

SPECIAL ISSUE

BYTE

EXTRA EDITION

Display until January 15, 1992

TOMORROW



Key technologies forecast by Letwin, Kapor, Canion, Nelson, Kay, Carr, Singh, Dyson, Metcalfe, Shaffer, Slater, Sinclair, and many others

TODAY

Buying and resource guides for  327 products from four key categories, plus introductions and trend analysis by the BYTE staff

CPU Wars



OSes

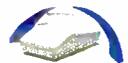
Desktop Systems



Future Software

The Business Perspective

Windowing



Computers and Society

 Networking

On-line Services

Surveys



European Outlook

Key Technologies and Trend-Setting Products

OUTLOOK '92

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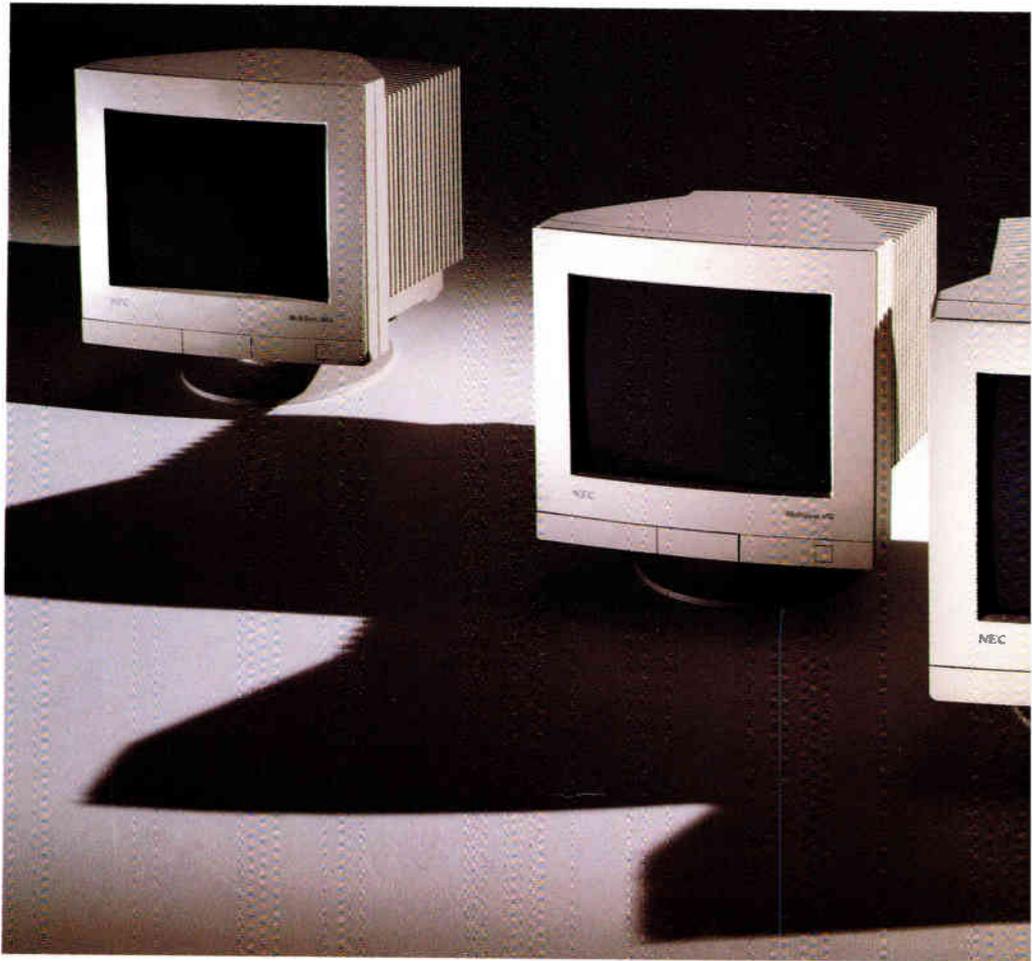
NEC

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**Dependent on graphics board and signal being used.



MultiSync 455



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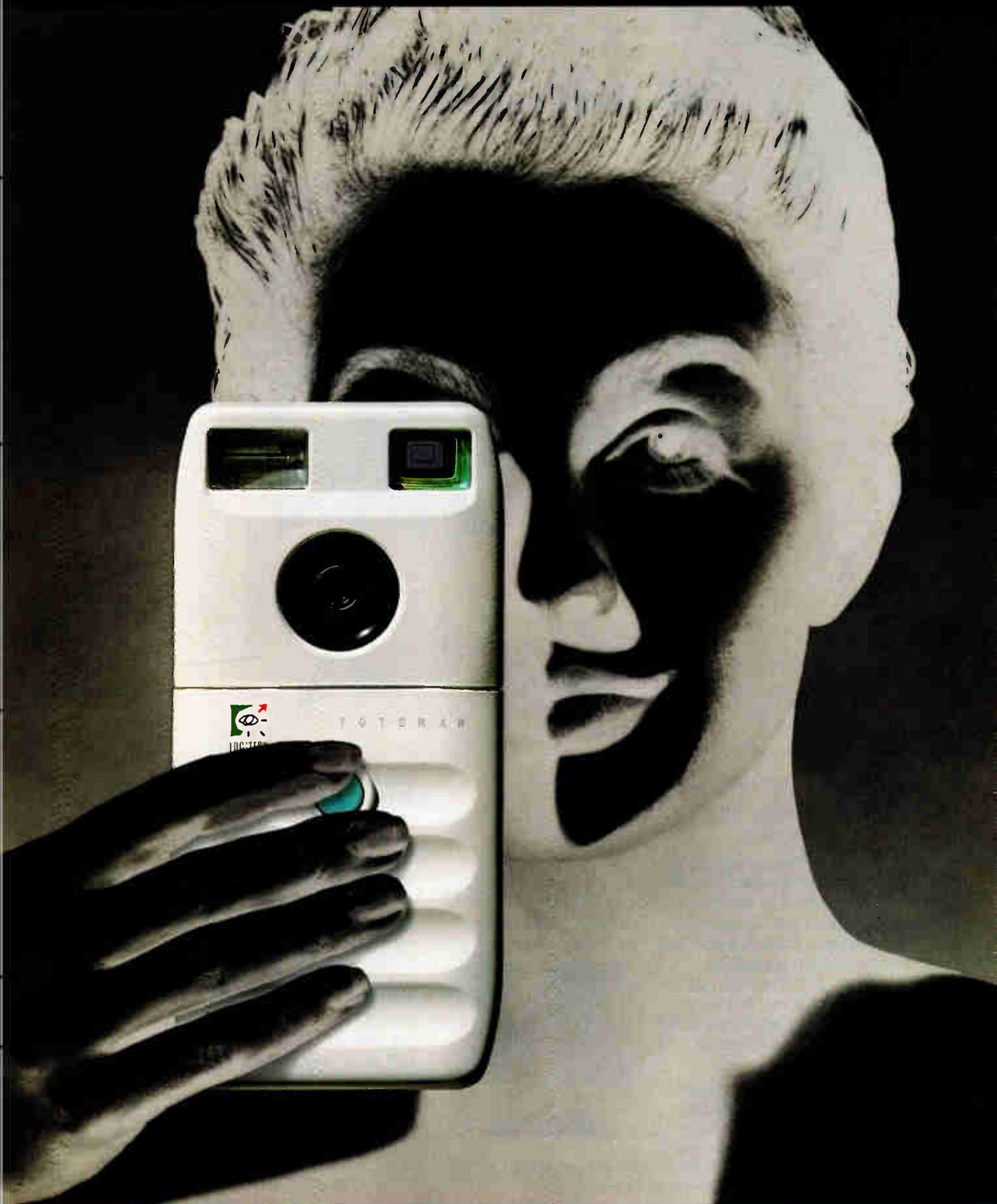
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A true of power, and

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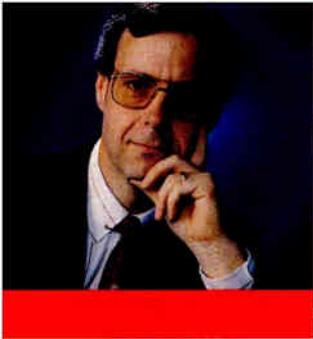


How're you
going to do it?
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World Radio History



GENE
SMARTE

EDITORIAL

R.I.P. IBM

**The first of a new series
of annual issues
encompassing all of
personal computing**

No, it's not what you think. You haven't pulled a Rip van Winkle and slept through the passing of an industry giant. The Rest In Peace refers to BYTE's annual IBM issues, the ones we've labored on for the past seven years. So what happened? Has BYTE abandoned the DOS world, gone platform-specific, maybe? No, but we have fulfilled our mandate to cover the powerful ground swell that the users of the world created.

While BYTE's mission has always been to look at technologies and products without respect to platform, processor, operating system, or any other specific characteristic, the significance of the DOS-based systems over the past several years has been obvious. And that's a big reason why we produced a special thirteenth issue each year at this time devoted to the DOS environment.

Still, we didn't ignore the rest of the world; each year we also had articles on connectivity, Macintosh, Unix, and other important systems and topics in our annual *IBM Special Editions* (as well as each month in *BYTE*). Each year, we'd review our reader surveys and trade show polls, talk with users and corporate leaders, and visit researchers and developers to gather data on topics that we felt were the most significant for that year.

During the past couple of years, the industry has reached critical mass. We cannot quite yet include "personal computer" in the same breath with "toaster" or "typewriter," but we are not far away. The diversity of hardware and software, while increasing in complexity and capacity, is becoming more and more transparent to users. Macintoshes, Sun workstations, and plain-vanilla DOS boxes can share data and increase efficiency via networks. Information resources and computing benefits are becoming easier to obtain.

Vociferous supporters of niche systems and products will always be with us, and that's fine, even desirable. But it is clear that computing is becoming more universal; it is becoming a tool rather than an end in itself. It spans platforms, processors, and operating environments as easily as it does oceans and continents.

There are truly worldwide issues that computing power influences, such as international monetary transactions, strategic communications and information gathering, and, most important, the free flow of information among individuals. Recent events in the

Soviet republics attest to the power of fast and widespread information dissemination.

Just where is all this ubiquitous "appliance" computing taking us? Where are we now? Where will we be in a few years? What technologies and products should we be buying today that we can use tomorrow? What do users want? What can industry provide? What can computing technologists develop? These and a hundred other questions are easy to ask. We've tried to get some of the answers in this issue.

So, here we are, with what we hope will be the first of a series of special annual issues devoted to personal computing's future, with emphasis on emerging technologies and their impact on the future *and* a cross section of the most significant products you can buy today.

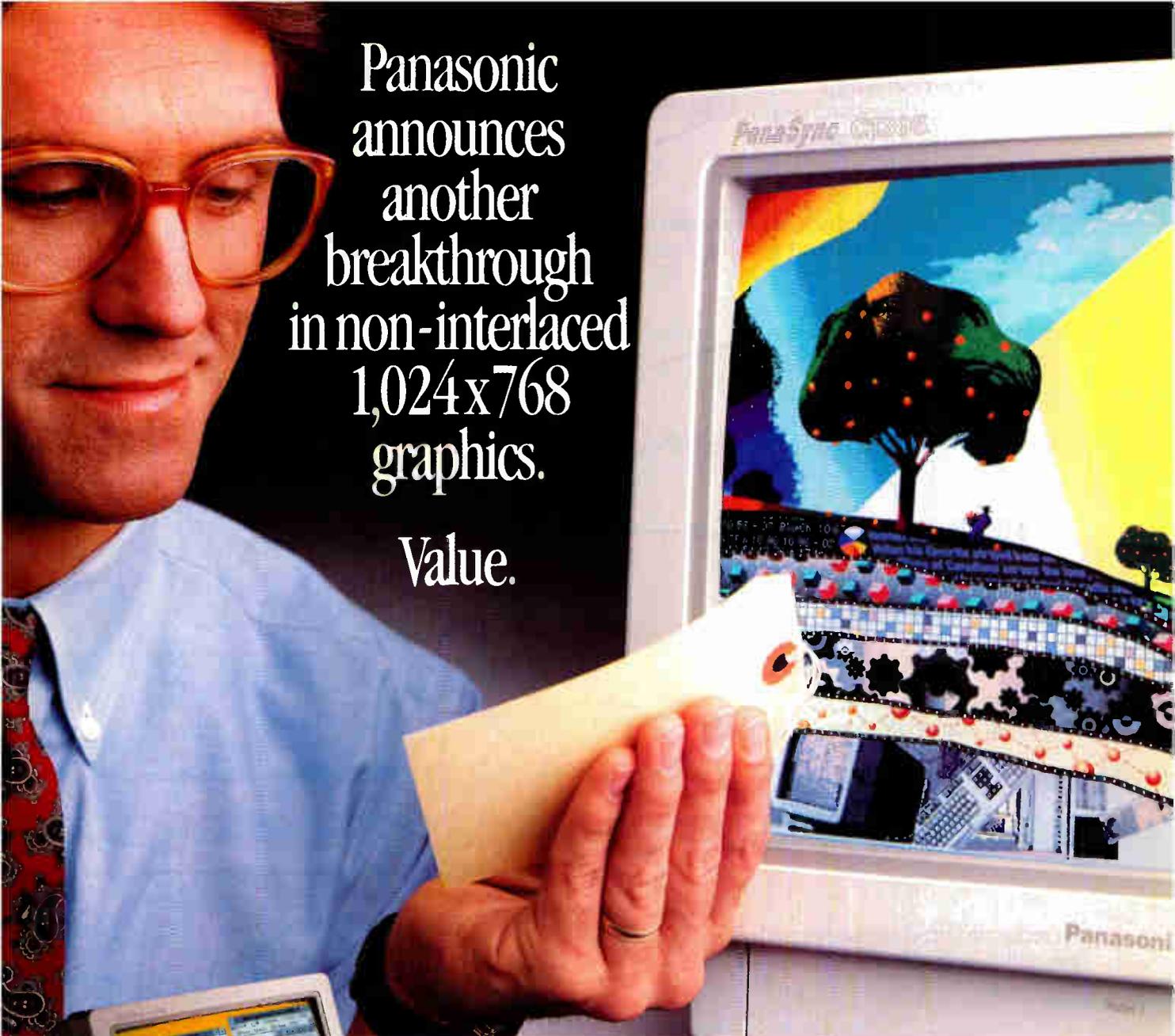
For the future, we searched high and low to identify the important issues. We interviewed scores of corporate players, industry gurus, and academic researchers. We asked leading questions but also gave people an opportunity to speak their minds on what they felt was important. *BYTE's* News and Technology Department selected six areas likely to have a major impact on the future of personal computing. You can find the results of this forward-looking effort in this issue's Technology Forecast.

What about the buying decisions you need to make today? We've addressed that point in the Product Perspectives section. The *BYTE* Lab chose four critical product categories and provided feature-comparison data for many competing products. We've added something special: accompanying text for each category that gives you enough background to make intelligent decisions, setting the context of the product category, describing trends, and hinting at future developments.

I'll not expound further here on this issue's contents. Read the overview, "This Way to 1992," to get a feel for where the whole industry is today and for lots of pointers to the various topics included in *Outlook '92*.

As this is the first in the Outlook series, we expect it to grow and evolve with the industry, to try to stay just a little ahead of what's happening. In 1992, we'll again be identifying the most important technologies and products for *Outlook '93*. We invite your comments and suggestions for topics and spokespersons for our next issue. Your input can be a vital part of our providing you with the timely information you seek.

—Gene Smarte
Senior Editor, Special Projects
(BIX name "gsmarte")



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breakthrough
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For further information on the PanaSync C1395 Multi-Frequency Monitor, telephone 1-800-742-8086.

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World Radio History

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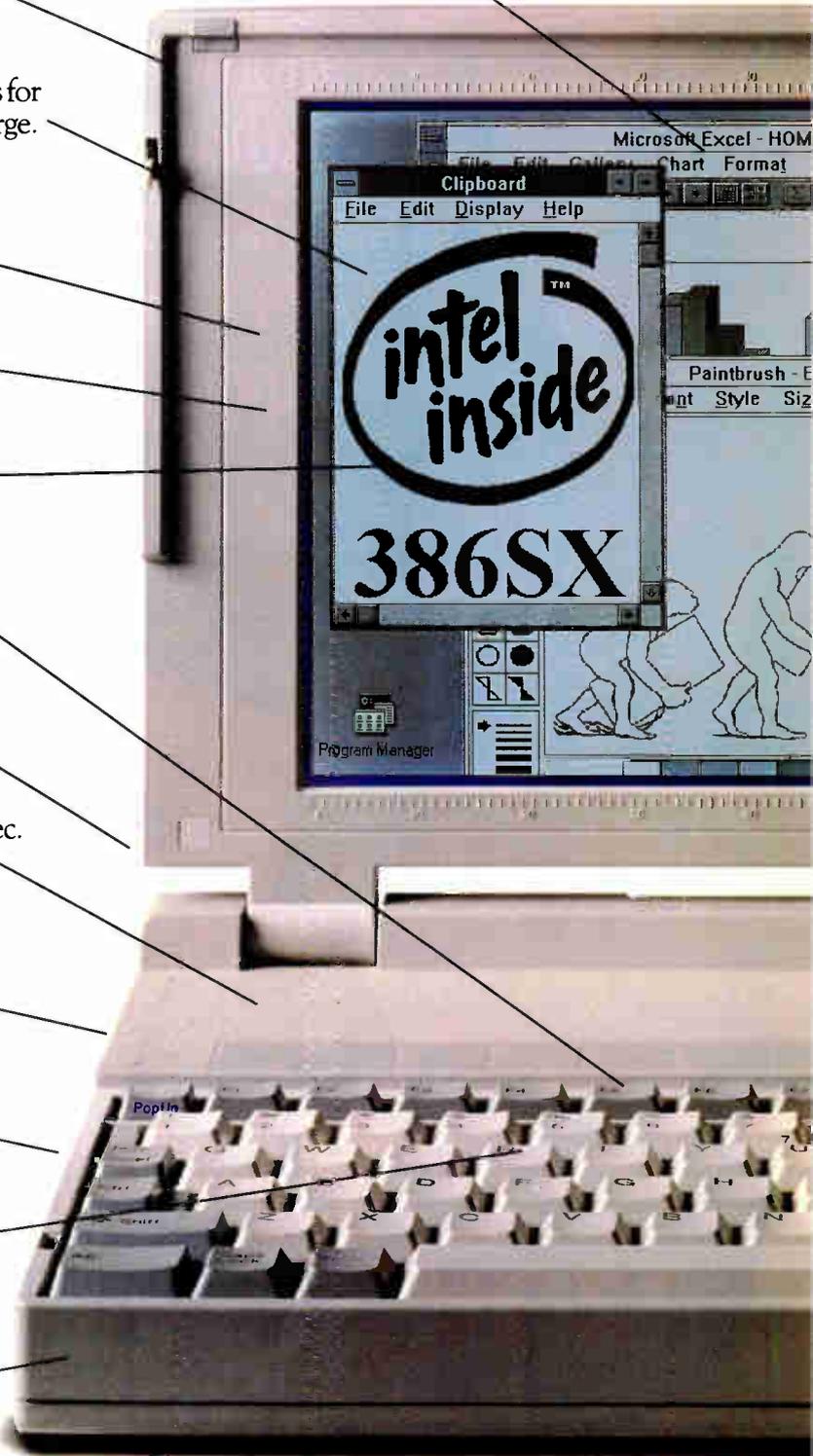
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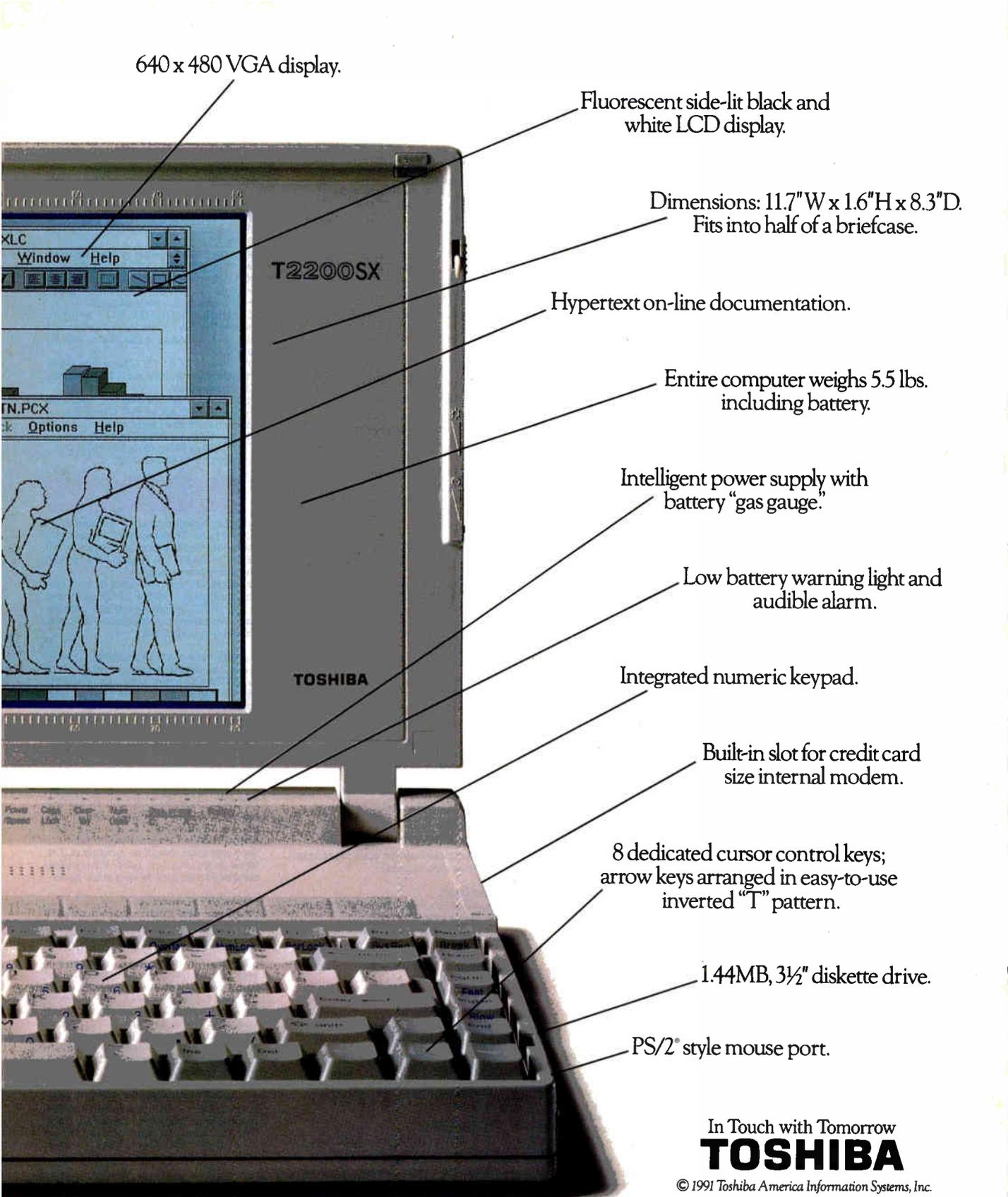
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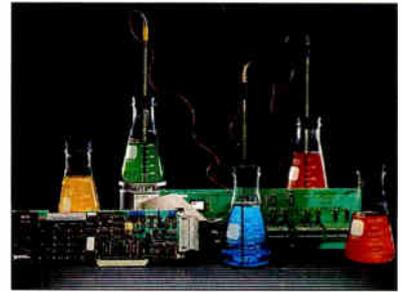
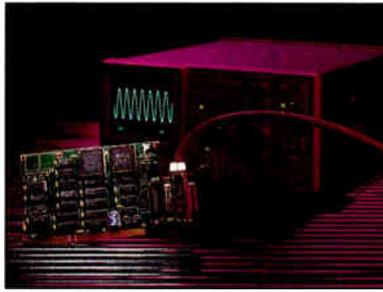
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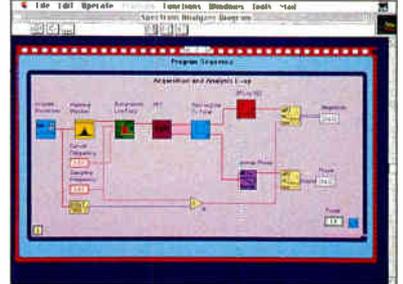
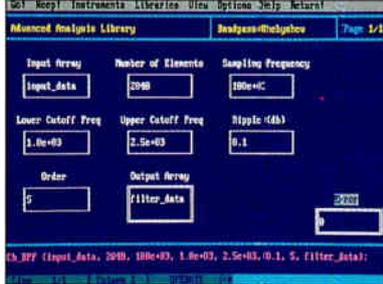


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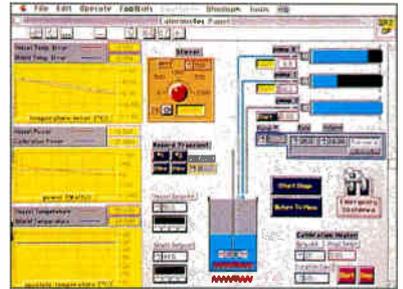
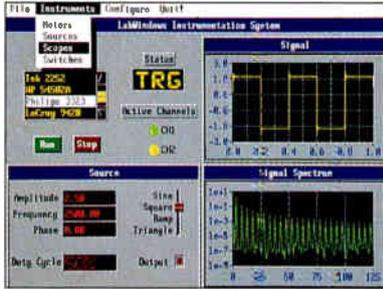
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are looking for new development tools to try to simplify the task of software development.

Clearly, the most promising trend is the shift to object-oriented programming, which is discussed by Ellen Ullman in the "Software Technologies" section of the Cornerstones article. Barry Nance looks at OOP, programming languages, and other software development issues in his article "The Future of Software Technology."

Open the Window; What Do You See?

Software development is one side of the ease-of-use coin. The other side of that coin is the interface that a user actually sees on a computer screen. Of course, software development tools and user interfaces are closely related. In fact, developers spend a good deal of time integrating their applications into the windowing environment and user interface of the computer system on which

their applications will run.

User interfaces pose a very thorny problem for developers and software vendors. On the one hand, users don't like change; they don't want to have to learn new tricks. This ensures the continued popularity of interfaces such as Microsoft Windows and the Macintosh Finder. On the other hand, major advances in user interfaces will require users to give up some of their old habits. The key is making the changes so easy to learn that users will willingly abandon their old ways.

In his article "Mind Melding," Owen Linderholm looks at some of the philosophies and theories behind user-interface research and some of the interfaces that we can expect to see in the future, presenting the views and predictions of several experts and visionaries in the user-interface field. And Andy Reinhardt investigates new forms of user interaction, such as pen and voice, in the "User Interaction" section of the Cornerstones article.

Picture Windows

Part of the user-interface story is the capability to display images on the screen. More and more computers have high-resolution displays capable of displaying millions of colors, and users of these computers are looking for true color imagery to use in scientific visualization, motion video applications, and graphic arts work. D. Barker looks at the state of graphics in the "Information Representation" section of the Cornerstones article.

Finally, BYTE editors Stan Miastkowski, Tom Yager, and Tom Thompson look at the latest applications for Microsoft Windows, the X Window System, and the Macintosh, respectively, in the "Windowing: Not by DOS Alone" Product Perspectives section.

A Stop at the Hardware Store

The hardware technology that's generating the most interest right now is the notebook computer. Although in their infancy, notebook computers promise to have a major impact on the computer marketplace. Two articles in this issue take a look at notebook systems. In the "Hardware Technologies" section of the Cornerstones article, Owen Linderholm examines some of the new technologies that make notebook computers possible: low-power CPUs, advanced display technology, and flash EPROM, for example. In the Product Perspectives section, Michael Nadeau takes a look at DOS-based notebooks and discusses some of the new

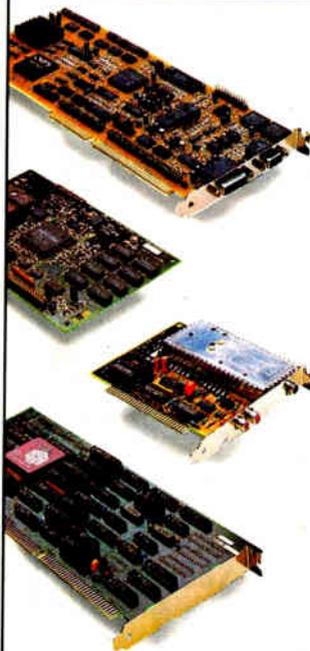
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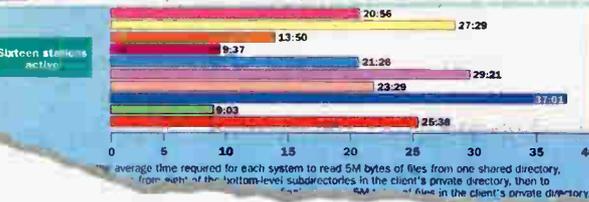
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by Bill O'Brien

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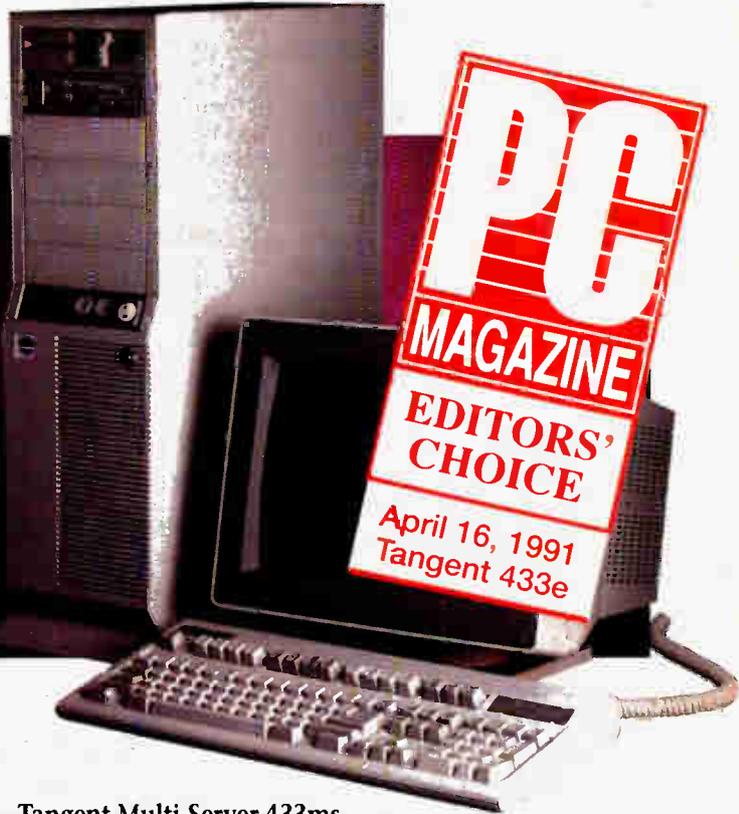
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pen-based systems that are now entering the market.

