Apple's needs under the noses of the U.S. semiconductor giants is due at least in part to the development speed that the macro-cell approach offers: ARM started delivering silicon to Apple just four months after receiving the specification.

When you're designing a hand-held, battery-operated computer, raw speed is not the sole CPU performance criterion. Pen-based computers running handwriting-recognition software need plenty of processing power, but power consumption and physical package size are more important. The ARM CPU, capable of 20 to 25 MIPS, isn't a performance leader when compared to newer RISC designs like Sun's SuperSparc, the Mips R4000, and DEC's Alpha, but it offers the best combination of speed, size, and power consumption for hand-held systems.

The ARM610 yields a speed-to-power ratio of about 0.35 MIPS per milliampere, five times better than the SparcLite's and 10 times better than the Motorola 68030's. The ARM610 is thrifty because it's implemented as a fully static CMOS device; you can stop and restart the system clock at any point in the instruction cycle with no loss of state information. Other low-power designs, like Intel's 386SL, are fussier about when you stop the clock, and they require extra logic to restart safely. The ARM610 also contains other tricks to minimize power usage—especially by the potentially power-hungry cache and MMU.

Good manufacturing yields, a consequence of its small (22-mm) die size, make the ARM610 competitive in dollars per MIPS as well. The ARM610 comes in a 144-pin plastic surface-mount thin-quad flat package, which is the size of a postage stamp and only 1.4 mm thick. In order to squeeze the 22-mm-square die into this tiny package, the manufacturers grind down the backs of the finished silicon wafers to a thickness of less than a millimeter before cutting them up.

Core Architecture

The ARM610's CPU core is a 32-bit microprocessor of classic RISC design, with full 32-bit data and address buses (see "RISC Basics," April 1991 BYTE, page 298). All ARM instructions are 32 bits long, are decoded directly by hard-wired control logic, and use no microcode. The CPU has only 10 types of instructions, most of which execute in a single cycle. It has a three-stage execution pipeline, so one instruction can execute while the CPU decodes its successor and fetches a third from memory.

ARM's pipeline is shallow and simple compared to recent radical designs such as the Mips R4000 and DEC's Alpha; there are no instructions that manipulate pipeline sequencing explicitly. As a result, the ARM610 cannot equal those processors for sheer burst speed, but it's straightforward to program in assembly language (you don't have to worry about complex pipeline dependencies) and presents an easy target for compiler writers.

ARM's 32-bit data path contains a 32-bit hardware multiplier and, as an unusual touch, a barrel shifter that is closely coupled to the ALU. Most ARM arithmetic and logic instructions contain a bit field

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that can specify a shift of their second operand register so that you can combine, say, an add and a shift (or a rotate) into one instruction. The CPU uses the barrel shifter internally to align data and to extract bytes from whole words during byte-addressing operations.

As is usual for a RISC processor, the ARM610 employs a load/store architecture where data-processing operations take place only between register contents; they never take place directly between a register and memory (or between memory and memory). The ARM610 has 37 32-bit registers, of which 31 are general-purpose data registers and six are status registers (see figure 2).

However, only 16 of these data registers (R0 through R15) and only two of the status registers are ever visible to the programmer and to user programs. Of these, register R15 is reserved as the program counter. The other 15 data registers, called *banked* registers, get switched in whenever any sort of exception is processed for the ARM610's own internal use. In this way, the ARM610 preserves the contents of the user registers without writing them to an external memory stack. This is how the ARM610 gets its quick response to interrupts, exceptions, and context switches, which makes it a suitable processor for real-time systems.

The ARM610 processor operates in six different modes that can be switched by software or by external hardware signals. *User* and *supervisor* modes are for normal program and protected operating-system use. *FIQ* (fast interrupt request) and *IRQ* (interrupt request) modes are for interrupt handling. FIQ mode has a minimum interrupt latency of just four processor cycles and a worst case of 26 cycles, which is less than 5 microseconds in a 25-MHz system. *Abort* mode is for handling address exceptions from the MMU in virtual memory systems. The ARM610 enters *undefined* mode whenever an undefined instruction is executed. It uses this mode to trap coprocessor instructions issued when the required coprocessor is not present and to vector out to a suitable software-emulation routine.

The ARM6 core is basically an integer CPU with no floating-point hardware, but it has an on-chip coprocessor interface that it can use to access up to 16 external coprocessors. Three of the 10 ARM6 instruction types are reserved for coprocessor instructions, so off-chip functions look completely consistent with internal functions from the programmer's view.

The ARM610 design ignores this external coprocessor interface (i.e., it's not brought out to the chip's pins), so you can't

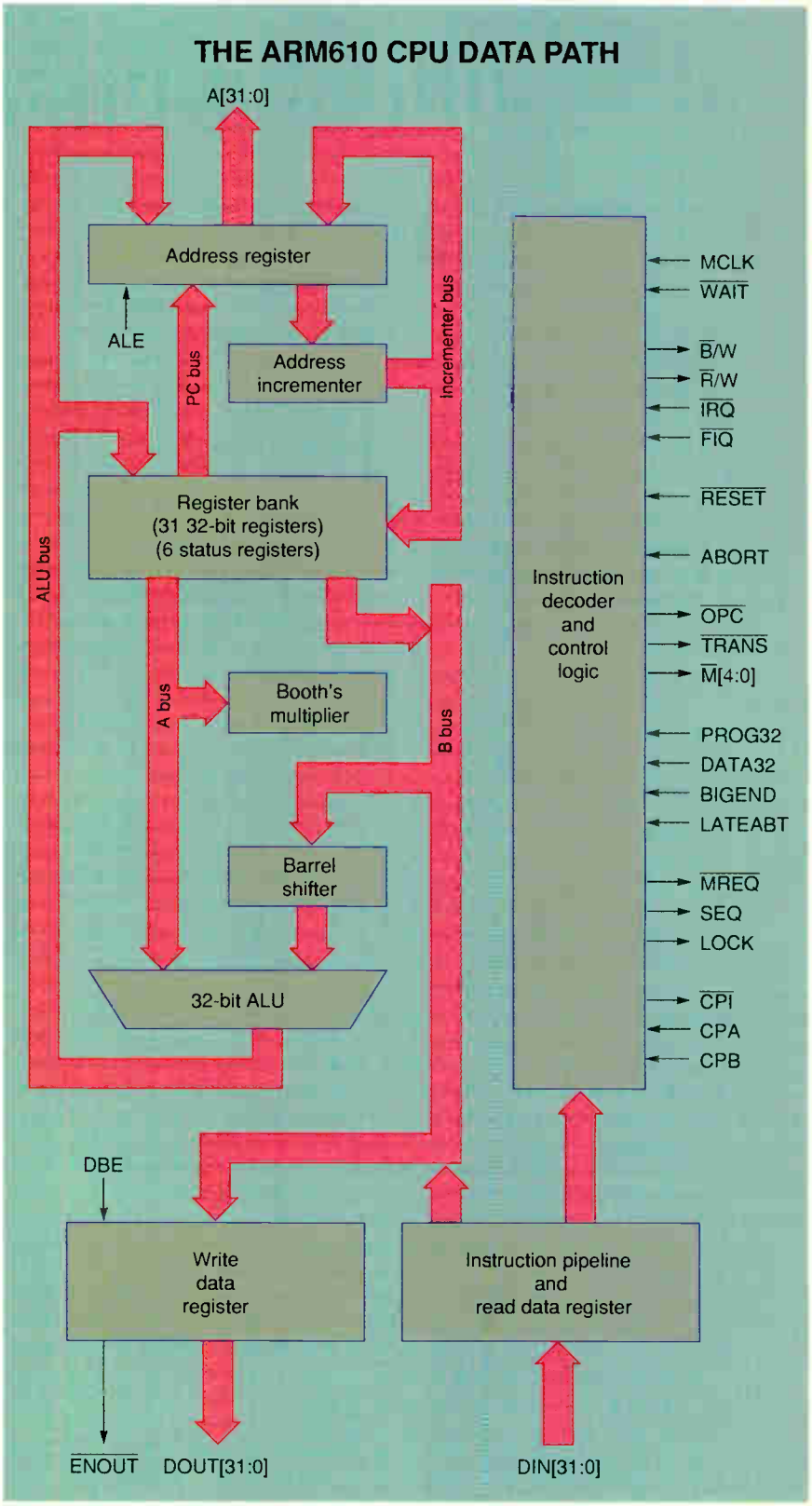

Figure 2: *Of the ARM's 37 32-bit registers, only 16 data registers and two status registers are visible to the programmer. The other data registers get switched in whenever any exception is processed for the ARM's internal use.*

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Origins of the ARM

Acorn, designer of the ARM (Advanced RISC machine) architecture, was founded in 1979 by Chris Curry and Herman Hauser, both of whom had previously worked with Sir Clive Sinclair, inventor of the legendary Sinclair Research ZX80. The firm shot to success by winning a BBC design competition for an advanced personal computer to accompany an educational TV series. The BBC Computer (which users nicknamed the "Beeb") used Motorola's 8-bit 6502 processor. The Beeb was advanced for its time; it had higher-resolution color graphics than the Apple II and a fast (2-MHz) processor.

By 1983, Acorn was looking for a successor to the 8-bit 6502, which had reached an evolutionary dead end. Acorn's designers were unimpressed by Motorola's 68000 and Intel's 8086. The BBC system software depended heavily on the excellent interrupt response of the 6502, and adopting the comparatively sluggish 68000 would have meant adding lots of DMA and other hardware complications. Instead, Acorn bravely—some say foolishly—designed its own CPU, the true heir to the 6502. A 32-bit CPU, the ARM CPU skipped a whole generation. Acorn based the design on the then-new RISC ideas pioneered at Berkeley.

Acorn appointed Steve Furber (who is now ICL Professor of Computer Engineering at Manchester University) chief architect, and VLSI Technology the silicon foundry. Using VLSI's CAD software, Furber's Cambridge team laid out the ARM—their first CPU project—in 18 months using software simulation rather than hardware prototypes. It worked from first silicon, clearly vindicating the RISC philosophy.

Acorn's third-generation chip, the ARM3, still powers the Archimedes PC, which is widely used in British schools. The ARM3 introduced a two-speed caching scheme that predates Intel's DX2 clock-doubling technology by several years. VLSI Technology's version of the ARM CPU, sold as an embedded controller, found its way into the Radius Graphics Accelerator for the Macintosh, thereby bringing the chip to Apple's attention.

add an FPU. However, it does implement coprocessor 15 on-chip and uses it to control the ARM610's various subunits, including the cache, write buffer, and MMU. You must therefore use coprocessor instructions to perform operations like flushing the cache or enabling address translation. One such control instruction switches the ARM610 chip between big-endian and little-endian byte ordering, and another switches between 32-bit and 26-bit addressing for compatibility with older ARM software (the earlier ARM1, ARM2, and ARM3 had only 26-bit address buses).

The ARM610 is a fast CPU designed to work with slow, inexpensive DRAM memory systems; therefore, it contains an on-chip cache. This 4-KB mixed data and instruction cache holds 256 lines of four words (16 bytes) each, organized as four blocks of 64 lines (64-way set-associative). This extraordinarily high degree of associativity entails very complex checking logic when compared to, say, the Intel 486's 8-KB four-way cache. But it greatly improves the hit rate, which otherwise would be poor in such a small cache. Such logic is hard to design, but it makes for a smaller and less power-hungry chip than would simply adding more cache RAM.

In another power-saving move, ARM turned off the cache RAM's sense amplifiers on the ARM610 for all accesses except the first one during sequential memory accesses. (Modern fast RAM cells use analog sense amps to second-guess digital voltage transitions before they are stabilized, but they consume a lot of power.)

The ARM610 uses a write-through cache. Rather than writing directly to memory, it writes to a write buffer that can hold up to eight words and two separate addresses. The buffer then completes the write to memory in its own time, allowing the CPU core to execute the next instruction without pause. This further insulates the CPU from low-speed RAM. Up to two write operations can be pending in the buffer, and one of these writes can be a sequential transfer of seven words to consecutive addresses. The MMU controls both the write buffer and the cache, so it must be enabled to use them.

The MMU

The most radical aspect of the ARM610 is its MMU, which combines a sophisticated conventional virtual memory controller with a novel scheme for partitioning memory along object-oriented lines. This aspect of the chip's design is the subject of a patent held by Apple Computer and licensed to ARM.

Virtual memory is the use of secondary storage (typically a hard disk) to extend the amount of available RAM by transparently swapping blocks between disk and memory. Instead of accessing physical RAM locations directly, all application programs work through virtual addresses.

The virtual address space is much larger (often measuring gigabytes) than the actual amount of RAM present, and it is divided into units, called *pages*, that get swapped between disk and memory. The MMU keeps in memory a set of tables that map the virtual page addresses into physical RAM locations.

When a program tries to access an object whose virtual address falls in a page that's not in memory, the MMU raises a special kind of exception called a *page fault*. The CPU traps this fault and then jumps into an operating-system routine called the *virtual memory manager*, which swaps in the required page (and in so doing may swap out another page to make room). The MMU then updates its page tables, the suspended task restarts, and the memory access succeeds as the MMU translates the virtual address into a real memory address.

The ARM610 MMU maps both virtual addresses and memory-access rights. Every address is protected by permissions, in much the same way as files are protected under Unix. When a task attempts access, there are two considerations: whether the address is actually in RAM, and whether the requester has permission to access it. Attempting to access an address without permission results in a *permission fault* exception. The novelty of the MMU is that it maps virtual memory and permissions as separate, orthogonal concepts.

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The ARM610 Instruction Set

The ARM610's instruction set is small and regular, as you would expect from a true RISC processor. The most unusual fact about ARM (Advanced RISC machine) instructions is that they are all conditionally executed. The 4 most significant bits (28 through 31) of every instruction code form a condition field that is compared with the contents of the N, Z, C, and V flags in the PSR (program status register) before execution. Only if this test succeeds will the CPU execute the instruction.

Unexecuted instructions don't cause an abort, but instead proceed through the pipeline, acting like a NOP (no operation). Conditional instructions let you avoid writing explicit branch instructions in many cases, and since a skipped instruction is less costly than the pipeline break caused by a branch, this greatly improves the processor's throughput. RISC processors with deeper pipelines, like the Sun SuperSparc and Mips R4000, have adopted more complex schemes such as "delayed branch with annulment on branch not taken." This approach may be faster, but it lacks the elegant simplicity of the ARM scheme.

There are 10 main ARM instruction types that are encoded in a 32-bit word. Each of these types can be modified by the 16 possible condition-field values; in the ARM assembly language, this is symbolized by appending the two-letter condition name as a suffix to the main mnemonic. Thus, ADDEQ would be "add if Z flag is set," and MOVHI would be "move if C is set and Z is clear." The first two instruction types perform data processing. The first breaks down into 16 integer addition, subtraction, and logic instructions, while the second comprises the hardware multiply instructions.

The next three instruction types are the data transfer instructions, which load and store register contents to main memory. These comprise the single register transfers (LDR and STR); the single data swap (SWP), which exchanges the contents of a register with a memory location; and the block data transfers (LDM and STM).

The ARM610 supports only base relative addressing (and PC relative addressing if you choose R15 as the base register), but it has tricks to achieve more complex modes. The U, P, and W bits in the instruction code determine whether to add or subtract the offset to the base register, either before or after the transfer and with or without writing back the modified base address. Thus, you have the effect of pre- or post-indexed automatic incrementing and decrementing. The block transfers can load or save any subset of the currently visible registers.

There are just two branch instructions—branch and branch with link (B and BL)—but, again, these can take 16 conditional forms. Branch with link saves the old contents of the program counter into register R14 of the current bank.

The last three main instruction types are the coprocessor instructions, which comprise data transfers between coprocessor and main memory (LDC and STC), register transfers between the ARM610 and the coprocessor (MRC and MCR), and coprocessor internal operations (CDP). Another special instruction, software interrupt (SWI), forces the CPU into supervisor mode. You can use it to call operating-system routines. The ARM610 ignores the 24-bit operand field of this instruction, but it's useful for passing information to the supervisor routines.

In truly object-oriented systems, objects are protected entities; only those tasks that are *methods* of the class of which an object is an instance can legally access its data. Enforcing this protection in software is a slow process, since it requires that all data be accessed indirectly via a class table. The ARM610 supports this protection efficiently in hardware. By combining address and permission mapping, the chip can divide the virtual address space into a fine-grained, protected object store.

Three major components of an object-oriented operating system can benefit from this hardware support. The virtual memory manager uses address mapping to control disk swapping. A *persistent object store* uses both address and permission mapping to bring objects transparently into memory when they are referenced. And a concurrent garbage collector can use permission mapping to deny all programs access to the region of memory that it is currently "sweeping."

Persistent object storage erases the distinction between the concepts of "in memory" and "on disk" from the user's viewpoint. There are no files—just a catalog of objects that you can activate without knowing their storage location. Any system that uses dynamically created objects needs a garbage collector to stop the memory from clogging up with redundant objects.

Current systems use garbage collectors that periodically take over the whole machine. This behavior is responsible for that noticeable pause familiar to any Smalltalk or Lisp programmer. The ARM610 MMU lets you implement an efficient *concurrent* garbage collector as a permanent background task. Any other task can call upon the garbage collector, which protects each page of the task's memory in turn, copies any live objects (i.e., ones that have valid pointers) into an active page, and disposes of all other objects.

Put more formally, the ARM610 MMU maps permissions via the concept of *domains*. 16 contiguous and disjoint regions of virtual memory that are distinct from pages. All tasks run in an *environment* consisting of a set of permission maps for one or more domains. The environment is said to be a client of these domains. An environment might have a different permission map for each domain of which it's a client, but all clients of a domain share the same virtual address mapping.

An object-oriented operating system assigns a software manager to each domain, and these managers dole out permissions to application tasks. Object-oriented programming systems map their classes onto domains, using the MMU to protect each object's integrity.

Virtual Memory

The ARM610's MMU keeps its translation tables in physical memory, but the

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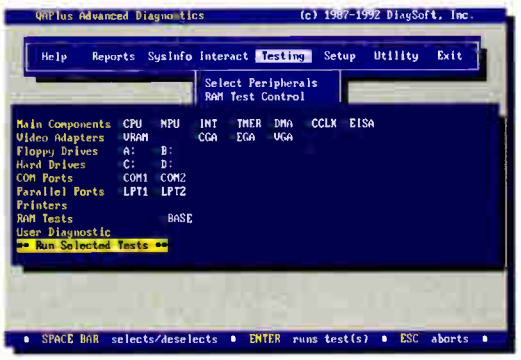

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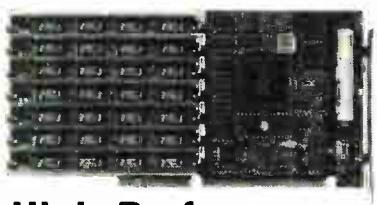

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table entries are cached in an on-chip TLB (translation look-aside buffer) that has room for 32 addresses. The virtual address space can be mapped either in 1-MB sections, which require only a one-level table lookup, or in pages, which need a second lookup level. The MMU supports small (4-KB) or large (64-KB) pages. Large pages allow single table entries to map large data objects. This helps to keep the translation tables small.