An important catalyst for the development of lightweight notebook computers is the advancement of techniques for storing data, both on disk and in volatile memory. Storage technology encompasses not only the basic magnetic and optical media, but also techniques for storing data in more efficient ways—techniques such as the use of cache controllers and data compression. Andy Reinhardt brings you up to date on the latest developments in storage technology in his article “Disk, DAT, and the Optical Thing.”

In spite of the surge of interest in notebooks and portables, the heart of the computer industry remains the desktop machine. While there may not be any earth-shattering changes in these systems in the next few years, they will remain the primary focus of computer buyers. But there will be some changes. Desktop systems will sport faster processors and hard disk drives in the next few years, as well as multiple processor architectures.

From the product perspective, BYTE technical editors Alan Joch, Tom Yager, and Tom Thompson take a look at DOS-based PCs, Unix machines, and Macintoshes, respectively, in their article entitled “Desktop PCs: The Buyer’s Market Continues” in the Product Perspectives section.

Indeed, desktop machines will continue to drop in price, and the workstation market will become more competitive. According to Tom Yager, Next

Computer may finally start to make some big sales in 1992. For a more general perspective on desktop machines as well as other types of computers, see the “Hardware Technologies” section of the Cornerstones article.

In spite of the surge of interest in notebooks and portables, the heart of the computer industry remains the desktop machine.

The Next Revolution

In a nutshell, that’s what this Outlook ’92 issue is about. These pages contain a lot of interesting material and food for thought. When considering computer technology, it’s always fun to try to anticipate what the next revolution—the next great technological breakthrough—will be. But it is also very hard to predict. To many observers, technological change has been a slow and arduous process. But then again, this industry is only about 25 years old and has only begun to mature over the last five years.

From a historical perspective, it is quite amazing how much progress has been made in the computer industry in

such a short time. Compare the computer industry to the automotive industry, for example. There haven’t been any major changes in cars in 30 years. Sure, cars now have better suspensions and engines, more electronic gadgetry, and more aerodynamic bodies, but the basic design and function of the car have remained essentially the same. Meanwhile, computers continue to expand into uncharted territory, providing functions and capabilities that few people ever imagined just 25 years ago.

Soon we’ll be seeing a whole new class of workers using computers—namely, mobile workers, such as doctors making the rounds, delivery personnel, maintenance workers, real estate appraisers, and so forth. Many of these workers have never used computers up to now and will provide a new market where the computer industry can innovate and provide new capabilities without the burden of backward compatibility.

As long as data can be exchanged with existing computer systems, compatibility may not be very important in this new market. And that is an exciting prospect. 1992 should be an important year for the mobile computing, or pen-based, market. And if I may take the liberty, I believe that this is the market where the next revolution in computing will take place. ■

Nicholas Baran (Sandpoint, ID) is a consulting editor for BYTE and coeditor of Pen-Based Computing, The Journal of Stylus Systems. You can contact him on BIX as “nickbaran.”

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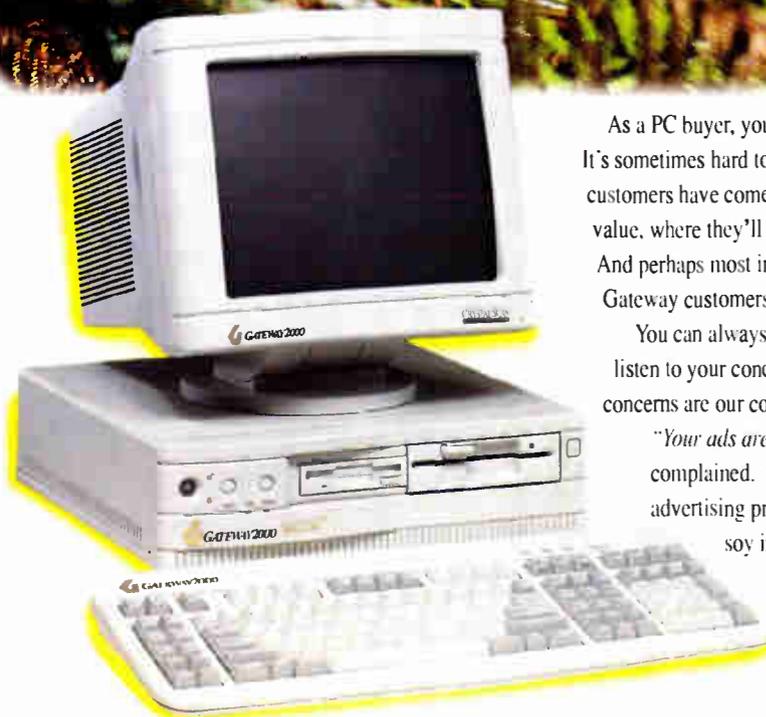
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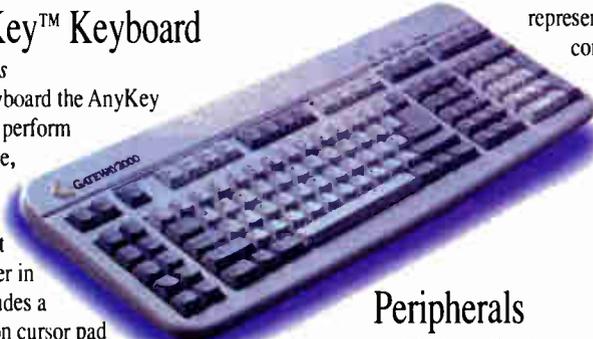
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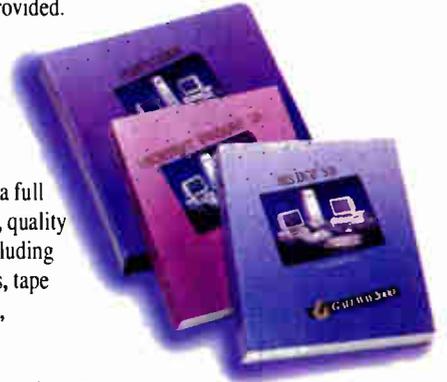
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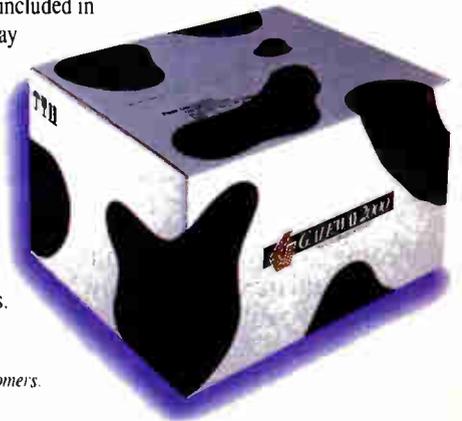
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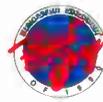
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The screenshot shows the CA-Compete! interface with the following data tables:

	LPs	CDs	Tapes	Total
Units	19,499	34,678	23,597	77,774
Price	\$0.75	\$1.40	\$1.05	\$1.07
Sales	\$14,624	\$48,549	\$24,777	\$87,950
COGS	\$13,671	\$24,314	\$16,544	\$54,529
SG&A	\$1,462	\$4,855	\$2,478	\$8,795
Total Cost	\$15,134	\$29,168	\$19,022	\$63,324
Profits	(\$509)	\$19,381	\$5,755	\$24,627

	Actual	Plan	Variance
LPs			
Units	19,499	21,344	(1,845)
Price	\$0.75	\$0.75	\$0.00
Sales	\$14,624	\$16,008	(\$1,384)
Cost of Goods Sold	\$13,671	\$13,058	\$613
Selling & Admin.	\$1,462	\$1,921	(\$459)
Total Cost	\$15,134	\$14,979	\$155
Profits	(\$509)	\$1,029	(\$1,539)

	1989	1990	1991
% Sales	100.00%	100.00%	100.00%
Sales	100.00%	79.63%	77.77%
COGS	81.57%	72.00%	72.00%
SG&A	12.00%	12.00%	12.00%
Total Cost	93.57%	91.63%	89.77%
Profits	6.43%	8.37%	10.23%
Tax	2.70%	3.52%	4.30%
Net Income	3.73%	4.86%	5.93%

	Actual	Plan	Variance
Units	34,678	30,200	4,478
Price	\$1.40	\$1.40	\$0.00
Sales	\$48,549	\$42,280	\$6,269
Cost of Goods Sold	\$24,314	\$18,476	\$5,838
Selling & Admin.	\$4,855	\$5,074	(\$219)
Total Cost	\$29,168	\$23,549	\$5,619
Profits	\$19,381	\$18,731	\$650

	Actual	Plan	Variance
Units	23,597	26,100	(2,503)

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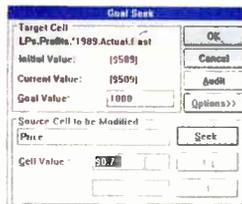
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- Curve Builder...
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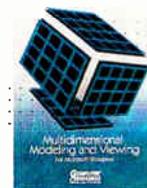
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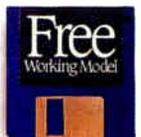
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CORNERSTONES OF THE FUTURE

From the vantage point of 1991, we can look back to the mid-1980s and see a dazzling array of computer news events. In 1984, Apple introduced the Mac, IBM brought out the AT, and a company called Satellite Software delivered a package called WordPerfect. New arrivals in 1985 included the 386 processor, Windows 1.0, and PageMaker for the Mac. Not all of these products may have seemed important at the time, but with proverbial 20/20 hindsight, we now know they changed the course of computing. Other news events were not as predictive. In 1986—a barren year for lasting breakthroughs—IBM introduced the RT and the PC Convertible, Atari unveiled the 1040ST, and Sperry and Burroughs merged into Unisys. Although some of these announcements were hailed at the time, they didn't turn out to be as successful as their proponents had hoped.

The Crystal Ball

What new products, technologies, and business events of the last 18 months will, from the perspective of five years hence, turn out to be as significant as the Mac and Windows? That was the question we posed to BYTE's staff and contributing editors, who responded with a dizzying assortment of suggestions, ranging from pen-based personal computers to globalization, from wireless LANs to the glut of industry consortiums. Out of dozens of trends, BYTE news editors distilled six major themes that highlight the direction of the industry.



■ **Hardware technologies.** The perennial ideals of computer design—smaller, faster, and cheaper—are still driving innovation. Portables are so powerful that they may obviate the desktop computer, while workstations are encroaching on the high end of the personal computer's turf.

■ **Software technologies.** From the rise of 32-bit operating systems to the emerging “document-centric” paradigm, the software technologies that underlie desktop computing are undergoing dynamic change. Distributed client/server computing requires standards for objects and remote procedure calls. The growth of imaging applications may dictate operating-system enhancements such as Apple's QuickTime.

■ **User interaction.** GUIs have made interacting with computers easier than ever, but humans and machines still don't speak the same language. Handwriting and speech recognition may be the wave of the future, but they're still imperfect. The most interactive experience of all is virtual reality.

■ **Information representation.** Not every problem can be solved with mathematics. Some of the most complex issues are best explored with images, and as some pioneering designers have realized, other than the human brain, there's no better tool for manipulating images than the computer.

■ **Communications.** In the future, computers will be so interconnected that you'll be able to access instantly any piece of data, from anywhere in the world, without even knowing where it originated. New techniques for wireless communications mean you won't even need a cable to be “plugged in” to the data pulse.

■ **Ownership and power.** New technology is exciting, but it's meaningless outside the context of the companies that deliver it to users. Shifts are under way in the power structure of the computer industry that will influence technology directions for decades. At the same time, rapid arrival of new technologies has outpaced our ability to evolve the legal and ethical infrastructure. Will our social institutions adapt to computers, or vice versa?

The next few pages are an effort to identify and analyze current trends and events—the cornerstones of the future—that will shape computing between now and the mid-1990s. For a gaze into our crystal ball, read on.

—Andy Reinhardt



CORNERSTONES

HARDWARE TECHNOLOGIES

Smaller, Faster, and Cheaper Still Apply

**Dazzling but relentless innovation meets
descending hardware prices**

The demands on computer hardware are greater every year, as a rising tide of expectations, fueled by relentless innovation, meets the descending price curve. The most dazzling improvements have come at the extremities of the market: workstations so powerful that they can outrun a mainframe, and tiny, full-featured portables that may have obsoleted the term *desktop computer*.

Portables Get Real

Only a year ago, notebook computers were scarce and expensive, while bulky laptops were the norm. Since then, notebooks have appeared so fast that the lowly laptop has all but disappeared. The technologies that brought this about were the 2½-inch hard disk drive and inexpensive, VGA-quality LCDs. With desktop docking stations and peripherals like the Xircom LAN interfaces, notebooks are now good enough to be your primary system. It's no wonder they are the fastest-growing part of the computer market.

New and emerging technologies will make portables even better in the next few years. A major challenge is power consumption and battery life, but the low-power 386SL chip from Intel goes a long way toward solving the problem. Zenith has already shown with its new Mastersport 386/SL that this processor can greatly enhance battery life—up to 8 hours versus a norm of 3 hours. When other power-saving techniques are coupled with more efficient nickel-hydride or lithium batteries, the operating life of notebooks could become almost limitless.

The future for notebook displays is color. A new generation of active-matrix color LCDs is arriving from companies such as Sharp, Hitachi, and IBM/Toshiba, but they now have outrageous prices and consume huge amounts of power. When the costs come down and the panels are combined with special chip sets



Nonvolatile silicon storage may replace hard disk drives in portable systems.

that make eight-color displays show 256 or more colors, we will see the rapid emergence of good quality, VGA-compatible color notebooks.

Another intriguing possibility for the future lies in flash EPROM. The use of silicon memory—either battery-backed or nonvolatile—in lieu of rotating storage has advantages in speed, size, and power usage. The Fujitsu FMR-Card notebook, available only in Japan, has a full-size keyboard but weighs just 2 pounds and can run for 100 hours because it uses only silicon storage. The JEIDA/PCMCIA standard will help boost acceptance of IC cards and drive down their prices.

The major limit to how small portables can get is the need for a keyboard. But pen-

based computers, running operating systems such as Pen-Point or Windows for Pens, can be smaller and lighter. Portables also need to have built-in communications; with the rise of wireless networks and packet radio, someday you will be able to hook up your portable to any system in the world, from anywhere and at any time.

Unix Workhorses

The success of Sun's Sparcstation line and the appearance of SPARC clones indicate the growing vitality of workstations. IBM, DEC, and Hewlett-Packard are rushing into the open-system business, while the Advanced Computing Environment (ACE) initiative is trying to steer a course between RISC and CISC, and between Unix and OS/2. Although some question the longevity of Intel's 80x86 architecture, the 486 is putting heavy iron onto business desktops. The trend that ties these systems together is networking. As LANs become the norm in corporations, you will see more "downsizing" from minicomputers and mainframes to client/server personal computer networks.

Intel has already demonstrated a 100-MHz version of the 486, and 64-bit processors



The 386SL chip promises dramatically longer operating life.

CORNERSTONES

HARDWARE TECHNOLOGIES

such as the Mips R4000 are just around the corner. With increased use of techniques such as superscalar architectures, pipelining, and parallelism, and the potential for more esoteric data-flow processors, desktop computer power will continue growing at a breakneck speed.

The More Personal Computer

The counterpoint to the corporate networked workstation is showing signs of life again after years of abandonment: IBM, Tandy, and especially Apple are trying to put the "personal" back into personal computers with inexpensive, easy-to-use systems for the home. The long-awaited "cheap Mac," in the form of the Mac Classic, has put Apple neck and neck with IBM in sales of microcomputers. This success alone proves that the vision of a computer in every home still has great potential.

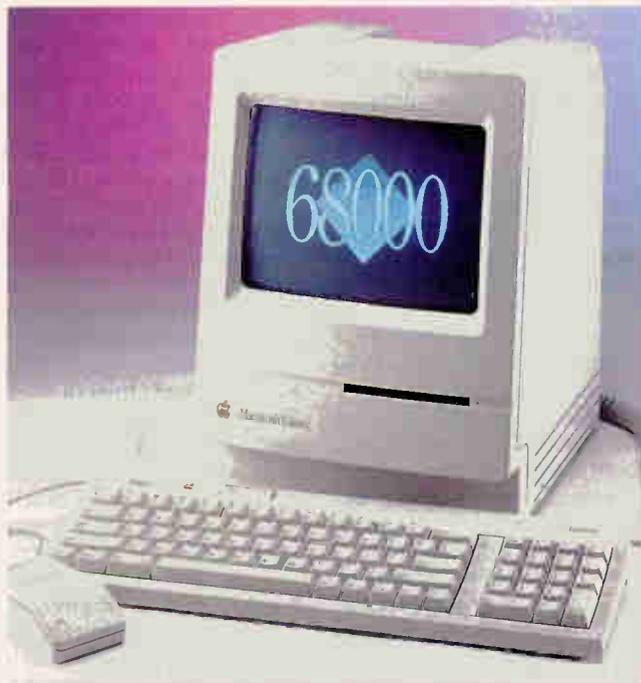
In the near term, add-in cards for CD-quality sound, high-resolution graphics, and

digital video—and agreements on multimedia standards—will make computers far more entertaining. Eventually, computers and TVs will merge into a universal information appliance. Whether computer or consumer electronics companies will lead this charge remains to be seen.

Seeing the Light

The final frontier in computing may be the use of optics instead of electronics for processing and storing data at the speed of light. IBM has demonstrated a holographic storage method that operates at room temperature and is able to store bits of information at the molecular level. Other advances include holographic, laser-based gate switches, equivalent to the circuits used in current microprocessors. The challenge is to turn these technological demonstrations into real products. When they come, they may revolutionize storage and computer operating speed.

—Owen Linderholm



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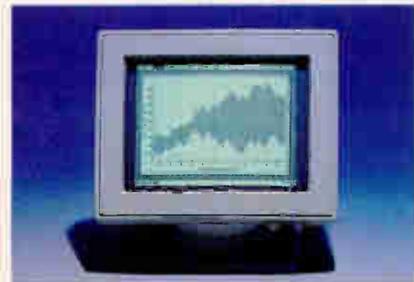
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The Object-Oriented Future

The operating system sees applications as true objects—encapsulated code and data

When Microsoft released Windows 3.0 in May 1990, it was hailed as a milestone for bringing the GUI to the PC. But we may look back and see it as a more significant event. Windows 3.0 popularized a new role for desktop operating systems.

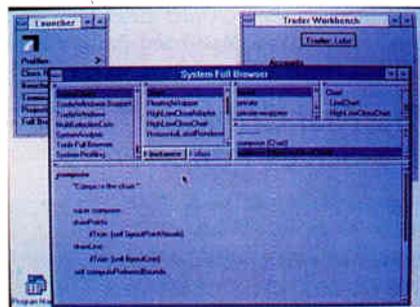
The Object-Oriented Operating System

The operating system, no longer just an interface to the machine, has now taken on more responsibility for applications. It helps programs share data and allows them to be linked to one another. It has become a medium for the creation of new programs out of small application components, or *applets*. From the vantage point of the operating system, applications have become true objects—encapsulated code and data.

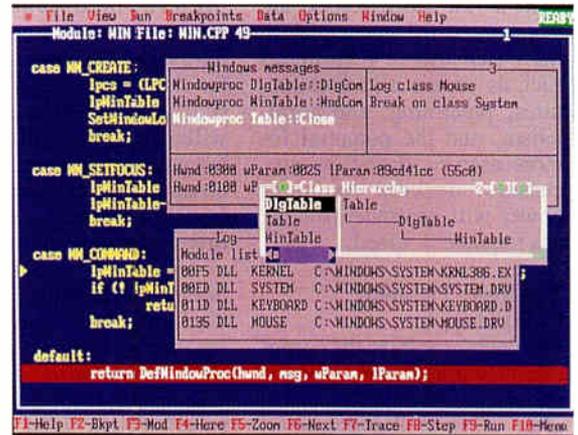
Most important, the *user* now controls the linking and data-sharing processes. What were once low-level mechanisms, available only to programmers, are now high-level functions of the user interface. You create the links between applications and decide which procedures will share data.

The role of Windows as an interapplication medium began in version 2.0 with Dynamic Data Exchange. DDE came of age with version 3.0 because extended memory management let multiple programs load simultaneously and exchange live data. Then, in January, Excel 3.0 became the first program to use Microsoft's Object Linking and Embedding technology. OLE allows both data and logic from one program to reside in another; for example, a graph and a pointer to the program that created it can be embedded in a document, or a table can be linked back to a centralized source. The libraries that implement OLE will be a standard feature of Windows 3.1.

Nearly simultaneously with their introduction to Windows 3.0, the idea of component applications and object linking came to the Mac world. With the release of System 7.0 in May,



Objectworks/Smalltalk from ParcPlace: where object orientation began.



Borland C++ 2.0: Borland's serious entry into object-oriented languages is fuelling the switch from C to C++.

Mac applications began to pass messages to one another using AppleEvents. Object linking became possible with the Publish/Subscribe mechanism.

Although Excel 3.0 was the first program to use OLE, Microsoft did not invent object linking. The first major product that offered object linking was NewWave from Hewlett-Packard, but Windows 3.0 and System 7.0 have popularized the idea. Object linking, message passing, data sharing: These are now firmly established as proper and vital functions of future desktop operating systems.

The Component Software Platform

When HP released its NewWave applications development platform in 1989, it also introduced the Agent, a mechanism that became accessible to end users in the May 1990 release 3.0 of NewWave.

The Agent is a type of scripting ability that records both keystrokes and underlying logic, a form of object linking. But, more significant, it lets you name the link, save it, and run it later—in essence creating a new application. With the Agent, the application becomes a suite of high-level components, and you are the application builder.

A new and potentially more

powerful component platform is on the way. In July, Apple and IBM stunned the industry by announcing a joint venture to develop a multiprocessor object-oriented operating system. Apple will contribute its nascent system software, code-named Pink. IBM will contribute the IBM/Metaphor Computer Systems software, called the Constellation Project. Constellation applications were originally designed to be small objects combined by developers into copyrighted components; users could assemble the components into customized applications.

When the new Apple/IBM platform appears in 1993, it should consolidate the component software paradigm at every level, from the user interface to the software development process to the heart of the operating system itself.

Fine-Grained Objects

The current programming model is changing. Programmers who used to write in C are moving to C++. Smalltalk, where object-oriented programming began, is still with us. And this year saw a burst of new OOP environments: Borland brought out C++ 2.0 in February, and in March came Objectworks/Smalltalk for Windows from ParcPlace, and Borland's

CORNERSTONES

SOFTWARE TECHNOLOGIES

Turbo Pascal for Windows, with its ObjectWindows class library. In September, Digtalk unveiled the Look and Feel Kit, a tool that makes the lines of message transmission among Smalltalk objects visible.

The future will be full of talk about granularity. What we once called "programs" will simply be fine-grained objects—class libraries of C++ and Smalltalk objects, the new software atoms. What we once called "applications" will be coarser-grained objects—classes built into components, and components linked and relinked into something like "recombinant applications." And what we call the "operating system" will be kept busy passing messages among all those objects.

—Ellen Ullman

NewWave from HP: The Agent lets you create new applications from existing ones. It may be the most important new idea in software.



Digtalk's Look and Feel Kit lets you develop applications—like this Icon Browser program—by choosing components and connecting them with "wires."

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USER INTERACTION

Getting to Know You

Pen-based input, voice recognition, and other new technologies make computers smarter

Not long ago, the most interactive way to work with a computer was using a so-called glass teletype, or a keyboard/CRT combo that displayed only characters. Now, we routinely use graphical displays and mouse pointers to manipulate lushly colored and textured interfaces. The Macintosh GUI set a standard in 1984, and Microsoft Windows 3.0 has brought much, but not all, of the Mac's ease of use to PC compatibles. Windows 3.1 and Symantec's Norton Desktop for Windows should improve that situation. And for low-end systems, GeoWorks offers a route into the world of GUIs.

At the same time, elegant GUIs such as Motif, Open Look, and NextStep have entered the Unix market and made using that notoriously arcane operating system something almost anyone can do. Meanwhile, Apple's new System 7.0 enriches the Mac's icon environment with powerful internal improvements such as 32-bit addressing, virtual memory, and interapplication communication.

In the next few years, GUIs will come to dominate computing. New software development will shift to graphical environments because they have numerous benefits: For users, they offer a reduced learning curve and a consistent methodology

across applications; for developers, they offer such built-in tools as display and device drivers, interapplication communication, and interface widgets. But the GUI is only the part of the computer that a user sees; in the future, the way in which we interact with computers will undergo a far more profound transformation.

Making a Point

The mundane mouse may be an endangered species, because a desktop pointer isn't very practical when there's no desk. New 386SX notebook PCs running Windows highlight this problem: Mobile users still want a GUI but may have nowhere to put a mouse. Microsoft and Logitech have both devised small hand-held trackballs that clip onto the side of a laptop, but these are only stopgap measures.

The solution is to design a pointer that is built into the system, as Apple did with the Macintosh Portable's trackball. A built-in pointer can consume system real estate, but two new devices help to avoid that problem. One is the Isopoint, developed by Culver Research and used in the Grid 1550SX laptop. The Isopoint

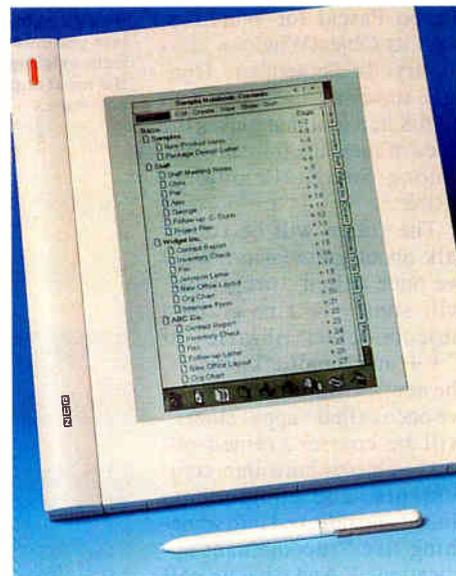
is a small rolling tube, located below the space bar, that you spin or slide back and forth with your thumb to move the cursor. The other is Home Row's Push-n-Point (also known as J-Mouse), a tiny isometric joystick built into the keyboard under the *J* key.

Capturing Gestures

The future of mobile personal computers may not lie in more-clever pointers but in a wholly new concept: pen-input computing. The latest generation of portables are nothing more than computers wrapped around LCD panels. A prime example is the NCR System 3125, a 386SL-based tablet less than an inch thick that weighs under 4 pounds.

With pen-input systems, instead of using an external pointer to move the cursor, you work directly on the screen with a stylus. More important, the systems understand block printing, so you can enter text by writing on the screen instead of by typing. This makes it possible to use computers while standing up or walking around, which opens up a new range of uses.

What makes these systems



Pen-input PCs like the NCR System 3125 may fundamentally alter the definition of a computer.



The Isopoint is a space-saving alternative to the mouse or trackball.

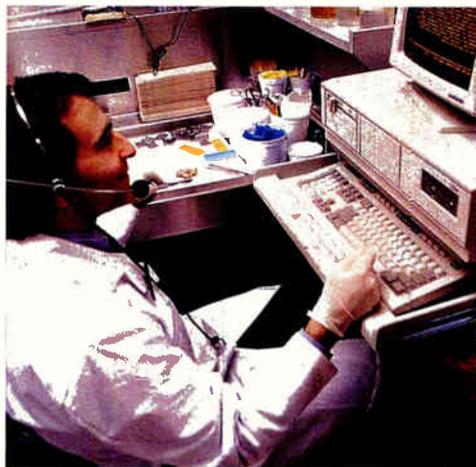
CORNERSTONES

USER INTERACTION

more than just nifty notepads is that they run new, more naturalistic operating systems. Go Corp.'s PenPoint is a break from the past: Designed from scratch for pen computing, the object-oriented system understands gestures and uses a notebook metaphor to lend its interface a familiar appearance and behavior. Microsoft Windows for Pens is an extension to Windows, so it will run existing software, but its backward compatibility may take a toll on intuitiveness.

Speak to Me!

In the long run, the most intuitive interface is speech, and remarkable strides have been made in the last few years toward the Holy Grail of speech recognition. Devices from Dragon Systems and Kurzweil AI can now recognize thou-



Talking to a computer is a long-cherished dream, but years of work still lie ahead.

sands of discrete spoken words without the user's having to extensively pretrain the system. These devices are finding applications in fields such as medicine and as aids to the handicapped.

The problem still to be solved is how to get a computer to recognize conversational speech. A product from Verbox Voice Systems can understand unbroken streams of words, but it has a limited vo-

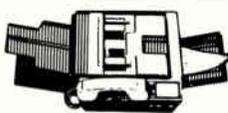
cabulary and must be trained to know the speaker. In the next five years, as greater processing power becomes available, true continuous speech recognition will become possible, but it may still be too expensive for common use.

While new pointers make using a conventional GUI notebook easier, handwriting and speech recognition profoundly alter the human/computer relationship. Yet even these changes maintain a wall between the user and the machine. In the distant future, however, virtual reality will break even that barrier. We won't anytime soon see simulated environments as sophisticated as the holodeck in *Star Trek: The Next Generation*, but it's something to look forward to.

—Andy Reinhardt

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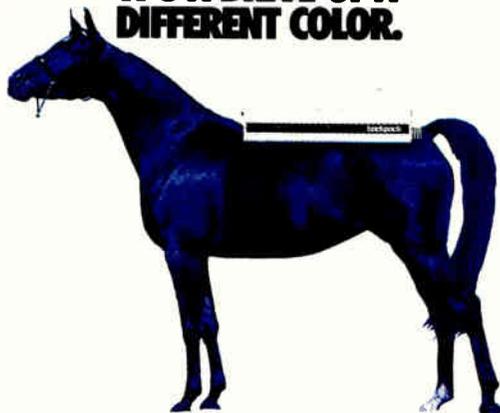
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World Radio History

CORNERSTONES

INFORMATION REPRESENTATION

Multimedia Animates Information

The computer is evolving as a visual processing machine

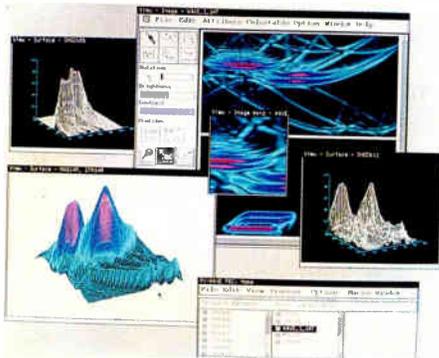
Since Apollo commercialized the concept of integrating two-dimensional graphics in a high-performance workstation, the computer has been evolving as a visual processing machine. Developments of the past year have further refined the idea—and the ideal—of visual computing. In the next five years, heavy R&D will be focused on perfecting the computer as a tool for presenting data graphically.