When the CPU requests a memory access, the MMU's access-control logic first looks in the TLB for a translation of the virtual address. If it's there, the access-control logic checks to see whether the access is permitted. If so, the MMU outputs the physical address immediately. If the TLB misses, then the MMU computes an index into the external translation table, which is offset from an address held in the on-chip translation-table base register.

If this translation-table entry is for a section, it will contain the actual base address of the section. This is combined with an index contained in the virtual address to give the physical address. If the translation-table entry is for a page, then it contains the base address of another table, the *page table*, and a second lookup is required to get the physical address. In both cases, the MMU checks permission before the access proceeds, and it updates the TLB by overwriting the existing entry with the resulting physical address.

A Compact CPU

If the Sun SuperSparc and the DEC Alpha were top-fuel dragsters, the ARM610 would be a European sports car. It's small and economical, but it still outperforms popular PC CPUs like the 486 and 68030. And its MMU contains the key to the next generation of system software.

Although ARM isn't yet a mainstream architecture in the U.S., Apple will benefit from its many available language compilers and programming tools. That would not have been the case if Apple had used a totally new processor in the Newton. Also, ARM's lack of mainstream status is unimportant, because few people will want to port old PC or Mac software to such a radically different computer.

Newton created one of those rare conceptual breaks in computer evolution that opens up a brief window of time in which a new, more suitable processor can be adopted, free from compatibility constraints. I'm glad Apple had the courage to grasp the opportunity. ■

Dick Pountain is a BYTE consulting editor based in London. You can reach him on BIX as "dickp."

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BEN SMITH

BASH, THE BOURNE AGAIN SHELL

Ever since AT&T's Korn shell (developed by David Korn) appeared, the Unix community has been looking for a freely distributed version of this excellent shell. The Free Software Foundation's BASH (the Bourne Again Shell) fulfills that requirement. A Unix shell is the program that interprets user commands and script programs—essentially, it's the user interface. Prior to the Korn shell (and now BASH), the two most popular Unix command interpreters were the Bourne shell (i.e., `/bin/sh`, the old AT&T standard) and the Berkeley C shell (i.e., `/bin/csh`).

The features that the commercial Korn shell and the free BASH both offer are fast performance; functions and command-line aliases; tilde expansion to home directory paths; many `set` options for configuration, control, and debugging complex scripts; a dynamic shell variable that keeps track of the working directory; and an easy-to-edit command history—while maintaining the basic syntax of the standard Bourne shell. BASH includes the best features of the Berkeley C shell, including job control and an embedded arithmetic interpreter.

A free Korn-shell replacement from the Free Software Foundation

One feature that makes the Korn shell so popular is the command-line editor, which BASH includes. As with the VMS command interpreter, you can scroll through previous commands, edit them, and issue the edited version. Unix shell command editors can look like either `vi` or `emacs`, depending on your preference. With the appropriate commands, you can use all the line-editing operations you're used to, including cut and paste.

The most obvious difference between the Korn shell and BASH (besides the license) is in the command-history expansion syntax. The Korn shell uses the syntax `r` *command-abbreviation*, where *command-abbreviation* can be a command number or the first few characters of a recently issued command. The Korn shell's `r` is actually an alias for `fc -s`, the Korn shell's fix-command program.

BASH, on the other hand, uses a syntax that is nearly identical to that of the Berkeley C shell, a "bang" character followed immediately by an abbreviation. The only difficulty with using the bang character for history is in issuing E-mail and UUCP commands, which use bangs to separate network address elements. To prevent the shell from interpreting the bang as a history command, you have to preface it with a backslash, as in `uunet\!bytepb\!ben`.

BASH has been ported to a huge list of machines. It is professionally supported by a team of programmers that can be reached at `bash-maintainers@ai.mit.edu`. Brian Fox is the primary author.

The source code for BASH (BASH.SRC) is available on BIX as well as on a great number of anonymous FTP sites. BYTE is now posting the source code for Software Corner and Some Assembly Required on the UUNET system, under the directory path `/published/byte`. UUNET is the most connected computer in the world. By placing our files on UUNET, we are making them available to 11 million computer users. For more information about UUNET, send E-mail to info@uunet.uu.net or retrieve the file `uunet:/published/byte/README`. ■

MAC/Tom Thompson

Viewing JPEGs with JPEGView

JPEG is an up-and-coming standard for compressing image data. That's good, because JPEG can trim the size of large 24-bit images, thus conserving hard disk space. But it's bad if a JPEG-encoded file lands on your Mac and you don't have an application that understands this format. Enter Aaron Giles's JPEGView 1.1, a freeware utility that lets you view almost any flavor of JPEG file on the Mac.

JPEGView can read PICT images, JPEG-encoded PICT images (courtesy of QuickTime's compressor/decompressor software), and JFIF (JPEG File Interchange Format) files. JPEGView works reliably, too. I've used it to read JPEG-encoded images produced by Adobe Photoshop. You can then save the image in standard PICT format for use in your graphics application. If you think your work with graphics might involve JPEG-encoded files, keep JPEGView handy.

DOS & WINDOWS/Steve Apiki

Easy-Open Windows Files

Opening and reopening Windows application files can be tedious, especially if the data files for a single application live in many different directories. Open Axess 1.4 (i.e., Axess104.exe) is a $10 shareware utility by Steven Gutz and Randy Westman that remembers the last few filenames, file types, and directories that you've accessed, sparing you the trouble of navigating the same directory tree access after access.

Open Axess takes advantage of the Windows 3.1 Common Dialogs. When you launch Open Axess, it hooks into the common File Open dialog box. Thereafter, any time you choose File/Open from an application that uses Common Dialogs, you get a dialog box with its control menu augmented by several Open Axess menu choices. The menu choices let you instantly choose from among the last few files, types, and directories you've opened. You can also specify a list of permanent files.

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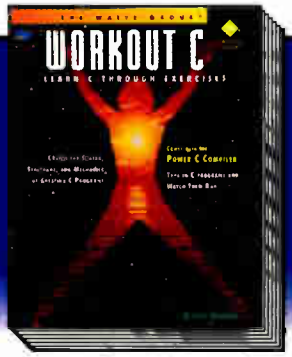

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BRUCE D. SCHATZMAN

AN OBJECTIVE WAY TO COMPUTE

Externally, Windows NT looks like Windows 3.1. But internally, Windows NT is as similar to Windows 3.1 as CP/M is to VAX/VMS. It took Microsoft over three years to design and build NT. Why? What is so different? The answer lies not so much in describing preemptive multitasking or symmetric multiprocessing, but in the overall system model itself.

Windows NT is different because every component is woven from the same material into a smooth, consistent fabric. While earlier versions of Windows resemble a patchwork quilt of components, Windows NT is more like a long, continuous piece of cloth.

The new operating system gets its smooth uniformity from a design that is completely object-based. Virtually everything in the operating system is defined as an object, and an important component of NT, called the object manager, is dedicated solely to overseeing the creation, usage, and destruction of these objects.

The Object Rationale

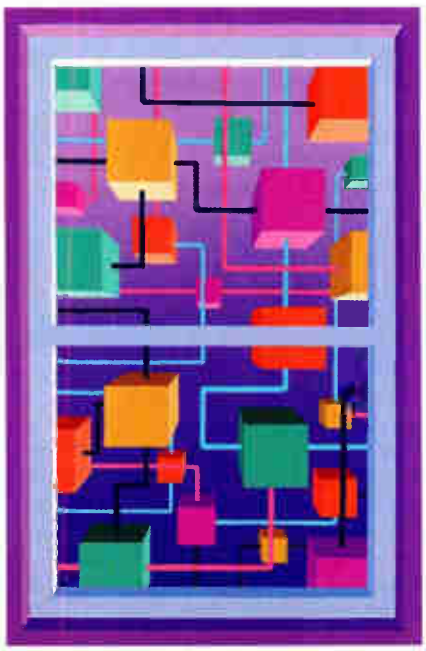
Windows NT is among the first of a new generation of operating systems that use an object-based model. Most operating-system manufacturers are switching to this model to leverage the advantages offered by OOP (object-oriented programming). OOP lets programmers think in terms that more closely model the real world. Instead of writing procedures that manipulate data as a separate entity, OOP lets you define objects of different types that combine attributes (i.e., data) and behavior (i.e., procedures) into a single package.

OOP also allows a more natural way of achieving abstraction, which lets programmers deal with higher-level components without having to deal much with the lower levels of the system. Thus, objects can be treated like "black boxes"—the manufacturer (in this case, the programmer) of the black box simply describes what it can do and how to use it.

Besides the greater power available to programmers, basing everything on objects usually leads to a simpler and more elegant design. If everything is defined as an object, you can manage all system elements in a single, consistent manner rather than using a different mechanism for each type of element. This makes the system much easier to modify or extend.

Note, however, that Windows NT is not a *true* object-oriented operating system. Most of it is written in C, not C++. Some of the advantages of C++ (e.g., inheritance and polymorphism) were therefore not available to the NT designers. But contrary to popular belief, C++ or any other OOP language is not a prerequisite for achieving an object-based design. Pen-

An object-based system model sets Windows NT apart from its predecessor



Point appears to the user (and programmer) to be object-oriented in every respect, but it too is written mostly in C. Thus, I use the term *object-based* instead of *object-oriented*, which is a stricter definition.

NT Objects Defined

Virtually everything handled by Windows NT is an object. Files, processes, threads, RAM sections, drivers, and devices are all examples of objects. All NT objects follow a generic template that is divided into two parts: header and body. An object header contains fields of data such as the object's name, a security descriptor, and its temporary or permanent status. The body contains a set of data values (or attributes) that are relevant to the type of object and a set of functions (or services) that operate on that particular object.

All objects have the same kind of information in their header, but the body is specific to each type of object. Thus, a process object has different attributes and services than a file object, but both have the same header structure. For example, a file object has a *size* attribute and a *write* service, neither of which is relevant to a process object. Likewise, a process object has attributes and services that would not be used by a file object. The figure illustrates the generic object template and a specific object type (i.e., a process) that follows the template.

The primary benefit of having a standard object template is the ability to handle a wide range of system elements in a consistent manner. For example, all objects in the system have a *quota-charges* attribute that records the resource cost of using that object. Thus, a resource accounting program that monitors system resource usage can be built easily because there is no reason to write different code to handle each type of system element differently.

The Object Manager

Because objects are such a pervasive part of the Windows NT operating system, it

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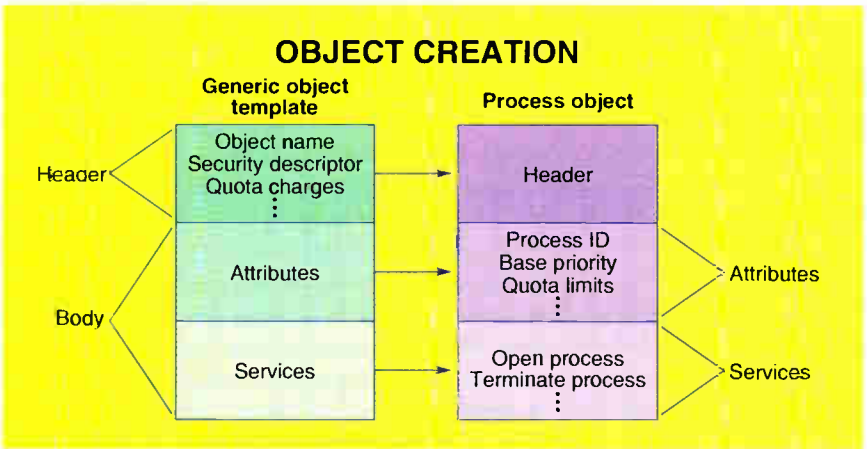

Windows NT creates specific new objects from a generic object template. Here, the created object is a process.

makes sense to have a software module dedicated solely to the management of objects. The NT object manager performs this role. The object manager provides a set of basic object management services to processes that want to manipulate objects. These basic services include object creation, location, and destruction.

However, the object manager oversees only the lowest common denominator of object operations; it is not responsible for performing object-specific operations because it knows nothing about the internal structure of an object or what it might be used for. For example, if a thread tries to write to a file, the object manager becomes involved in security considerations (an operation common to all objects); but when data must actually be written to the file, the object manager calls upon the I/O subsystem to perform the operation.

Every manipulation of an object must pass through the object manager at one level or another, and this has many desirable consequences, especially in the area of security. A central idea behind Windows NT security is to create a gate through which every use of system resources must pass. Because every resource is an object, the object manager becomes this gate.

The Key to Security

Security is a perfect way to illustrate the benefits of NT's object-based operating-system model. In many operating systems, the security system consists of some loosely associated modules, each of which is responsible for a certain type of resource (e.g., files, memory, or processes). Although this works, there are disadvantages to the design. The primary downside is complexity. It is difficult for system programmers to implement different security systems for different system resources, and adding new security systems for new resources is not straightforward.

In contrast, Windows NT offers a centralized security system that works hand in hand with the object manager to provide a uniform security system for virtually all system resources. Because all resources are represented by objects, and all objects have a well-defined format, the security system acts upon resource objects in a consistent manner. The result is a much cleaner design that is easily extensible when new object types are introduced.

When a user logs onto an NT system, the user's credentials (i.e., ID and password) are authenticated by the LSA (local security authority) process. Note that *log-on* now means local log-on to an NT workstation on your desktop as well as remote log-on to an NT server across a network. Thus, the operating system now secures both the desktop and all network servers, instead of just network servers.

If the LSA finds the user's credentials in the server's encrypted security database, NT creates a user process and permanently attaches it to an object known as an access token. An access token is like a security pass that is checked when the user's process tries to access a system resource.

On the other side of the equation, all system resources (i.e., objects) have a security descriptor, which states the access rights to that resource. The security system therefore compares access tokens to security descriptors to approve or deny access. For example, when a user process tries to open a file for write access, the object manager sends the process's access token to the security system, which checks the file's security descriptor to see if the privileges in the access token are sufficient to write to the file.

Each security descriptor contains, as its main component, an ACL (access control list), which is a list of users and privileges that apply to that object. An object's ACL can be modified only by the owner of the object. Thus, access to resources is completely at the discretion of the resource owner and is applicable to any system resource, providing an extremely fine level of security granularity. If desired, ACLs can specify groups of users or all users, which makes resource access easier to set up and administer.

The Programmer's Perspective

Although objects are an important part of NT, most Windows programmers will never see them directly. This is because virtually all programming for the Windows NT operating system is done through the Win32 subsystem, which provides a 32-bit superset of the Windows 3.x APIs. An application running on Win32 doesn't need to know that it is running on NT at all, and you don't need to know anything about NT objects to write applications for NT.

However, programmers creating system-oriented programs such as backup utilities or desktop extensions need to access objects directly. In this case, objects are handled much like files are handled in traditional programming. Programmers can easily deal with objects because they are already familiar with manipulating files.

If Windows NT looks like Windows 3.1 to the user, was it worth the effort to build such a sophisticated object model? The answer is most definitely yes. In addition to the benefits I've outlined, the existence of an object-based infrastructure indicates that Windows NT was designed to be the foundation of future operating environments that Microsoft will deliver.

Although the object model is completely internal and not visible to the user, expect future versions of Windows to externalize an object model in the user interface. This externalized object model will probably use Windows NT object services for infrastructure and include major extensions for object management through OLE 2.0 and other object services. When this happens, computing will change dramatically, and users will interact with computers in a completely natural manner. ■

ACKNOWLEDGMENT

Thanks to Helen Custer, author of Inside Windows NT *(Microsoft Press, 1992), for providing much of the reference material for this article.*

Bruce D. Schatzman is an independent systems consultant in Bellevue, Washington. You can reach him on BIX c/o "editors."

World Radio History

ASK BYTE

Lean, Mean Windows

Is there a run-time version of Windows that I can use to run a low-end Windows desktop publishing package in standard mode without dealing with the intricacies of Windows itself? If not, which Windows program files do I need to absolutely run this software in standard mode?

Charles Izevbigie
Tallahassee, FL

Some vendors included a run-time version of Windows with their applications before the advent of Windows 3.0. Unfortunately, run-time versions are no longer available.

The Windows 3.1 installation program lets you load the minimum files required to run in standard mode. The minimum configuration requires between 5 and 6 MB of disk space. If you want to pare Windows down even more, use the Windows Setup Option menu to remove nonessential files from your Windows subdirectory. Target the READ.ME, .BMP, and .WAV files; accessory applications; games; and screen-saver files. If you decide you need a file again, simply repeat the process to add it back into your Windows subdirectory.

—Stan Wszola

Tracks and Sectors

Is there a reason why I shouldn't format a 3½-inch high-density floppy disk to 720 KB in a 1.44-MB drive using the Format command's `/f:720` or `/s:9` switches? Why can't I use Diskcopy to duplicate a 720-KB floppy disk to a new, unformatted 1.44-MB floppy disk?

Christopher Bedford
Lansdowne, CP, South Africa

It's physically possible to format a 1.44-MB floppy disk to 720 KB, but I wouldn't do it. There are differences in the magnetic media for the various types of densities, and the head current to write to the different media varies proportionately. A 1.44-MB disk requires higher write currents than a 720-KB disk. Your 1.44-MB/720-KB drive will switch to the lower write current when you format to 720 KB. Using the lower write current on a disk that requires the higher one will make your disk unreliable. This same reasoning applies in reverse: You cannot reliably format a 720-KB disk to 1.44 MB (and you should never use those disk hole punchers that let you do so).

As for your Diskcopy question, the answer becomes obvious when you consider the sector differences. All the 3½-inch disk formats use 80-track sectors, but a 720-KB floppy disk has nine sectors per track, while a 1.44-MB floppy disk uses 18 (a 2.88-MB floppy disk uses 36). If you try to run Diskcopy, the program doesn't know which 720 KB of the 1.44-MB disk you want to use. The reverse situation is more obvious, because it's physically impossible to cram 1.44 MB of data onto a 720-KB disk. Diskcopy will simply read the two disks and refuse to copy unless they're identical.—Stan Wszola

CP/M Conversion Artist

I want to move my WordStar book manuscripts from a Morrow Designs MD-3 CP/M system to a 386 machine and convert them for use with Microsoft Word for Windows. Are there any programs that can read WordStar files on CP/M floppy disks? Is there a service that will convert them? Unfortunately, I don't have OCR (optical character recognition) hardware and software to read the printed pages.

Wayne Irwin
Northridge, CA

Media Master from Intersecting Concepts (30851 Agoura Rd., Suite 200, Agoura Hills, CA 91301, (818) 879-0086; fax (818) 879-0623) is a universal disk-conversion program that reads about 200 foreign disk formats, including the 40-track MD-3 disks. To use it, run the software, insert the CP/M disk, and simply copy the files to your 386 hard drive. Once the files are on your new machine, Word for Windows should be able to convert them from WordStar format.

Media Master has one drawback: It hasn't been updated for DOS 5.0. Under DOS 5.0, your 80-track, 1.2-MB floppy drive won't be able to read the 40-track format. If you run DOS 5.0, you'll need to get a 360-KB floppy drive or boot up from a DOS 3.x or 4.x boot floppy disk.

—Howard Eglowstein

Video Control

I have a Sony camcorder with the Control-L port that Tom Yager mentioned in his article "Practical Desktop Video, Part 2: Raw Material" (May BYTE). I want to build an editing controller for my camera, but my dealer doesn't have access to any documentation for this port. Where can I get it?