Even as sophisticated 3-D graphics percolate down to personal computers, multimedia is seizing the low end of the market. No matter how you define it, the basic goal of multimedia is to make computers more stimulating and, ultimately, more informative. The GUI has banished the cold command-line interface; now, by integrating high-quality sound and video, computers will become tools for interacting with information.

Big Deal

Two pacts made this year by Silicon Graphics, a leader in visual computing, could turn out to be very significant because of the influential parties involved. Microsoft licensed SG's Iris Graphics Library, a set of tools for building applications that can generate and manipulate realistic 3-D images. Microsoft plans to incorporate SG's technology in applications and operating systems, which suggests that 3-D may be an integral part of its future software—and, therefore, of yours.

Compaq, with an eye on the workstation business, will rely on SG—in which it has taken an equity stake—to deliver the



Scientific visualization lets you see patterns in data that numbers alone would never reveal.

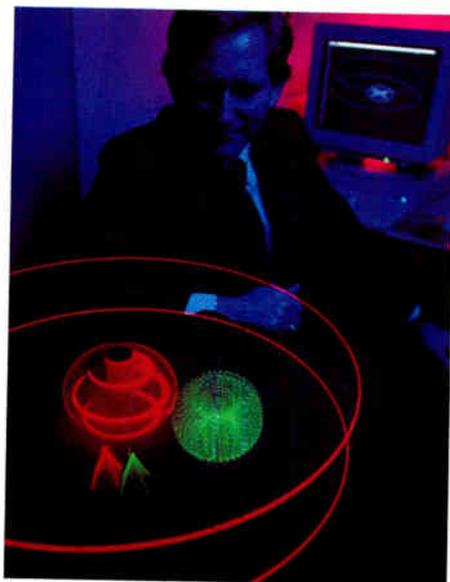
imaging technology Compaq needs to keep up in the 1990s.

The two companies are working together on unspecified products, but SG confirms they involve 3-D graphics. Both companies are members of the Advanced Computing Environment initiative, as is Microsoft, so 3-D imaging may be standard on ACE machines.

Visualization = Discovery

The point of visualization is to make data easier to interpret by representing it graphically. In the past year, software that does this has migrated down to the realm of mortals. For example, PV-Wave from Precision Visuals now runs in the graphical SunView and Motif environments on workstations from Sun, DEC, Hewlett-Packard, and SG. This package makes beautiful raster images of floating-point data, so instead of seeing reams of numbers, your answer is a colorful, animated image.

Software this powerful isn't available yet on personal computers, but Precision Visuals may produce a Windows version of PV-Wave. For low-cost machines, Spyglass's Transform converts floating-point results into 2-D graphics,



In the future, flat panels could be succeeded by 3-D displays like the TI OmnView.

while Spyglass Dicer displays volumetric data as a colored cube that you can "slice" to reveal interior data. This category of software is bound to grow in the nineties.

Render unto Mac

For now, the Mac is the platform of choice for professional illustrators or visual communicators who cannot afford a workstation. A multitude of programs let you construct complex 3-D images on the Mac. For example, Pixar's RenderMan, a scene-description language that defines visual attributes such as surface textures, lighting, reflection, and motion, now runs on the Mac. Supporting applications like MacroMind Three-D and Paracom's Swivel 3D can model realistic illustrations that look like something on a Personal Iris workstation. Comparable programs will come to the IBM world when the required hardware, such as 24-bit color boards, becomes more common.

Moving Pictures

An important element of the visual computer is motion video. Apple and SuperMac

CORNERSTONES

INFORMATION REPRESENTATION

have demonstrated technology that pumps video from disk through the Mac at speeds fast enough to make it a movie machine. Their research will yield commercial products within a year. Chips & Technologies has introduced a PC Video chip that drastically cuts the cost of hardware for displaying windows of live, full-motion video. The \$40 chip, which replaces components that cost about \$300, incorporates all the logic needed to put a digitized image in a window and control its size, shape, and location. Video boards using the PC Video chip will sell for \$500 to \$800, or about \$1000 less than they cost now, C&T says.

No matter how high the number of pixels and colors, however, current displays are still flat. But in the future, we



Silicon Graphics' 3-D technology is at the center of two significant licensing deals.

may have true 3-D displays that project realistic images. Texas Instruments has already demonstrated such a device, called OmniView, that lets

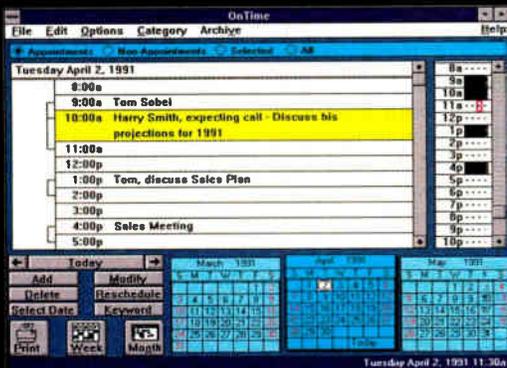
you see solid-looking objects without wearing special glasses. Picture the holograph of Princess Leia in *Star Wars*, and you get an idea of what an

OmniView image looks like.

The promise of lower prices suggests that motion video boards will become more commonplace. But personal computers still need lots of storage and a fast bus to move digital video through the system. One solution is to reduce the amount of data by using new hardware and software compression schemes such as Digital Video Interactive and those being developed by the Joint Photographic Experts Group and the Moving Pictures Experts Group. These technologies will likely be built into systems in the future. Indeed, with prices for 3-D graphics falling faster than for personal computers in general, it's safe to say we are at the dawn of the age of visual computing.

—D. Barker

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Tapping into the Global Network

Wireless communications, E-mail, and network standards

In the 1990s, computers and communications will be inseparable. We're almost at the point now where, by definition, a personal computer is a node on a LAN. The rise of client/server computing and groupware will further alter our way of working: Instead of using your own personal computer and then sharing data with other people, you will use the network for what Steve Jobs calls "interpersonal computing." Both the location of the data and the means by which it is obtained are quickly becoming completely transparent.

Cutting the Cable

One of the most promising technologies for communicating anywhere, anytime is wireless networking. Proponents such as NCR and Motorola say that wireless LANs are easier to install and modify than their cabled cousins. Unfortunately, every product now on the market comes with trade-offs in throughput, range, or flexibility. Yet most experts agree that wireless networking will continue to improve and, barring impediments from the FCC, will become a dynamic area of connectivity.

Wireless communication is especially well suited to the emerging crop of pen-based computers, since they are intended for use by mobile workers. Photonics has demonstrated a prototype diffuse infrared transceiver that lets a mobile unit tap into a network without requiring a physical connection. The Pen-Point operating system from Go Corp. instantly recognizes a wireless network when you walk into a room with a pen-based computer in your hand and transmits automatically any messages queued up in the system's Out Basket.

Apple has petitioned the FCC to set aside a chunk of the radio spectrum for data communications. The proposal would let mobile computers that are located up to 150 feet from the base transmitter hook into a wireless LAN. If the proposal is approved, the frequencies would be available to any vendor, not just Apple.

Infrared as well as spread-spectrum radio address connectivity over a short range. For even wider coverage, an emerging option is packet radio, such as the

nationwide Ardis network, a partnership between IBM and Motorola. Further out in the future, Motorola's ambitious Iridium project will launch dozens of satellites to create a worldwide communications network.

E-Mail Overload

For many people, E-mail has become an indispensable business tool. But when the messages pile up, E-mail can be too much of a good thing. Two companies to watch, Beyond and Agility Systems, are now readying programs that are based on the work of the MIT Information Lens project and act as smart front ends to E-mail systems. Using message templates, rules, and graphical editors, both programs will prioritize mail messages based on their importance and urgency and will automatically respond to certain types of messages.

Standards Are the Key

Other networking and communications trends worth noting include the following:

- Sun's Network File System is quickly becoming the lingua franca of networked systems. At the same time, Sun and Hewlett-Packard are working to ease interoperability between Sun's Open Network Computing and Apollo's Network Computing System. But

on the OS/2 side, 3Com has dropped LAN Manager, giving it back to Microsoft.

- The X.400 messaging standard, which lets users on different E-mail systems send messages to one another, is becoming widely adopted. GO-SIP now requires X.400 functionality, and the Electronic Mail Association says that all major U.S. E-mail services have agreed to link their services via the standard.

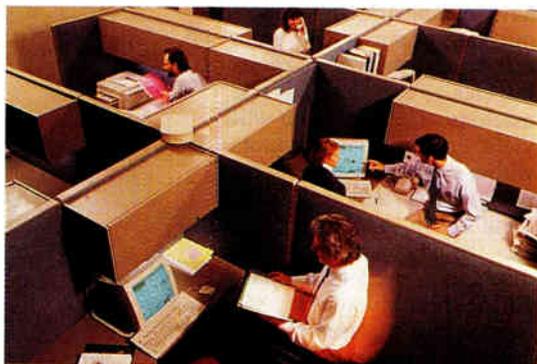
- Switch makers AT&T, Northern Telecom, and Siemens, along with other companies, are pushing the new National ISDN 1 standard. This may be the last best chance to bring ISDN to the U.S. by the end of 1992.

- Telecommunications service and hardware suppliers are moving quickly to adopt frame relay, a fast packet-switching protocol that outperforms X.25.

- The ISO and the Unicode Group are sponsoring rival efforts to develop a successor to ASCII that will make it much easier to write multilingual software.

- The National Science Foundation has a research project under way to develop an advanced computer network that will transmit data more than 700 times faster than is currently possible—at 1 billion bits per second using fiber-optic cable.

—David Andrews



The Altair wireless modules connect up to 32 Ethernet-addressable data devices within a physical area known as the microcell—about 5000 square feet.



Beyond Mail uses rule sets to let you specify what you want done with your E-mail.



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LOOK WHO'S TALKING

HEWLETT-PACKARD

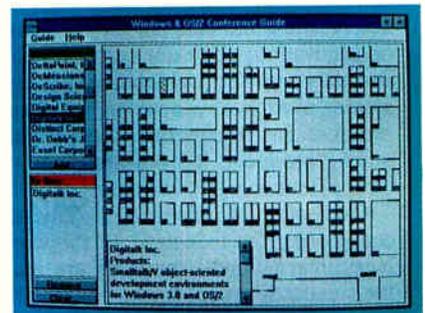
HP has developed a network troubleshooting tool called the Network Advisor. The Network Advisor offers a comprehensive set of tools including an expert system, statistics, and protocol decodes to speed problem isolation. The NA user interface is built on a windowing system which allows multiple applications to be executed simultaneously.

NCR

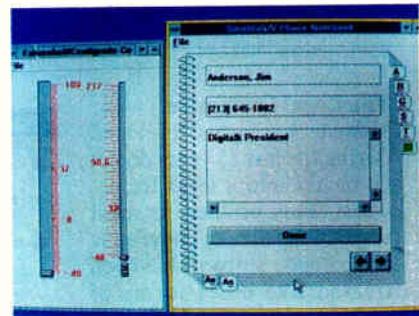
NCR has an integrated test program development environment for digital, analog and mixed mode printed circuit board testing.

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This Smalltalk/V Windows application captured the PC Week Shootout award—and it was completed in 6 hours.



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Technology Is Not the Problem

Legal squabbles focus on competition and threaten innovation

Sometimes the computer business is like a soap opera, replete with backstage intrigue, strange bedfellows, and failed partnerships. In the last year alone, we've seen a public feud between IBM and Microsoft, AT&T's acquisition of NCR, an aborted merger between Lotus and Novell, the establishment of the Advanced Computing Environment initiative, Borland buying Ashton-Tate, IBM and Apple joining forces... and the list goes on and on. This dynamism fuels the innovation that has made computers the world's growth industry, but unfortunately, these lawsuits put the focus on competition rather than on innovation, and their outcomes could even chill creativity. But they are also tremendously important, because the legal system must evolve new rules to keep up with technological progress. In a market that values "openness" and compatibility among products, it's not always obvious who should control critical technologies and data.

Ownership of innovation is only one of the social problems confronting the industry. As the world becomes a global village, international standards are increasingly necessary, yet the standards process, which is weighed down by political and economic parochialism, has become ever more glacial. Widespread gathering and dissemination of personal data raises troubling questions about privacy protection. The interconnection of networks has provoked new concerns over data security, especially in the face of the computer-virus menace. And new questions about the health effects of computers have frightened some users.

The Legal Quagmire

Many technologies developed during the last 25 years do not fit neatly into a legal framework. This problem is most acute in the area of copyrights and patents: Software has been treated like other forms of written expression, but it is not. Three lawsuits currently trudging through the courts may help clarify what protections should be afforded to

software. All three could have major implications for developers and users.

Ashton-Tate v. Fox Software is a judicial roller coaster, if you can imagine the ride moving at a snail's pace. The case started two years ago, when Ashton-Tate alleged that FoxBase unlawfully mimicked the look and feel of dBase III. A judge threw out Ashton-Tate's case last December and then reinstated it in April. This suit is significant because it could establish the noncopyrightability of a programming language.

By contrast, both *Apple Computer v. Microsoft* and *Lotus v. Borland* concern copyrighting a user interface. The Apple case is largely a contract dispute, but it is important because so many users are involved. Lotus's suit follows in the wake of its victory against Mosaic Software for copying the menus of 1-2-3. It could answer the question of how much copying is too much, especially when the objective is to comply with a de facto industry standard.

Who Owns It?

If you create code or data, you usually own it. But what if you improve upon software that you did not originate? New technologies that allow or even encourage modification of electronic assets pose vexing problems of ownership. For example, you can buy a class library for an object-oriented programming language and then create greatly improved descendants of various classes. Should you be able to sell these?

New topologies also create problems. A client/server net-

work allows data to be spread among several locations; as long as all the sites belong to the same company, ownership of the data is clear. But what if your wide-area network includes servers belonging to another company, and a new database table is created that joins data from both sources? Who owns the new table?

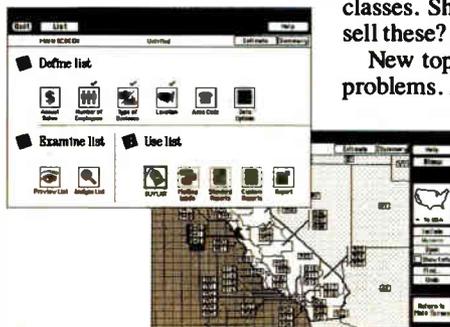
Keep It Private

The proliferation of vast databases of personal information is seen by some as a threat to individual privacy. This point was highlighted by the fracas over Lotus MarketPlace, a Mac CD-ROM product that provided detailed demographic data on households and businesses in the U.S. On the eve of its availability last January, Lotus canceled MarketPlace, citing a deluge of protest from people who feared it would violate their privacy.

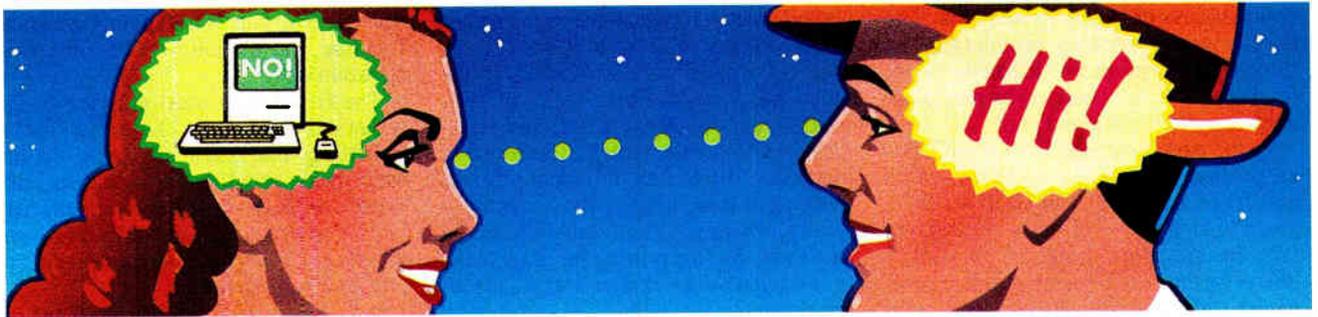
The source of concern was not necessarily the data itself: The same information is widely available for mainframes and minicomputers, and Lotus had taken considerable steps to prevent misuse of the program. Rather, people were worried that MarketPlace would make accessing and using such data less expensive and easier. The visceral reaction revealed the public's unease about privacy in the electronic age.

One group working to address this problem is the Electronic Frontier Foundation. The EFF has helped defend several hackers snared in government raids, but its long-term objective is to ensure that the First Amendment protections afforded to print and broadcast media are extended to new, electronic forms of expression. The group also aims to educate law-enforcement officials and the public about three interrelated issues that will live with us through the 1990s: computers, privacy, and ownership.

—Rich Malloy



A torrent of criticism killed MarketPlace, but privacy concerns won't go away.



Mind Melding

How far can the human/computer interface go?

OWEN LINDERHOLM

To the novice, the user interface is the most important part of the computer and the computer program. It's how you interact with the computer system and how the system displays results to you. Everything else can be considered black magic. To understand how user interfaces will affect you, you must first establish what is important about them, what sort of decisions must be made when designing them, and which of these decisions are critical to the way the user interface will operate.

Manufacturers and system designers must study new technology and evaluate the situations it will be used in and the tasks it will be used for. They should create a user interface based on how people will want to use the technology rather than what will be expedient or easy for the designers or the manufacturers.

Menuing systems, either character or GUI, are an example of how a simpler selection mechanism evolved after a technology was in place instead of when it was designed. Hardware designers are only now trying to take advantage of the software design and trying to do things like accelerating their graphics systems for drawing straight lines and filling in rectangular areas on the screen. If computer systems had been designed with thought to their uses, this kind of hardware acceleration would already be present. Until computer systems are as standard and as easy to use as everyday appliances like toasters and automobiles, they will continue to hold back people from making full use of them.

BYTE asked five people important in the past, present, and future of user-interface development to discuss some of the major issues of the field.

What do you see as important about the interface between the computer and the user?

Stuart Card: The most important user-interface [UI] problem now is how to increase the number of functions users can do while, at the same time, decreasing the training time. The number of features is increasing nearly exponentially for almost everything from word processors to thermostats, from spreadsheets to jet-fighter cockpits. Workstations come with manuals that would require nearly the whole work year just to read.

Clearly, then, user-interface widgets can-

not increase linearly with the number of functions they connect to: The user interface would be impossibly baroque for high-functionality systems, and the manual impossibly ponderous. The user interface sets the ratio of what you've got to know to what you want to be able to do, and this ratio determines what it is possible to use computers for.

Paul Hudspeth: The most straightforward UI is a command-line prompt. You type in what you want, and it does it. The problem is that it requires you to remember what to type and what parameters are needed. Enter the wonderful world of GUIs. They're great—not typing but direct manipulation. The problem is that there are lots of entities to deal with: tools, windows, palettes, and icons.

System 7.0 has human-interface elements that illustrate what Apple is all about. The key points are the trade-off between layers of complexity and functionality. The trade-off is that adding functionality increases complexity. The whole goal is to make the operating system transparent so the user can concentrate on doing things. The other goal is to work the way people do.

It is important to understand that just because a user interface has icons and windows doesn't mean it works the way people do. Apple knows that users don't give something 20 seconds to figure it out. If [users] can't figure it out right away, then they close the feature and don't use it.

Aaron Marcus: Without an effective user interface, the user cannot fully access the power of the computer. User interfaces consist of the following components: a collection of metaphors, a cognitive model, a task-oriented organization of functions and data, a navigation system for moving within the model, appearance characteristics (the look), and interaction techniques (the feel).

The user interface is a *mask* (i.e., appearance) and a *ritual* (i.e., interaction) that clothes task-oriented, user-centered



PAUL HUDSPETH
Product manager at Apple

organizations of functions and data. The user interface enables products to be more appealing, easily learned, easily used, and it enables users to be more productive in their work and play.

In the past, user interfaces were modest portions of code. In the future, more and more attention—and code—will be given to supporting effective user-interface designs. New kinds of companies will arise that will be user-interface companies, offering products that work with a variety of hardware, applications, networks, operating systems, and user groups. As user interfaces become consumer items, more and more emphasis will be given to marketing differentiations in user-interface design.

Ted Nelson: The real problem is that the design of software virtuality, as I prefer to say, is an extremely complex, aesthetic design issue—and universally confused with a technical issue. In other words, I hold that the design of software is intrinsically a branch of cinema. This is an exact statement about the nature of software and the nature of cinema. Motion pictures are events on a screen that affect the minds and hearts of the viewer. Software is events on the screen that affect the mind and heart of the viewer, *with* interaction. So the only difference is that interaction is possible, so you have ex-

tended cinema in which the user exerts a certain measure of control.

Now, *virtuality* is my term for the most important defining traits of software. Other people say things like *interface*, and to me the entire issue is one of virtuality. Virtuality is essentially the seeming of something as distinct from its reality, which is the nuts and bolts of the hardware. So, everything has a virtuality, and you either design it explicitly or you do not.

Virtuality consists of conceptual structure and feel. This concept of virtuality extends to everything from video games to automobiles to music to software. So, software is merely a special case of the design of virtuality.

A movie's virtuality is the conceptual structure and feel of that movie. So, the conceptual structure is the script and the characters, and the feel is the *mise-en-scène*, the atmosphere, the feelings that go with different scenes. And these are highly arbitrary and idiosyncratic and basically controlled by the director with great difficulty in the creation of the motion picture. So, that's where the distinction between conceptual structure and feel is for a movie.

The conceptual structure of all automobiles is the same. They go left and right, forward and back, fast and slow, and there is very little beyond that. But the feel of different automobiles is very different, and that is why automobiles have such variety.

So, what I claim is that the conceptual structure and feel is the heart of a lot of things, but it is certainly the heart of software design. The conceptual structure is arbitrary, and the feel is very hard to control. And so, creating, under control, the sort of feel you want to have for the software is a very difficult matter that everyone attempts in a different way.

Alan Kay: I think the big breakthrough when personal computing came about was the idea that some human is going to have to use it, and we're not going to be able to train all of them, and so the person is going to have to do some learning on their own. One way of characterizing what we did at Xerox PARC [Palo Alto Research Center] is to say that the job of

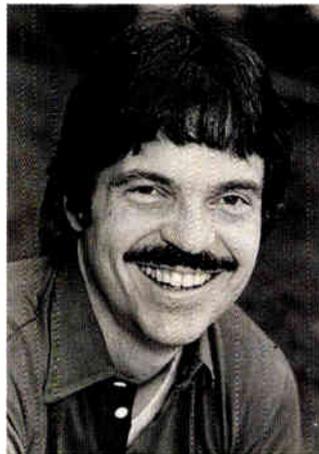
the user interface is not mainly access to function, but the job is to be a learning environment.

The first law in user-interface design is that the users aren't like us, and *that* is something that most engineers do not even think about or believe. It is like driving in Boston. If you don't already know it, that must mean you're a foreigner, so tough. That's the engineering approach to user interface.

The biggest set of ideas that we put into that thing—that later became the Macintosh-style user interface—came from cognitive psychology, most specifically from Jerome Bruner. Bruner redid many of Piaget's experiments [on child psychology]. You probably know the famous one of the water pouring, where you pour from a squat glass into a tall, thin one. The six-year-old kid says, "There's more water." Well, Bruner got that result with children, but he did something that Piaget never thought to do. He covered up the tall, thin glass with cardboard

after the kid gave the typical answer, and the kid changed his mind and said, "Oh, wait a minute! There can't be more water. Where would it come from?" And when Bruner revealed the tall, thin glass again, the kid changed his mind back and said, "No, look, there's more water." He could reliably switch the thing back and forth depending on whether the kid could see or was prevented from seeing.

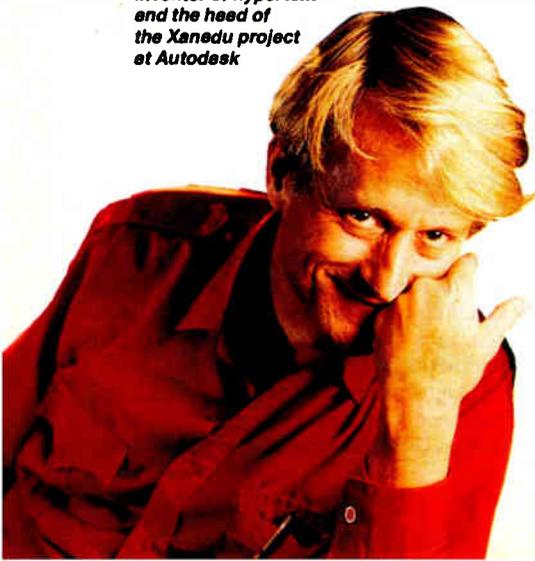
There's nothing in Piaget's model of stages going from kinesthetic stages to iconic stages to symbolic stages that accounts for that. So, Bruner had this idea that maybe it wasn't like a caterpillar becoming a butterfly, which is the way Piaget thinks of the metamorphosis of the child's mind. Bruner said maybe what's actually going on here is we have multiple mentalities. There is a separate kinesthetic mentality and a separate iconic mentality and a separate symbolic mentality. The Piaget progression is actually a change of dominance between them, but they are all there at the same time. That is what led to a user interface that said, "Well, the mentality that orients us in space, which is the one that makes us feel a part of the world, is actually the kinesthetic one."



ALAN KAY
One of the developers of the Xerox Star system, and the inventor of the Dynabook concept of a portable computer

People say things like interface, and to me the entire issue is one of virtuality.

TED NELSON
Inventor of hypertext and the head of the Xanadu project at Autodesk



The iconic mentality is very good at remembering scenes. You have probably flipped channels on TV and flipped into the middle of a movie you haven't seen for 18 years, and it's probably taken you 2 or 3 seconds to recognize that you've seen that movie before. If you think about what that means, you can appreciate a lot about what the iconic mentality can actually do. Most people—about 60 or 70 percent—after they have recognized the movie, can remember what is going to happen next. So, the visual system is quite remarkable at being able to remember almost every scene that you have ever seen. And the other thing that it is very good at is it can keep track of about 100 things at the same time, almost subliminally. If you put up 100 pictures of animals scattered randomly on a big wall, you can find the elephant about four times faster than you could find the word *elephant* if the words were put up on the wall.

Finally, we have a symbolic mentality whose main interest is to chain together paths of evidence for things. Its greatest strength is finding out things that are in the context that aren't there obviously, and its greatest weakness is that it does not pick the context that it works in.

The obvious thing seemed that what we should do is try to find some synergies between these mentalities that don't often talk to each other. And the way that you practically realize it in a computer system is you give kinesthetic contact with what is going on by using something like a mouse. You could make that a lot stronger by making the mouse react to the things that you are dealing with. We have mice at Apple where you can feel the weight of the things that you are moving around, which gives you an even closer kinesthetic contact with it.

Then you have the icons and the windows, which give a theatrical representation of something underneath that your visual system can recognize almost instantly. And then, finally, you should have a system like HyperCard or SuperCard or something like that, which provides a symbolic underpinning that gives you abstraction in each of these different areas. And that was our rendering of Bruner's educational environment back then.

Now we look at some of the technologies involved in some of the leading user interfaces at the moment. These include advanced GUIs, such as Apple's System 7.0, speech-recognition systems, virtual reality devices, and handwriting recognition.

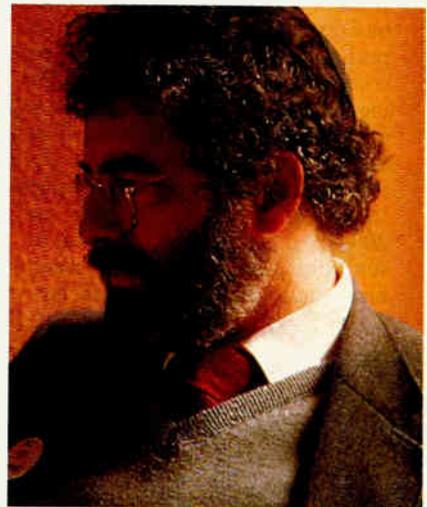
Nelson: I have a very radical position on software, which can be very easily stated. I believe that there is virtually no acceptable software in the world today. People think I'm joking; people think I'm making some sort of a wisecrack. I mean it passionately. Everybody is imitating the Macintosh now. That's like nowhere. All the looks and feels have not been seen and felt. I think it's hilarious that they want to standardize now. There are going to be many new ideas that will change software so radically that software 10 years from now will be scarcely recognizable.

Marcus: In hardware technologies, palmtops, and pen-oriented computers, an example is Go Corporation's handheld computer. High-performance PCs and workstations with high-quality color and multimedia are another example. A really important feature is the use of sound cues in the interface.

On the software side, we are seeing sophisticated GUI paradigms. One example is OSF/Motif. We are also seeing multimedia display software and hypertext software, which is now sometimes used to support on-line help. Other current design and technology challenges include software agents, color design, control-panel design, expert assistance, internationalization, I/O devices, intellectual property rights, sound, spatial organization, standards, symbolism, virtual realities, and video.

Card: To me, leading-edge technologies are interactive computer graphics, as represented on the latest Silicon Graphics computers; integrated pen/flat-panel display interfaces, as represented by the Go system; recognition-based input technologies, as in the Nestor character-recognition system or the Kurzweil and Dragon-Dictate speech-recognition systems or other perceptual-recognition technology; and the virtual reality technologies, as represented in the work of Tom Furness at Armstrong Aerospace Medical Research Laboratory or the NASA group or VPL [VPL is a company that makes virtual reality devices, namely, goggles you wear that enable you to see 3-D from the computer and a DataGlove that you wear to manipulate things in the 3-D environment].

We now turn to technologies that may improve user interfaces in the future, especially hardware, software, and design technologies. These include new input devices, such as DataGloves, pen-input systems, and better voice recognition.



AARON MARCUS
Head of Aaron Marcua & Associates

New software technologies include agents—software programs that actively perform tasks for you with minimal instruction—and more refined graphical interfaces, perhaps in 3-D.

Probably the most important technologies, however, will be the result of new designs that make use of existing and as yet unenvisioned technology in better ways than current interfaces do.