David Annett
Upper Hutt, New Zealand

Sony publishes the Control-L specification in a document called "Protocol of Control-L," publication #997245311. In the U.S., it's available from Sony Publications (P.O. Box 20407, Kansas City, MO 64195, (816) 891-7550 ext. 33). The U.S. office isn't equipped to send copies overseas, so you should ask your local dealer to order it for you, or have a friend in the U.S. order a copy and mail it to you.—Howard Eglowstein

BYTE on UUNET

For years, BYTE has offered electronic copies of each month's featured programs through BIX. Now we're also posting these files on UUNET. If you have access to any machine on the Internet, you can retrieve files from UUNET for free. The most common method for retrieving files is to use FTP utilities. A version of FTP exists for nearly every popular operating system today. Here's what to do.

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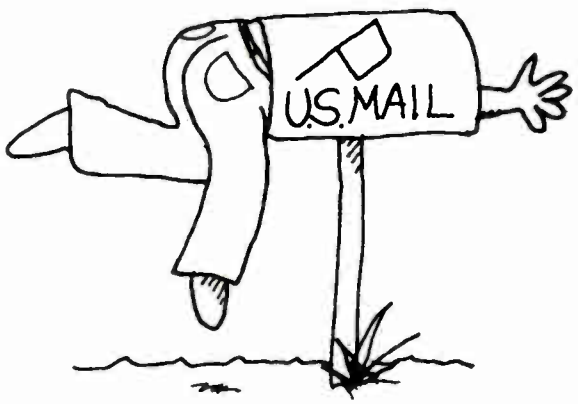

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ASK BYTE

Once you're on the Internet, type `ftp uunet.uu.net`. *FTP should respond with*

```
Connected to uunet.uu.net
220 uunet.uu.net FTP server (Version 4.1
   8/1/ 8/1/91) ready
```

followed by

```
Name (uunet.uu.net:ben):
```

Enter your user account name or press the Return key to use the default. At the ftp> prompt, type `help` *to see a list of all the commands. Commands can be abbreviated.*

Go to the BYTE files by changing your working directory to the top of the BYTE file tree (i.e., `cd/published/byte`*) and list the files. The file lines that begin with* `d` *represent subdirectories with files that pertain to the issue date indicated. Here's a sample session:*

```
ftp> dir
drwxr-xr-x 7 cas0005  other  112 Aug 16
   13:45 oct92
drwxr-xr-x 8 cas0005  other  134 Sep 12
   13:02 nov92
226 Transfer complete.
ftp> cd nov92
250 CWD command successful.
ftp> dir
-rw-r-r-7 cas0005  other  12999 Aug 16
   13:45 bash.tar.Z
-rw-r-r-8 cas0005  other  45231 Sep 12
   13:02 whisk.Z
226 Transfer complete.
```

To retrieve whisk.Z, enter

```
get whisk.Z
local: whisk.Z remote: whisk.Z
200 PORT command successful.
150 Opening BINARY mode data connection
   for whisk.Z (45231 bytes).
226 Transfer complete.
45231 bytes received in 21.74 seconds
   (2.03 Kbytes/s)
ftp> quit
221 Goodbye.
```

If you want to use filename globbing to retrieve more than one file, use FTP's `mget` *command. FTP has many other options that speed up multifile transfers.*

This file-retrieval process is equally as simple from Singapore as it is from the University of California. We look forward to seeing more international readers accessing the software that we publish in BYTE.—Ben Smith ■

The BYTE Lab welcomes your questions. Address correspondence to Ask BYTE, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send BIX mail c/o "editors."

We read every letter, but due to the volume of mail received, we cannot guarantee a response. We edit all letters for clarity and brevity. Letters appear in BYTE about four months after we receive them.

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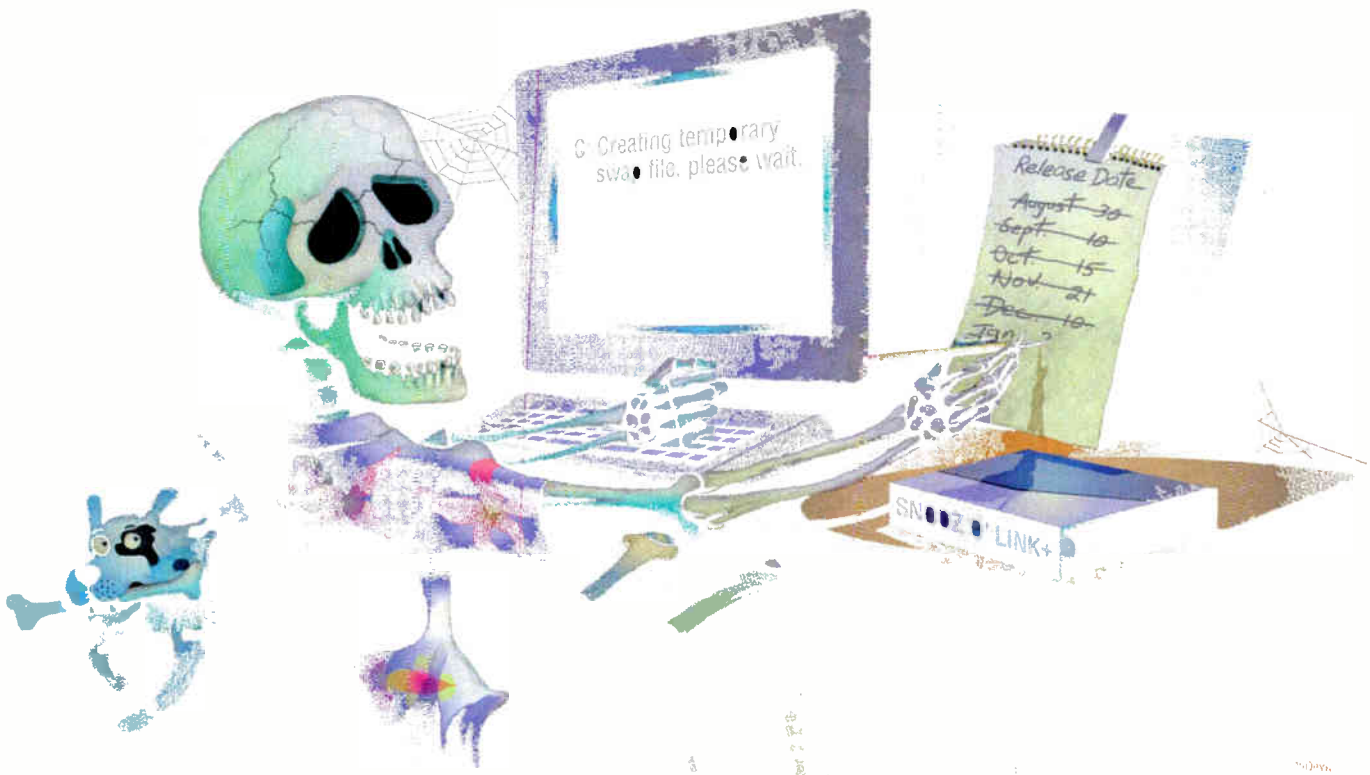

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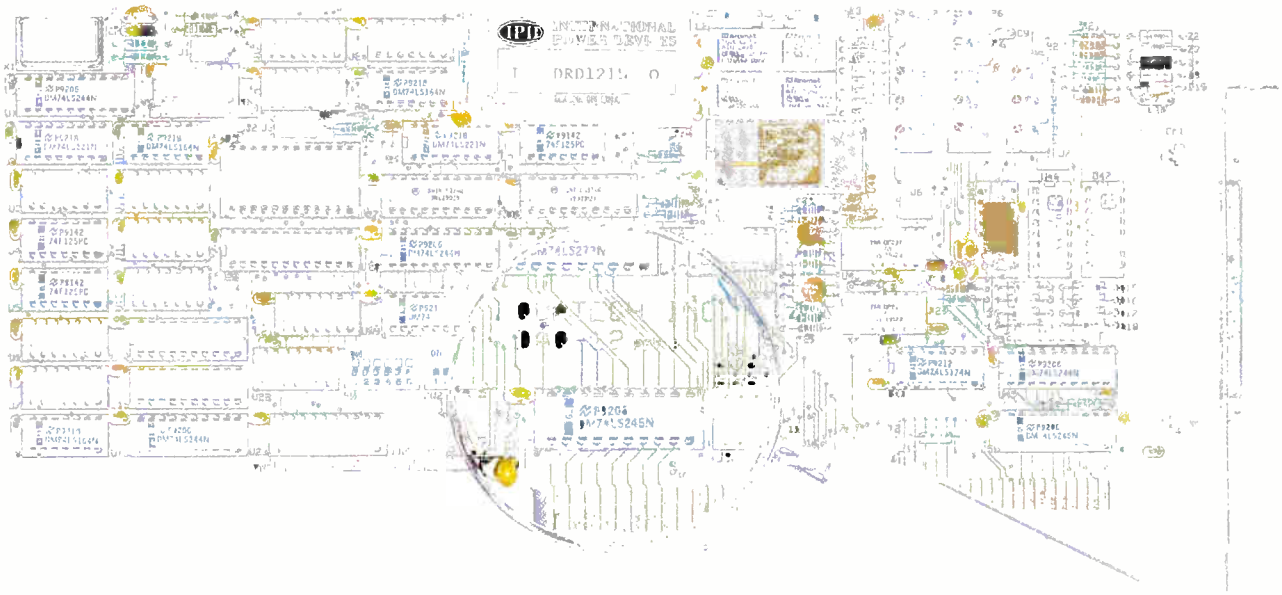

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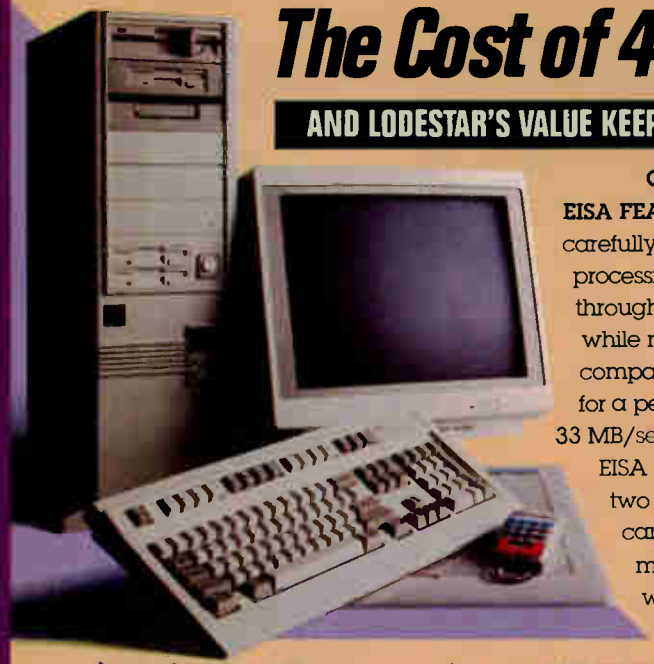

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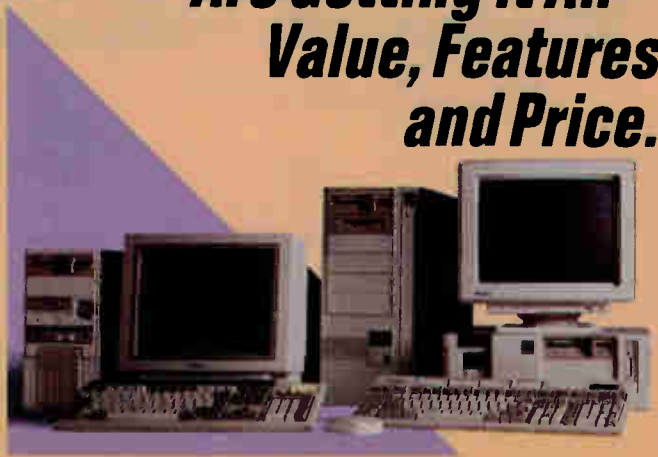

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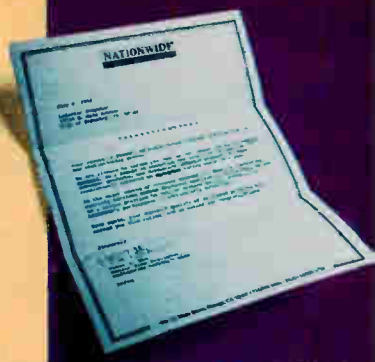

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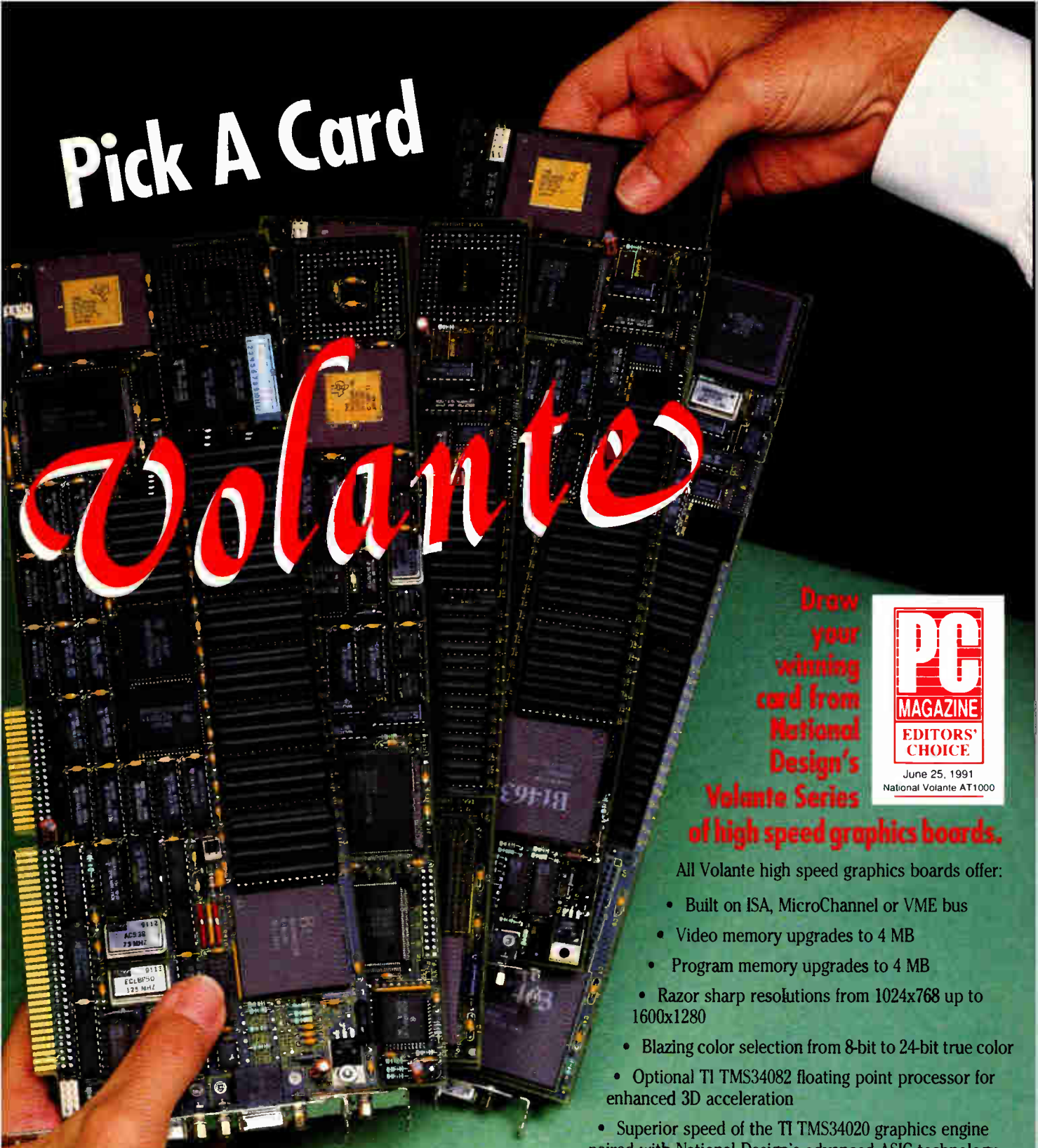

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- Config. as COM1-COM2

VALUE

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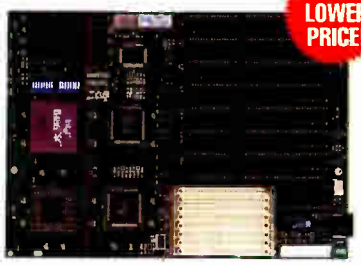

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MCT-VGA-3000 1024x768, 512Kb DRAM $89.95
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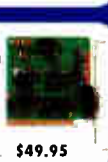

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CP-3000	Conner	42Mb	28ms	3.5" IDE	$189
ST-351A	Seagate	42Mb	28ms	3.5" IDE	$199
CP-30084	Conner	84Mb	19ms	3.5" IDE	$269
ST-3096A	Seagate	88Mb	16ms	3.5" IDE	$269
CP-30104	Conner	120Mb	19ms	3.5" IDE	$319
ST-3144A	Seagate	131Mb	16ms	3.5" IDE	$349
CP-3204F	Conner	212Mb	16ms	5.25" IDE	$499

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FDD-1.2 1.2Mb, 5.25", Beige $89.95
FDD-360 360Kb, 5.25", Black $89.95
FDD-2.88A 2.88Mb 3.5" drive, Beige $149.95
FD-505 5 25" & 3.5" cambo drive, Beige $149.95

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MCT-CIDEFH 16-bit IDE CACHE controller $199.95
MCT-IDE-8 8-bit IDE controller $99.95
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SOUNDBLASTPRO 8-bit MIDI sound board $219.95

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PART #	SIZE	SPEED	TYPE	PRICE
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414256-80	256K x 4	80ns	DIP	5.49
1MB-80	1M x 1	80ns	DIP	4.99
1MB-60	1M x 1	60ns	DIP	5.49
41256A9B-80	256K x 9	80ns	SIMM	14.95
41256A9B-60	256K x 9	60ns	SIMM	16.95
421000A9B-10	1M x 9	100ns	SIMM	39.95
421000A9B-80	1M x 9	80ns	SIMM	45.95
421000A9B-60	1M x 9	60ns	SIMM	49.95
424000A9B-80	4M x 9	80ns	SIMM	149.95
424000A9B-60	4M x 9	60ns	SIMM	159.95

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8087	5MHz	89.95	80387-DXP	≤ 33MHz	89.95
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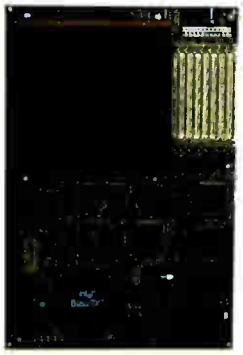
RMB MOTHERBOARDS



Buy Smart...Buy RMB Upgradable Motherboards

Model	No Memory	2 Mb	4 Mb	8 Mb	16 Mb	32 Mb
386 SX-25	$149	$225	$301	$453	$729	NA
386 SX-33 *16k*	$169	$245	$321	$473	$749	NA
** 386 DX-33	$255	NA	$407	$559	$835	$1415
486 SX-25	$275	NA	$427	$579	$855	$1435
* 486 SX-25 *Local Bus Slot*	$349	NA	$501	$653	$929	$1509
* 486 DX-33 *Upgradable*	$599	NA	$751	$903	$1179	$1759
*** 486 DX-33 *Local Bus Slot*	$685	NA	$837	$989	$1265	$1845
*** 486 DX-50 *Local Bus Slot*	$899	NA	$1063	$1227	$1479	$2059
*** 486 DX-50 E1SA *Upgradable*	$1150	NA	$1314	$1478	$1730	$2310

*64k Cache Memory **128k Cache Memory ***256k Cache Memory

Future Upgradability: 486 DX-33 to → DX-2/66 MHz or 486 DX-50 to → DX-2/100 MHz

486DX-50 MHz E1SA *only* $1150

Overdrive socket for easy 486DX-2 100 MHz upgrade. Local Bus Slot

• SIS ATQ chipset • AMI Bios • Intel CPU

The RMB Advantage

MIS managers from across the country are discovering the advantages of upgrading with RMB Motherboards:

- Save hundreds or even thousands of dollars by avoiding replacement costs with upgrades.
- Every RMB Motherboard with SIMM memory comes with the memory completely installed, burned-in and fully tested to assure quality performance.
- **Take the RMB challenge!** If you have an entire department to upgrade, try one RMB Motherboard for 30 days. If you're not completely satisfied, return it for a full refund.*

*Ralin will refund full product price. Price will reflect purchase price or current market price, whichever is lower.