Key: When you have pervasive networking, the user interface that works so well on the Macintosh and Windows 3.0 simply won't work anymore. The reason is that it is a browsing interface that assumes you are going to be dealing with somewhere between 100 and 500 resources, and now we are talking about being connected up to over a trillion resources. You can't make the Mac or Windows better in order to deal with this. We have to think of something else, and the thing that is suggested is to have what are called agents.

Agents are semi-intelligent software programs that you can delegate your goals to. Initially, because these agents won't be very smart, the first ones to come along, the equivalent of the simple word processing done 10 and 15 years ago, will be agents that will act like your personal news reporters, whose jobs will be to scour the networks that you are connected to and find things that are relevant to the goals you are pursuing right now. So, you can think of them as a personal news service. But, of course, their job is not just to find anecdotes but also tools and other kinds of things that are related to what you are doing.

Probably the best example of the kind of agent we'll be dealing with 10 years

from now is a system called CYC. It is basically an attempt to model, as an expert system, the general knowledge and common sense of a human being. So, the idea is that common sense is a collection of, usually, rules of thumb that may or may not be logically connected with other rules of thumb. There's something like a fabric of them—there may be 200,000 or a million of them that we use, some organized logically and some organized figuratively. And it will be a very

difficult task to work out what goals people are working on until you have some sort of structure like this.

You can think of this as an encyclopedic system in which the modeling is as interested in what is in between the sentences as it is in the sentences themselves. In other words, what is it that the reader has to know in order to go from one sentence in an encyclopedia article to the next? When they model these articles, they do not just model the knowl-

edge in them, but they model the knowledge the human has to have and the inference processes that the human has to have in order to make sense out of each article.

Marcus: Some of the technologies to improve human-computer interfaces in the future include virtual reality systems, like VPL's prototype applications that provide color, animation, and sound in wraparound environments that the user is a part of. Interaction with the environment is facilitated through DataGlove-like devices or speech input.

Multimedia will work with hypertext to create full, rich hypermedia environments that offer video, sound, etc., with complex, linked relationships.

Spoken and manual input, including writing and drawing, will help eliminate keyboard and mouse input.

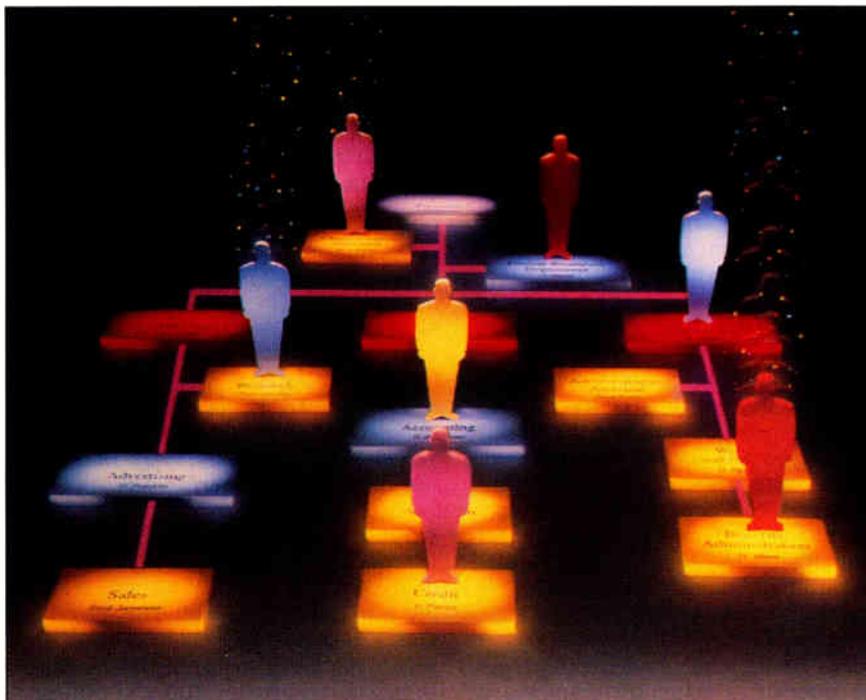
Agents will simplify the performance of routine tasks. Multiple metaphors and knowledge visualization [schemata] will permit users to understand processes and structures better and more quickly.

One novel development will be the licensing of *personalities*, such as Marilyn Monroe, to promote data and function display and make user interfaces more engaging.

Hudspeth: The problem is that you have to present larger and larger volumes of information at a high level that makes deeper levels available as you look into them. The major breakthrough in software-human interface is automatically associating attributes with information. Somehow the system will know how to associate and gather information. So, the computer is going to have to know how to associate different kinds of information.

Card: The extent to which an understanding of the human—the cognitive structure of the human; the nature of human activity; and the task, organizational, or social settings of humans—is important to fundamental advances in human interfaces is underappreciated. The success of future systems will depend heavily on the extent to which they are compatible with their social and organizational settings. As work on human interfaces matures, knowledge is gradually beginning to accumulate as methodologies, tools, and theories, and I expect these to affect design in the future.

I expect improvements in theoretical foundations for user interfaces and in design methodologies and in toolkits. There is even a prospect for some human progress in computational human factors



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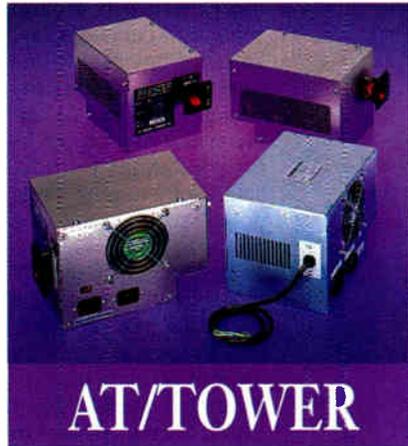
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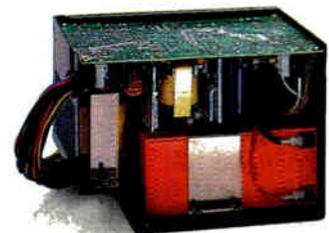
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as part of CAD tools for human interfaces.

What do you think user interfaces will be like in the year 2000?

Nelson: There will be a lot more of this glove stuff. This is very important. But there will still be some people clunking along on DOS, and there are people who like that stuff. I think that the greatest rule of the computer field is that nothing ever goes away, or things don't go away anywhere near as quickly as people expect them to. So, there are those who will still be using Lotus. I'm all for people doing exactly what they want to do—no matter how stupid. I want everyone to have the software that they want most, and the only problem is how to get it to them.

Kay: One of the best predictions we can make is that there will still be lots of COBOL programmers. You just can't get rid of anything that's once worked. The style of interface I was associated with, the overlapping windows and all that stuff, I'm sure will still be there, but I think that many of the windows will be controlled by a bevy of agents. The agents will get smarter and smarter, and if CYC can work, if there's not something fundamentally wrong with CYC, then it should be possible to have a system that has a low-level understanding of a rather large number of human goal structures and can simply act as an amplifier for those goal structures. I don't think we should worry about whether it's going to be intelligent like a human or not. That's not an operative thing. The real question is whether it can be more useful than annoying.

Hudspeth: Have you ever seen Knowledge Navigator [an Apple video showing an animated, intelligent software agent]? Don't laugh! Apple is really serious about this. We are working on all the pieces that have to go into place to make that kind of user interface possible—multimedia, voice recognition, telephones, and so on.

Card: The concept of the workstation is just a temporary technological compromise. Alan Kay and company understood from the beginning that what they



DR. STUART CARD
Researcher at Xerox PARC

wanted was a portable machine based around some thin panel display. Desktop workstations were just a temporary expedient, because the appropriate display technologies weren't ready, and CRTs require large power supplies and big tubes.

As soon as the display technology begins to be adequate, the workstation concept weakens in favor of all sorts of computational media. So, I expect user interfaces in the year 2000 to be not so workstation-centric.

Furthermore, computers are merging with televisions, VCRs, fax machines, telephones, and consumer products.

User interfaces in the year 2000 will be different, because there will be a lot of direct pen-based interaction with large, wall-size displays, with notebook-size devices, and with smaller devices. There will be more graphics and animation. Many devices will be seriously portable and heavily linked into communications networks. Input will make heavier use of recognition-based technologies.

Marcus: By the year 2000, user interfaces will consist of large, wall-size displays for group viewing; projections on personal eyeglasses that overlay displays on normal views; and the specialized displays on various appliances, like wrist-watches that contain the equivalent of a current workstation, in a piece of clothing with microprocessors built in to change its thermal or color characteristics, or auto displays.

Multimedia, hypertext, three dimensions, color, multiple agents and metaphors, speech input, completely portable access to telecommunications with people and computers will all be standard. User interfaces will be consumer products, appearing in many different designs, including designer labels by the design profession's leaders.

User interfaces are obviously complex parts of any program. Much of the functionality of user interfaces is now being moved from end-user programs to the operating system in order to ensure that the interfaces that users see are consistent. It is also becoming clear that the most popular, consistent, and usable interfaces are being based on research on

what people really can use easily rather than on guesswork. This approach of using cognitive psychology is paying off in ease of use, but it has not yet addressed all the issues of presenting the complexity of information.

Ironically, just as user interfaces are becoming aids of our use of computers on current platforms, the underlying hardware technologies are changing to new modes of input and output that will require interfaces to be redesigned. But this time around, the designers have a jump on things, and they know where we are headed. So, we can expect the next range of technologies to be considerably easier to use, not just because pen-input and voice-input are naturally simpler, but because all these things are being carefully integrated into an entire system of information acquisition and retrieval. ■

PARTICIPANTS

■ **Aaron Marcus** is head of Aaron Marcus & Associates, a consulting firm based in Emeryville, California, that specializes in user interfaces and visual communication. He is a frequent speaker on the subject at conferences.

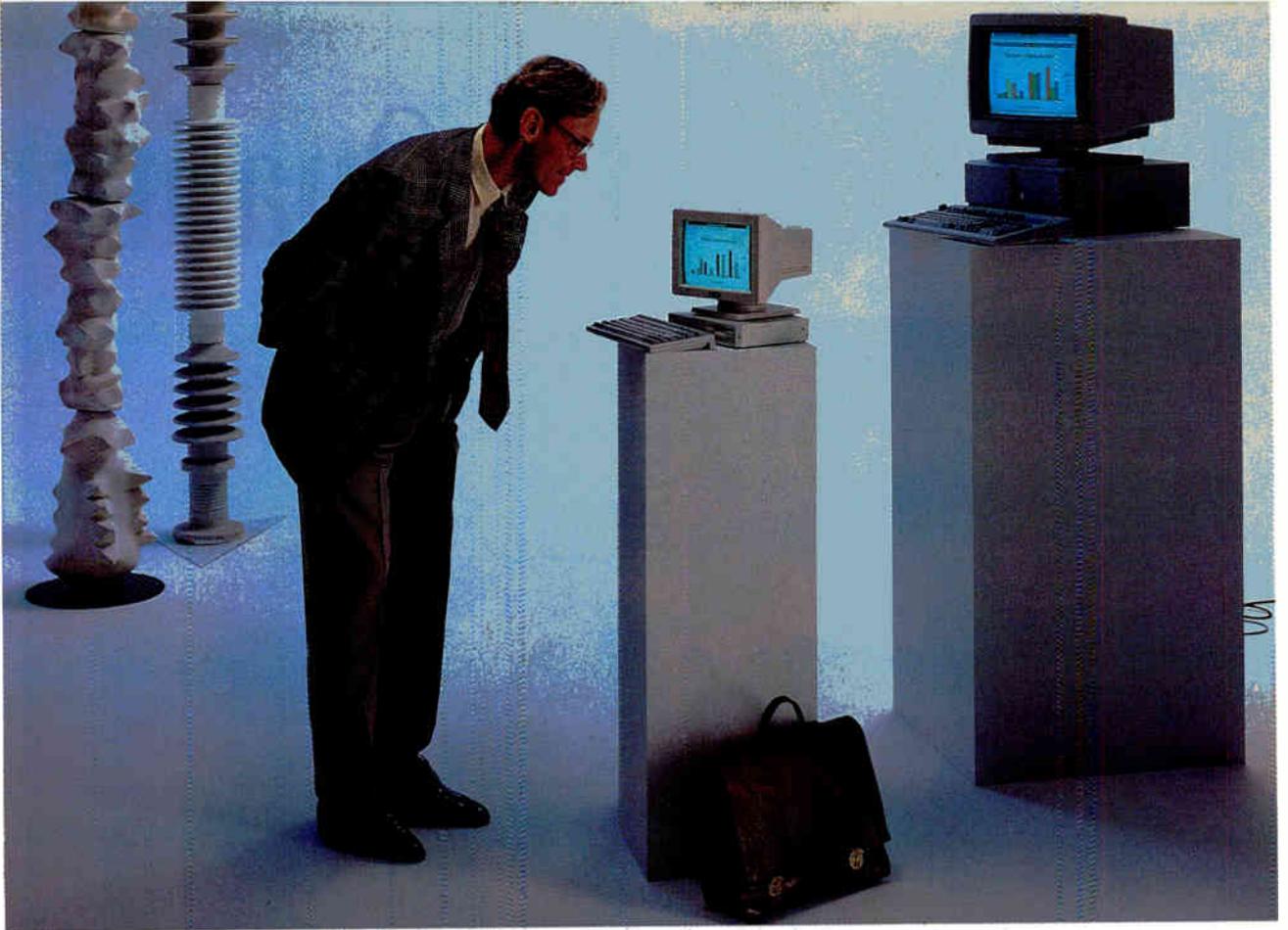
■ **Dr. Stuart Card** is a researcher at Xerox PARC, doing work, in particular, on using 3-D environments. His recent work was extensively covered in "An Easier Interface," an article in the February BYTE.

■ **Paul Hudspeth** is the product manager at Apple for the Finder in System 7.0. His responsibilities include the interface of System 7.0 and future operating-system products.

■ **Ted Nelson** is the inventor of hypertext and the head of the Xanadu project at Autodesk. He is also working on ZigZag, a new project that integrates all the standard applications of a computer into one program.

■ **Alan Kay** is an Apple Fellow and one of the developers of the Xerox Star system, which was the forerunner of the Apple interface. He is also the inventor of the Dynabook concept of a portable computer that can be used anywhere, with worldwide access to a huge network of computer information, while remaining a friendly, easy-to-use, portable system.

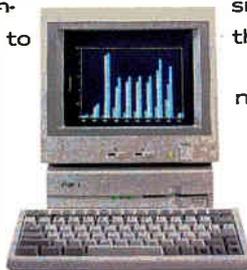
Owen Linderholm is a BYTE senior news editor in San Francisco. You can contact him on BIX as "owenl."



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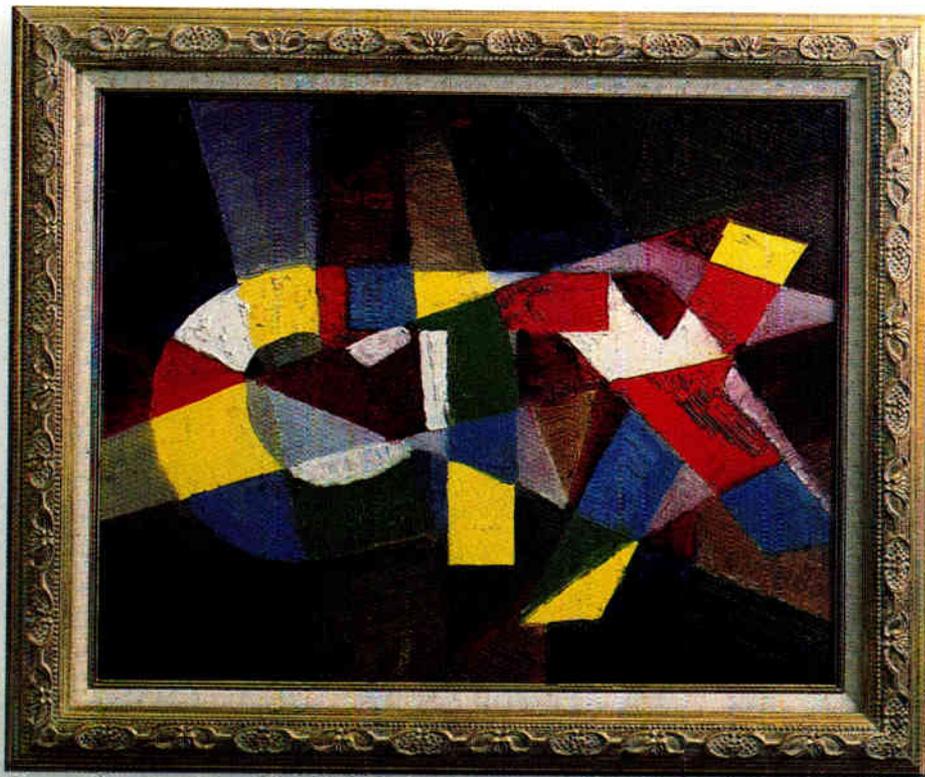
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World Radio History



A Business Wish List

Some still-missing ingredients include universal data accessibility, affordable technology, and ease of use

JANET J. BARRON

Everyone has "wish lists." Airline companies want more passengers to fill their more-often-than-not high-priced seats. Automobile dealers want more customers to take away some of the many gas-guzzlers gathering rust on their lots. Home sellers want more home buyers. And the PC industry wants more people to become PC users.

We decided to find out what the highest priority items are on your high-technology wish list—what's still missing that would make your working life easier and more efficient. And we also inquired about what you need in the way of capabilities, systems, and technology to make your company more productive and profitable.

Who Participated

To get informative feedback, we solicited opinions from people in widely diverse areas of business: a consultant in the computer field; an executive of a medium-size business; the president of one of the nation's largest computer retailers; BYTE's own editor in chief; an academic; and a representative of a vendor that produces a potpourri of computer hardware and software.

And to give you an idea of what a wish list might look like from a more "galactic" perspective, we asked for, and received, input from Craig I. Fields (see the text box "A Global Business Wish List" on page 50). During the Reagan administration, Fields directed the Defense Advanced Research Projects Agency (DARPA). Currently, he is president and CEO of one of the oldest and best-known computer consortiums: the Microelectronics and Computer Technology Corp. (MCC) in Austin, Texas.

High on Their Lists

Generally, when we survey a number of people on a particular topic, we find a good bit of similarity in

their responses. In reading through these thoughtful wish lists, you'll see some common threads. However, several participants presented some significantly different opinions on why the industry hasn't yet put a computer on every desk. They also set out some interesting reasons why business computer users are still seriously frustrated about some important "wish we had, but still don'ts."

Almost all the respondents mentioned the inability to get at information they need to have and use it when and where they want. Patricia Seybold, president of the Seybold Office Computing Group in Boston, put it this way: "The basic problem is having the right information in the right form for the right people at the right time."

She provides a perfect example of this phenomenon: "One very large retailer has this wonderful centralized information system. But none of the people there—in the catalog store, the retail store, the warehouse, etc.—can tell you anything. They used to be able to, and they're very frustrated. I ended up having to order two dishwashers and cancel one."

Seybold also told us war stories about situations in the manufacturing environment where, because of an inability to access information when and where it is needed, some decisions about which batch of goods to produce are being made by the wrong people. One suggestion she offers as a possible solution to this situation is the use of *data dictionaries*.

Modularity is an issue that more than one of our respondents mentioned. Several participants discussed the need to upgrade their capabilities without having to throw out the computer with the obsolete software (or CPU, as it were). Fred Langa, BYTE's editor in chief, comments on CPU-upgradable systems and their entry into the arena to address this problem.

System administration is another area in which modularity of a different kind would be welcomed, says Paul N. Wyatt, vice president of engineering at Covalent



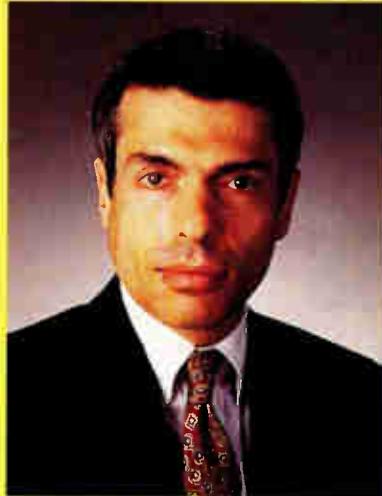
WILLIAM A. BOLLER
General Manager of Strategic
Consulting, Hewlett-Packard

A GLOBAL BUSINESS WISH LIST

Most businesses in developed countries use information technology to improve the quality of products or services or to lower the cost—and thus the price—of those products or services. These firms also use information technology to get new products and services into the marketplace faster than the competition and to better service customers through better marketing.

There are plenty of tactical problems in employing information technology: interoperability, standards and the installed base, privacy and security, reliability and availability, intellectual property protection, and much more. But despite the continuing stream of difficulties—which probably will never end—businesses continue to employ, and in fact are increasingly dependent on, information technology. We have even created the position of CIO (chief information officer) in the executive suite.

How do we make industry more productive? One opportunity, and in fact a crucial need, is to develop an information infrastructure that provides a foundation for improved business success and economic performance. The telecommunications system is the underpinning of this emerging business information infrastructure. The 1990s will see an explosion of global (increasingly digital) networking underlying a distributed information infrastructure driven by changes in telecommunications regulation and technology. That networking



CRAIG I. FIELDS
President and CEO
Microelectronics and Computer
Technology Corp.

will be transparent, seamless, and high-capacity—up to gigabits per second between fixed sites. And that networking will be ubiquitous—sustaining large numbers of portable and mobile subscribers with increased availability of spectrum and digital signal processing.

Global Network

The global network will reach not only businesses, government, and schools, but homes as well. It will carry not only numbers, text, and speech, but high-definition pictures and video. And the global network will connect not only

automated data-processing systems—ranging from laptop/pocket PCs to supercomputers—but also media systems, such as television, and embedded systems, including “smart” buildings, homes and appliances, motor vehicles, and industrial equipment.

But a global telecommunications network is not enough; more is required to have a real business information infrastructure. To stay competitive in the global marketplace, businesses must adopt information technology for better integration among business enterprises and for computerized commerce.

Businesses have been investing heavily to automate and augment operations within the firm. The next frontier is automation *among* firms, for marketing, designing, developing, producing, testing, and servicing products with the shortest time to market, the highest quality, and the lowest capital investment. Increasingly, the productivity of complex, global enterprises is limited not by labor or capital, but by the problems associated with both human and machine information processing.

For example, getting a product to market rapidly depends on countless highly interdependent, informed decisions made by hundreds or thousands of individuals working for a number of vertically integrated companies. Success in the 1990s requires new, highly developed technologies that promote the sharing of information not only within but also among enterprises.

Looking into the distant future, we

Systems in Fremont, California. High on Wyatt's wish list is “standard architectural frameworks to allow us to independently select and procure personal software and groupware and then ‘snap them together’ into an enterprise-wide information system.”

One subject that popped up as regularly as your monthly electric bill is a promise that's been made and broken so often, some users have lost faith in the whole industry. This high-on-the-wish-list issue is the serious and continuing need for something called *ease of use*.

Recently, the results of a number of studies have been made public concerning people's ability (or, rather, their in-

ability) to program their home VCRs. It seems that even the most intelligent folks have been unable to perform this seemingly simple task. Is it any wonder then that the complexity of today's high technology prevents the average person from being able to get a new PC or piece of software up and running, much less from being able to install a network or integrate several dissimilar computing environments?

You Gotta Have Deep Pockets

Now, just for the sake of argument, let's suppose that every item on your business wish list somehow could be satisfied. Could your company afford to be a dues-

paying member of this utopian world? Probably not. It's hard for businesses to find the funds to keep up with the state of the art in what's already available, much less what's coming in the future. As the price curve for older devices and components curlicues downward, the curve of our ever-increasing performance needs skyrockets upward.

Read what William A. Boller, general manager of strategic consulting at Hewlett-Packard, has to say on this subject. He and others agree that funding and justifying high technology's ever-increasing costs is a *major* predicament for both end users and MIS departments alike.

We solicit your feedback on the subject

must achieve a rich information infrastructure on top of the growing global network. And we also must achieve real enterprise integration among firms via the right standards, electronic catalogs, scheduling tools, automated and secure invoicing and payment, and much more. When we get to this point, then savvy businesses will enjoy

- more rapid product cycles achieved through reuse and continual incremental refinement;
- elimination of almost all unplanned engineering changes and reworking;
- the possibility of point-of-sale customization enabled by intelligent factories oriented toward short runs and flexible product mixes;
- tighter coordination with subcontractors and suppliers, making possible production economies without [having to rely on] scale;
- elimination of some supervisory jobs and the attendant streamlining of organizations; and
- creation of new markets facilitated by the information infrastructure itself.

Much of the necessary technology is already here or is coming close to reality. The challenge we face is to integrate the technologies efficiently and adopt them into our corporate processes and cultures.

of a business wish list. Write and tell us how the items mentioned here agree with those on your list and where they differ. What do *you* think we still need that we don't yet have? Then take a stab at providing some possible solutions for the missing links. We look forward to hearing from you. In the meantime, enjoy reading what our correspondents have to say on the issue of a business wish list.

William A. Boller
General Manager of Strategic Consulting
Hewlett-Packard

Quite candidly, businesses view technology as a means to achieve an end. They

are not interested if you talk to them about technology unless you start discussing their particular business issues. There are two that are most significant to them. One is to improve their competitiveness. The other is to improve their financial viability.

When you talk about white-collar productivity, a priority is *ease of use*. That term breaks down into ease of use for the end user and ease of use for in-house systems people. There are two categories of ease of use. One is for the plug-and-play systems like the PC, and one is for the MIS community. When you talk about ease of use for the end user, you talk about technologies such as a common GUI. And you talk about the transducer-to-the-human. Do you use a keyboard or voice recognition to get the data into the machine? Do you use a CRT or a voice synthesizer to get the data out of the machine? Now, when you get into portability, you can't carry around a CRT, so manufacturers use LCDs. Then there's the question of voice synthesis and being able to use your modem to talk back to your office and get in and out of the system, and what have you.

When you consider the possibility of using technologies such as agents, then you get into object orientation and distributed computing, client/server, etc. End users don't say, "I want object orientation." They say, "I need to show my boss I'm being productive. In order to do that, I need to have systems and technologies that are easier to use. Where are those?"

Besides ease of use, there's another consideration, and that's *value for use*—i.e., it does something good. A sports car is easy to drive, but if your objective is to deliver furniture, it's not functional. So when you start talking about value for use, you're talking about *access to data*—the functionality and the quality of the data that are provided.

On that level, you get into technologies like artificial intelligence, and you also definitely get into the data-access issue. You're talking about networking, connectivity, distributed computing, and client/server. You're talking about being able to sit at a local terminal—PC or workstation—and empower the user to effect decisions. Empowering users means enabling them to get from their local desks out through networks to other data sources.

Then there's interoperability. Now you're talking about a requirement for being able to interface with multiple remote systems. In addition, you have the legacy (older) systems that you have to

work into that scenario, and you have to have some consideration for the future systems. Now you have uncovered the requirement for open systems.

Competitive and Financially Sound
The reason for open systems is to allow workers to be more successful in interfacing more broadly, horizontally. The bottom line is that companies will need such things as open systems, client/server, objects, AI, distributed databases, and sophisticated technology. These things will allow the user to add value so that the systems can contribute to the company's overall productivity, making the company more competitive and more financially sound.

CEOs say, "Come show us how to improve our competitiveness, cost/performance, return on investment, and so forth, so we can stay in business and continue to make a profit." The MIS community has clearly been asked by its management to show productivity improvements. They have to prove that cost/performance is there—they have to do more for less. A lot of executives are now going to the MIS department and saying, "Before I give you next year's budget, I want you to show me what I got from the last five years' worth of funding. Show me how my business is better." □

Fred Langa
Editor in Chief
BYTE

For business, the biggest problem—and it's been there since day one and probably will be there until infinity—is pricing. Yes, prices have dropped signifi-

**For business,
the biggest problem
is still
pricing.**

FRED LANGA
Editor in Chief
BYTE



cantly. The trouble is that computer users' needs continue to grow. In theory, things like GUIs, where the machines become easier to use, open up computing to more people. But the price tag is so high the industry doesn't achieve the critical mass that it might if the price were lower. So users are still on the outer edge of the price curve.

Portable computing is a big deal these days. Being able to be productive whenever and wherever you need to is a very attractive benefit. Yet these portable machines can be even more expensive than the desktops they are designed to replace. The things that free you from your desk become so expensive or valuable that you don't want to take them anywhere.

If you want to spend money in a corporate setting, even if the technology is there, it's a question of "If it ain't broke, don't fix it." It keeps coming down to dollars. Of course, if you have an infinite checkbook, you can solve all your problems. Vendors have to achieve as much profits as possible. But some of them are very shortsighted, because they are focused on maximizing short-term profits—value *subtracted* rather than value *added*.

Many systems manufacturers are responding to these types of budgetary concerns, and that's why we're now seeing this slew of CPU-upgradable systems. Suppose you buy something today, and six months down the road you change your mind. These types of systems keep you from having to turn in the whole box. Instead, you just upgrade the CPU.

The advantages of this solution are indirect and aren't that important to individual end users. When those users go to upgrade, they want a larger hard disk, a better monitor, a better video card, and so forth. When they need a new box, they want to start over. The benefits to

the CPU-upgrade strategy are more for the MIS directors who have to support a large number of systems and for people in the channel (e.g., dealers and resellers). MIS people can buy a finite number of boxes and a pile of CPU cards and just plug and play as needed.

Getting in Sync

Businesses often have problems getting many different generations of systems in sync with each other. Wireless technology holds real promise. Being able to jump across physical locations and device generations via transparent connectivity is the way it should be. People sitting and talking to each other don't have to think about manipulating their vocal cords. It just happens.

Time consumption is another problem (see "Why Doesn't Software Work?" in the March BYTE). The hours required to learn each new program is one reason some people don't switch software; they just don't have the time to start all over again.

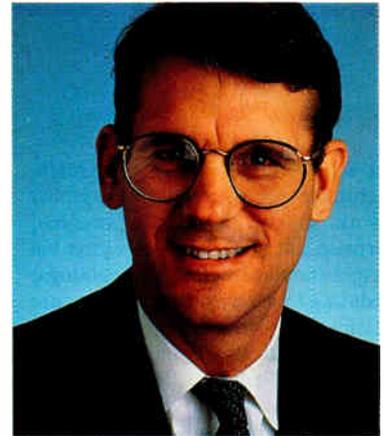
What do businesses want to achieve the most with the technology that already exists? In the short term, it's to keep from wasting money and to expect that buying technology will deliver great benefits, speed things up, and make things better. But they've found out that it doesn't. In the long term, it would be to find a way to realize the benefits that people have been talking about for 15 years now—to achieve *the promise*.

Most of the basic capabilities are available; the trick is to get access to those capabilities. There are still some minor things we need, such as networking for dissimilar machines. But you can solve most of those problems if you write a big-enough check. It's doing things easily and simply that's a problem, not the absence of the technology. The tools really are there. □

Paul N. Wyatt
Vice President, Engineering
Covalent Systems

Especially in small and medium-size firms, the use of technology to *manage* business is very limited. Islands of information exist, but integration of these islands into an enterprise-wide information-system is extremely rare.

The software development backlog of the 1970s was partially solved by firms purchasing personal or departmental software packages that solved specific problems. It's easy to see the benefits to be obtained by sharing data among these packages, but this process is a difficult



EDWARD R. ANDERSON
President
ComputerLand U.S.A.

task. The problem is not just hardware and operating-system incompatibility, but data format incompatibility.

Because of the complexity involved, trained personnel are needed to administer systems beyond the desktop level, such as multiuser systems and networked PCs. But small and medium-size businesses are unable, or unwilling, to add systems administrators to their staffs.

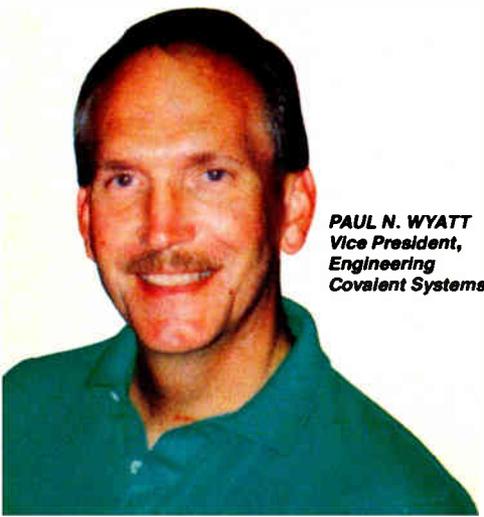
To solve this predicament, information-system standards must go beyond the operating-system, user-interface, and database levels. We must develop standard architectural frameworks that will allow us to independently select and procure personal software and groupware and then "snap them together" into an enterprise-wide information system.

Other technology needs include the enhancement of DBMSes to store the rules for using data along with the data, and the ability to transfer these rules with the data. In addition, systems administration and recovery must be made foolproof and nearly automatic.

Most business-oriented computer technology is used to automate tasks and processes that were previously performed manually. For businesses to grow and prosper, we must use technology to restructure business processes. Data must be turned into information that is available when and where it is needed. We must use computers to impose strategy and control instead of simply to collect operational data.

Better GUIs

For computer systems to be widely used, they must be nonintrusive. The user-interface technologies must go far beyond Mac-like GUIs. Pen-point interfaces such as that developed by Go Corp. will



PAUL N. WYATT
Vice President,
Engineering
Covalent Systems

be useful for some applications, but additional innovative interface technologies are required. Business will continue to adopt technology slowly and in isolated pockets. Enterprise-wide adoption of technology requires that procedures be rethought and re-worked and that organizations be changed. This is a very painful process.

Companies still want computers to be a wonder drug that will solve problems management hasn't been able to solve. When computers are unable to live up to this promise, users become disillusioned. The computers that businesses adopt the quickest and easiest are those that are embedded within machinery to improve their capabilities and the quality of their output. □

Edward R. Anderson
President
ComputerLand U.S.A.

We have three classes of customers—small, medium, and large. The medium-to-large accounts have similar needs. Recently, the large accounts have communicated to us that they are very nervous about the lack of profitability in the retail channel. In other words, by virtue of all the recent consolidations, there are only about 10 top resellers in the U.S. and only five chairs for those 10 to fit into.

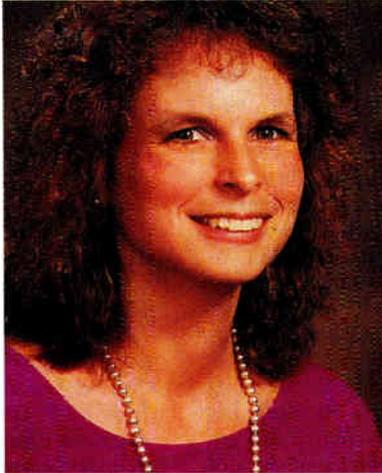
To address the issue of consolidation of the retailer channel, we agreed to buy the NYNEX Business Centers by June 1 [1991]. The philosophy is to merge the back offices, keep the front offices, and eliminate the duplicate real estate. Retailers will either go broke, go away, or consolidate and get larger. Those without enough margin will go broke.

One Size Doesn't Fit All

Some people outside the [computer] retail business think that large companies want to deal with vendors so they can get good deals. Our experience is that they want to deal with an intermediary instead so they can write one purchase order and get a mix of products. For instance, they might want to buy one brand of hard disk drives, another brand of

monitors, and so forth.

Since these companies are migrating to new products or generations of products, the support issue also is becoming more and more important. We hear things like "I'm in the airline business and modular outsourcing is a very important issue to me. What can you do that I do internally because I don't want to be in that kind of business (i.e., help, service, maintenance, training, and so forth)?"



PATRICIA SEYBOLD
President
The Seybold Office
Computing Group

Everyone used to talk about "selling the whole solution." We believe the business is radically and rapidly changing to à la carte service: "Can you give me around-the-clock server maintenance, unbundled service pricing, and so on?" They don't want to feel like they will be gouged

by a dealer selling total solutions, some of which they don't need. They want to pay for select services that they do need—both on a contract basis and ad hoc—with a guarantee of real results. □

Patricia Seybold
President
The Seybold Office
Computing Group

It sounds pretty simple. The basic problem is having the right information in the right form for the right people at the right time. First, businesses need information in the field to serve the customer, and they don't have it. Second, they're trying to consolidate all the information related to the customer and have that available to everybody involved, but they can't.

A single individual needs to be able to have consolidated information about inventory, ordering, pricing, everything. And whomever the customers contact, those people need to have the whole picture, but they don't. In the manufacturing arena, decisions about which batch of products to make are sometimes being made by the wrong person.

So what are some of the technologies necessary for solving this problem? Besides the obvious ones people are already using, there could be data dictionaries and data repositories. A data dictionary is basically an English dictionary refer-

ring to what kind of information you have and how to find it. By looking at a data dictionary, you could see what kinds of information the corporation has—what they call the *fields*—and how to go about finding them.

Then you have to deal with how to take data (in a formal database or flat files) and organize, manipulate, and manage it. Object management is one way to turn data into information and add meaning and context. You may be hearing the term *intelligent database*, but an intelligent database implies a single database, whereas object management implies a layer of software, or whatever, that will span across databases, networks, and systems and pull in information from many different sources.

E-Mail: Backbone of Connectivity

One technology that has already made a reasonable amount of progress is E-mail. It is a backbone of connectivity in general. It's now accepted in large corporations that E-mail is for much more than just sending memos. It is in fact the communications infrastructure used to send information across the whole organization. You can think of it as EDI [electronic data information]: Every time that anyone does anything, everyone gets a notification. They know exactly what's going on at all times.

We need capabilities not only in the area of technology but also in tools—integration tools, system-integration tools, and application development tools. People need real-time evolutionary application development tools for ad hoc application development; it takes too long today. If it takes two years to develop an application, by the time it's developed, it's obsolete. We need to be able to develop applications from start to finish within six months. Rapid prototyping is becoming much more popular. The distinction between prototyping and production is going away.

Other technologies that seem particularly necessary include laptop pen-based systems, voice and image integration, and workflow design (visualization and improvisation). As you begin to do workflow design like application development (much of the implementation will use an E-mail backbone), you find that you can't do it once and get it right. You have to design your workflow to improve the process and improvise with flexibility, modularity, and interconnectedness.

Usability Essential

The next hurdle is usability. Just about everybody in any business will tell you

that computers and systems of all kinds, including your home VCR, are much too hard to use. Clearly, we need some breakthroughs in this area. An encouraging direction is the Go Corp. tablet and its software and an increased awareness of the role of multimedia—bringing it all together finally. We need to put a big push on usability and portability.

Another technology hurdle is operating systems and networks. You cannot build a real-time organization with today's technology. Networks aren't robust enough; operating systems have to be brought down and brought up again. You can't make modifications on the fly. Basic infrastructures and basic operating systems and networks need to be reworked.

There needs to be a shift in the corporate culture that says "learning is a responsibility of every individual and every group and every division." And that we, as a company, will value that and reward you and set up infrastructures to foster that. Part of this scenario is that *everyone* must have systemic interrelationships. Everyone needs to be able to know everything that affects his or her job; the old-timey "check your brain at the door" thinking just won't make it. Everyone has to be empowered. I think we're heading in that direction now. □

Dr. Walter Bender
Principal Research Scientist
MIT Media Lab

We're still not able to communicate information to the place we want to communicate it. Also, we can't manipulate data in a timely or convenient fashion. For example, when I'm at my desk, I have this wonderful workstation and a network that can transmit, manipulate, and retrieve the information I want. But when I'm out of my office, at a remote site, on the road, or elsewhere, I don't. I only have devices such as a laptop, radio, or a cellular phone. These are much less powerful tools, and, in this kind of a different situation, I'm greatly limited in my capabilities.

The notion that information and communication channels can be scalable is not accurate. Information architecture is not scalable, either in terms of bandwidth or content. I can do multimedia when I am at my desktop, but not when I'm at a remote site. How do I translate the data that was going to come as video, and light, as text? Dimensional multimedia

as seen by your face looks different from flat text.

E-Mail vs. Fax

On a related theme, the form in which we are pushing this information around doesn't make it amenable to very sophisticated manipulation—for example, the difference between fax and E-mail. Both are very efficient ways of getting information from here to there. But when a fax arrives, it is static. When E-mail arrives, I can manipulate it. That's one reason we're beginning to see optical character recognition really

take off.

Building a structure around these particular transactions would make this information easier to work with across environments. How do you find the message this information refers to or the person who sent it? References are beginnings, and they are an indicator of more structure and better things to come.

With this kind of capability, you could take E-mail data and make it into a report that would help you do a better job of tracking competition, for instance. The more structure the computer builds in, the more it can do and the less you have to do—the less you have to manipulate. After all, you should be analyzing and thinking about the implications of the data—not having to worry about the logistics of retrieving it.

We need a lot more capabilities like these audit trails in E-mail (embedded in the information) so the computer can leverage off that data to make it more pertinent to the user. Technology should eliminate some of the burden of manipulation—do the logistics for us—so we can concentrate on the higher aspects of the evaluation and analysis of the information. ■



DR. WALTER BENDER
Principal Research Scientist
MIT Media Lab

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■ **Paul N. Wyatt** is vice president and chief technical officer of Covalent Systems in Fremont, California. He is responsible for engineering and product marketing.

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■ **Dr. Walter Bender** is director of the Electronic Publishing Group at MIT's Media Lab. In 1980, he received his M.S. from MIT. In the late 1970s, he worked with Nicholas Negroponte and the Architecture Machine Group (forerunner of the Media Lab), where he has been ever since. His current work is on computational access to information.

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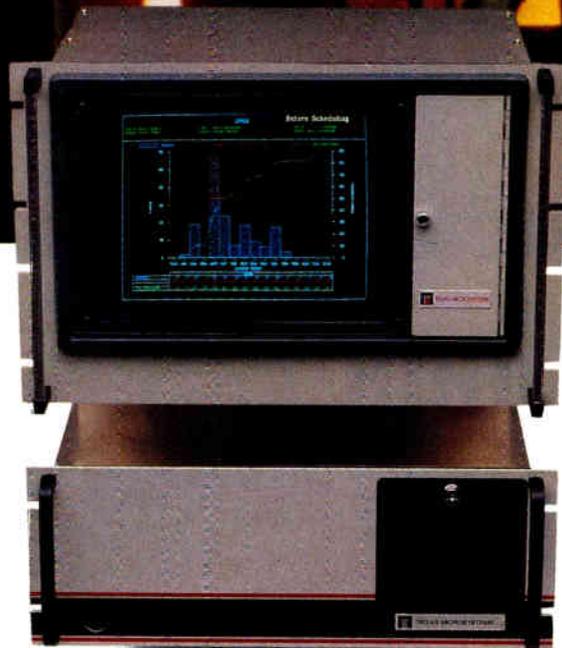
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The Outlook for Europe

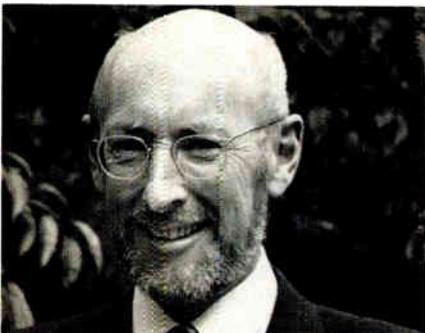
Europe's research and innovation may have led the computer industry once, but what's the future for its researchers, innovators, and manufacturers?

ANDY REDFERN

Since Charles Babbage first began designing his mechanical Difference Engine, Europeans have played a significant—often leading—role in the advancement of computer theory, design, and manufacture. Manchester University may well have created the world's first computer, but the tide has been turning ever since, and Europe's research and innovation lead has significantly diminished. Japanese and U.S. companies now dominate virtually every area of computing, from the initial research to the fully implemented design. Can European companies regain a strong position, or will they become just the minor research departments of the American and Japanese multinationals? And if European innovation can survive, just what will European researchers be excelling in over the next five years?

The recent wave of purchases of European companies by American and Japanese manufacturers has generated resentment, and some countries are renewing calls for protectionist measures to shield their industries. Coupled with the fact that the European Commission (EC) seems to be perpetually investigating charges of "dumping" everything from floppy disks to dot-matrix printers, the argument for protectionism seems to be strong. The new French prime minister Edith Cresson is already being dubbed Europe's new Iron Lady as she attempts strong stands against the Japanese. "The Japanese have a strategy to conquer. And they're about to devour Europe," she asserted in a recent interview. Her feelings toward the U.S. are slightly more conciliatory; she maintains that the Americans and the Europeans "need to collaborate."

But some figures in the high-technology industry see things in a more positive light. Sir Clive Sinclair, the creator of a number of successful microcomputers in the early 1980s, has reason to fear foreign countries dominating Europe. His company, Sinclair Computers, was swallowed up by Amstrad after his company crashed. His products



SIR CLIVE SINCLAIR
British Inventor and Innovator

were squeezed out of the market by American and Japanese consoles and game machines on one side and the emerging IBM PC standard on the other. Yet he strongly disagrees with Cresson's stance: "There is no room for protectionism in Europe. Through technologies like parallel processing we have the base technology in place to take a lead, but whether we have the commercial sense to capitalize on it is another question."

Sinclair also does not support the way many European governments prop up their ailing high-technology companies. "The government should only help by getting the general structure right. It should simply be responsible for providing educated staff and maintaining freedom for enterprise and innovation." He does not see the long-term value of European governments pumping money into companies that are failing to compete in the world market. Although there is European legislation to prevent member states from creating unfair advantage through government subsidy, it hasn't stopped the French government from recently announcing a \$1 billion investment in Bull.

Fortress Europe

Even more vociferous than Sir Clive Sinclair is Peter Horne, the managing director of the U.K. personal computer manufacturer Apricot. It is his belief that "Fortress Europe is being built, brick by insane brick" as the European community contemplates new ways of staving off the external competition. He fears that the information technology industry will go the same way as the automobile industry.

The EC already exercises a quota system limiting the number of Japanese cars that can be imported into Europe. Its definition of *import* includes Japanese designs manufactured in Europe, as well as the cars shipped directly from Japan. Horne maintains that "this policy systematically discourages the flow of Japanese capital and skills into the EC and artificially bolsters European manufac-



turers in the short term.”

Cynical commentators might observe that Horne has an ax to grind because Apricot was bought by the Japanese industrial giant Mitsubishi Electric in May 1990. He maintains that without the investment from Mitsubishi, Apricot might not have remained in the personal computer hardware market, and jobs, R&D, and manufacturing expertise would all have been lost.

Apricot is not the only European company to have looked outside Europe for the investment that it needs. European banks have been notoriously bad at providing the necessary levels of investment that high-technology firms need to maintain R&D of new technologies.

International Computers Ltd., which is undoubtedly Europe's most consistently profitable computer manufacturer, sold an 80 percent stake to Fujitsu in November 1990. Since then, its investment in R&D has increased from £16 million to £215 million. Fujitsu has left the company to plan its own strategy for growth, simply offering a £250 million three-year revolving-credit agreement. This provides a level of investment and support for technological innovation that previously had been difficult for ICL to find in Europe.

Even though Japanese investment has protected 400 jobs in the U.K. at Apricot and 21,000 jobs around the world at ICL, the EC has not welcomed this investment that some claim protects European innovation. The Joint European Submicron Silicon Initiative is a European research collaboration designed to spearhead a new generation of microprocessors and other assorted silicon chips. In the beginning, ICL was heavily involved in this project, but its acquisition by Fujitsu caused it to be expelled from three of the projects and from the European Information Technology Round Table lobby group.

The other advantage that this inward investment has had for companies like

Apricot is in providing new resources to tackle previously impossible markets. Apricot has just launched its range of products in Japan—a move that would have been impossible without Mitsubishi's help. Ray Andersen, managing director of IXI, the X Window System GUI manufacturer, believes that a European



RAY ANDERSEN
Managing director of IXI

company will only be secure in the long term if it ventures into the U.S. and Japanese markets. He insists that European innovation will survive only if companies are willing to tackle the overseas companies in their own markets. Relying on people to buy your product because they live in the same country as you do will never bring major success.

Andersen also believes that fear of Japanese investment is shortsighted. “Ownership of the companies may be changing, but the people aren't. If I could see an area of the world where there were original ideas being generated, then I'd want to invest in research initiatives in that place, and that is exactly what the Japanese are doing. It is far more than tokenism.”

European Innovation

The fact that Japanese and U.S. companies invest in European innovation and research would seem to indicate that European researchers have something new and original to say. Niels Jensen, managing director of Jensen & Partners International (JPI), one of the world's leading compiler manufacturers, believes that European developers “provide a higher quality of research” than anyone else. Being a language developer, he looks to the compiler market to illustrate his point.

“The C language has spread all over the world, but from a technical standpoint it is probably the poorest choice. All kinds of unsuitable applications use C, simply because the U.S. market has become dominated by it. In Europe, some application developers have been more sensible in selecting the language

that best suits the application. For example, the European Space Agency has chosen the European-designed Modula-2 language for the bulk of its development.”

Jensen believes that C++ is another bad step for the industry as a whole. It is not a well-thought-out and -researched language that places power in the hands of the users, he believes, but a clumsy add-on to C that is more likely to cripple the industry than to help it.

“European research in programming languages is way ahead of everyone else. Oberon is an excellent example of what happens when a language is researched rather than thrown together.” Jensen admits that JPI is currently producing a C++ compiler, but he explains that the company is simply committed to providing the best compiler for each language and actually hopes people will use the multilanguage environment as a way of gradually migrating to Modula-2.

The Next Five Years

Sinclair, Horne, Andersen, and Jensen all have one thing in common: They believe that Europe's researchers have original ideas to offer the world. But what do they see as the major areas of growth and expansion over the course of the next five years?

Andersen believes that information organization, open systems, and communications are fields in which European companies have the base platform of research. Communications is one area in

European developers provide a higher quality of research.

NIELS JENSEN
Managing director
of Jensen &
Partners
International



which European companies have invested in the infrastructure to such a level that they could be dominant.

As an example, he points to the system of *back billing* used by phone companies. When a phone call is carried by more than one carrier, there has to be a simple way of billing the call originator. The European system was designed to allow for virtually all possible billing eventualities, so even if a call is made to a mobile phone number in a different country, all the costs are charged to the call's originator. The U.S. system cannot cope with these complex calls that way, and the part of the call charges that cannot be backwardly billed is added to the call recipient's bill. These technical advantages, Andersen insists, will give Europe a chance to dominate and lead the communications market.

Sinclair sees highly parallel processing as the one area where Europe is poised to dominate a market, although he believes that mass-market sales are still some way off. Similarly, AI is an area of development that has been predicted as a major growth area for at least 10 years, and Jensen now believes that the next five years will see AI finally taking center stage. "Speech recognition is the key to mass-market success—talking is the easiest way to communicate. Many people are frightened of mice and keyboards. In fact, the mouse is probably one of the most ridiculous user-interface tools yet to be invented. Pen computing is a step on the way, but speech recognition will be the next revolution."

**Eastern Europe—
A European Advantage?**

The major area of opportunity for European companies must surely lie in the democratization of the Eastern Bloc. Although U.S. and Japanese companies have been

PETER KRAUGER
Managing director
of Dighthurst



quick to dip their toes into the Eastern European waters, few of them have yet invested heavily. Surely through the European expertise in translating and adapting software for new cultures and through proximity to the new market, the European companies must have a significant advantage.

Everyone is talking about getting a slice of the Eastern European action—everything from joint ventures to the relaxing of the Coordinating Committee for Multilateral Export Controls agreement has caused a mood of optimism to sweep most of the Western world (see the text box "What Is the CoCom Agreement?" on page 62). In fact, this has led to the creation of the false perception that Eastern Europe is already a thriving market. But many companies have found that making serious investments in the Soviet Union and other Eastern nations is considerably harder than they had anticipated.

Opus, the U.K. PC manufacturer, has started a joint-venture company, called Balutech, with four other organizations (including the Soviet Union's state-run airline Aeroflot) to allow its products to be manufactured and marketed in the Soviet Union. Martin Breffit, Opus's marketing director, is quick to acknowledge not just the advantages of the joint venture but also the huge amount of time involved in negotiating it. "It took 2½ years to set the joint venture up. We now have an 11,000-square-foot production plant in Riga that basically completes partly assembled computers sent from our U.K. production plant."

Although business has so far been slow, Breffit believes it has been very successful. Balutech has sold around 500 machines and suffers mainly from the lack of hard currency to pay for the kits from Opus in the first place. "Lots of people require PCs," says Breffit. "They just haven't got the money to pay for them." Five hundred machines may sound like peanuts compared to the widely reported order of almost a million PCs that the Soviet Union placed just over a year ago. The country wanted the machines, but in the end the suppliers—Siemens-Nixdorf, Apricot, Bull, and many other European manufacturers—could not deliver because there simply wasn't the hard cash available to buy the machines.

As to whether the recent tightening of central government will make any difference, Breffit believes that in the long term it won't significantly affect Balutech's ability to bring technology to the marketplace.

Hard Currency? Hard Luck

By far the biggest problem to be faced by most companies entering the Eastern European markets is the lack of hard currency (e.g., dollars, sterling, or deutsche marks) to pay for the equipment or services being supplied. Companies demanding hard currency often find themselves undercut by those willing to take a



MARTIN BREFFIT
Marketing manager of the U.K.-based
PC manufacturer Opus

more creative approach.

Uniexport is a high-technology company specializing in the export of electron microscopes and spectrum analyzers to universities and medical centers across Eastern Europe. To be successful, it has had to learn about the ancient art of bartering. Basically, the company found that while its equipment was in great demand, its sales volume was severely restricted by the lack of currency. So, on a number of occasions, it has exchanged its products for commodities, simply to help complete the sale.

Uniexport has accepted things as diverse as software and timber as payment for its hardware. But, explains John Ingleby, a member of Uniexport's sales staff, often the problem is that even the raw materials being supplied are not up to Western standards and therefore fail to command a good price in the market. "In one case, we were offered some gallium-arsenide wafers, and everyone was looking forward to seeing them, as they had great potential for generating cash in Europe and the U.S.A. But when they arrived and we looked at them under the microscope, the surface looked like sandpaper. They could create the basic raw material, but their polishers just weren't good enough. And, of course, they need foreign currency to buy better ones."

But if the Soviets can't compete on technology, then perhaps they have the

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WHAT IS THE COCOM AGREEMENT?

The Coordinating Committee for Multilateral Export Controls is an alliance of 17 nations devoted to preventing the export of militarily useful high technology to the nations that formerly made up the Eastern Bloc. Its current list includes some 120 products that, to be exported, require a license granted by the member state or CoCom itself. The list includes a range of vastly different products, but the two most sensitive areas are high-speed computers and high-speed communications.

In June 1990, several of the organization's members campaigned to reduce the list to just eight product categories. Through negotiation, that number has been expanded to 10, but this may still not be enough to bring the new proposals in.

Some members have fears stemming from the use of technology during the Gulf War. The war taught CoCom that the dividing line between military and commercial use is more blurred than

people had imagined. For instance, fiber-optic cable proved to be significant in allowing communications between the Iraqi control centers. Surface cables and radio signals can be destroyed, but deeply buried fiber optics are almost impossible to locate and eliminate. And a single fiber can multiplex many data and voice calls.

In June, the CoCom restrictions on many goods were relaxed. There is no longer a restriction on selling 32-bit processors or machines based on them. In fact, the agreement now allows any chip that has chip features greater than 1.5 microns to be sold throughout Eastern Europe. Needless to say, the restrictions still apply to any products intended for military use, and night-vision equipment and high-speed fiber-optic cables are still banned.

Even though these changes have been implemented, it seems doubtful that there will be a flood of technology into Eastern Europe. There just isn't the foreign currency to pay for it.

opportunity to market their expertise. For example, Uniexport is investigating the possibility of importing image-processing software from the Moscow State University.

Ingleby explains that the faster a computer is, the better it runs image-processing software, but fast hardware can make programmers lazy. He maintains that because of the slow speed of the technology available to Russian programmers, they have been forced to write much slicker code, and the combination of slick code and a fast PC may well be an attractive proposition for a number of Western researchers.

But even here there are problems. The cultural difference results in the creation of a style of software that is different from what the Western Europeans were expecting. American software, except in the games industry, has traditionally been conservative and tries to look serious. But many of the Soviet programmers like to add fancy sounds and graphics to their packages. Uniexport has had to try to explain the difference and then temper the software produced to make it more suitable for sale outside Eastern Europe.

Even though bartering has been important to his company's success in dealing with the Soviet Union, Ingleby is realistic about the value of the products and technologies he's found in the U.S.S.R. "I can't understand how they became a world force. In all our searching, we have yet to come up with anything really useful," he says.

Licensed to Sell

After hard currency, the other area of risk for companies is the apparent confusion over what technologies can and cannot be exported to Eastern Europe. Although the CoCom agreement appears fairly specific, there are some cloudy areas, and in the past, some companies have faced lengthy investigations to ascertain exactly what their products were being used for.

Digithurst is a Northern European supplier of video-output and image-processing cards whose production facilities were located in the U.K. It has sold a number of systems to various universities across the Soviet Union. But in early 1988, something happened that caused the company to be investigated for three months, during which time it was not al-

lowed to export anything from its U.K. production facilities.

One night on the evening news, Soviet General Secretary Gorbachev was at a university in Moscow. The university's academics were showing him the high standard of Russian technology, and Gorbachev was in turn showing this technology to the world press. He lifted up a circuit board and told everyone that Russian technology was finally catching up with Western technology. Peter Kruger, Digithurst's managing director, was more than a little amused, as what Gorbachev was holding looked like one of the video boards he had sold to the university.

The amusement turned sour the next morning when the U.K.'s Customs and Excise officers moved in and slapped a ban on all his company's exports while they investigated whether or not the technology was on the proscribed list. Kruger still appears nervous when he tells the story; no business can afford to risk that kind of an export ban. The company has since opened production in other European countries so that if anything similar were to happen again, the results would not be so devastating to the company's overseas sales. Kruger acknowledges that there have been subsequent relaxations since early 1988, but his experience stands as a stark reminder to all those who would follow him into Eastern European markets.

Observers may not agree on how fast the market in Eastern Europe will grow, but what they all agree on is that it will grow, and in some places very rapidly. As this growth is coupled with the removal of trade restrictions between most European countries, many people are now talking about the New Europe.

One Europe—One Market?

Once the European community decided that 1992 was the year for the cross-border trade restrictions to end, each member state's government set about an aggressive campaign to alert the country's companies to the benefits they would get if they were prepared to enter Europe in 1992.

In the U.K., the Department of Trade and Industry used Alan Sugar, managing director of Amstrad, as an industrial figure who could communicate to small and medium-size businesses. During the TV campaign, he explained that he currently had to make a different machine for each European country because of the different regulations regarding health and safety and electrical emissions. He said that in 1992 he would only have to make

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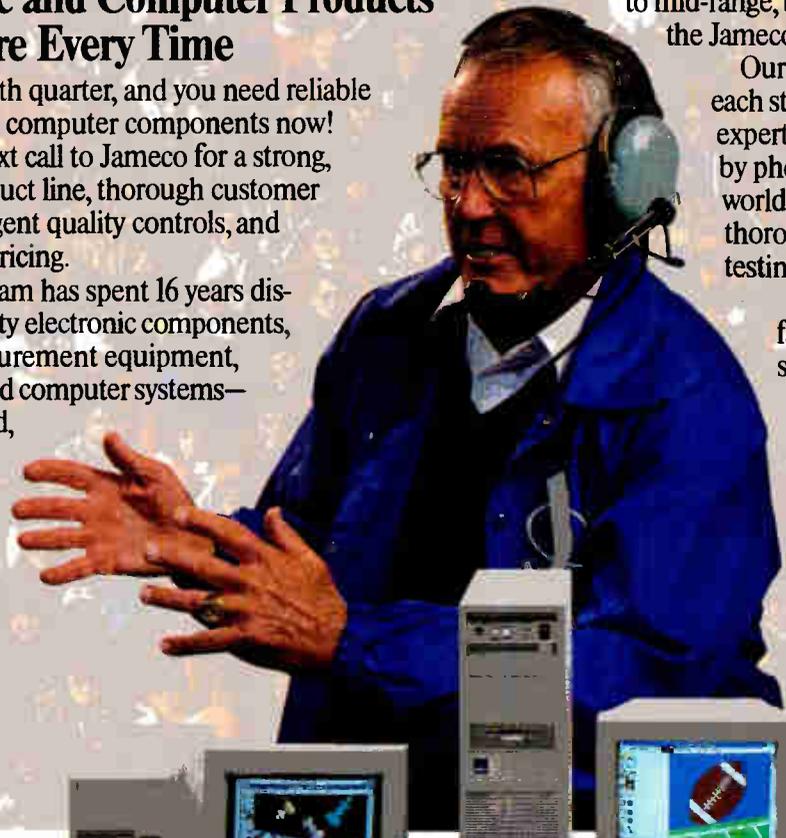
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one machine, because those regulations would have been standardized throughout the European community.