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Maxtor®	7080A 80 Meg IDE with 17ms access time	$229.00
Maxtor®	7120A 120 Meg IDE with 15ms access time	$289.00
Maxtor®	7213A 213 Meg IDE with 15ms access time	$415.00
Maxtor®	LXT-340A 340 Meg IDE with 13ms access time	$769.00

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Magnavox® CM9089 SVGA w/0.28 dot pitch	$289.00
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CTX® CVP-5468A SVGA w/0.28 dot pitch	$269.00

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2400 bps w/ 9600 bps send/receive Fax	(FC 9624)	internal	$ 79.95
	(FX 9624)	external	$ 95.00
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	(VX-V32)	external	$ 199.00
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*WINFAX software option available for $15 if purchased with VFP-V32bis or VFX-V32bis modem.

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Circle 285 on Inquiry Card.

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Mono or color monitor
Up to 5 drives

8.75" high

14" color monitor
Up to 3 drives

12.25" high

Rack Mount Monitors

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8.75" high

14" mono or color monitor

12.25" high

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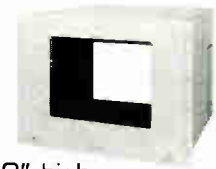

14.0" high

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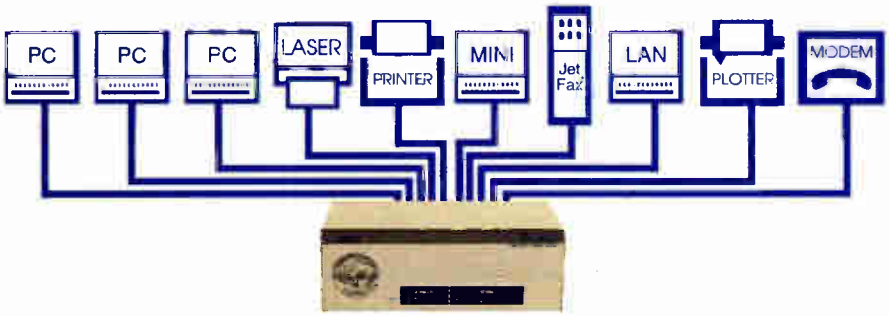

Buffalo SL Series Features:

• Two Models:
SLmkII - 4 parallel and 6 serial ports.
SLP - 8 parallel and 2 serial ports.

• Flexible Configuration:
Any port of your SL Series box may be set as either input or output.

• Rapid Data Transfer:
The SL Series software allows PCs to transmit up to 8,000 characters per second parallel and up to 115,200 bits per second serial, much faster than the DOS serial limit.

• Automatic Switching:
SL Series Buffalo boxes will automatically buffer data, convert between parallel and serial, and route data from your PC to the device of your choice. No commands are needed when sharing only one printer.

• User Upgradable Memory:
SL units are available with installed buffer memory from 256KB to 4MB. Buffer modules can be added later to expand any unit to the full 4MB.

• Easy Installation & Use:
Connect one cable for each PC or output device to the SL Series box. Run the SETUP program to configure the Buffalo box and to install the pop-up menu. Then, simply select your printer and print as you did before you installed the box.

• Pop-up Menu Option:
Select printers, macros, and other control functions using the cursor or a mouse. The pop-up menu appears over other applications and desktop publishing.

• Network Server Support:
Connected to a network server port, the SL Series can direct data to a variety of shared output devices.

• Windows Support:
Buffalo hardware and menu software are Windows compatible.

• Toll-Free Technical Support:
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	Leunig	02241-66071
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World Radio History

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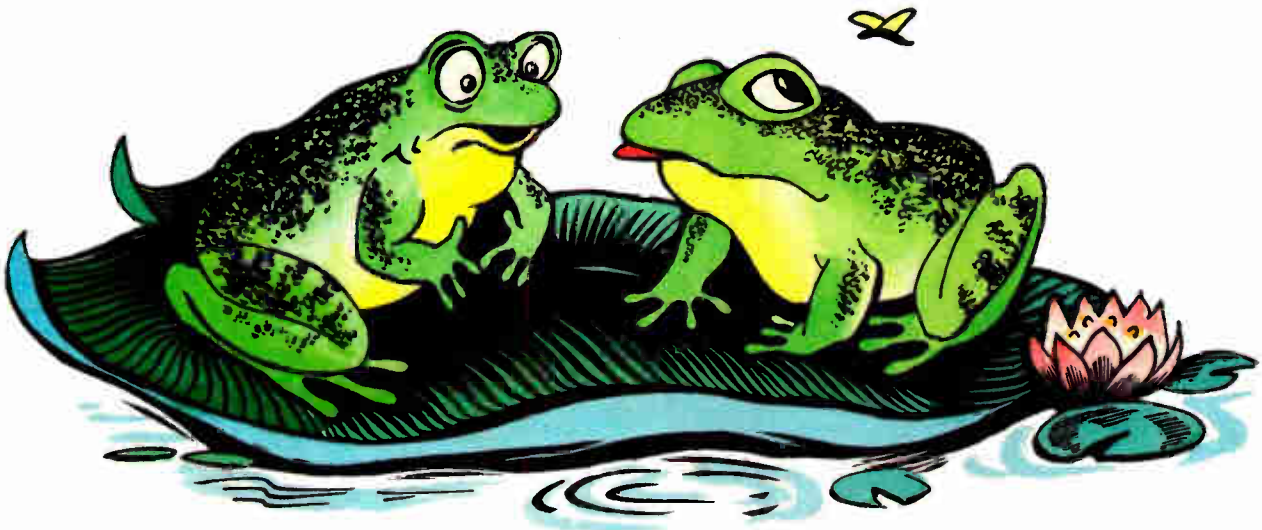

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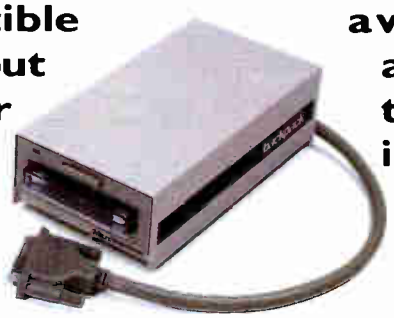

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HORIZONS

A report on power protection.

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Disaster Avoidance, see page 3

IBM users vote BEST's UPS number ONE for second straight year

For the second year in a row, BEST has been named the top UPS by 50,000 owners, users, and buyers of IBM AS/400, RS/6000. and Systems/3X computing products. The FD series FERRUPS® was selected for the coveted 1992 Midrange Systems Buyers Choice Award.

The award recognizes the most innovative and reliable products and services in the IBM midrange computing industry. Winners are chosen by *Midrange Systems* subscribers. "Being selected as a Buyers Choice Award winner by the market's most influential buyers is a significant honor," according to the magazine's Associate Publisher, John Curran. "This recognition is a tribute to your entire organization, from R&D to marketing and sales. There's no better endorsement than a satisfied customer."

FERRUPS is BEST's line of advanced, on-line, line-interactive UPS. Products feature Artificial Intelligence, automatic battery and inverter checks, alarm and inverter logs, five indicator lights, 16 audio alarms, RS232 communications, and more than 100 operational parameters that may be monitored or programmed by the user.

FERRUPS also features:

- Sine-wave output
- 2000-to-1 spike attenuation
- Complete galvanic isolation (including output neutral-to-ground bonding)
- 120 dB of common-mode noise rejection
- True no-break power

BEST won the Buyers Choice Award over manufacturers in both the single- and three-phase UPS markets. Competitors included American Power Conversion, Sola, Tripp-Lite, Liebert, and Minuteman.

BEST wins top honors in all five UPS categories in Computerworld study

The top honors in all five Uninterruptible Power System (UPS) categories in the 1992 *Computerworld* I/S Brand Preference Study went to Best Power Technology, Inc.

In the study, which focused on Local Area Network products, 515 *Computerworld* subscribers were asked which manufacturer they most closely associated with five areas of product excellence. BEST got highest consumer ratings in the categories of *Best Technology, Best Price/Performance, Best Service/Support, Best Documentation,* and *Prefer to do Business With.* BEST won with fairly wide margins — as much as 32 percentage points higher than its closest competitor.

Circle 391 on Inquiry Card.

World Radio History

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Fortress leads the pack in LAN Technology review

BEST's newest Uninterruptible Power System, Fortress®, has received the coveted "Network Specialist Preferred" rating from *LAN Technology*. Fortress showed the best performance of the seven leading UPS products tested.

"Aptly named, the Fortress produced rock-solid, stable power under all test conditions," the magazine stated in its April 1992 issue. "On the strength of its electrical performance, the Fortress topped the seven products in our review."

In fact, the Fortress was the *only* product that provided uninterruptible, no-break power in every test. Other products tested had power breaks lasting as long as nine milliseconds. Some gave square-wave output with as much as 33 percent total harmonic distortion.

Other products tested included "UPS" from American Power Conversion, Tripp Lite, Sola, and Para Systems.

LAN Technology's editors were impressed at what they found. "The LI 660 shined in our tests," they wrote. "It did not follow the overvoltage condition, and instead delivered a constant 115 Volts rms to the load. The unit's output had less than three percent total harmonic distortion for all conditions. In both the one-cycle dropout and power outage tests, the LI 660 provided smooth, sinusoidal power to the test load.

"The LI 660 . . . was a fine piece of equipment, and we picked it as the top performer in the review," the editors concluded.

Other products tested did not fare as well, however. For instance, APC advertises a maximum three milliseconds transfer time for its Smart UPS 600 standby system. But in the *LAN Technology* one-cycle dropout test, the Smart UPS broke power for a full 4.5 milliseconds — hardly an "uninterruptible" performance. As the editors noted, the Fortress "was not measurably affected by the one-cycle dropout."

LAN Technology '92
Network Specialist
PREFERRED

Government Computer News editor: "Fortress is my main UPS"

The applause for Fortress, the world's smallest, smartest, true no-break UPS, continues to roll in!

The latest comes from John McCormick, who writes the "Power User" column for *Government Computer News*. In his March 16, 1992 column, "In the Dark About Emergency Power Supplies," he shares his insights on UPS.

"Washington is a real power city, but recent power- and water-related incidents in Washington have brought a new meaning to the term 'power user,' " McCormick wrote in the column. "I have a lot of sophisticated computer equipment here. Without reliable power, I would have nothing when the lights go out."

A stickler for quality and long runtimes, McCormick relies on BEST technology. "A Fortress LI 2K from BEST is my main UPS," he writes. "The control and display capabilities of the Fortress are impressive, starting with a countdown of the time left when operating on the battery."

The reviewer was also impressed by the fact that Fortress "will run equipment beyond its rated capacity, and audibly warn you to shut something off. Line, output, and battery voltages can all be displayed, as well as a percentage of load reading."

As a power user, McCormick appreciates the flexibility that Fortress' digital display and keypad give him. "There are so many options that one important setup step is to decide on what is important for your installation and reset those features from factory defaults."

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World Radio History

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Disaster avoidance and recovery is growing business priority

Computing and telecommunications disasters are increasingly headline news. One of the most recent occurred when AT&T lost a major switching center in downtown New York City for seven hours due to a power failure on September 17, 1991. The crash blocked 5.5 million calls, closed New York's airports, and disrupted more than 1,000 flights.

More recently, Chicago's thriving "Loop" district was completely shut down in mid-April of this year, when the Chicago River flowed through a hole in an old freight tunnel, flooding the basements of scores of high-rise office buildings. Commonwealth Edison shut off electrical power to the entire area to protect its transmission equipment, forcing the closure of the Mercantile Exchange and the Chicago Board of Trade. Worldwide stock and commodities trading was disrupted, and business losses were estimated at as much as $50 million per day.

With nightmares like these in the news, it's little wonder that businesses across the country are scrambling to develop ways to avoid major power disasters. AT&T is actively recommending this type of planning to its customers.

The concern is justified. The Enterprise Technology Center recently reported a number of terrifying statistics:

- On average, a company loses as much as three percent of its gross sales within eight days of a sustained computer outage.
- The average company struck by a computer outage lasting more than 10 days ***will never fully recover.*** Half of these companies will be out of business entirely within five years of the outage.
- Your chances of experiencing a disaster are one in 100.
- Power outages were one of the three most common causes of disaster in 1989 and 1990.

Power Quality, a trade journal for utility officials and others in power-related industries, recently devoted an entire issue to the topic of disaster avoidance and recovery. "Today, large areas of business and other activities depend on continuous operation of computers linked by telecommunications companies," power consultant Harold Morser wrote in one of the articles. Morser named a number of major industries that are easily crippled by computer and telecommunications disasters, including:

- International banking
- World stock markets
- Insurance companies
- Government agencies
- Airlines

In other applications, the loss of computing or telecommunications capability may imperil life itself. Among these, Morser listed:

- Life-support equipment in hospitals
- Intercommunication and management of fire, police, and ambulance services

"Failures or errors in any of these systems carry severe penalties for providers and users," Morser writes.

Morser recommends the use of an Uninterruptible Power System (UPS) to avoid short-term power failures, and a UPS backed by a generator for avoiding longer ones. But he admits that traditional approaches to long-term power protection aren't always cost-effective.

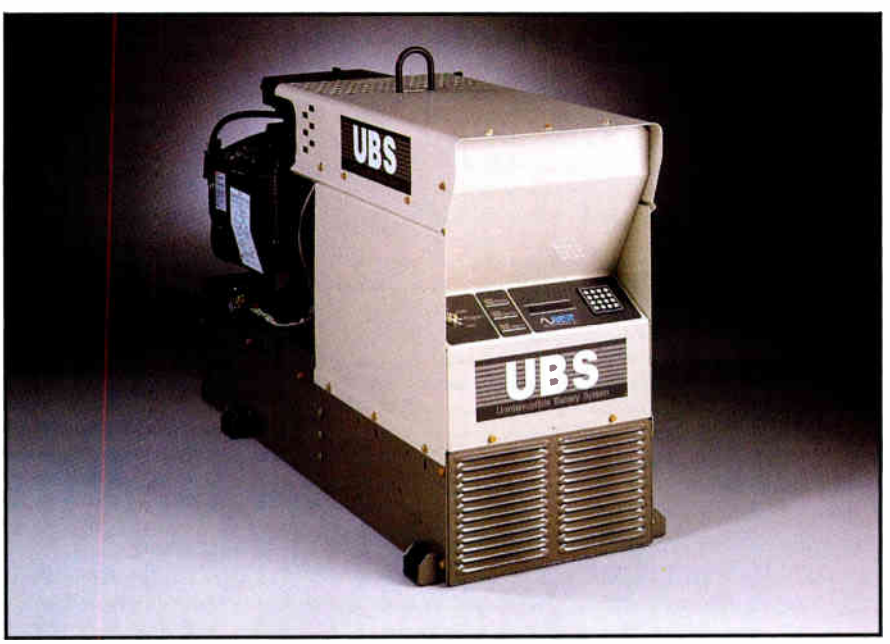
Moreover, generators and battery banks used for power support need careful tending, Morser notes. "My personal view as a former diesel engineer is that operating life and reliability are far better if the [generator] is run for sustained periods . . . on a regular basis," he writes.

UBS® — A cost-effective approach to disaster avoidance

Fortunately, there *is* an affordable, reliable solution to the threat of computer and telecommunications failures — BEST's "Infinite" Battery System (UBS®).

This revolutionary, cost-effective approach to extend Battery Reserve Time is the perfect solution to provide Hours, Days, or even Weeks of

Continued on page 4



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World Radio History

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"Infinite Battery" solves disaster avoidance problems

Continued from page 3

continuous, high-quality, DC power.

Traditional solutions to extend a facility's battery reserve time require the addition of parallel ranks of batteries, or the replacement of the existing battery plant with one having a larger ampere-hour capacity. Simply adding batteries to the system requires additional floor space, increases the maintenance required for the system, and often requires additional battery charging equipment. These additions are expensive, add to the complexity of the power system, and reduce the system's overall reliability.

BEST's "Infinite" Battery System (UBS®) is unique in providing DC power for extended Battery Reserve Time. It does so without the problems associated with battery plant additions, or those associated with AC phase control and transfer switch operation. The AC generator output waveform ceases to be a concern, and frequency stability problems vanish.

To ensure reliability, the microprocessor-controlled UBS® has an *automatic self-diagnostic* test system. It automatically monitors parameters such as *fuel, oil,* and *cranking battery power* and sounds an alarm if the UBS® fails any system check. A total of 55 *system parameters* can be *monitored, controlled,* and *forwarded* to remote central maintenance facilities. The UBS® also allows for remote control and monitoring using a password-protected system. A keypad and display allow for local monitoring and control of the UBS® unit.

The UBS® is automatically cycled to run for 20 minutes every two weeks to ensure reliable automatic starting when needed.

UBS® by BEST is the first power source designed specifically to provide high-quality, reliable DC power for essential UPS and communication systems.

BEST leads industry with Double Lifetime Warranty

Competitors rush to "clone" innovative program

Best Power Technology has once again demonstrated its leadership in the UPS industry by announcing a first in the power protection industry; a limited Double Lifetime Warranty on all its power protection products.

The Double Lifetime Warranty applies to the transient surge suppression circuitry in each FERRUPS®, Fortress®, Patriot™, Citadel™, or SpikeFree™ sold by BEST for installation in the United States and Canada.

Not surprisingly, competitive manufacturers have scrambled to improvise "me-too" warranties. But BEST's leadership in this area is driven by its proven track record of product reliability and performance.

Subject to certain terms and conditions, this bonus warranty extends BEST's basic manufacturer's warranty to offer repair or replacement of transient surge suppressor circuitry in the event of defective material or workmanship or circuitry damage through normal use during the life of the product. Also, this expanded coverage includes reimbursement of up to $25,000 per occurrence of physical damage to specified computer equipment damaged as a result of defective surge suppression circuitry.

Full details of this warranty coverage can be obtained from a BEST dealer or by calling BEST at 800-356-5794.