Although there is some truth in this, it overlooks the biggest barrier for any company trying to sell across the whole continent—the language differences. Although the basic hardware will be the same in every country, the keyboard, the version of DOS, and the documentation will probably need to be different. So selling into this single market requires a number of different products to meet the different cultural requirements.

Some European manufacturers have tried creative solutions to this problem. One Dutch-based PC manufacturer is investigating the possibility of creating

a keyboard that uses a tiny LCD instead of a key cap on each key. The screen can then be programmed to display whatever key layout the user requires: The standard QWERTY, the French AZERTY, or the more unusual Dvorak keyboards would be available at the flip of a switch. Researchers within the company believe that they can create a design cheap enough that the slightly more expensive keyboard will still be much cheaper than it would be to create lots of different versions.

Siemens-Nixdorf has already developed an alternative technique. Using a laser printer, the company has perfected a technique that prints the characters onto the finished keyboard as the final stage of the production process.

Although making slight variations for different products may seem a problem to some, many European companies perceive it as an advantage they can capitalize on. Richard Muller, general sales manager of MT Datacom, one of the few indigenous modem manufacturers in the Netherlands, believes that his company can use the remaining differences to its advantage. Getting a modem approved by the relevant communications company in each country is a difficult task. Couple with that the need to support different languages and different communications protocols, like the exclusively European V.23 split-baud-rate system, and you can see why European companies believe they have the edge.

Muller maintains that the experience

that his company has gained in getting through the various approval bodies and in supplying its systems across Europe is a tangible advantage that will allow it to react to new markets and new standards much more quickly than U.S. manufacturers will be able to. USRobotics' acquisition of the sinking U.K. modem manufacturer Miracom takes on a whole new meaning when viewed in these terms.



PETER HORNE
Managing director of Apricot

The changes brought about in 1992 don't stop there. As Europe will effectively be a single market, companies will be unable to prevent products from being sold across national barriers. Previously, a manufacturer could appoint a distributor to a geographical area and could prevent the distribution com-

pany from supplying customers outside its territory. Now, any distributor can sell anywhere that people want to buy the product it sells, even if that particular market was traditionally covered by a different dealer. Companies that try to coerce their dealers into respecting national boundaries are in danger of prosecution for restriction of trade.

In fact, the companies that will suffer most from this are American and U.K. manufacturers. English is fast becoming the accepted language of computing, so in Sweden, for example, 50 percent of the copies of Ventura Publisher sold are English, even though a Swedish version is available. But the converse is not true; a Swedish company can be sure that the Swedish version will sell only in Sweden, as few other countries have large numbers of Swedish speakers.

The changes across Europe will continue for many years to come. With economic union attempting to create a single European currency by 1995 and the Channel Tunnel linking the U.K. to mainland Europe in 1993 (for the first time since the ice age), new opportunities will abound.

The consensus appears to be that European innovation will still play an important—some believe key—role in the shaping of the new technologies developed by the computer industry in the next five years. What is uncertain is whether those Europeans will be working for American-, Japanese-, or European-owned companies. ■

PARTICIPANTS

■ **Sir Clive Sinclair**, British inventor and innovator, has launched a string of ground-breaking electronic products, including a number of Z80-based home computers, the Z88 notebook machine, a miniature TV, and the world's first truly pocket-size calculator. Through Sinclair Research, he is working on wafer-scale integration, mobile communications, and a collapsible briefcase-size bicycle.

■ **Peter Horne** is managing director of Apricot, the U.K. personal computer manufacturer bought by Mitsubishi in 1990. He worked for the European Organisation for Nuclear Research at CERN before joining Apricot in 1983.

■ **Ray Andersen** is managing director of IXI, a world leader in developing an intuitive GUI to Unix through the X Window System. Although his company has scored major successes in both the U.S. and Japan, he believes that the time difference between the U.S. and the U.K. is one thing that holds most European companies back.

■ **Niels Jensen** is managing director of Jensen & Partners International, maker of the TopSpeed language compilers. A firm believer in European innovation, he left Borland's European operation with Modula-2 when Borland began taking all its R&D to its Scotts Valley, California, headquarters. Danish by birth, he currently lives in the U.K.

■ **Martin Breffit** is marketing manager of the U.K.-based PC manufacturer Opus. After nearly three years of negotiations, the company has opened a joint-venture company in the Soviet Union called Balutech. The Balutech venture includes a Soviet state ministry and Aeroflot, the Soviet state airline. Balutech is building personal computers for the Soviet market from kits supplied by Opus.

■ **Peter Kruger** is managing director of Digithurst, a company specializing in the development of graphics cards, data compression tools, and image-processing software. He believes that his biggest achievement so far has been to make German women more beautiful through a specialist image-manipulation application for hairdressers.

Andy Redfern is the bureau chief in BYTE's London office. He is responsible for BYTE's International Section. You can reach him on BIX as "aredfern."

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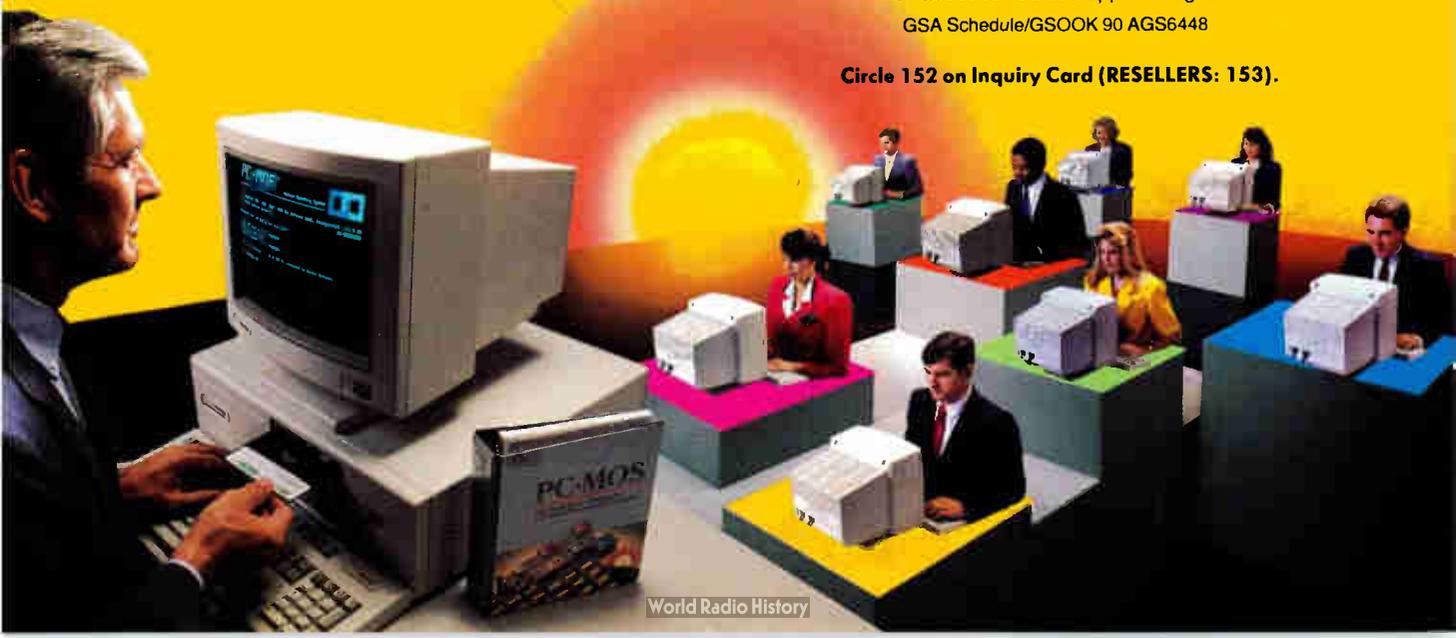
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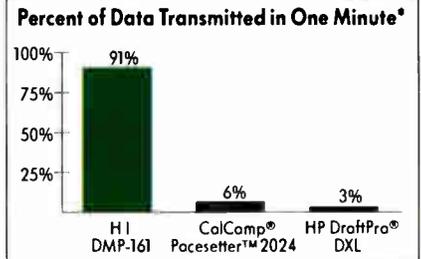
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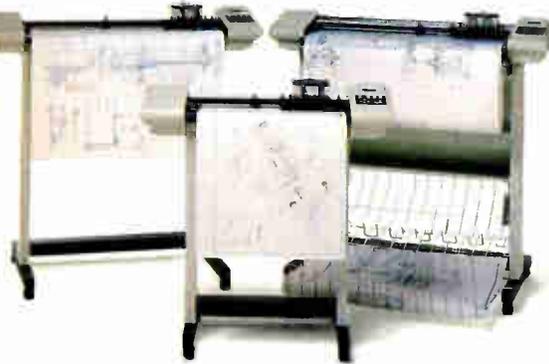
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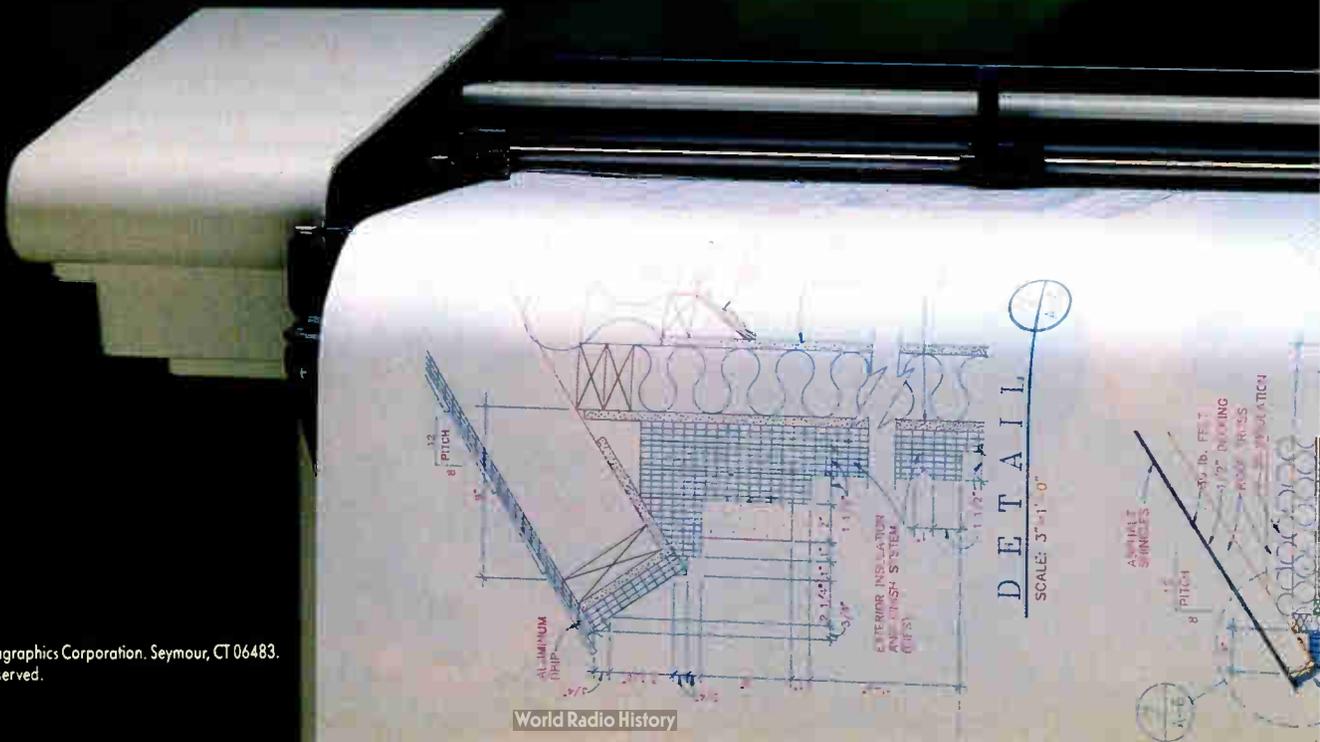
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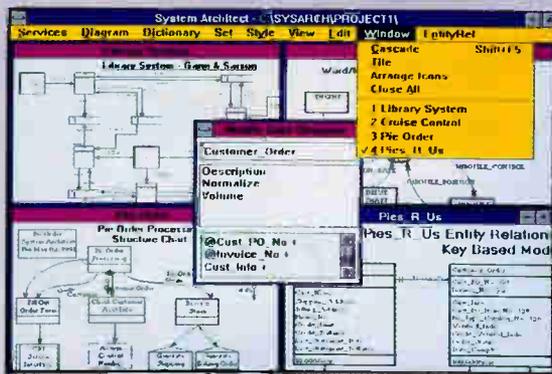
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A cross section of viewpoints on program development reveals some common and some diverse themes

BARRY NANCE

Software technology is getting more complicated. Developers have to hack through a jungle of computer languages, operating environments, user interfaces, and shifting standards to choose how they'll create their software. It's not an easy job. Software purchasers will have to live with the result for years to come. Which advances in software technology will prevail? Which ones will be just a flash in the pan?

I chose a cross section of well-known developers and asked each to talk about current and future trends in software technology. The following dialogue reveals some common and some diverse themes.

In general, do you think software purchasers are getting what they need? What should developers be doing differently to give purchasers a better product?

David Norian: I don't think that software purchasers are getting the technical support they need. While the products are getting more and more complex, and in many ways more and more expensive, it seems that support is starting to be thought of as an additional business opportunity.

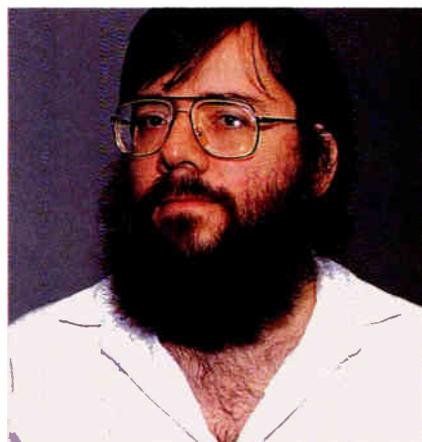
Products are, in many major categories, largely feature-complete. There's just not a whole lot of additional stuff to do. Because of this, we may be entering a new, more exciting arena—one where the approach is rethought, rather than just adding a new function or feature. Lotus Improv on the Next [computer] is a good example of this type of product.

Michael Geary: Applications are getting too big, and they try to do too much. Versatile and powerful, yes; but overwhelming. I think what we need are simple little programs that are easy to understand and use, and that work together to accomplish more complex tasks.

Patrick Wood: Software vendors think the purchasers are [getting what they want]; purchasers often aren't. In general, I think people are getting what they want—there's a lot of creative stuff being done with paint software, word processors, DTP [desktop publishing] systems, and the like. Do the users want more? Of course! The computer is an incredible tool, and any software that makes it easier/faster/more creative/cost-effective will be in demand.

Torje Mathisen: I would like to see more building-block-type software, with easy integration between different apps and user-specified links between them—something like all the best features of HP's NewWave, Microsoft's Object Linking and Embedding, and Remote Procedure Calls joined together seamlessly. This would probably depend on a very object-oriented API from the OS.

Tom Thompson: If the user's needs fit the off-the-shelf application, they are [getting what they want]. (Specialized software should be written in-house for businesses.) Developers should add features that the customer needs, not what they think [customers] want. Some effort should be done to get feedback from the



GORDON LETWIN
Chief architect of MS/DOS and OS/2

users before making an upgrade so that the proper features are added.

Walter Bright: Purchasers' needs seem to always outstrip the capability of the available software by a constant time frame of six to 12 months.

Would you characterize most PC software users as sophisticated, repeat buyers or first-time buyers? What effect does this have on software developers?

Nanian: No, I don't think that most PC users are sophisticated—far from it. Although compared to users on other systems, they are more tolerant of faulty design.

Geary: I think that the vast majority of software users are barely able to cope with the programs they are using. They probably use only 10 percent of the features in any given application. Having found it so hard to use the software they are now using, they are afraid to try anything new.

New software will be bigger, more complicated, overwhelming. It'll be oriented to corporate workgroups and MIS control instead of liberating individual

computer users, as was the promise of the personal computer.

Wood: Both. There are new users coming on board every day. I think most major purchases are done by repeat buyers. For example, most first-timers won't pay \$500 for PageMaker (or whatever it costs these days), but with Windows bundled with most PCs, every new user is "buying" something.

Mathisen: I don't know about the single-user community, but in a large company like Norsk Hydro, the buyers are definitely in the sophisticated category.

Thompson: Most are repeat buyers, unless the purchase is a unique program like a CAD/CAM application. Even for repeat, volume buyers, GUIs are a win, because the consistency between each program interface makes it easier to learn and remember. Developers should write to a GUI and stick to the guidelines.

Bright: About half and half. This makes it very tricky for a developer, as the needs of the two groups are quite different.

Is there a shift from off-the-shelf software to in-house-developed (corporate) software? Does this affect how software is written?

Nanian: In some arenas, yes. I think that's mostly due to the fact that many of the major packages aren't sufficiently customizable. Clearly, you need to write a flexible package as well as one that has a lot of functionality.

Gordon Letwin: I can't speak authoritatively on this marketing question, but I'd guess that it's going away from internal development. Software development is always a difficult and disappointing task; as commercial packages become more sophisticated, in-house development seems less and less practical. How many equipment companies build their own electric motors? As the commercial products become better, it's harder and harder to justify a "make" decision over a "buy" one.

Bright: There will always be a large market for both standardized off-the-shelf software and for custom work. I don't see the ratio changing.

Wood: For office software, yes, I believe this is true. I think that it affects how software is marketed more than how it is written: Larger corporations are interested in buying source [code], customizing it, and self-supporting the resulting product.

Mathisen: Both: More off-the-shelf software is bought each year, while at the same time, more "glue" software is written in-house to integrate everything.

Thompson: Where an off-the-shelf application doesn't fit a particular need, an in-house program will be written. What this really means is that there will be a growing market for development tools and GUI libraries.

Will the Common User Access (CUA) part of Systems Application Architecture (SAA) catch on as a user-interface standard?

Nanian: I hope not. It's just not a very good standard,

Purchasers' needs seem to always outstrip the capability of the available software by a constant time frame of six to 12 months.

WALTER BRIGHT
Principal of Zortech,
maker of Zortech C++



although any standard is better than *no* standard.

Geary: Yes, it already has. But “standard?” Everyone messes it up. Consider Borland’s C++. It tries to be CUA, but they got the Minimize and Maximize icons reversed! (They did Max/Min instead of Min/Max, like it’s supposed to be.) And instead of Control-Home going to the top of a document and Control-PageUp to the top of a window, those are reversed to the antique DOS standard of Control-Home being top of window and Control-PageUp [being] top of document.

Bright: Yes. Just like the controls on a car are roughly standardized.

Wood: Bah, humbug. MAP has more of a chance than SAA. Once again, this only affects the big, corporate user.



PATRICK WOOD
Coauthor of several books

Mathison: It probably will, because of IBM’s backing.

Thompson: For an IBM house, yes. But for Unix and a mixed environment, other GUIs will pervade. It depends on how effectively digital video is integrated into computers and whether video-style applications will truly address a need. (Do I really need to *see* the person I’m talking to?)

Will text-mode applications still be developed, or will everything eventually run under a GUI?

Nanian: A “graphical” command-line tool is not very useful. Even on the Macintosh, certain segments of the community run command-line applications (e.g., their programming environment). But that command line may run within a graphical environment.

Geary: Text-mode apps will still be developed, but they will look a lot like the GUI apps. At least this gives some user-interface consistency.

Bright: Text-mode apps will continue, but they will probably reside in a text window inside a GUI. Text apps are so

simple compared to GUI apps. They are well suited to one-time programs.

Letwin: Yes and no. The cost of a GUI gets proportionately lower. Eventually, standardization pressures will eliminate the non-GUI low end.

No GUI app is forced to take advantage of the GUI environment. There are still TTY-style interfaces around, here

and there. These applications run on CRTs, even though they don’t use full-screen capabilities.

Writing a character-mode full-screen application is a hassle. You’ve got to play games with the character set to get nice boxes; you’ve got to compute and keep track of your screen size; the work is tremendous. A good GUI does all of this for you.

Wood: Text mode will be developed—

there’s still a huge installed base of non-windows systems—but the market will be the lower-end home users and small offices. Over the next five to 10 years, text mode will go the way of the dinosaur. It will not happen overnight.

Mathison: Text mode will stay, maybe in separate windows. Most business applications are basically “fill-in-the-forms” types of programs, which don’t need GUIs.

Thompson: GUIs will grow, because today’s growth in computer sales practically demands this. There will still be text-mode applications, especially for development or batch-style environments.

Will multimedia have any serious effect on the software marketplace? Do you think you’ll do some multimedia programming in the near future?

Nanian: I don’t know—but I don’t expect to be doing any multimedia programming. It’s nice, though, to be able to combine text, graphics, and sound in a mail message on the Next. If that’s what you mean by “multimedia,” it’s great. But the “multimedia solution” touted by many isn’t, in my opinion, very useful. Personally, I prefer books.

Bright: Not till the hardware price drops drastically.

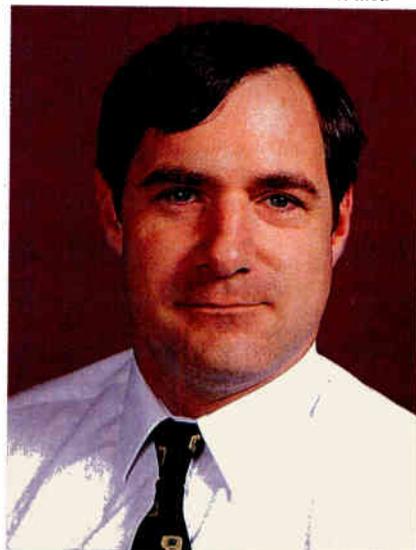
Geary: I don’t know what effect it will have, but I’d like to do some. Sounds like fun! But is it part of the trend to bigger, more complex software that individual programmers can’t write and individual users can’t use?

Wood: Maybe. I think the jury is still out on multimedia, regardless of what Jobs [and] Gates (et al.) say. It’s a technology looking for a market right now. Most users don’t have access to the technology to make multimedia work for them. It takes more than a Mac and a LaserWriter to do multimedia, much unlike the desktop publishing revolution that all the vendors point at as the model for making MM happen. Will I program for multimedia? No.

Mathison: Not for day-to-day running of big companies, but maybe for presentations, visual effects, and PR. It will take many years, if ever, before this is a mainstream application.

Thompson: Multimedia is having a serious effect on the market now, but probably for all the wrong reasons. There will be a marketplace for multimedia, but it won’t be as large as DTP, since a lot more expertise is required to storyboard an idea and fit information into a tightly timed sequence. That takes more skill than any DTP layout requires. No multimedia programming for me in the near future, because I don’t think the hardware’s there yet.

continued



TOM THOMPSON
BYTE senior technical editor at large

Do you think developers are paying more attention to making software LAN-aware?

Nanian: I think they're doing so now.

Geary: Probably. I don't have a lot of personal interest in this area; I'm more interested in developing software for individuals rather than groups.

Bright: No serious app on the market today can exist without being network compatible.

Mathisen: Most already do, I hope!

Thompson: This issue is already being forced by Apple's System 7.0. A System 7.0-savvy application can request processing resources from another application. New products that ignore the ability to "augment themselves over a network" won't survive.

Do you see a shift toward mission-critical, distributed-processing systems on PCs replacing mainframe software (i.e., "downsizing")?

Wood: Yes, but not on distributed PCs. PCs will become powerful enough to handle transaction processing-type jobs by themselves. I see multiprocessor PCs running in shadow mode with shadow disk drives for mission-critical jobs. It's starting to happen. Take a look in any digital-switching office. A #5 Electronic Switching System is just an AT&T 3B20 computer in a big frame. Not much more smarts than a 32-bit PC or Unix system.

Mathisen: Absolutely! *Client-server* and *RPC* are the buzzwords here this year. When the price/performance ratio between 3090s and RS/6000s is so incredibly high, even the accountants get interested.

Bright: Yes. I definitely think that the future is networked workstations.

Lotwin: The only thing keeping mid-size mainframes alive is the software compatibility issue, plus tradition and inertia on the part of corporate MIS. Micros will continue to eat at the mainframe market from the bottom up. The process is retarded by some human and technical factors, but it's an inevitable trend. And it's one that will be accelerated as networking improves.

Note that, in the past, many micro software products were just mainframe products redone for small environments. As such, people knew what a compiler or an operating system was supposed to look like. The first versions of these products, on micros, were already mature. Distributed data and software processing are brand new, and it takes time and generations of products for even the smartest people to feel their way. Look at version 1.0 of any product you admire today—software, cars, telephones, anything—and you'll laugh.

Thompson: PCs aren't as reliable as mainframes. You'll need mainframes that hold sensitive material, with controlled access, for some time to come.

Will programmers need OOP [object-oriented programming] skills in the future?

Nanian: OOP techniques are crucial to the development of more complex, structured programs and also important to new, more complex environments. They are not yet exploited well on the PC, but they are very well handled on the Next.

Geary: Yes, but I think a lot of the OOP people are living in fantasyland. They are making up terminology no one can understand. The book *Doublespeak* could use a new chapter on OOP. A friend of mine who has done a lot of



DAVID NANIAN
One of Brief's authors

C++ programming but hasn't forgotten how to program said, "I finally realized that when I can't figure out what the OOP gurus are talking about, it's probably because what they're saying really doesn't make any sense."

Mathisen: Yes, at Norsk Hydro, we started to use OOP for production software development two years ago.

Thompson: The complexity of GUIs will require OOP to handle the application's front-end, while the programmer writes the relevant function code.

Should developers be familiar with multiple programming languages?

Nanian: It's not that important at the moment. C [and] C++ are pretty dominant.

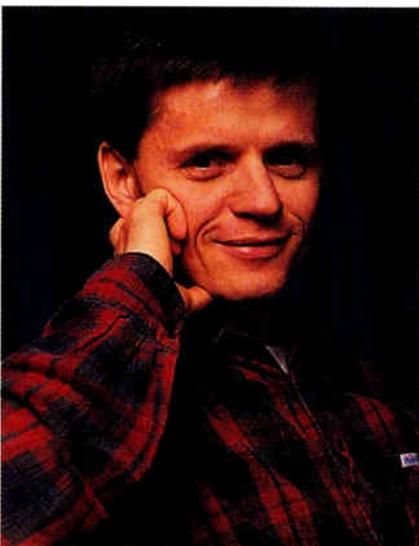
Geary: Definitely. Programmers should be comfortable in assembly, no matter what high-level tools they are using. Programmers should start using "tool" languages like AWK and PERL. People seem to love making fun of AWK. I think it's because they're set in their ways and afraid of trying something new. Also, programmers shouldn't hesitate to make up a minilanguage customized for the application when it's appropriate.

Mathisen: Maybe? Some will need it; others will write everything in C++. Personally, I like to understand my CPU to the bare metal, and that includes ASM programming and knowledge of cycle counts, op-code lengths, and what code will be generated by the different compilers I use.

Thompson: For [a person's] resumé, this sounds good. Whether or not programmers of the future will actually use a smattering of languages is another matter. It's probably safer to standardize on one language.

Should developers be familiar with multiple operating systems?

Nanian: As the market begins to fragment more and more, the answer



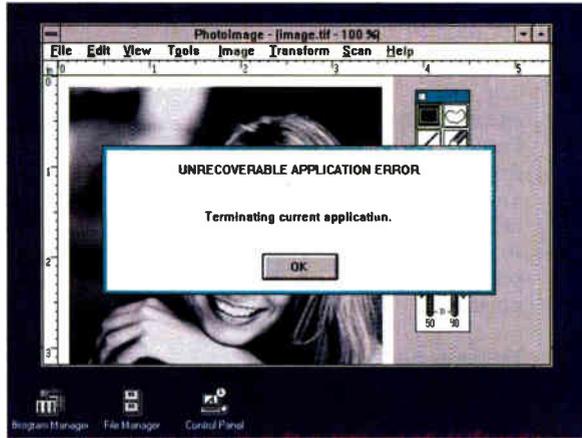
TERJE MATHISEN
Develops PC software for Norsk Hydro

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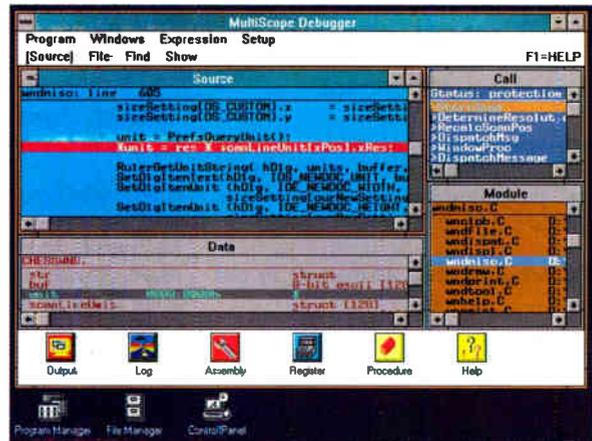
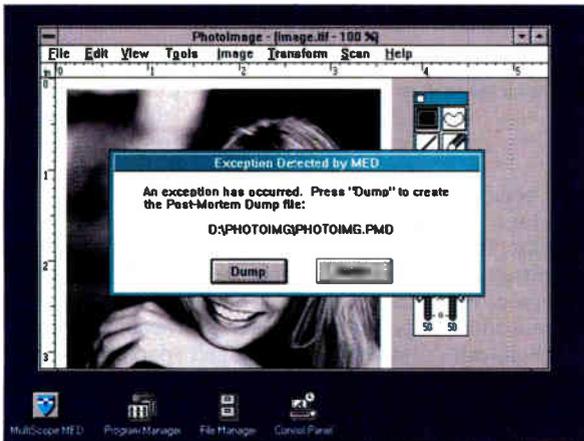
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becomes pretty clear. While a presence in DOS is important, it's difficult to get significant market share, because it's very crowded. Having your application run on many OSes makes this less of a problem.

Mathison: Yes, distributed programming and RPC need people who can understand both ends of a connection. This *might* change as the tools get better and more standardized.

Thompson: It helps; but in most cases, a big organization will hire consultants and programmers with expertise in a particular OS to do a port.

Will skills in Windows/Presentation Manager programming techniques (message queues) be useful?

Geary: Definitely. Learn to write programs where the user is in control, instead of the program. Learn the philosophy behind this kind of programming—not just the nuts and bolts. Every programmer should read the Apple *Human Interface Guidelines* and Donald Norman's *The Design of Everyday Things*.

Mathison: Yes, and I believe this type of programming should preferably be done with an OOP language, as all the basic mechanisms are OOP oriented.

Thompson: Apple Macintosh System 7.0 "Publish/Subscribe" and "Apple events" programming paradigms will be important (and useful).

Will developers use CASE more in the future?

Nanian: I hope not, at least not in its current form.

Bright: I'm not sold on CASE. I don't use it.

Geary: Probably, but everyone I know who has tried these tools has gone back to traditional programming methods.

Wood: Depends on the project. For big team projects and mission-critical software, it's quite likely. For smaller (less than 20K lines of code), no.

Thompson: CASE's reputation is entirely overblown. It's a product looking for a solution. A better answer is OOP.

Which programming languages will be most popular?

Nanian: For now, C++, C, and (hard to believe) COBOL—which is very popular in many companies—will prevail.

Geary: Same as always: COBOL! And of course C, and gradually C++.

Bright: C++, FORTRAN, and COBOL will be prevalent.

Wood: C, C++, Ada, Pascal, and FORTRAN are the languages that programmers are writing code in.

Mathison: Turbo Pascal, Turbo Pascal for Windows, C++, and maybe a pure OOP language like Actor or Smalltalk for prototyping will be popular.

Thompson: I think the answer is C or C++.

Should developers design and code for Unix, DOS, OS/2, or all three—or for something else entirely?

Nanian: Depends on the product, really.

Geary: Maybe people should code for XVT so they can run on all three and Macintosh, too. (The XVT toolkit, from Marc Rochkind's Advanced Programming Institute in Boulder, Colorado, is a C library that lets you write applications that are portable between the Macintosh, Microsoft Windows, OS/2 Presentation Manager, and the X Window System.)

Bright: All three. You should never bet on any single platform.

Wood: Unix—yes. DOS—yes. Windows/DOS—absolutely. OS/2—who cares?

Mathison: Depends. Commercial programs for the mass market should probably be written directly for the target OS, using all possible tricks to get maximum performance, while in-house programming could probably use a higher level of abstraction to facilitate porting between different OSes.

Thompson: Macintosh!

Will programmers begin to rely on source code generator tools, or will "doing it by hand" still be the custom?

Nanian: Source code generation, no. Interface generation (e.g., Interface Builder on the Next), probably. Object library built into the operating system, yes.

Interface Builder is a terrific program on the Next [and] handles the vast majority of the "stuff" you have to deal with to

program the interface on a graphical system. Since the interface objects themselves are built into the Next system, you need only use Interface Builder to drop a few of them into your program, "connect" them to controls (most of which are handled completely by the system), and link.

Bright: Hand coding will always be where the professionals work.

Geary: Corporate programmers will probably use source generator tools; the

shrink-wrapped apps will be written by hand.

Letwin: Source code generators will be one of the tools used more and more in the future. As machines become more powerful and RAM cheaper, you can waste more time and space for a given program. So the goal is to always write the program as fast as you can, as long as you stay within the requirements for speed and memory usage.

The methodology you use depends strictly on the limits called out in the requirements. I use Excel as a "programming language" to do certain operations that I'll only do a handful of times. I don't care how much RAM Excel needs; and I don't care if the program takes 1/2 second or 1/100 second. I got my answer in short order without even having to write a C program.

There are always tasks that push the speed/memory envelope and need to be written efficiently. Some things—like floating-point emulators and OS kernels—need to be written in ASM. Today, C is fast enough for most software



MICHAEL GEARY
Known for his work on SQL Windows

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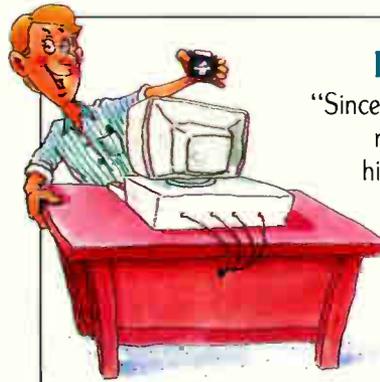


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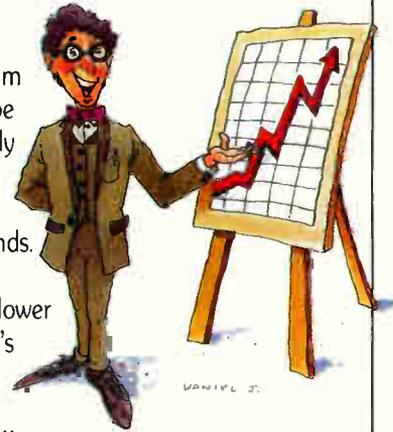


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Mathisen: I *might* use code generators for repetitive type of coding, but this is an area handled better by the reuse of objects.

Thompson: A small shop might use a source code generator, but most developers will use a set of customized, optimized routines and libraries that are made by hand.

What programming tools do you expect to use over the next few years?

Nanian: Compilers, editors, debuggers, profilers, source code control systems, interface builders, object libraries. Specifically? Hard to say, really. Depends on what's available.

Geary: Same old stuff I've been using, probably. C++ instead of C, if I can get past the jargon and remember how to write programs. More of my own little tools written in AWK or PERL. More customizing in the editor. I never did get the hang of writing macros in Brief, though. (Sorry, David!)

Maybe someday I'll get to write applications in a truly interactive language—like I used to do 18 years ago at Tymshare.

Wood: C, C++, Unix, source debuggers under Unix, Borland C++ (and related source debuggers), whatever Windows app generators happen to be in vogue when I get stuck with a Windows project. Lint, GNU tools. Profilers. We're not likely to use CASE in the foreseeable future, even though we support more than 50K lines of code. I just don't see us starting from a clean code base in the near term.

Mathisen: Some prototyping tools, alternate compilers with better optimization, prototyping languages like Actor.

Thompson: Debuggers, editors, resource editors, code profilers, memory watchers (monitors), C compilers.

What's It All Mean?

I've saved my own comments for last. I feel fortunate to be able to look at what these developers have had to say and see

some patterns that will fundamentally influence software over the next several years.

Some things are crystal clear. Whether you are a developer of software or a purchaser of software, a GUI is in your future, and it will likely be SAA/CUA compliant. Your computer will be networked with others in the office if it is not already. The concept of *downsizing* is putting the brakes on mainframe growth. You may not understand all the buzzwords that go along with OOP, but OOP is here to stay.

By this time next year, multimedia and Coleco's ADAM computer may share a common trait: obscurity. CASE may be shunned in favor of the do-it-by-hand methodology. But you'll see software products ported to many environments—DOS, Unix, OS/2, and the Mac. As I said, life is getting complicated. ■

PARTICIPANTS

- **David Nanian** is one of the authors of *Brief*, a popular programmer's text editor from *Solution Systems*.
- **Michael Geary** is best known for his work on *SQL Windows*, a product from *Gupta Technologies*, and *Adobe Type Manager (ATM)* from *Adobe*.
- **Patrick Wood** is coauthor of several books, including *UNIX System Security (Howard W. Sams & Co., 1985)* and *UNIX System Networking (Howard W. Sams & Co., 1989)*, and is familiar with *Unix*, *PostScript*, and desktop publishing.
- **Terje Mathisen** develops PC software for *Norsk Hydro*, the largest company in Norway.
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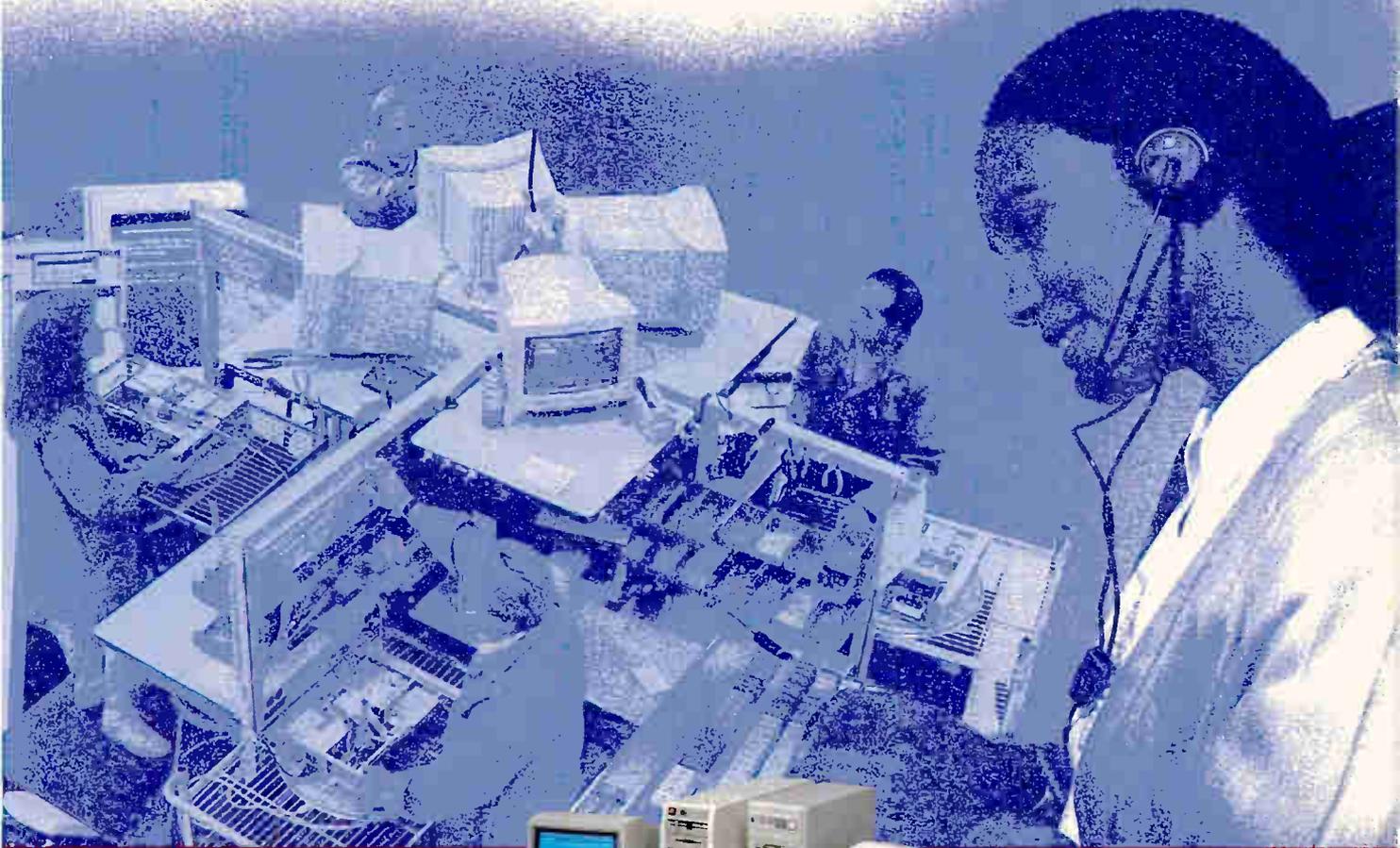
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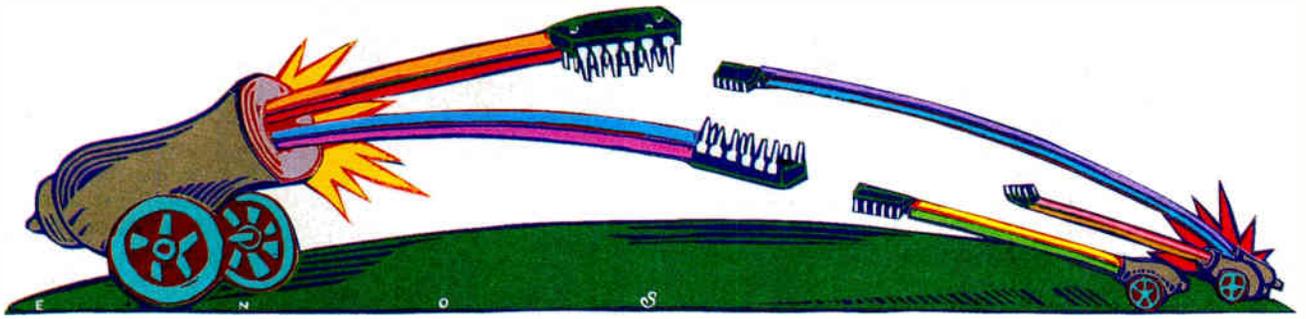
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CODE B1410A



Processor Wars

Intel's dominant position on the desktop is being challenged—and, for a change, the winner will be you

BOB RYAN

This past year has been one of transition in the hardware industry. Predictably, processors have gotten faster, memories have gotten denser, graphics have gotten hotter. These trends are not new; they were set in motion with the invention of the IC over 30 years ago, and they will continue for at least the next decade. The big event in 1991 was the end of Intel's monopoly on the 386 architecture. The effect of this event promises to be an even bigger story in 1992.

The most important piece of hardware in any computer system is, of course, the CPU. Intel's designs and products dominate the desktop computing market, with Motorola a distant second and various RISC vendors—including Sun Microsystems—showing up as mere blips on the horizon (albeit as stronger blips with every passing day). Having one company as the sole source of the architecture on which so much of the industry depends makes many in the industry nervous. As long as it alone supplied 386-family products, for example, Intel wasn't forced to compete on the basis of price. In 1991, however, several companies introduced 386-compatible CPUs. The repercussions from these introductions will reverberate throughout the industry in 1992.

King of the Hill

Ever since IBM chose the 8088 for the original IBM PC, Intel has enjoyed success unparalleled in the semiconductor industry. By maintaining compatibility with previous models while upgrading the capabilities of the 80x86 line, Intel has done a masterful job of moving forward both the technology and the industry.

Through the first half of the 1980s, Intel, though dominant, was not the only company supplying chips (8088s and later 286s) for MS-DOS computers. Through various second-source and cross-licensing agreements, companies such as NEC, Advanced Micro Devices (AMD), and Harris also produced industry-standard chips and provided important competition for Intel. With the advent of the 386 in 1986, however, Intel became the sole supplier of the architecture that will undoubtedly carry the industry into the twenty-first century. That monopoly ended this year, and 1992 will see various

companies and groups attempt to loosen Intel's stranglehold on the industry-standard architecture. In addition, the year will also see important advances in microprocessors in general (see the text box "A Banner Year for Processors" on page 87).

Clones and Beyond

There are basically two ways you can go about challenging the dominance of Intel on the desktop. The first involves making alternatives to the 386, either by cloning it directly or by making a functional equivalent. The second is to redefine the industry-standard architecture so that it can include hardware architectures outside the 386 family.

After a tortuous legal battle that, as of this writing, is not yet completely resolved (questions about AMD's use of Intel's microcode remain), AMD this year released its clones of the 386 chip, thus becoming a second source for the 386 architecture. Cloning the 386 is the most obvious way to introduce more competition into the desktop CPU marketplace, and AMD has already scored some design wins with its chips. Whether it can garner enough of the market to remain a viable alternative to Intel will be one of the prime questions answered in 1992.

While cloning the 386 or the 486 is the most straightforward way to produce a 386 chip, it is highly unlikely that any other company can go this route. No other company has the legal access to Intel's patented technology that AMD has.

The alternative to cloning—creating a functional equivalent of the 386 architecture—is a much tougher proposition. As Richard Shaffer of Technologic Partners/*ComputerLetter* says, "Reverse engineering is legally cleaner and more broadly available [to other companies], but it is an order of magnitude more difficult. Not even Intel knows what all of its instructions do. Some instructions of the 386/486 are undefined; others combine in unpredictable ways. So it's hard to reverse-engineer or emulate an instruction



RICHARD SHAFFER
Editor and publisher of *ComputerLetter*

set if you can't fully and completely specify it."

Although more difficult than cloning, creating a functional equivalent of the 386 architecture is the method used by NexGen Microsystems. NexGen has produced an eight-chip superscalar RISC implementation of the 386 architecture that it claims is binary-compatible with Intel's top-of-the-line 486DX and runs twice as fast.

Other companies are also expected to announce functional equivalents to the 386 architecture by early 1993. Like NexGen's implementation, these are expected to be "clean room" efforts. Some of these chips are expected to plug directly into sockets meant for Intel (and AMD) chips and perhaps to add features and functionality not found in straight clones of the 386.

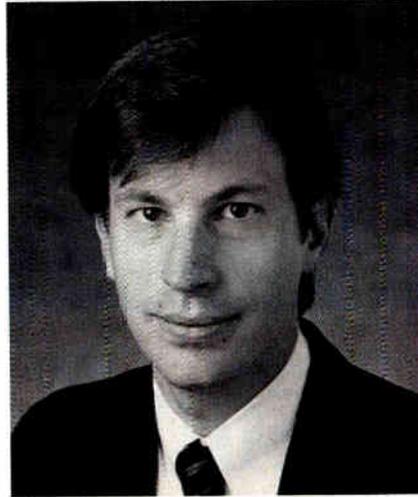
Over the Hump

Though formidable, the technical obstacles facing AMD, NexGen, and others could pale in comparison to the task of convincing OEMs and end users that they offer a viable alternative to Intel's chips. Any firm that wants a piece of Intel's business must ensure that its products can do whatever an Intel chip can do.

Gary Baum, director of product marketing in Chips & Technologies' New Product Development Group, is familiar

with the problems inherent in producing compatible products. Chips & Technologies created the first chip sets that let OEMs create IBM AT-compatible products with just a few pieces of silicon. "When Compaq and others came out with systems in the early eighties, everyone's concern was whether the systems were really compatible [with the IBM PC]," says Baum. "Today, Fortune 1000 companies buy clone PCs and don't think twice about the compatibility—it's a given."

Baum thinks the pattern will repeat itself with alternative processors: "Initially, compatibility will be an issue, but those concerns tend to be short-lived. The industry will know very rapidly whether or not the products are compatible—it won't take very long. There may be start-up bugs—everybody has some errata, as Intel did with the 486—but if the alternatives prove to be fundamental-



TOM MACDONALD
Product manager for Intel's 386/486 microprocessor family

ly compatible, then everything is cost/performance and functionality. And, in that regard, there may be reasons not to use Intel processors, just as there are reasons not to buy all your computers from IBM."

Baum doesn't see IBM or Compaq using a second source for processors: "They don't have to use alternative processors to get the benefits of them being there," he says. "They've always been treated

very well by Intel." J. Rod Canion, co-founder of Compaq, concurs, saying, "Intel has been dropping prices and reinvesting in their technology. In fact, I think they've done a great job providing new technology. We don't have any reason to look elsewhere." (Canion wouldn't comment on Compaq's plans vis-à-vis NexGen, in which it has a minority investment.) According to Baum, the winning designs for the alternative processors will most likely come initially from other first- and second-tier clone makers.

Whatever the fallout inside the industry, consumers are sure to be big winners in 1992. According to Baum, by next year OEMs may have a choice of up to 40 different 386/486 processors, including differently clocked versions of the same chips, each with a different mix of price/performance and functionality.

Tom MacDonald, marketing manager for Intel's 386/486 product line, doesn't sound like a man who expects to lose a lot of sleep—or a lot of business—from renewed competition in the 80x86 product arena. "There have always been different competitors, and they change names over time and try different things," says MacDonald. "We don't view any one company or architecture as competition. Intel's plan is to continue to offer products that meet the requirements of different market segments. The 386SL is a terrific example. We will continue to proliferate the 386/486 family so that it meets the [needs of the] individual market segments that have formed over the last few years in the computer industry."

Michael Slater, editor and publisher of the *Microprocessor Report*, thinks the big fallout from the clone chips will be

There is no reason [the 386DX] should cost so much more than the SX when it only costs about \$10 more to build.

MICHAEL SLATER
Editor and publisher of *Microprocessor Report*



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major price reductions in 386DX chips to even out the anomalies in DX pricing. "There is no reason [the 386DX] should cost so much more than the SX when it only costs about \$10 more to build," asserts Slater. "Likewise, the [386]DX shouldn't cost just \$50 less than the 486SX, which costs a lot more to fabricate."

ACE up a Sleeve

While fending off alternative sources of its 80x86 products, Intel faces another challenge for supremacy on the desktop in the form of RISC-based systems. In fact, Richard Shaffer sees RISC as the most important long-term threat to Intel's hegemony in business personal computing.

"Companies need to forget about chip-level compatibility," says Shaffer. "All the user really cares about is industry standard in terms of the graphics interface and the [underlying] applications programming interface." According to Shaffer, the best chance the industry has of injecting more competition into CPUs for the desktop is the ACE initiative.

Announced last April, ACE (Advanced Computing Environment) is the result of the efforts of a group of industry companies—including Compaq, Microsoft, and DEC—to create a new standard for desktop computers. The ACE plan is not to standardize the hardware, but to standardize the user environment. The ACE specification supports two hardware architectures—the Intel 386/486 and the MIPS R3000/ R4000—and two operating systems—Microsoft's OS/2 3.0 (a.k.a. OS/2 NT) and The Santa Cruz Operation's Open Desktop. Many observers see ACE as an attempt by Compaq and others to break into the workstation market; Shaffer sees it as an attempt to break Intel's monopoly by bringing RISC to the commercial desktop.

"If you can raise the level of user awareness to the graphical interface, then the engine under the hood becomes irrelevant to most consumers, who focus basically on the dashboard," says Shaffer. "ACE creates an alternative MPU system and an alternative OS that will run what the user thinks are the same programs, so that he doesn't care whether his 1-2-3 is running on a Sparcstation or on a PS/2. Once you accomplish that, Intel's clout in the market diminishes substantially. Long term, I think that's the real significant contest."

Although one of the effects of ACE will be to diminish the impact of Intel on the marketplace, Shaffer doesn't see it as simply an anti-Intel strategy. "ACE is

A BANNER YEAR FOR PROCESSORS

Major introductions and processor shipments in 1992 will intensify both the battle for supremacy in the workstation market and the dogfight between RISC and CISC (complex instruction-set computer). According to Michael Slater of the *Microprocessor Report*, new RISC processors scheduled to sample or ship in 1992 include at least three SPARC processors, the next-generation processors from Mips and Motorola, and the latest 860 from Intel. The year will also see the introduction of the Intel 586 and the Motorola 68050. The 586 may, in fact, be available in limited quantities by the end of the year, whereas the state of the 68050 is less well known. Undoubtedly, IBM and Hewlett-Packard are also upgrading their proprietary RISC architectures.

The SPARC processors that will ship—perhaps in quantity—next year are the Pinnacle processor from Cypress Semiconductor, the Lightning from LSI Logic, and, most important, Viking from Texas Instruments. Viking is a single-chip implementation of SPARC. Using a BiCMOS process (a CMOS core with selected bipolar elements in speed-critical areas), Viking promises to restore SPARC to the forefront of processor performance, where it has been absent since the introduction of the IBM RISC System/6000 and HP's Precision Architecture. At 3 to 4 million transistors, Viking also promises to set the record for the most highly integrated commercial processor, at least until the introduction of the 586.

The Motorola 88110, the next-generation 88000 processor, is expected to

restore some of the luster to Motorola's RISC prospects, especially if, as expected, Apple selects it as the CPU of its RISC-based workstations. Whether the Apple win will be enough to ensure the long-term success of the 88000 family remains to be seen. The Mips R4000 is the 64-bit superpipelined successor to the R3000. The next-generation 860 will further entrench that chip in both high-performance multiprocessing and graphics processing. Although the 860 isn't a major contender in the desktop workstations market, its success in multiprocessing and graphics will ensure its long-term viability.

According to Slater, the most significant trend in both RISC and CISC processors is the use of multiple functional units. Current superscalar processors usually have one load-store unit, one integer unit, and one FPU. A number of the new processors will have multiple copies of one or more of these functional units (except perhaps the FPU, which takes up a lot of silicon), providing new levels of performance via microparallelism. As a result, Slater thinks that by the end of 1992, while IBM and HP will still dominate floating-point performance, Viking and the R4000 will be the integer-performance champions.

Despite all the hoopla about RISC, the fact remains that the most important introduction of the year will be Intel's 586 microprocessor. Packing up to 4 million transistors, the 586 will ensure that PC users have access to the same class of performance as workstation users have. And that promise should keep the 80x86 architecture dominant for a long time to come.

not about throwing out Intel and taking up RISC. It's about having your choice: Either of the operating systems will run on either of the two processors. You can't have both your hardware investment and all of your software investment, but you can come pretty close on both of them."

Shaffer is not sanguine about the probability that ACE can make significant inroads in the business marketplace: "The odds are very high against it, but I don't see any other logical approach. I don't know whether ACE will succeed in creating a RISC alternative that is truly por-

table in terms of software, but if they come close, then they will have kept Intel honest, and they will have kept the 586 at a reasonable price. That's a pretty remarkable achievement in its own right."

Compaq's Rod Canion takes a different view of ACE. "ACE isn't simply an attempt to move RISC onto the desktop or to move Compaq into workstations. It is actually a far-reaching idea that will play out over the next decade. ACE is designed to provide a standard computing platform that bridges PCs and workstations, and even minicomputers and

mainframes. As desktop computers and networks take on many of the tasks of larger machines, we think it is necessary to bridge the Unix-PC gap and provide a platform that incorporates both."

Canion also disputes the risky nature of ACE. "I think there is little risk in ACE. Certainly for the companies currently using Mips, the risk is minimal." Canion states that Compaq looked at other solutions to the standards problem but didn't find any in the workstation arena that met its requirements for openness. "We looked at Sun [Sparc International] and decided that Sun wasn't as open as we would have liked."

Tom MacDonald of Intel doesn't see much use for ACE: "We don't think another consortium is necessary—there are already many consortia—but more importantly, there is *already* one industry standard, and that's the PC, based upon the Intel 386/486 architecture. Given the performance of the architecture, given the huge installed base of software—40,000 to 50,000 applications—and an installed base of 70 to 80 million systems, there clearly is one established standard, and why would anyone want to do anything else?"

With ACE nothing more than a design goal until systems and software arrive, it is unclear how easy it will be to move software between the various ACE platforms. While Canion expects that the first ACE hardware and systems software will hit the market in 1992, getting a critical mass of applications software in place will obviously take longer.

The Cup and the Lip

While there is great appeal in a platform that spans the enormous installed base of 80x86 computers and allows for migration to high-performance RISC machines, much can go wrong between now and the introduction of the first ACE systems. Already, there are cracks in the ACE initiative, as a number of companies make the case for running AT&T Unix System V release 4 using AT&T's application binary interface for Mips processors. While this would provide a software standard for Unix applications, it would also jettison the initiative's stated goal of bridging Unix and the current 80x86 installed base, resulting in something akin to the 88/Open group that supports the Motorola 88000 family of processors.

In addition, the head start enjoyed by non-ACE members Hewlett-Packard, IBM, and especially Sun Microsystems narrows the chances that ACE can gain a significant foothold in the RISC work-

station end of the market.

A more basic question is whether you need a bridge between the 386/486 architecture that dominates business computing and the RISC technology that underlies almost all Unix workstations. As Gary Baum says, "From a processor perspective, RISC and CISC [complex instruction-set computer] will continue to blur."

Tom MacDonald of Intel states that the "RISC is better than CISC" argument is simply false. "We've proven time and time again that the 486 is as fast as any microprocessor on the market," says MacDonald, "and we'll continue to grow the performance of the 486 family to be competitive with any microprocessor on the market." Another problem, as Richard Shaffer points out, is that "RISC is just very small. It can grow phenomenally and still be only a tiny percent of Intel's market."

Michael Slater thinks it is simply too early to tell about ACE: "I can come up with a dozen different scenarios in which it establishes itself as the second desktop standard and a dozen more where it fizzles out. We just don't have enough information to go on."

Another obstacle facing RISC vendors, whether of the ACE persuasion or not, is the specter of Intel moving its designs into workstations, rather than sitting on its hands waiting for RISC to garner a greater share of the desktop. As Tom MacDonald puts it, "The 486, when married to high-performance graphics, an integrated design, small form factor, networking, and so forth (as in the DECpc), can provide everything and more than can any technical workstation on the market. We view the 486 as the basis of a new class of computers called 'business workstations' that will bring the PC architecture into what you'd call the workstation market, but it's really a business workstation for the business user."

Meet the New Boss

1992 will be a pivotal year for many companies in the microprocessor arena. For AMD, NexGen, and any others who enter the 386 market, the year will make or break their attempts to garner a significant share of 386 architecture sales. 1992 will also bring intensified competition in the workstation market as the prime players keep upping the performance ante. In addition, the year will see the strongest challenges to date by RISC vendors—especially Sun and the ACE companies—to establish some form of RISC as the second standard on business desktops. In fact, Richard Shaffer sees

this as the biggest development of the year.

Of course, for any other company or architecture to make major inroads in desktop computing, it has to contend with Intel, simply because Intel owns the market. And as the 586 shows, Intel isn't about to roll over without a fight. As Shaffer says: "Intel has a lot of competition left in it. It owns the market, so it can cut prices on the 386, the 486. Most RISC folks have point products, not complete product lines; they don't have processors at every price point you could possibly want. Intel does. There are some pieces of rust on the armor, but it is still an incredibly strong company."