BEST, the world's largest manufacturer of single-phase UPS, is the first in the power protection industry to offer this type of warranty on UPS, SPS, and power conditioners, as well as surge suppressors.

According to Best Power Technology Sales Corporation President Bill Paul, "The new Double Lifetime Warranty demonstrates our confidence that BEST products will protect computers and other sensitive electrical equipment from lightning and surges. Each power protection solution BEST offers has advanced surge suppression capabilities. And we're willing to stand behind our products with the best warranty in the business."

Paul isn't troubled by the crowd of clone warranties hastily introduced after BEST announced its program on January 1, 1992. "It's not the first time we've led the way in power protection," he said. "Besides, given the marginal field performance of some of these competitive units, it's questionable how long their manufacturers can afford to provide this kind of coverage."

For more information on Best Power Technology's products and services, and how they can benefit you, contact:

BEST

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DPT

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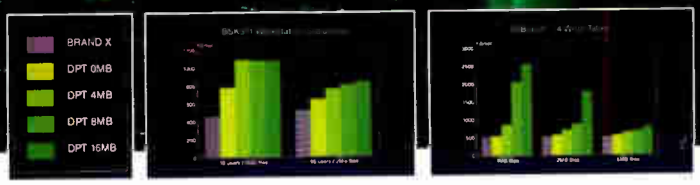

Windows, Netware, Unix and other high-end applications need a SCSI controller that delivers top disk I/O performance and a growth path. Only SmartCache Plus delivers both – and costs no more than less advanced controllers!

As the industry's fastest SCSI controller, SmartCache Plus is the easy choice. It's the smart choice, too – because if your system needs a performance boost, you can transform it from a non-caching host adapter into the world's fastest *caching* controller! Expandability is so simple: plug-on modules add caching, up to a total of 16MB of cache memory, and disk mirroring!

SmartCache Plus is supported by all major operating systems and applications, and provides connectivity to hundreds of SCSI devices. Reliable, scalable and simple to install, SmartCache Plus breaks your system's disk I/O bottleneck without breaking your budget!

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Circle 262 on Inquiry Card (RESELLERS: 263).

GET THE FACTS!

This free comprehensive Performance Report details the SmartCache Plus advantage over its leading competitor in nine different benchmarks for DOS 5.0, Netware 3.11 and Unix applications. For your copy, contact DPT Channel Marketing today...

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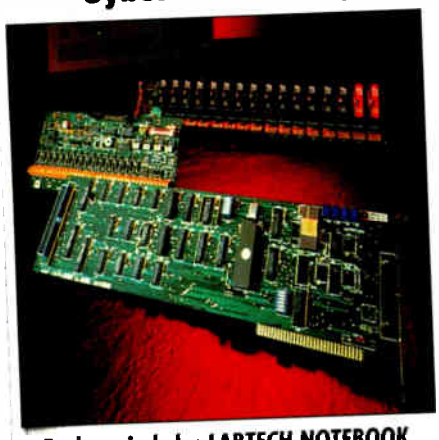
CyberResearch System of the Month Features RTI® DAS from Analog Devices



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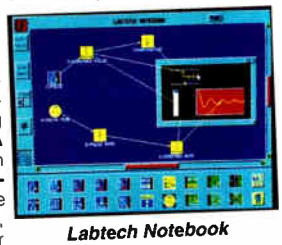


Labtech Notebook

CyberResearch has now made this top-of-the-line product affordable for everyone. By bundling an **RTI 815A** together with **LABTECH NOTEBOOK®** software at one low price, we've saved over $500 and made it possible for you to afford the very best.

Each combination package includes:

- **RTI 815A** data acquisition board configured for 32 Single-Ended or 16 Differential analog input channels with a 50 KHz A/D conversion rate, 2 analog output (D/A) channels, 16 Digital I/O lines, and 3 Counter/Timer I/O channels.
- **LABTECH NOTEBOOK** menu-driven software with new IconView diagramming user interface and drivers for controlling the RTI 815A board.

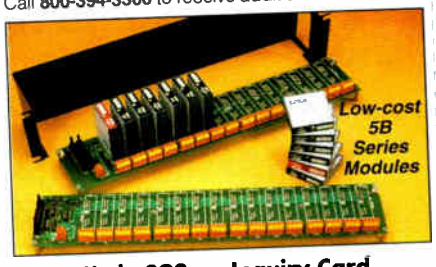
Order **#RTI 815LN** RTI DAS Combination Package.**$1995**

Guarantee Valid Data with Signal Conditioning Modules

Signal conditioning modules serve several purposes; they protect your computer, isolate your signal of interest from noise, amplify low-level signals, and provide power and excitation to transducers.

One name is virtually synonymous with signal conditioning: **Analog Devices**. And CyberResearch is your Analog Devices distributor carrying every signal conditioning line: the versatile **3B** series, the low-cost **5B** series, and the new, intelligent **6B** series with on-board A/D conversion.

Call **800-394-3300** to receive additional information.



Circle 392 on Inquiry Card.

VGA to Video Converter — VGA to your VCR

Redlake's **TapeCaster** converts VGA screen output to video for applications such as recording animation and creating training tapes. The TapeCaster is extremely easy to use: no base addresses, no interrupts, no software required — just plug and play.

- True, precise NTSC/PAL video timing.
- Simultaneous VGA & video display.
- Composite Video & Y-C (SuperVHS) output for use with equipment ranging from an inexpensive VCR to broadcast-quality professional video. This is a full-color image acquisition board, not monochrome with pseudo-color.

#NTSC 200 TapeCaster – NTSC Video Output (For use with VCR's in the U.S.A.).....**$750**
#PAL 200 TapeCaster – PAL (European) Video Output **$750**

Circle 393 on Inquiry Card.

New A/D Board perfect for Portable Systems

Designed specifically for use in portable PC's, the **PC 126** from **United Electronic Industries** packs a lot of power into a small package. Unlike many A/D boards, the PC 126 operates entirely on +5V power, usually the only power available in a portable. It's features include:

- 50kHz A/D sampling @ 12-bit resolution
- 16 Analog Inputs and 2 Analog Outputs.
- **Free:** Driver software with source code in C, menu-driven Status-30 software, *and* data streaming-to-disk software.
- Consumes 190mA@+5V (less than 1 Watt!)
- 8 Digital Inputs & 8 TTL Digital Outputs.

#PC 126 16-Channel 50 kHz Data Acquisition Board with software **$545**
#INST 347 50-Terminal Screw Terminal Block with 2-Meter Cable to PC 126 .....**$105**

Circle 396 on Inquiry Card.

Opto-Isolated RS-422 Converter Protects Your PC

Your computer can be protected at the power supply, but suffer a devastating shock from power surges picked up over long data lines. The Model **262** converter from **Telebyte Technology** serves double-duty, providing both high-speed RS-232 to RS-422 conversion *and* optical isolation.

- **Optical isolation exceeds 10,000 Volts**
- Earth ground connection
- Switch selection of DCE or DTE
- LED status indicators on data lines
- Wall transformer powers the unit
- Data Rates to 19K baud over 2 **miles**
- RS-232 Connector: DB-25 (select Male/Female)
- RS-422 Connector: 4 screw terminals + ground

#COMH 262 Optically-Isolated RS-232 to RS-422 Converter Module.....**$139**

Circle 394 on Inquiry Card.

New PC Products for

FREE

PC Systems Handbook for Scientists & Engineers

This Combination Tutorial/Catalog Includes Many Examples of PC-based Scientific & Engineering Systems

Have you wanted to enjoy the many benefits of configuring your own PC-based Data Acquisition or Instrumentation system, but didn't know where to begin? The PC Systems Handbook will lead you every step of the way, explaining all aspects of systems configuration with easy-to-understand text and clearly documented diagrams. A detailed glossary and two dozen "Tech Notes" help you understand the terminology. Our new 1993 Edition will be expanded to 196 pages with a hard spine, making it suitable as a permanent addition to your bookshelf. And there is absolutely no charge for this invaluable reference book delivered within the United States. A handling charge is required for Handbooks sent overseas. Please call or Fax for information.

Topics Covered Include:

- Industrial Rack-Mount PC's — 8088's, & 80486 Models
- Real-Time Data Acquisition, Analysis, & Process Control Software
- PC Plug-in Boards for Analog/Digital, Digital/Analog, & Digital I/O
- Connect your PC to Test Instruments with IEEE-488, RS-232, RS-422
- Stepping and Servo Motor Control with your Personal Computer

Circle 396 on Inquiry Card.

Notice to International Customers

You can buy direct from CyberResearch and **save 50%** or more! A majority of the leading brands of PC-based engineering products are available for export from CyberResearch at the same low prices as those enjoyed by our customers in the United States.

Due to contractual restrictions, products from some manufacturers are not available for export to certain countries.

Please fax a request for quotation listing brand and/or performance requirements, and we'll fax back a prompt response.

Circle 396 on Inquiry Card.

World Radio History

NEW Rack-Mount Computer Systems with Pull-out Keyboard & VGA Color Monitor

Select a Complete System Configuration

Utilize components from our extensive product line and we will install and test them **at no extra charge** at our world headquarters in Branford, CT before shipping the complete system to you.

High-Performance Rack-Mount PC's at Economical Desktop Prices!

Now you don't have to pay a huge premium to enjoy the benefits of a 19" rack-mountable PC.

Rugged Chassis Saves Rack Space

Many manufacturers would require you to use 10.5" of height for a PC, 14" for a monitor, and 3.5" for a keyboard drawer (on which you are supposed to balance the keyboard while you type.) This comes to 28" (16 rack units) of rack height. Our new VRK models include all of these components in just 10.5" (6 rack spaces) tall. You can fit 2⅔ PC's in the space of their system, or simply have a rack-mount PC where it was never possible before.

VRK Rack-Mount PC's come in heavy-duty metal cases for EMI/RFI protection.

The VRK line includes the following features:

- Your choice of 80386 or '486 microprocessor. From affordable 386sx models to Ultimate-Performance 50MHz EISA-Bus Computers.
- 4MB of RAM (2MB on 386sx model).
- 10" VGA High-Resolution Color Monitor, with VGA Card included at no extra charge.
- Eight Expansion Slots.
- **Industrial Keyboard** pulls out and locks — does not move while typing. A protective door keeps keys safe from foreign materials when not in use.
- 1.2MB (5.25") or 1.44MB (3.5") Floppy Drive.
- 3 Full-access Drive Bays for Floppy Drives, etc.
- Hold-Down keeps Expansion Cards Firmly Seated.
- Floppy & IDE Hard Disk Controller Included.
- Dual-Fan Cooling System w/Honeycomb Filter.
- Rack-Mounting Slide Rails Included FREE.

#VRK 386-20S Rack-Mount 20MHz 80386sx PC w/VGA Monitor,Rack-Mount Keyboard, & 2MB RAM ...**$3395**
#VRK 386-33 Rack-Mount 33MHz 80386 PC w/VGA Monitor, Rack-Mount Keyboard, & 4MB RAM...**$3795**
#VRK 486-33 Rack-Mount 33MHz 80486 PC w/VGA Monitor, Rack-Mount Keyboard, & 4MB RAM...**$4195**
#VRK 486-50 Rack-Mount 50MHz 80486 PC w/VGA Monitor, Rack-Mount Keyboard, & 4MB RAM...**$4495**
#VRK 486-50E Rack-Mount 50MHz EISA-Bus 80486 PC w/VGA Monitor, R-M Keyboard, & 16MB RAM .**$5895**

Prices subject to change (reduction) at any time

Also available as chassis-only for installation of computer by others. Call or FAX for the latest pricing, quantity discounts, and more information on the entire VRK rack-mounting product line.

Circle 395 on Inquiry Card.

Scientists & Engineers

PC Products for Scientists & Engineers

When you need PC-compatible equipment for science and engineering, there's only one name to think of: CyberResearch. We offer the largest selection of hardware and software for data acquisition, instrumentation, communications, motion control, etc. We stock all your best-known suppliers like those featured on these pages and many more.

FREE Application Engineering

At CyberResearch we have no salespeople. Our engineers have one priority: to help you find the best technical solution to your problems. Calling our Applications Hotline is like having your own free consultant. Call and let our experience work for you.

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You can order from CyberResearch with confidence. If you are not completely satisfied with your purchase, simply call our toll-free hotline within 30 days of receiving the item. A friendly customer service technician will arrange for a full refund, replacement, exchange, or credit. No Problem. No Hassle.

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Circle 395 on Inquiry Card.

Elma Rack-Mount Keyboards

If you use a standard keyboard with your rack-mount system, you know what a nuisance and a hazard it can be. These industrial keyboards are designed to fit easily into any EIA 19" rack. Rugged and reliable, these keyboards are made in the U.S.A. by a Swiss electronics company & demonstrate classic Swiss craftsmanship.

- 101-key layout & full-travel construction with tactile feel for touch-typing
- **#0IX 3010** drawer-mounted/**#0IX 6010** (shown) slides out with locking door
- Occupies only 1 rack space (1.75" high)

#0IX 3010 Low-cost, Drawer-Mounted Rack-Mount Keyboard.....**$295**
#0IX 6010 Slide-out, Rack-Mount Keyboard w/locking drawer.....**$395**

Circle 395 on Inquiry Card.

The EASYTEMP System from Keithley/Metrabyte

THE SYSTEM
A complete software & hardware solution, the EasyTemp system can acquire 16-bit data at up to 50,000 samples per sec.

Hardware
Thermocouple wire included with each system.

Software
New EASYEST LX software lets you start acquiring data immediately. Specialized start-up software is designed to provide powerful, application-specific solutions.

Manuals
Detailed manuals facilitate speedy set-up of your EasyTemp system.

#KDAC 575 EasyTemp Temperature Monitoring System w/Software.....**$4450**

Circle 397 on Inquiry Card.

100MHz PC-Based Oscilloscope

CompuScope 250 from **Gage Applied Sciences** is a family of high quality 100 MegaSPS PC/XT– compatible Data Acquisition Cards with advanced oscilloscope software. Features include:

- 100MHz sampling on 1 channel (10ns/sample) or 50MHz simultaneous sampling on 2 chan.
- 8-bit resolution
- 50MHz bandwidth
- 32 or 128-KiloByte memory buffer
- Software programmable inputgains
- Store and load setups and signals
- Drivers available in C, Pascal and Basic.

#DSO 200 40MHz CompuScope Lite w/16K Buffer.....**$595**
#DSO 250L 100MHz CompuScope 250 Lite.....**$2750**
#DSO 250-32 100MHz Scope w/32K Buffer.....**$3495**
#DSO 250-128 100MHz Scope w/128K Buffer.....**$3895**

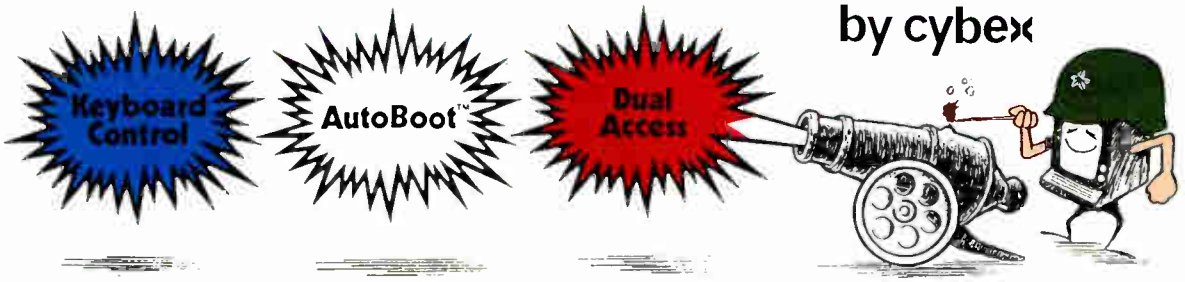
Circle 396 on Inquiry Card.

World Radio History

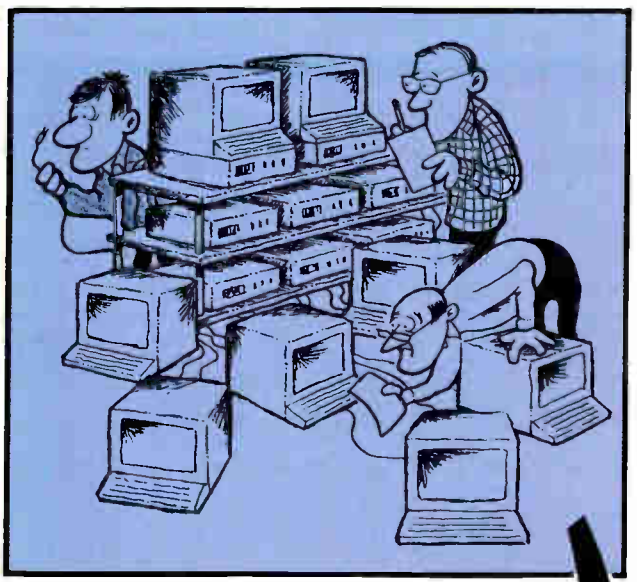
CONTROL UP TO 96 PC FILE SERVERS WITH 1 KEYBOARD AND MONITOR USING...

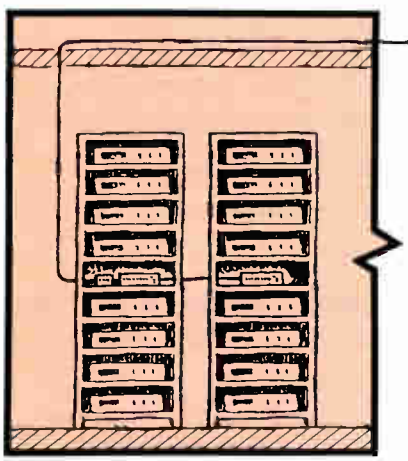
COMMANDER

by cybex



- Select via Keyboard
- Dual access up to 250 feet away (optional)
- No external power
- Mix PC, PC/XT, PC/AT and PS/2
- "AutoBoot™" Feature boots attached computers without operator intervention
- Shows PC power status





- PS/2 Mouse support available
- Each unit accommodates from 2 to 8 PCs
- Up to 12 units can be cascaded
- Mounting kit available for 19" and 24" rack installation

Dealer Program Available

Cybex Corporation
2800-H Bob Wallace Ave.
Huntsville, Alabama 35805
(205) 534-0011
Fax (205) 534-0010

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Circle 261 on Inquiry Card.

World Radio History

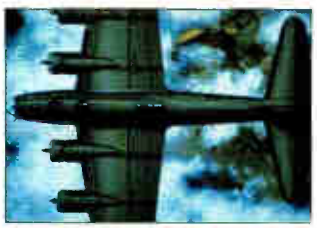
Become a legend before your own time.

What becomes a legend most? Find out for yourself as you pilot the legendary B-17 Flying Fortress and lead a 10-man crew through the same flak-infested skies that menaced the legendary flyboys of the *Memphis Belle.*

The most complete and accurate bomber simulation ever produced, the B-17 Flying Fortress will have you negotiating 25 perilous daylight missions over Nazi-occupied Europe.

You'll allocate crew members to their specific tasks. You'll devastate strategic targets in dangerous bombing runs. You'll take control of crew positions from pilot to bombardier. And you'll even customize your own Flying Fortress with historically accurate nose art.

So pick up your copy of B-17 Flying Fortress today. And experience a flight simulation of legendary proportions.



Actual screens may vary.

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ENTERTAINMENT • SOFTWARE

For IBM PC compatibles!

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Circle 267 on Inquiry Card.

World Radio History

NEVADA COMPUTER

Largest inventory of memory available anywhere...and we won't be undersold!

COMPAQ Memory

MODEL	MEM	PART#	COST
Portable III	512K	107331-001	$38
Portable III	INTFC	107808-001	99
Portable III	EXP BD	107811-001	249
Portable III	2MB	107332-001	98
Portable 386	1MB	107651-001	129
Portable 386	4MB EXP	107653-001	449
Portable 386	4MB DAGHT	107654-001	449
Deskpro 386/16	1-2MB	108069-001	299
Deskpro 386/16	2MB	108069W71	348
Deskpro 386/16	1MB	108071-001	114
Deskpro 386/16	4-8MB	108070-001	545
Deskpro 386/16	4MB	108072-001	249
Deskpro 286E; 386-20; 20E; 25; 25E	1MB	113131-001	59
Deskpro 286E; 386-20; 20E; 25; 25E	4MB	113132-001	158
Deskpro 386S/16	1MB	113646-001	72
Deskpro 386-20E; 25E	4MB	113645-001	208
Deskpro 386/33; 386/33l; 486/25; 33L;50L; Systempro	2MB	115144-001	102
Deskpro 386/33l; 486/25; 33L; 50L; Systempro	8MB	116561-001	298
Deskpro 286N; 386N; 386SX/20; 20N, Portable 486c, Deskpro M , Systempro LT Series 129160-001	1MB	118688-001	49
Deskpro 286N; 386N; 386SX/20; 20N, Portable 486c, Deskpro M , Systempro LT Series 129160-001	2MB	118689-001	94
Series 129160-001	4MB	118690-001	148
Series 129160-001	8MB	128877-001	298

COMPAQ Laptop Memory

MODEL #	MEM	PART#	COST
Contura Notebook	2MB	139497-001	$88
Contura Notebook	4MB	139498-001	148
Contura Notebook	8MB	139499-001	298
Compaq SLT/286	1MEG MOD	110235-001	99
Compaq SLT/286	4MEG MOD	110237-001	198
Compaq SLT/386	1MEG MOD	118303-001	89
Compaq SLT/386	2MEG MOD	118304-001	129
Compaq SLT/386	4MEG MOD	118305-001	199
Compaq Lte 286	1MEG BRD	117081-001	69
Compaq Lte 286	2MEG BRD	117081-002	99
Compaq Lte 286	4MEG BRD	117081-003	148
Compaq Lte 386/20	1MEG MOD	121125-001	78
Compaq Lte 386/20	4MEG MOD	121125-002	219
Compaq Lte Lite/20, 25	2MEG MOD	129769-001	148
Compaq Lte Lite/20, 25	4MEG MOD	129769-002	198
Compaq Lte Lite/20, 25	8MEG MOD	129769-003	448

IBM PS/2 Memory

MODEL #	MEM	PART#	COST
PS/1 and 386/SX	2MB	92F9935	$148
PS/2 L40SX; N33SX Laptop	2MB	79F0999	79
PS/2 L40SX; N33SX Laptop	4MB	79F1000	149
PS/2 L40SX; N33SX Laptop	8MB	79F1001	299
PS/2 30/286; Adpt Brd 1497259	512K	30F5348	35
PS/2 30/286;25/286; Adpt Brd 1497259	2MB	30F5360	89
PS/2 35SX, LS, 40SX,70-E61; 061; 121 Adpt Brd 6450609; 34f3011; 34f3077 XStation 120 & 130	1MB	6450603	49
PS/2 35SX, LS, 40SX, 50Z; 55SX; LS; 65SX;LS; P70; 70-E61; 061; 121 Adpt Brd 6450609; 34f3011; 34f3077 XStation 120 & 130	2MB	6450604	78
PS/2 70-A21; A61; B21; B61	2MB	6450608	89
PS/2 35SX, LS, 40SX, 55SX; 55SL; 65LS; 65SX Adpt Brd 6450609; 34f3011; 34f3077 XStation 120 & 130	4MB	34F2933	149
PS2/2 35SX; LS; 40SX	8MB	6450129	298
ALL 70's and 80's	2-8MB	6450605	249
PS/2 80-A21; A31; A61	4MB	6451060	198
PS/2 80-041	1MB	6450375	68
PS/2 80-111; 311; 121; 321; 081; 161	2MB	6450379	104
PS/2 90; 95 (Install in pairs) P75; 56; 57 (all models) PS/1 Pro 386SX M2123	2MB	6450902	98
PS/2 90; 95 (Install in pairs) P75; 56; 57 (all models) Powerstation/Powerserver 220 series PS/1 Pro 386SX M2123	4MB	6450128	159
PS/2 90; 95, P75; 56, 57 (all models) RS/6000 Powerstation/Powerserver 220 series PS/1 Pro 386SX M2123	8MB	6450130	298

D-Ram Chips

DESCRIPTION	150NS	120NS	100NS	80NS	70NS	60NS
64 X 4	$1.95	$2.25	$2.45	$2.95		
256X1 STATIC				1.95	$2.25	
256 X 1	.95	1.05	1.10	1.15	1.45	$2.20
256 X 4		3.95	4.45	4.95	5.45	4.95
1MEG X 1		2.95	3.45	3.95	4.45	4.75
1MEGX1 STATIC				4.95	5.25	
1MEGX4				17.00		

Zenith Memory

486/33ET	4MB	ZA-4200-M2	$198
486/33ET	16MB	ZA-4200-M8	598
Z-386/20; 25; 33; 33E	1MB	ZA-3600-ME	49
		ZA-3800-ME	
Z-386/20; 25; 33; 33E; 486/25E	4MB	ZA-3800-MK	148
Z-248; Z286LP; Z386SX	2MB	Z-605-1	98

In Touch with Tomorrow TOSHIBA Laptop & Notebook Memory

MODEL	MEM	PART#	COST
T2000SX/T1000 SE/LE/XE	1MB CARD	PA8311U	$68
T2000SX/T1000 SE/LE/XE	2MB CARD	PA8312U	108
T2000SX/T1000 LE	4MB CARD	PA8314U	168
T2000SX/T1000 LE	8MB CARD	PA8315U	298
T1200 XE	2MB BRD	PA8306U	98
T1600	2MB BRD	PA8302U	78
T2000 SXE	2MB CARD	PA2000U	108
T2200	4MB CARD	PA2001U	168
T2200	8MB CARD	PA2002U	328
T3100 E	2MB MOD	PA8341U	88
T3100 SX	2MB BRD	PA8308U	88
T3100 SX	4MB BRD	PA8310U	138
T3200 SX	2MB MOD	PA8307U	88
T3200 SX	4MB MOD	PA8309U	138
T3200 SXC	2MB MOD	PA8318U	88
T3200 SXC	4MB MOD	PA8319U	148
T3200	3MB BRD	PA7137U	148
T3300 SL	2MB CRD	PA2006U	118
T3300 SL	4MB CRD	PA2007U	148
T3300 SL	6MB CRD	PA2008U	235
T3300 SL	8MB CRD	PA2009U	895
T4400 SX (SXC) (T6400 SXC DXC)	2MB CRD	PA2003U	115
T4400 SX (SXC) (T6400 SXC DXC)	4MB CRD	PA2004U	214
T4400 SX (SXC) (T6400 SXC DXC)	8MB CRD	PA2005U	375
T4400 SX (SXC) (T6400 SXC DXC)	16MB CRD	PA2010U	745
T5100	2MB BRD	PA8301U	78
T5200/T5200C/T8500	2MB MOD	PA8304U	98
T5200/T5200C/T8500	8MB MOD	PA8313U	298

NEC Memory

MODEL	MEM	PART#	COST
Powermate 386/33i Express Te Series	16MB MOD	OP-410-6206	$695
Powermate 386/33E; 486/25E	2MB MOD	OP-41-5101	195
Powermate Portable SX	2MB MOD	APC-H751X	295
Powermate Portable SX	8MB MOD	APC-H753X+754X	695
Portable Plus	1-3MB BRD	APC-H750J	295
Portable Plus	2-3MB BRD	APC-H750J+751	295
Portable Plus	3MB BRD	APC-H750J+2 (751)	395
Ultralite 286F	1MB MOD	PC-22-21	148
Ultralite 286F	4MB MOD	PC-22-22	203
Ultralite SX/20	2MB MOD	PC-44-21	245
Ultralite SX/20	8MB MOD	PC-44-22	674
Ultralite III SL20 & 20P	2MB MOD	PC-47-21	119
Ultralite III SL20 & 20P	6MB MOD	PC-49-21	299
Ultralite III SL25C	2MB MOD	PC-47-21	119
Ultralite III SL25C	4MB MOD	PC-47-22	209
Ultralite III SL25C	8MB MOD	PC-47-23	799
Prospeed SX20	1MB BRD	PC-43-21	138
Prospeed SX20	4MB BRD	PC-43-22	365
Prospeed 286, 386SX/16	1MB CRD	PC-21-21	118
Prospeed 286, 386SX/16	2MB CRD	PC-21-26	219
Prospeed 286, 386SX/16	4MB CRD	PC-21-21	395
Prospeed 386	2MB CRD	PC-31-21	158
Prospeed 386	8MB CRD	PC-31-22	568

Simm Modules

DESCRIPTION	100NS	80NS	70NS	60NS
256X9	$9	$10	$11	$15
1MEGX3	27	28	30	34
1MEG X 9	29	32	34	37
4MEG X 9		109	119	129
256X36 1MEG (72 Pin)		50		
512X36 2MEG		85		
1X36 4MEG		139	159	169
2X36 8MEG		299	309	319
4X36 16MEG		499	539	579

Laser Printer Memory

	1 MEG	2 MEG	4 MEG
Brother HL	$99	$149	$249
Canon LBP4	128	178	
Epson Action Laser II		149	199
Epson 6000, Action LSR		109	178
Fujitsu 7100 & 7200	199	299	
HP Deskjet 500, 500C	.64 (256K)		
HP2, 2D, 3, 3D, 3P, 2P, 2P+		99	159
HPIII SI	49		149
IBM Laser 4019, 4019E			149
IBM Laser 4029			149
Konica LP3110/3115	98	149	
NEC 90, 290		118	
NEC 95		138	
OKI 400		108	
Packard Bell PB9500	108	125	168
Panasonic 4410/4430		128	198
Panasonic 4420/44501	89	118	198
Panasonic 4450	119		
Panasonic 4455		139	
QMS 410	109	149	249
Star LS04	129	179	269
StarScript 4	128	178	258
Tosiba Page Laser 6		109	168
TI	79	149	299
TI XL/PS17/PS35	59		

AST COMPUTER Desktop & Notebook

MODEL	MEM	PART#	COST
Exec NotebK 286; 386SX/20	1MB	500814-001	$48
Exec Notebk 286; 386sx/20;25; 25C	4MB	500814-003	138
		500780-004	
Bravo 4/33; 486/25; Prem II	2MB KIT WPB	500718-004	88
		500780-005	
Prem II (all models) cUPID-32 (500818-001; 500722-004) Prem 386/25; /33;/33T; 386SX/16	1MB WPB	500780-003	48
		500780-002	
Prem II (all models) Prem 386/33T; 386SX/16 Cupid-32 (500818-001)	4MB WPB	500780-004	148
Prem 486/33; Bravo 486/25; 4/33 Prem 386/33T; 486/25 all models Prem 486/25TE; /33TE; 386/33TE Prem II (all models)	8MB KIT	500780-001	288

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Packord Bell, Magnovox, Mitsuba	1MB	N/A	98
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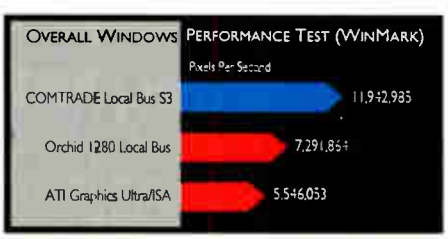

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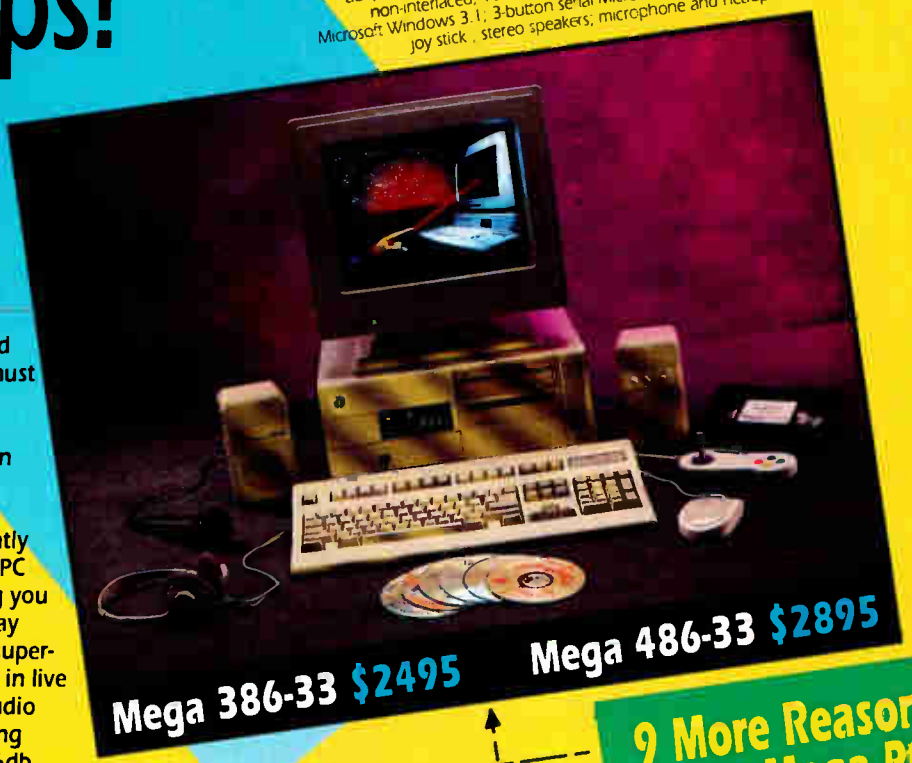

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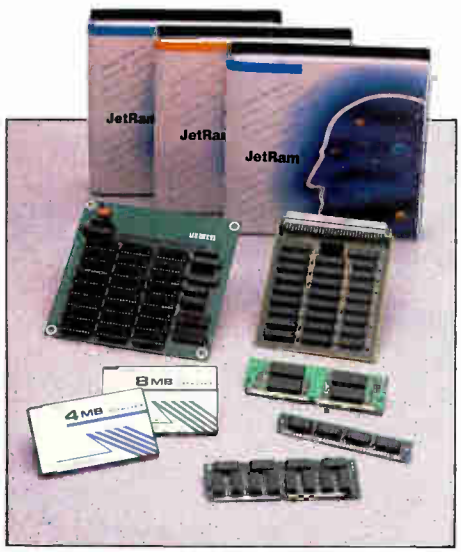

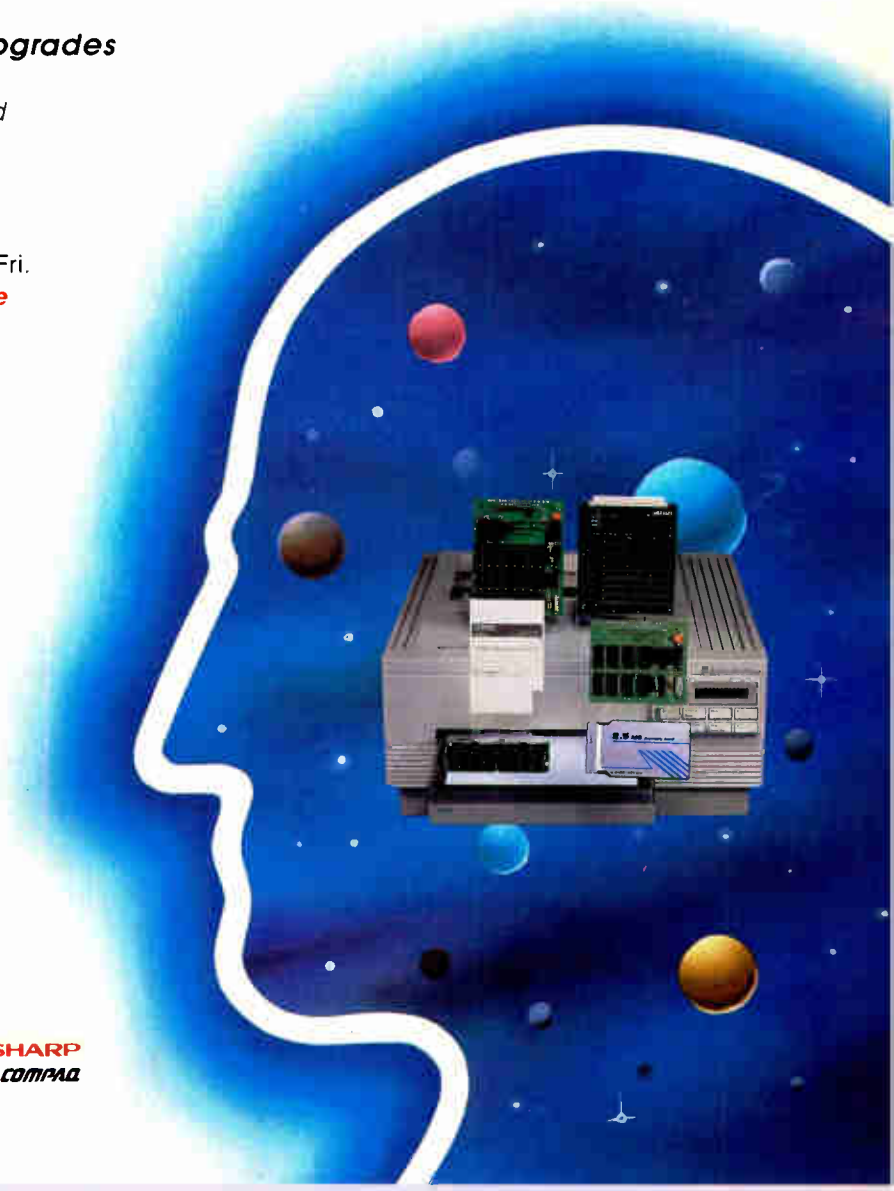

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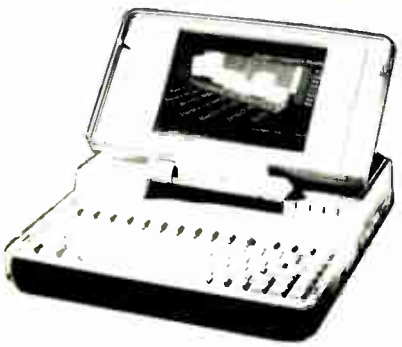

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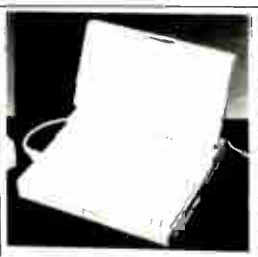

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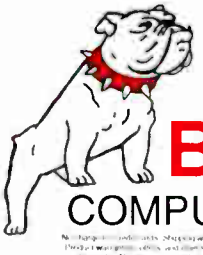

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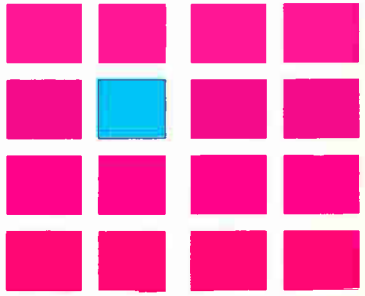

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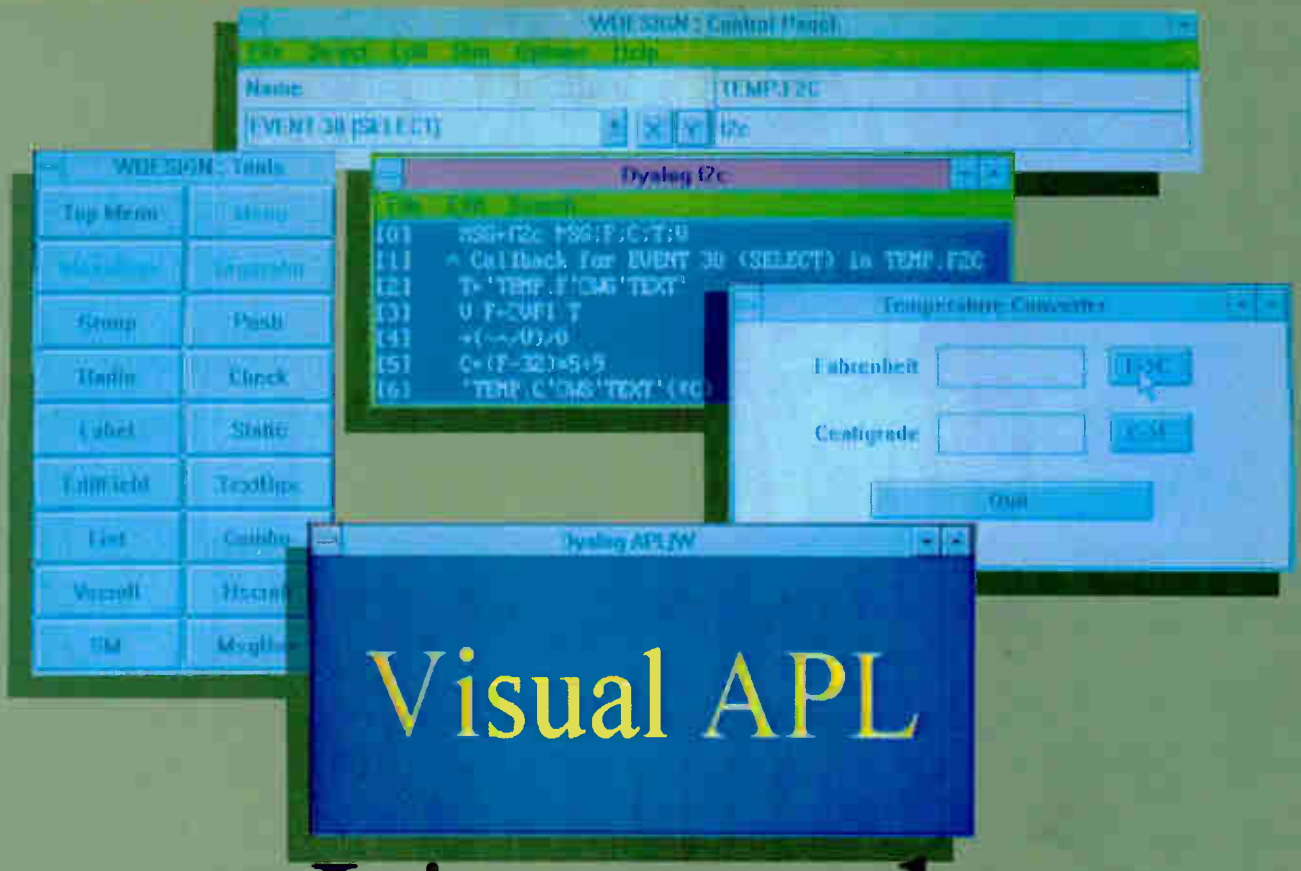

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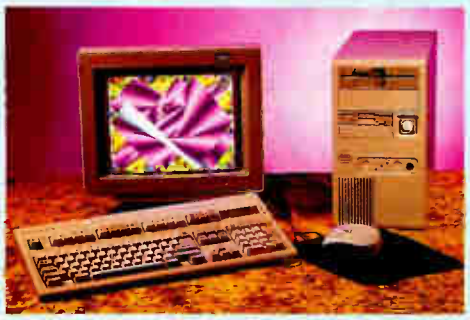

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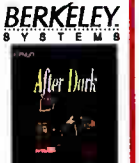

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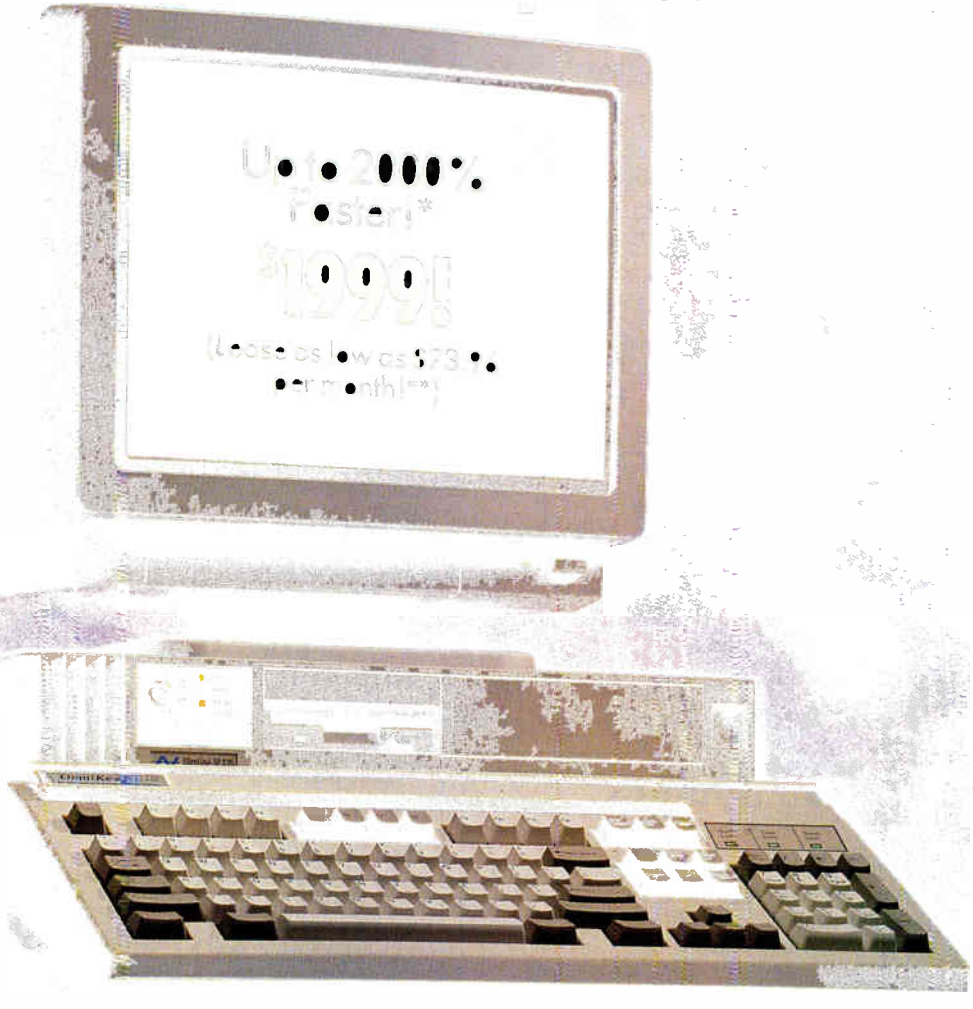
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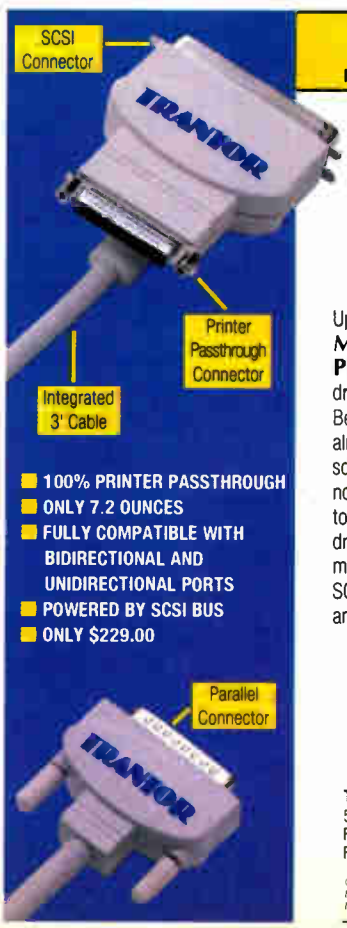

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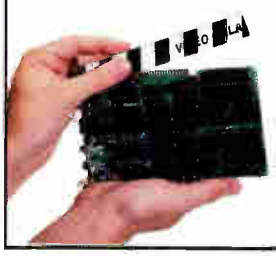

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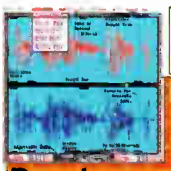

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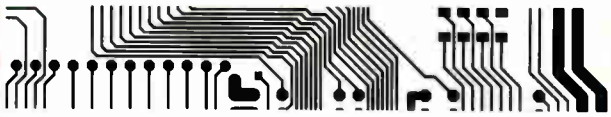

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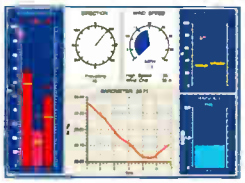

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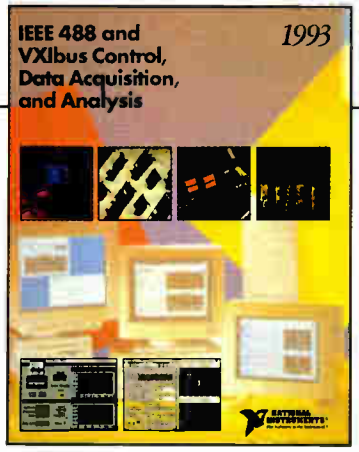

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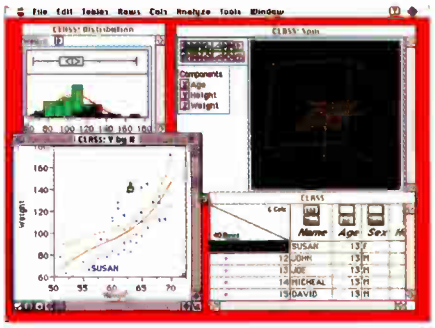

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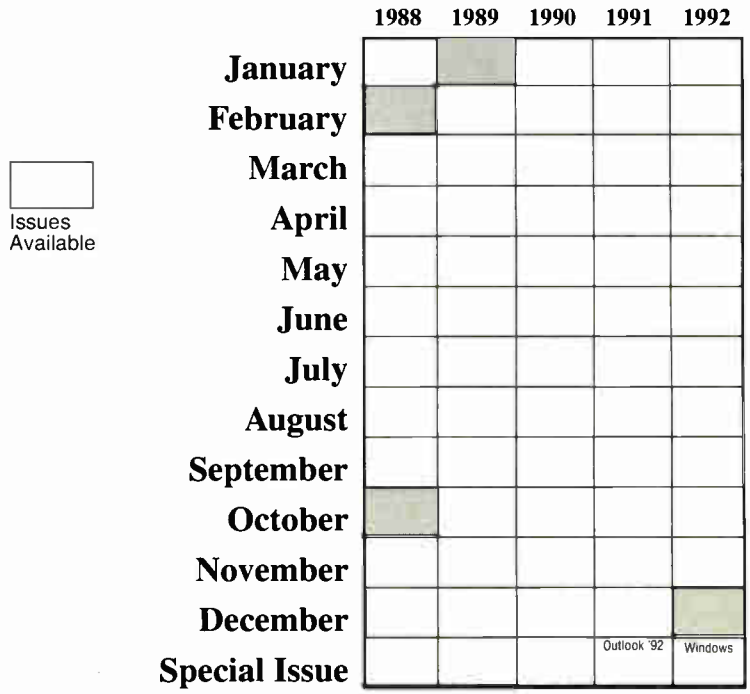

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292-293	ACCESS SOFTWARE	346-347	800-739-0073
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343-344	ACI / ACQUIRE	350	886-2-758-9615**
233	ACTIX SYSTEMS	174	800-927-5557
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256-257	ADVANCED COMPUTER PROD	341	714-558-8813
61-62	ADVANCED LOGIC RESEARCH	211	714-581-6770
83	ADVANCED MICRO DEVICES	10-11	800-222-9323
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196	APL * PLUS / MANUGISTICS	105	800-592-0050 ext. 875
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*	C++ REPORT	176IDRC-3-4	212-274-0640
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364	DATAMAN LTD	252UK-3	44-0300-21012**
388-389	DATATRONICS TECH	292IS-2	882-2-782-0305**
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522-523	EVOLUTION COMPUTING	340	800-874-4028
124-125	EXABYTE CORP	251	800-392-2983
390	FAST ELECTRONIC GMBH	184IS-3	49-089-533-401**
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*	JDR MICRODEVICES	311	800-538-5000
422	JEN ELECTRONICA	268IS-4	39-73-3224035**
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*	JNL OF OBJ ORIENT PROGRAMMING	176IDRC-1-2	212-274-0640
144	KEA SYSTEMS LTD	114	800-663-8702
310	KILA	350	303-444-7737
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591	616	641	666	691	716	741
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593	618	643	668	693	718	743
594	619	644	669	694	719	744
595	620	645	670	695	720	745
596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
600	625	650	675	700	725	750
601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764
615	640	665	690	715	740	765

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
972	997	1022	1047	1072	1097	1122

Inquiry Numbers 1123-1304

1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1162	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478
1329	1354	1379	1404	1429	1454	1479

World Radio History

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For free product information, mail your completed card today. For quicker response, fax to 1-413-637-4343!

See reverse side for card.

1. Circle the Numbers on Your Direct Link Card

Circle the numbers which are found on ads and articles in this issue or circle the product category number and receive information on all advertisers listed in that category.

2. Print Your Name and Address

Answer questions "A" through "E" and mail or fax card to 1-413-637-4343.

3. Product information will be rushed to you from the selected companies!

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POSTAGE WILL BE PAID BY ADDRESSEE

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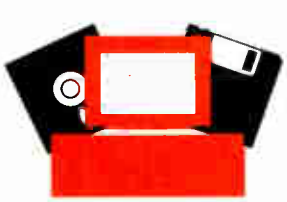

BYTE

Yes, I want FREE information on the following products!

Fill out this coupon carefully. ***Please Print.***

Name

Title

Company

Address

City State Zip

Phone Fax

A. What is your primary job function/principal area of responsibility? (Check one)

1 ❑ MIS/DP
2 ❑ Programmer/Systems Analyst
3 ❑ Administration/Management
4 ❑ Sales/Marketing
5 ❑ Engineer/Scientist
6 ❑ Other

B. What is your level of management responsibility?

7 ❑ Senior-level
8 ❑ Middle-level
9 ❑ Professional

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ❑ Yes
11 ❑ No

D. What operating systems are you currently using? (Check all that apply)

12 ❑ PC/MS-DOS
13 ❑ DOS + Windows
14 ❑ OS/2
15 ❑ Unix
16 ❑ MacOS
17 ❑ VAX/VMS

E. For how many people do you influence the purchase of hardware or software?

18 ❑ 1-25
19 ❑ 26-50
20 ❑ 51-99
21 ❑ 100 or more

❑ Please send me one year of BYTE Magazine for $24.95 and bill me. Offer valid in U.S. and possessions only.

November 1992 86 96 99

Product Category Information

Circle the numbers below for information on the entire category of products you're interested in.

Hardware

Accessories/Supplies	1
Add-in Boards	2
Bar Coding	3
Communications/Networking	4
Computer Systems	5
Data Acquisition	6
Disks & Optical Drives	7
Diskettes/Duplicators	8
Fax Boards/Machines	9
Graphics Tablets/Mice/ Pen Input	10
Keyboards	11
LAN Hardware	12
Laptops & Notebooks	13
Mail Order	14
Memory/Chips/Upgrades	15
Miscellaneous Hardware	16
Modems/Multiplexors	17
Monitors & Terminals	18
Multimedia	19
Printers/Plotters	20
Programmable Hardware	21
Scanners/OCR/Digitizers	22
Tape Drives	23
UPS	24

Software

Business	25
CAD/CAM	26
Communications/Networking	27
Data Acquisition	28
Database	29
Educational	30
Engineering/Scientific	31
Entertainment	32
Graphics	33
Macintosh	34
Mail Order	35
Mathematical/Statistical	36
Miscellaneous Software	37
On-Line Services	38
Operating Systems	39
Programming Languages/ Tools	40
Security	41
Shareware	42
Software Duplication	43
Spreadsheets	44
Unix	45
Utilities	46
Windows	47
Word Processing	48

General

Books/Publications	49
Recruitment	50
Miscellaneous	51

Inquiry Numbers 52-233

52	78	104	130	156	182	208
53	79	105	131	157	183	209
54	80	106	132	158	184	210
55	81	107	133	159	185	211
56	82	108	134	160	186	212
57	83	109	135	161	187	213
58	84	110	136	162	188	214
59	85	111	137	163	189	215
60	86	112	138	164	190	216
61	87	113	139	165	191	217
62	88	114	140	166	192	218
63	89	115	141	167	193	219
64	90	116	142	168	194	220
65	91	117	143	169	195	221
66	92	118	144	170	196	222
67	93	119	145	171	197	223
68	94	120	146	172	198	224
69	95	121	147	173	199	225
70	96	122	148	174	200	226
71	97	123	149	175	201	227
72	98	124	150	176	202	228
73	99	125	151	177	203	229
74	100	126	152	178	204	230
75	101	127	153	179	205	231
76	102	128	154	180	206	232
77	103	129	155	181	207	233

Inquiry Numbers 234-408

234	259	284	309	334	359	384
235	260	285	310	335	360	385
236	261	286	311	336	361	386
237	262	287	312	337	362	387
238	263	288	313	338	363	388
239	264	289	314	339	364	389
240	265	290	315	340	365	390
241	266	291	316	341	366	391
242	267	292	317	342	367	392
243	268	293	318	343	368	393
244	269	294	319	344	369	394
245	270	295	320	345	370	395
246	271	296	321	346	371	396
247	272	297	322	347	372	397
248	273	298	323	348	373	398
249	274	299	324	349	374	399
250	275	300	325	350	375	400
251	276	301	326	351	376	401
252	277	302	327	352	377	402
253	278	303	328	353	378	403
254	279	304	329	354	379	404
255	280	305	330	355	380	405
256	281	306	331	356	381	406
257	282	307	332	357	382	407
258	283	308	333	358	383	408

Inquiry Numbers 409-590

409	435	461	487	513	539	565
410	436	462	488	514	540	566
411	437	463	489	515	541	567
412	438	464	490	516	542	568
413	439	465	491	517	543	569
414	440	466	492	518	544	570
415	441	467	493	519	545	571
416	442	468	494	520	546	572
417	443	469	495	521	547	573
418	444	470	496	522	548	574
419	445	471	497	523	549	575
420	446	472	498	524	550	576
421	447	473	499	525	551	577
422	448	474	500	526	552	578
423	449	475	501	527	553	579
424	450	476	502	528	554	580
425	451	477	503	529	555	581
426	452	478	504	530	556	582
427	453	479	505	531	557	583
428	454	480	506	532	558	584
429	455	481	507	533	559	585
430	456	482	508	534	560	586
431	457	483	509	535	561	587
432	458	484	510	536	562	588
433	459	485	511	537	563	589
434	460	486	512	538	564	590

Inquiry Numbers 591-765

591	616	641	666	691	716	741
592	617	642	667	692	717	742
593	618	643	668	693	718	743
594	619	644	669	694	719	744
595	620	645	670	695	720	745
596	621	646	671	696	721	746
597	622	647	672	697	722	747
598	623	648	673	698	723	748
599	624	649	674	699	724	749
600	625	650	675	700	725	750
601	626	651	676	701	726	751
602	627	652	677	702	727	752
603	628	653	678	703	728	753
604	629	654	679	704	729	754
605	630	655	680	705	730	755
606	631	656	681	706	731	756
607	632	657	682	707	732	757
608	633	658	683	708	733	758
609	634	659	684	709	734	759
610	635	660	685	710	735	760
611	636	661	686	711	736	761
612	637	662	687	712	737	762
613	638	663	688	713	738	763
614	639	664	689	714	739	764
615	640	665	690	715	740	765

Inquiry Numbers 766-947

766	792	818	844	870	896	922
767	793	819	845	871	897	923
768	794	820	846	872	898	924
769	795	821	847	873	899	925
770	796	822	848	874	900	926
771	797	823	849	875	901	927
772	798	824	850	876	902	928
773	799	825	851	877	903	929
774	800	826	852	878	904	930
775	801	827	853	879	905	931
776	802	828	854	880	906	932
777	803	829	855	881	907	933
778	804	830	856	882	908	934
779	805	831	857	883	909	935
780	806	832	858	884	910	936
781	807	833	859	885	911	937
782	808	834	860	886	912	938
783	809	835	861	887	913	939
784	810	836	862	888	914	940
785	811	837	863	889	915	941
786	812	838	864	890	916	942
787	813	839	865	891	917	943
788	814	840	866	892	918	944
789	815	841	867	893	919	945
790	816	842	868	894	920	946
791	817	843	869	895	921	947

Inquiry Numbers 948-1122

948	973	998	1023	1048	1073	1098
949	974	999	1024	1049	1074	1099
950	975	1000	1025	1050	1075	1100
951	976	1001	1026	1051	1076	1101
952	977	1002	1027	1052	1077	1102
953	978	1003	1028	1053	1078	1103
954	979	1004	1029	1054	1079	1104
955	980	1005	1030	1055	1080	1105
956	981	1006	1031	1056	1081	1106
957	982	1007	1032	1057	1082	1107
958	983	1008	1033	1058	1083	1108
959	984	1009	1034	1059	1084	1109
960	985	1010	1035	1060	1085	1110
961	986	1011	1036	1061	1086	1111
962	987	1012	1037	1062	1087	1112
963	988	1013	1038	1063	1088	1113
964	989	1014	1039	1064	1089	1114
965	990	1015	1040	1065	1090	1115
966	991	1016	1041	1066	1091	1116
967	992	1017	1042	1067	1092	1117
968	993	1018	1043	1068	1093	1118
969	994	1019	1044	1069	1094	1119
970	995	1020	1045	1070	1095	1120
971	996	1021	1046	1071	1096	1121
972	997	1022	1047	1072	1097	1122

Inquiry Numbers 1123-1304

1123	1149	1175	1201	1227	1253	1279
1124	1150	1176	1202	1228	1254	1280
1125	1151	1177	1203	1229	1255	1281
1126	1152	1178	1204	1230	1256	1282
1127	1153	1179	1205	1231	1257	1283
1128	1154	1180	1206	1232	1258	1284
1129	1155	1181	1207	1233	1259	1285
1130	1156	1182	1208	1234	1260	1286
1131	1157	1183	1209	1235	1261	1287
1132	1158	1184	1210	1236	1262	1288
1133	1159	1185	1211	1237	1263	1289
1134	1160	1186	1212	1238	1264	1290
1135	1161	1187	1213	1239	1265	1291
1136	1162	1188	1214	1240	1266	1292
1137	1163	1189	1215	1241	1267	1293
1138	1164	1190	1216	1242	1268	1294
1139	1165	1191	1217	1243	1269	1295
1140	1166	1192	1218	1244	1270	1296
1141	1167	1193	1219	1245	1271	1297
1142	1168	1194	1220	1246	1272	1298
1143	1169	1195	1221	1247	1273	1299
1144	1170	1196	1222	1248	1274	1300
1145	1171	1197	1223	1249	1275	1301
1146	1172	1198	1224	1250	1276	1302
1147	1173	1199	1225	1251	1277	1303
1148	1174	1200	1226	1252	1278	1304

Inquiry Numbers 1305-1479

1305	1330	1355	1380	1405	1430	1455
1306	1331	1356	1381	1406	1431	1456
1307	1332	1357	1382	1407	1432	1457
1308	1333	1358	1383	1408	1433	1458
1309	1334	1359	1384	1409	1434	1459
1310	1335	1360	1385	1410	1435	1460
1311	1336	1361	1386	1411	1436	1461
1312	1337	1362	1387	1412	1437	1462
1313	1338	1363	1388	1413	1438	1463
1314	1339	1364	1389	1414	1439	1464
1315	1340	1365	1390	1415	1440	1465
1316	1341	1366	1391	1416	1441	1466
1317	1342	1367	1392	1417	1442	1467
1318	1343	1368	1393	1418	1443	1468
1319	1344	1369	1394	1419	1444	1469
1320	1345	1370	1395	1420	1445	1470
1321	1346	1371	1396	1421	1446	1471
1322	1347	1372	1397	1422	1447	1472
1323	1348	1373	1398	1423	1448	1473
1324	1349	1374	1399	1424	1449	1474
1325	1350	1375	1400	1425	1450	1475
1326	1351	1376	1401	1426	1451	1476
1327	1352	1377	1402	1427	1452	1477
1328	1353	1378	1403	1428	1453	1478
1329	1354	1379	1404	1429	1454	1479

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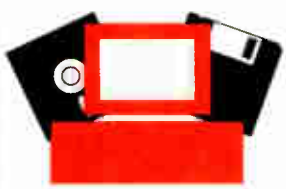

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Pittsfield, MA 01203-9926

USA

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YOUR DIRECT LINK

PRODUCT CATEGORY INDEX

For FREE product information from individual advertisers, circle the corresponding inquiry numbers on your Direct Link Card!

To receive information for an entire product category, circle the category number on your Direct Link Card!

Inquiry No.		Page No.
506-507	ADVANCED COMPUTER INT'L	340PC-12
90	ASP COMPUTER PRODUCTS	234
399	BUFFALO PRODUCTS	315
249	CANON INFORMATION SYSTEMS	60-61
136	IBM / LEXMARK	84-85
409	MINOLTA GMBH (INT'L)	99
159	NEC - PRINTERS	48-49
*	OUTPUT TECHNOLOGY CO	25
*	PACIFIC DATA PRODUCTS	243
285	RALIN WHOLESALERS	312-313
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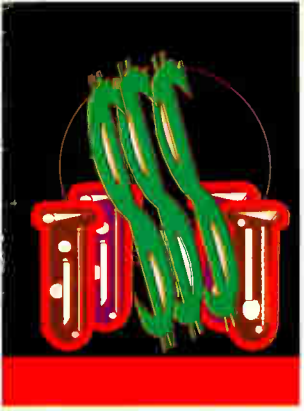

STOP BIT

ESTHER DYSON

ARTIFICIAL LIFE AND NATURAL MARKETS

Artificial life is a hot topic right now for computer scientists, biologists, and philosophers. But it may hold special meaning for the new entrepreneurs of Central Europe and the former Soviet Union by providing a respectable scientific model for the behavior of seemingly chaotic competitive markets. In a world where capitalist economics is still suspect, artificial life makes it clear that competition is a creative force, not a destructive one.

A nascent technology could legitimize capitalism in the former Soviet Union

The basic idea behind artificial life, or *ALife*, is to build electronic "creatures" that reproduce—but imperfectly. Sometimes there are slight changes between the original and its children; sometimes by combining features of two original creatures you can produce a best-of-both-sides (or worst-of-both-sides) copy. If you select the best of each successive generation as the starting point for the next generation, you'll see something awesome: evolution at a time scale humans can comprehend.

One of the most exciting experiments along these lines is Tierra, created by Tom Ray, now at the Santa Fe Institute for complex adaptive systems. Ray created a single electronic creature that reproduced itself, with slight mutations. Soon these creatures had filled up available memory, and imperfect copies started to do strange things—use each other's code, get more efficient at reproducing, and so on. These creatures were parasites, and they became new species competing for resources.

ALife gives biologists and computer scientists a way to experiment that isn't possible in the "real" world. Traditional experiments usually take years to create and test a generation so that the best ones can be selected for the next round. Most biologists have to work with incomplete, hard-to-assess fossil records instead of tidy, well-organized interactive computer graphics, where you can trace the exact progress of generations.

The ALife experiments illustrate the awesomely creative power of competition. Creatures evolve best when they coevolve, when one species spurs another to evolve, exploiting its weaknesses and enhancing its strengths. When different species compete, they find niches and evolve into specialists at competing with one another or cooperating with other species.

As it happens, you can see this same principle work in markets. I divide my time between places such as Silicon Valley and the emerging computer markets of Eastern Europe. Over and over, I see parallels between market processes and evolutionary processes, as illustrated by ALife. The major difference had been time scale, but now simulations let us look at both processes in real time.

In Eastern Europe, I can follow the stumbling, awkward process of market creation. The emergence of healthy competition is not automatic. The untrained notion of competition is that one side wins and the other loses. But as ALife illustrates, competition is a much more complex, self-organizing tool.

Slowly, the factors that made one side win get strengthened, while those that made the other side lose diminish. Competition fosters healthy diversity. Second-place finishers find other races to run, emphasizing different subsets of features. To compete successfully with Compaq, Dell didn't just do the same things better; it tried something different. The mathematics of how this happens are complex and can be observed in ALife simulations.

There's little coevolution in the new Russian markets, partly because competitors do not know enough about each other. Vendors don't have to compare their products to those of other vendors because everything is in such short supply. That will change.

As ALife shows, the way to evolve is by defining yourself against the other guy, by specializing. The market isn't only about sellers talking to buyers, who determine fitness; it is also about sellers talking to each other, so that they can find their proper specialization.

The former Soviets have been trained to think of markets as wicked and dirty—and, indeed, most of the markets they've seen so far fit this description. The Communist model depicted a cleanly run, scientific world where goods were produced and allocated according to just, scientific principles, and where prices reflected costs of production. But prices work better when they reflect customer demand—or *fitness* in evolutionary terms. Prices do not just allocate scarce goods; they influence design and investment in the production of future goods. By clarifying the scientific principles behind markets and market pricing, artificial life may help to make them respectable, even in the eyes of former Communists. ■

Esther Dyson is editor of Release 1.0, *a newsletter that discusses exotic software, and of* Rel-EAST, *a newsletter about emerging computer markets in Central and Eastern Europe. You can reach her on BIX c/o "editors" or by MCI Mail at 511-3763.*

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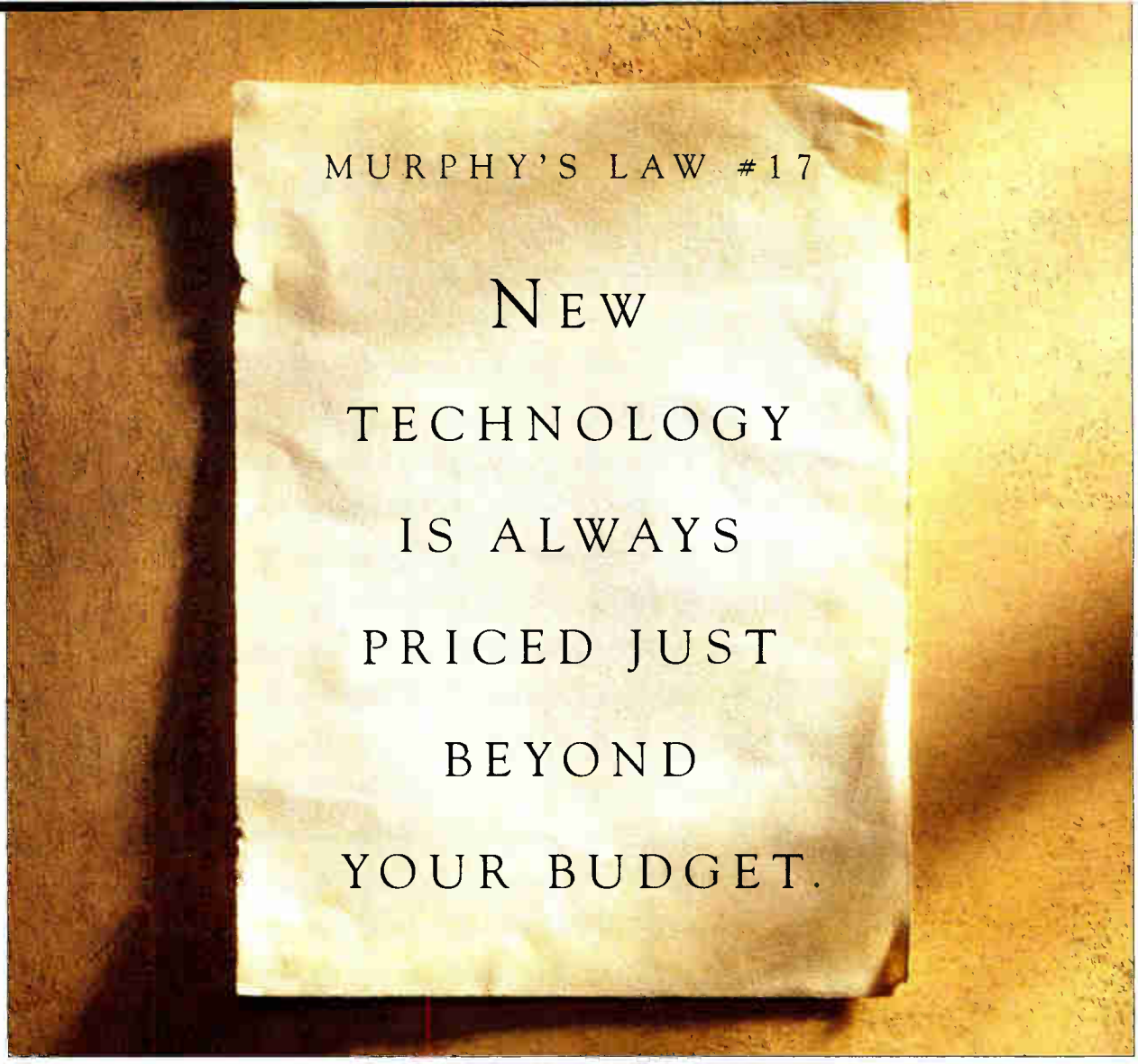

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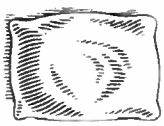

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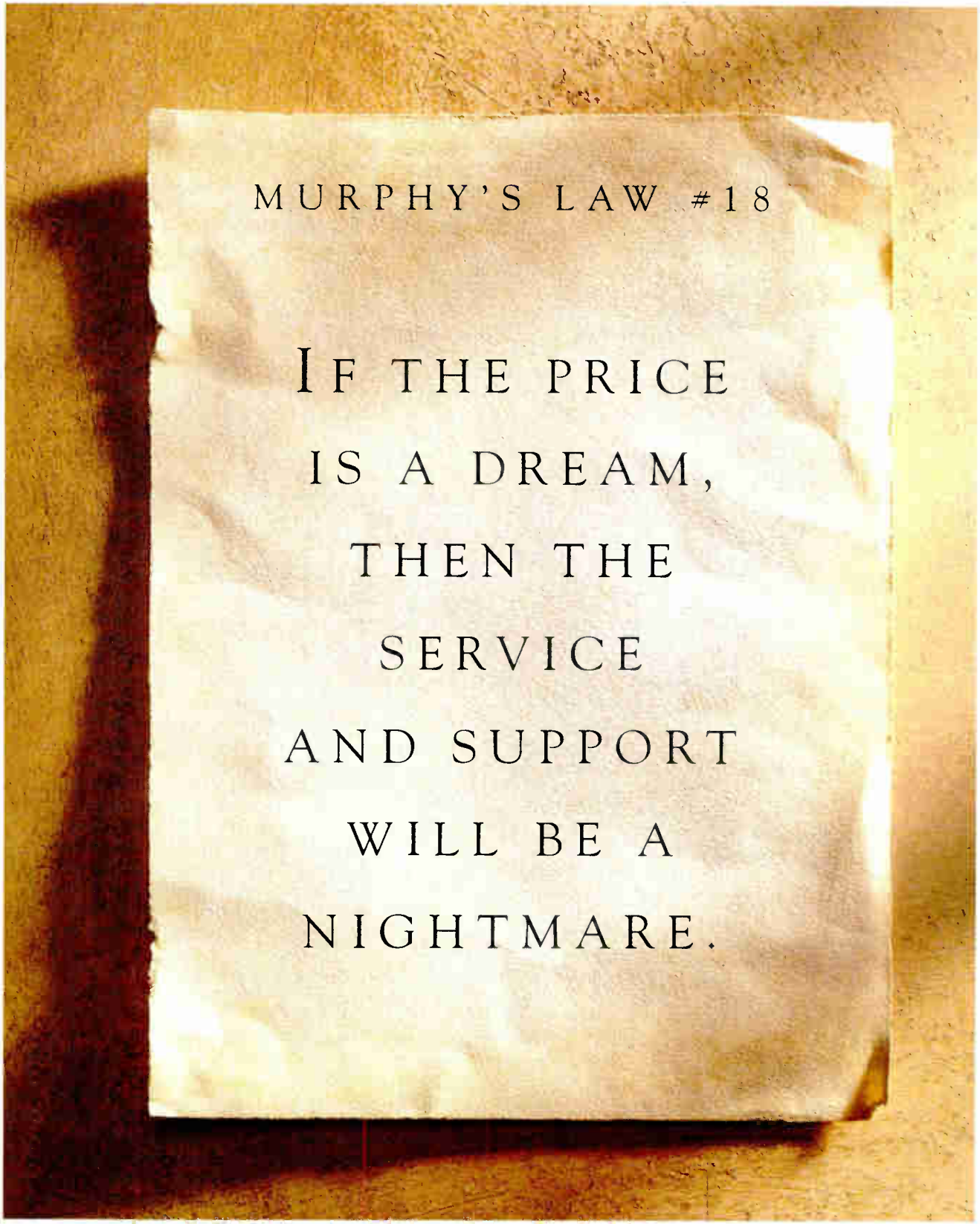

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