As Tom MacDonald puts it: "The Intel standard is clearly the one that meets the needs of the end user for performance and choice." Unless some other company, technology, consortium, or whatever can disprove that, the 386/486 architecture, both from Intel and from second sources, will still be king of the hill when we ring in 1993. ■

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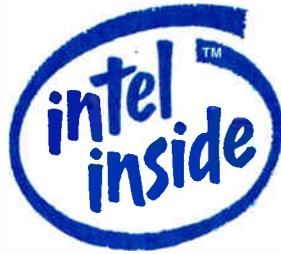
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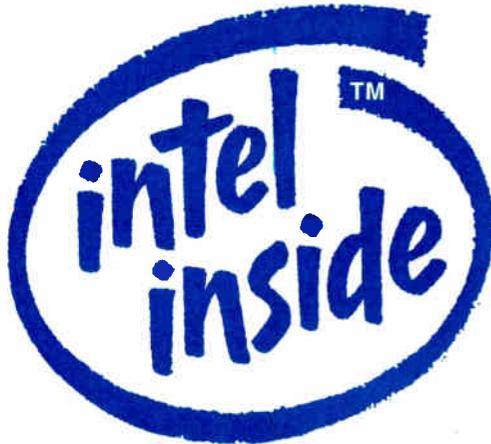


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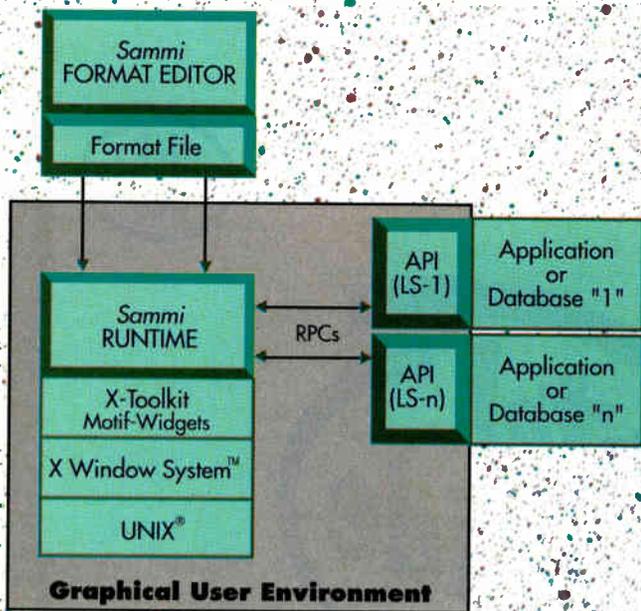
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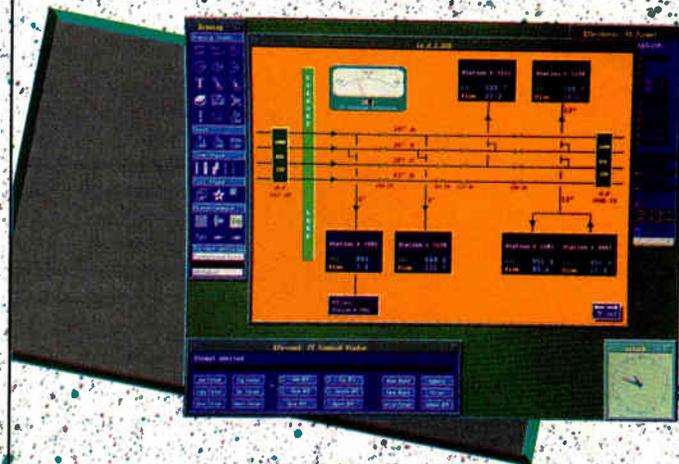
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Operating Systems Now and Beyond

Will the pen be the catalyst that radically alters our slowly evolving operating systems?

NICHOLAS BARAN

As we approach 1992, it is remarkable how little operating systems have changed since the introduction of the IBM PC and, a couple of years later, the Macintosh. Unix was already in existence and in widespread use in 1981 and is now an even more powerful force as workstations compete with PCs and Macs in the commercial and business markets.

MS-DOS has seen substantial improvements in its decade of existence but nevertheless is still a single-tasking, single-user operating system with a command-line interface. Similarly, Apple has bestowed the Mac OS with a host of new features in its new System 7.0, but the underlying core of the operating system is still the same as in earlier versions (see "Seven's a Success," June BYTE, for an overview of System 7.0).

The Move Toward GUIs

With the exception of the Mac OS, which has had an integrated GUI since its introduction in 1984, the big change in the operating-system arena in recent years has been the addition of windowing systems and GUIs to DOS and Unix, both of which traditionally have had command-line interfaces. Microsoft Windows 3.0 is gradually becoming the standard interface for MS-DOS machines, although millions of users still make do with the C> command-line prompt to run their computers.

The X Window System has become the standard windowing system on many Unix platforms and is supported by virtually every Unix system vendor. Next offers a Unix operating system with a proprietary GUI called NextStep, which is an integral component of the operating system. But, in both DOS and Unix environments (with the exception of the Next system), GUIs are an optional layer on top

of the operating system rather than an integrated component of the system, as in the case of the Macintosh.

Of course, there is one obvious reason for the slow change in operating-system technology, and that is, in a word, compatibility—compatibility with the huge data and application base that already exists on millions of computers around the world.

The Portable OS

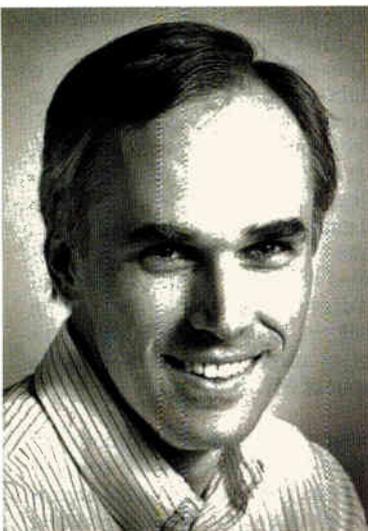
So far, I've been discussing traditional operating systems for desktop machines. However, a new type of operating system is beginning to emerge for operating pen-based, mobile computing systems. The forerunner in this category is the Pen-Point operating system from Go Corp. (For an overview of PenPoint, see "The Point of the Pen," February BYTE, written by Go's Robert Carr, one of the principal architects of PenPoint.)

Because pen-based, mobile computing is a new category of computing, application compatibility is not a major issue (as long as data can be exchanged between the mobile system and the desktop system at the home office). In fact, pen-based systems pose different design challenges and requirements and will therefore generate a new class of software applications. It is therefore reasonable to expect more dramatic changes and developments to occur in the pen-based operating-system arena than in the traditional desktop operating-system category.

With this background, operating-system developers and software engineers who work at the operating-system level nevertheless confront a variety of challenges and issues. While there may be few revolutionary developments in the near term, there are many ways in which operating systems will improve. I talked with several experts in academia and at some major software development organizations to find out what is going on.

Performance Is Not an Issue

First of all, it is becoming clear that performance is no longer an issue at the



JOHN OUSTERHOUT
Cal-Berkeley Professor of Electrical
Engineering and Computer Sciences

operating-system level. Professor John Ousterhout of the University of California Department of Electrical Engineering and Computer Sciences in Berkeley has developed several experimental operating systems (e.g., the Sprite network-oriented file system) and is currently working on a development toolkit for X. He says that "X is getting to the point of good performance on 10-MIPS machines, and on the 20- to 50-MIPS machines that we're seeing today, performance just isn't a problem."

PC veteran Vern Raburn of Slate puts it a little differently: "We finally have enough MIPS to isolate the developer from the hardware. ROM BIOS tricks are no longer necessary." Because many MIPS eases the burden for software developers, Raburn thinks that RISC architectures will become increasingly important. "The virtual monopoly of Intel is not going to last."

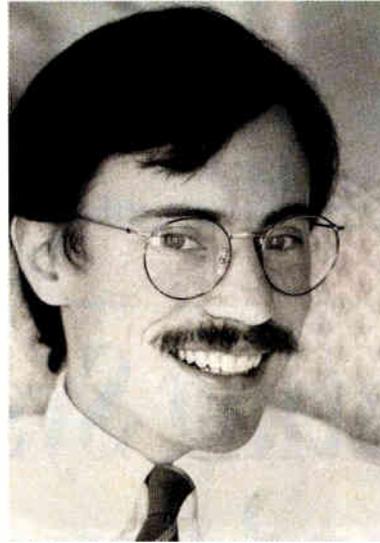
Portability—Microsoft's ACE in the Hole?

If, in fact, Intel loses its grip on the PC environment, then PC-based operating systems will have to become portable. In other words, operating systems will have to be able to run on multiple types of microprocessors and also offer binary compatibility at the application level. It should be possible to purchase a spreadsheet or word processing program off the shelf and run it on either an Intel-based or RISC-based system. Unix is the only operating system that approaches binary portability across hardware platforms.

However, virtually all Unix systems still require recompilation when moving an application from one platform to another, and in many cases, at least minor code modifications are necessary.

That could all change with the Advanced Computing Environment, an initiative recently announced by some 21 hardware and software manufacturers. The key element of ACE is operating-system portability on both Intel 80x86 processors and Mips Computer Systems' RISC processors. A key player in ACE is Microsoft, which plans to introduce a portable version of OS/2 that will run on both Intel and Mips platforms. The Santa Cruz Operation is in charge of delivering a portable version of SCO Unix for the two platforms.

The most interesting aspect of the ACE initiative is Microsoft's ambitious plan to produce a portable OS/2, which it calls the New Technology foundation or the NT Kernel. Not only will NT run on multiple hardware platforms, but it will also support Windows, DOS, and Posix-compatible programs. It also is report-



ROBERT CARR
President of Software at Go Corp.

edly able to brew coffee automatically.

Microsoft has talked about this idea for some time, but actually delivering such a system is an enormous challenge. I talked to Mark Linton about both Microsoft's and SCO's role in ACE. Linton, a former professor of computer science at Stanford University, is now working at Silicon Graphics on Unix and software development tools. (Silicon Graphics is a member of the ACE group.)

Says Linton, "It's an implementation

thing. Can we have a coherent application binary interface so that vendors can build one application that runs on all platforms? Can Microsoft really build a full-featured OS for multiple processors?" Linton points out that the task is enormously complex and perhaps more than Microsoft bargained for. "You have to consider multiprocessing, cache systems, multithreaded file systems, networking. It's a big challenge for Microsoft." As for competition between SCO and Microsoft, Linton says, "Whoever has the best product will win."

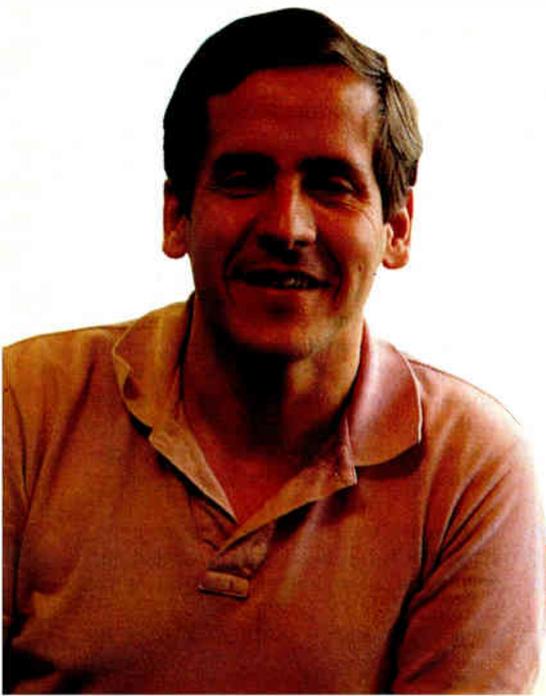
Microkernels Are the Key

The fundamental concept behind Microsoft's portable OS/2 is the layered or microkernel approach to building operating systems. First introduced in Carnegie Mellon University's Mach operating system (a Unix-compatible operating system developed at Carnegie Mellon and used in several commercial implementations, including the Next computer environment), the microkernel concept allows various functions of the operating system to be coded in separate layers or "protected subsystems." The basic operating-system functions are contained within the kernel or, in Microsoft's terminology, the Executive. The figure shows the basic layout of Microsoft's NT operating system.

The basic advantage of the microkernel approach is that many of the specialized functions required on various hardware platforms and different operating environments can be isolated from the main kernel of the operating system, thus allowing various layers to be added, de-

The fundamental concept behind Microsoft's portable OS/2 is the layered or microkernel approach to building operating systems, first introduced in Mach.

PITO SALAS
General manager of Lotus Development's Advanced Technology Group



pending on the implementation. Microsoft says that its Executive kernel will consist of about 50 kilobytes of code.

Berkeley's Ousterhout agrees that microkernels are, indeed, the wave of the future: "We may not see any dramatic breakthroughs, but [we will see] a lot more work in microkernels like Mach—the way operating systems are implemented."

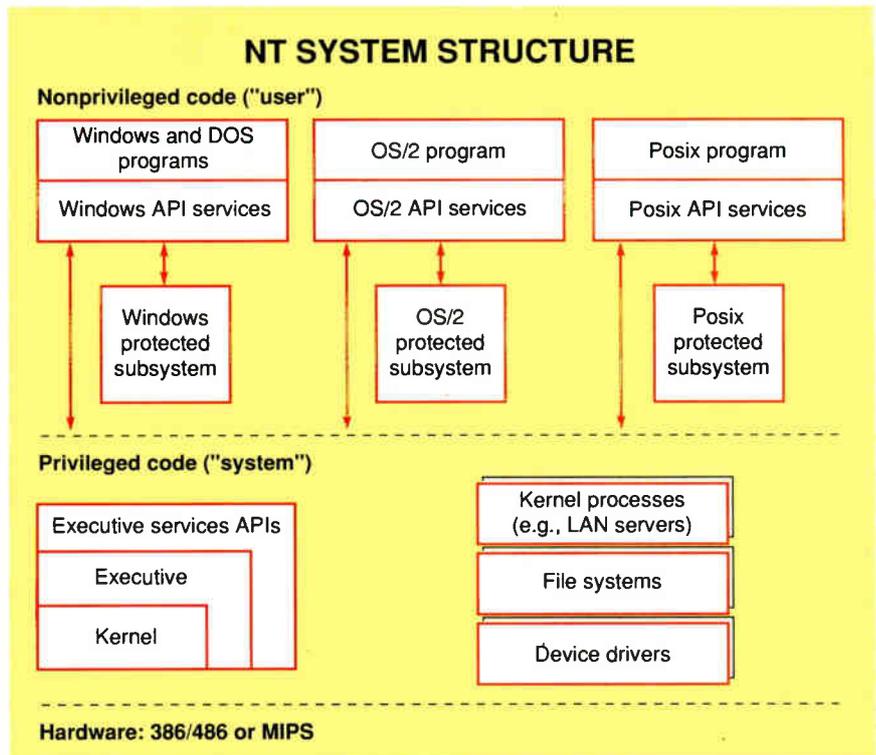
In any event, portability appears to be a key issue in future operating-system development. Linton says that real binary portability is more likely to occur because there will be fewer hardware platforms. In addition, software licensing (e.g., Sun Microsystems' licensing of SunOS) and consortia such as the X Consortium, ACE, and the Open Software Foundation will help promote the move toward true application portability across platforms.

The Need for Development Tools

Everyone that I talked to agreed that the biggest weakness of current operating systems is the lack of good software development tools—tools for debugging programs, for setting up interfaces, and for making programs run in window environments. For example, Ousterhout says that developing X-based applications is "extremely difficult. It requires an awful lot of code." Ousterhout is working on an X development toolkit that uses a high-level interpretive language called tool command language (TCL) to allow programmers to create simple scripts for specifying X functions in their applications.

I also talked with Pito Salas, the architect of Lotus Improv for Next computers and general manager of Lotus Development's Advanced Technology Group. Salas says, "The quality of tools that come with [the] Mac and Windows are not what they could be." Salas, who admits he's biased, thinks that NextStep is far ahead of the competition in the quality of its development tools.

The problem with Windows and System 7.0 on the Macintosh, says Salas, is that there is "always a certain wall that you hit because the underlying environment is what it was before. There's a threshold because of the compatibility requirements." NextStep, on the other hand, is "truly object-oriented," says Salas. (NextStep supports Objective C and uses object-oriented toolkits for software development.) He adds, "You just can't bolt on object-oriented languages." Nevertheless, Salas thinks that new and improved tools will appear on Windows and Mac systems.



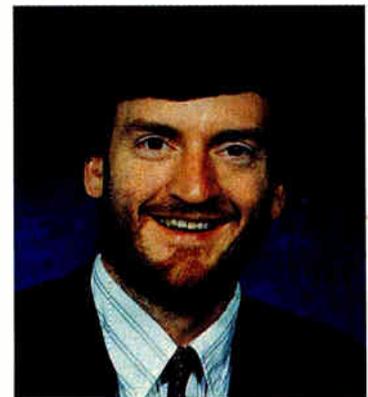
The ambitious layout of Microsoft's New Technology (NT) portable system software, designed to run on both Intel 80x86 and Mips Computer Systems RISC processors. The microkernel approach allows the basic functions of the operating system to be isolated in the Executive kernel, which Microsoft says will take up only 50 kilobytes of memory.

Silicon Graphics' Mark Linton agrees that new, high-level tools are needed for developing more sophisticated applications. "The good news is that software that we developed 10 years ago is easier to develop now. The bad news is that the software we want to develop now is much more complex." Linton concedes that "NextStep is definitely ahead" but says that other vendors will eventually catch up. Linton foresees tools based on C++ that are similar to NextStep's Interface Builder appearing on other Unix platforms. The problem with Next, says Linton, "is that they have kind of an Apple mentality—they don't care about portability or standards."

Go's Robert Carr told me that now that Go has released PenPoint, "we're turning our attention to development tools and will invest heavily in this area in the next couple of years." Go will eventually introduce a "suite of tightly integrated tools" for PenPoint software development, says Carr.

Carr offered a more pessimistic view of software development in the traditional desktop market. "There are so many obstacles," says Carr. "There's the bur-

den of developing for today's GUIs—the complexity of coding, poor development tools, and the saturation of the marketplace with standard applications. It's difficult to contribute to existing platforms. There's tremendous pressure in developing new spreadsheets, word processors, communications, E-mail, and so forth. The cost of replicating the basic functionality is enormous before you can add



MARK LINTON
Former computer science professor
at Stanford University

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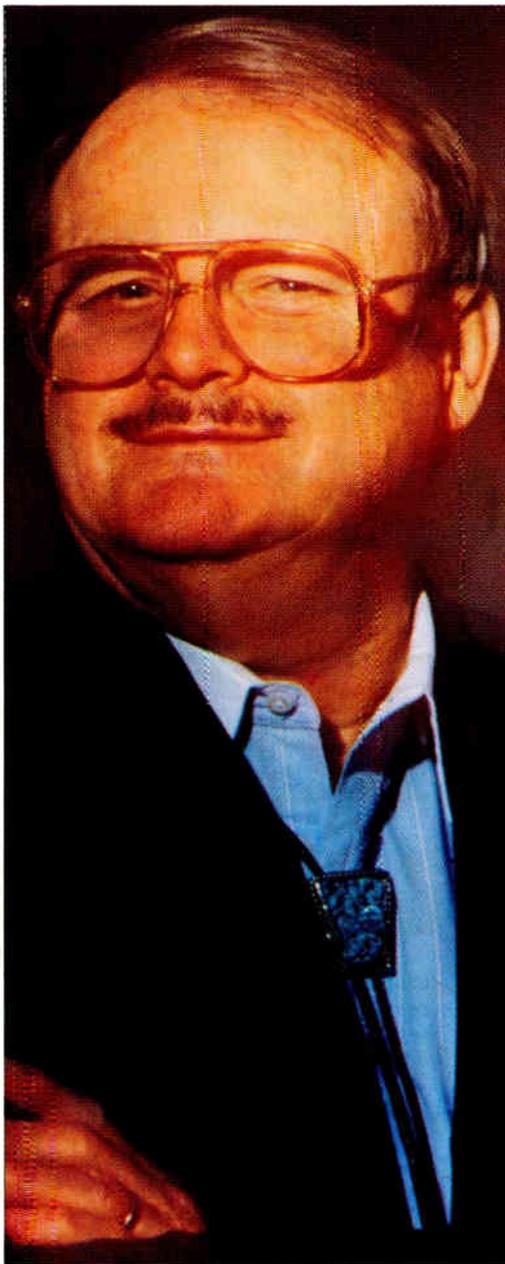
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any new functionality." The attraction of the pen-based computing environment, says Carr, is the possibility of developing new applications and new product categories. "We have a lot of very capable and very excited small developers working on PenPoint applications."

Will Pens Up the Ante?

As I mentioned earlier, pen-based systems pose new challenges to operating systems. It is not my purpose here to discuss the details of pen-based computing, or to evaluate its chances for success, which are still open to question. But whether pen-based systems become a major factor or not, the technology will have an impact on operating systems, particularly in the areas of communications and multitasking.

For example, Go's PenPoint operating system has a feature called "detachable networking." This capability allows a mobile notepad computer running PenPoint to instantly connect to or disconnect from a LAN, simply by connecting or disconnecting the network cable. The operating system automatically detects the connection or lack thereof and takes the appropriate actions to open or close the network link.

Mobile systems will require "superb data compatibility and connectivity," says Robert Carr. Indeed, a pen-based system must be able to exchange data with Unix, Macintosh, OS/2, and DOS-based networks with little or no effort required from the user. "Other operating systems," says Carr, "are islands that are good at talking to themselves but have a hard time talking to each other."

The other key feature in pen-based operating systems is preemptive multitasking. While preemptive multitasking is not new, it is of critical importance in a pen-based system for two reasons. First, communications must take place in the background. Second, the user must always have access to the pen. For example, PenPoint performs its handwriting recognition functions in the background as the user enters each letter with the pen. Says Robert Vallone, director of user research at Go, "Because transla-



ROBERT VALLONE
Director of User Research at Go Corp.

tion takes place in the background, the time to translate is perceived as the same whether it's one line or 20 lines. Preemptive multitasking is crucial for pen-based systems. The primary input device is the pen. It must be able to interrupt any task at any time; it can never be locked out."

PenPoint also supports the *embedded document architecture*, a concept in which documents from multiple applications can appear within each other and are instantaneously and smoothly accessi-

ble with the pen. There is no time for task switching as in a yield-based or cooperative multitasking environment such as Windows or System 7.0.

One problem that you have with yield-based multitasking systems such as Windows or System 7.0 is that applications written for these systems must follow a specific set of rules that require the application to yield processing time to other applications running on the system. If an application is not written properly (it "misbehaves") and does not have provisions for yielding CPU time, it can crash the entire system. There is no memory protection in a yield-based multitasking system.

Preemptive multitasking, on the other hand, requires no special programming rules for yielding CPU time. The system can regain control of the processor even if an application crashes. This is because each application runs in a protected area of memory. Preemptive multitasking makes for a much more reliable operating system and also makes software development less complicated. In addition, preemptive systems offer smoother responsiveness than yield-based systems, which can be very "jumpy" if applications do not yield processing time fast enough to another application on the system.

Pens May Force Switch to Preemptive Multitasking

Whether pen-based systems succeed or not, they have definitely sparked a great deal of interest from major developers such as Microsoft and Apple. Microsoft has released a version of Windows called

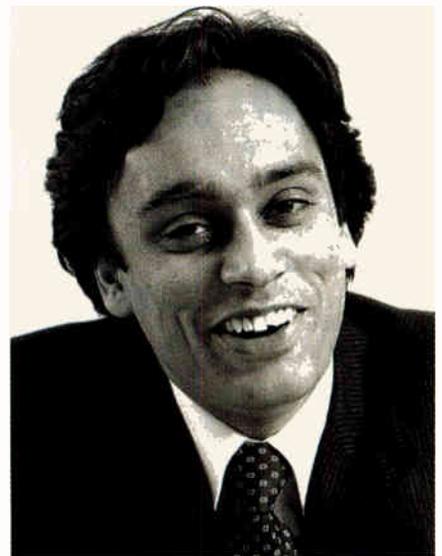
Windows for Pens, which supports pen input, and Apple is reportedly hard at work on a pen-based computing system.

For Microsoft and Apple to be competitive with Go's PenPoint, however, they will have to offer preemptive multitasking versions of Windows and System 7.0, respectively. (There is the possibility, however, that Apple may license Go's technology for its pen-based systems.) Microsoft will, in fact, come out with a 32-bit, preemptive-multitasking version of Windows next year, called Windows 4, which will support the NT Kernel. The logical step for Apple is to add preemptive multitasking in a future version of the Mac OS, regardless of its involvement in the pen-based arena.

Are There Winners and Losers?

In spite of the changes and advancements in operating-system technology, it is clear that the old standards are here to stay. MS-DOS is still the hands-down leader in numbers of users. Says Marshall McKusick of the Computer Systems Research Group at Berkeley, "MS-DOS won't go away any more than FORTRAN or COBOL are going to go away."

But Ousterhout sees Unix getting a stronger foothold in the PC arena. "I actually think that Unix and X will take a significant fraction of the market from PCs and MS-DOS." Ousterhout thinks that Unix systems offer more power and much better networking capability for about the same price as DOS-based PCs and cites the difficulty of software development under Windows as an increasing



PRADEEP SINGH
Product manager for Windows for Pens at Microsoft

factor in causing developers to switch to Unix.

But Pito Salas of Lotus is less convinced that Unix is making inroads into the PC market. "From what I'm aware

screen. The control and operation aren't radically different." However, Vallone sees the addition of new data types to support multimedia features such as audio files and video images.

Eventually, we will see greater portability, better multitasking, and better software development tools. The most interesting battle may occur in the emerging pen-based computing market. ■

Eventually, we will see greater portability, better multitasking, and better software development tools.

Technical Merit Is Not Enough

The endurance of DOS points out that technical merit is not necessarily the decisive factor governing the success or failure of a new operating system or environment. Next is a prime example. Although many industry experts acknowledge that Next's software is technically superior to that of its competitors, Next is nevertheless struggling in the marketplace. Says Robert Carr, "Next is doomed to be a niche market. They're fighting an entrenched desktop market."

But Go's PenPoint could suffer a similar fate. Says Microsoft's product manager for Windows for Pens, Pradeep Singh, "From a design perspective, PenPoint is very cool. They abandoned everything and started from a clean slate. It was an easy decision from a technology perspective, but not from a marketing perspective. It will take a long time for PenPoint code to settle down and become stable. We're only adding 35 APIs [application programming interfaces] to Windows, not building a complete operating system with multitasking and memory management." It must be pointed out, however, that it may also take quite some time for the code in the NT Kernel and in Windows 4 to settle down and become stable.

The bottom line is that operating systems will continue to evolve gradually.

PARTICIPANTS

■ **John Ousterhout**, a professor of electrical engineering and computer sciences, has developed several experimental operating systems (including Sprite) and currently is working on a toolbox for the X Window System.

■ **Mark Linton** is a former computer science professor at Stanford University and is the author of the widely used DBX debugger for Unix.

■ **Pito Salas** is the architect of Lotus Improv for Next computers and general manager of Lotus Development's Advanced Technology Group.

■ **Robert Carr** is vice president of software at Go Corp. and a principal architect of the PenPoint operating system.

■ **Robert Vallone** is director of user research at Go Corp.

■ **Pradeep Singh** is product manager for Windows for Pens at Microsoft.

Nicholas Baran is a consulting editor for BYTE and coeditor of Pen-Based Computing, The Journal of Stylus Systems (Sandpoint, ID). He can be reached on BIX as "nickbaran."

of, the interest is heavily weighted to DOS and Windows." The conservative conclusion is that both DOS and Unix will have healthy futures.

Says Mark Linton of Silicon Graphics, "There's a lot of investment in Unix technology that people want to carry forward." Linton says he expects to see significant architectural improvements in Unix over the next few years—improvements such as *multithreading* (concurrency within a single task) and improved standards for graphics and video.

Go's Robert Vallone says, "There will be very little, if any, movement in OS and GUI standards." If anything, various operating-system interfaces are becoming more and more alike. "A Mac user," says Vallone, "can navigate a Windows screen or an OS/2 or Motif

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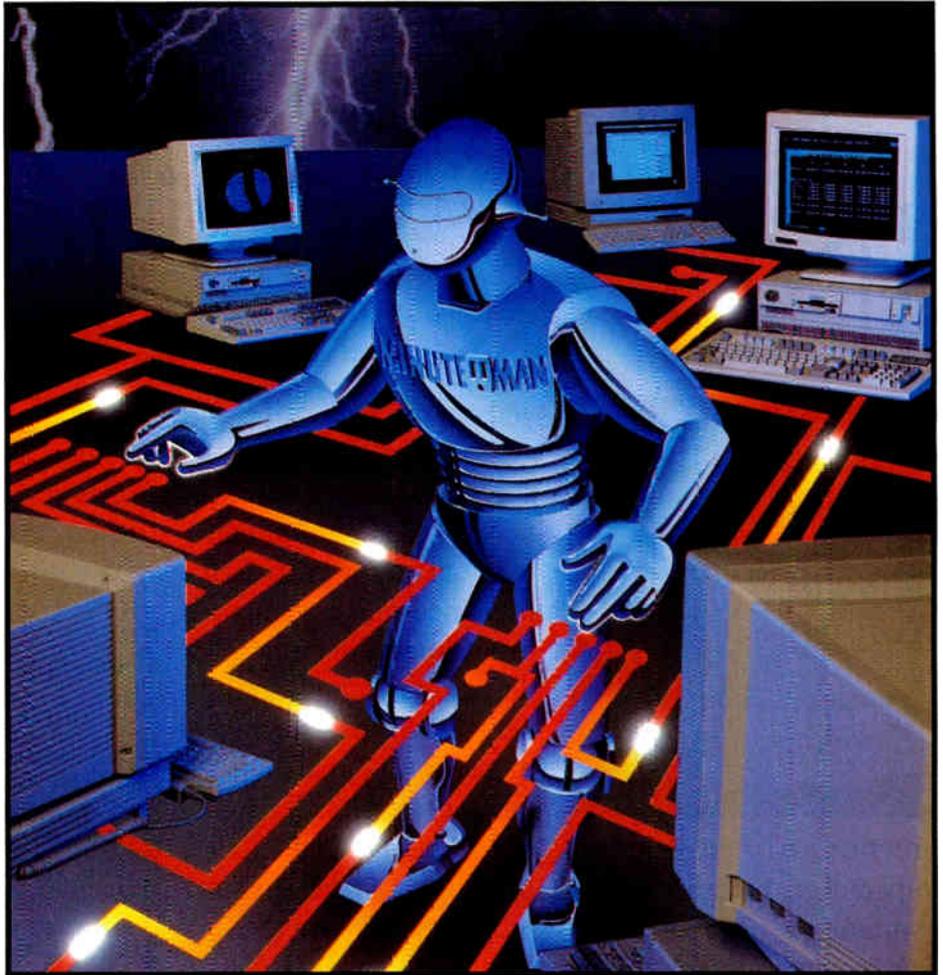
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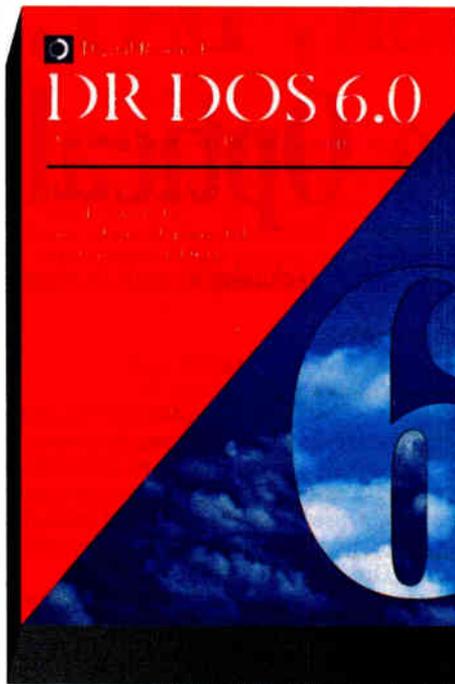
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What role will RAID (redundant array of inexpensive disks) play in the future?

Porter: RAID 5 will probably be more important in the PC arena. It's definitely going to be fairly widely used in servers for good reason: Compared with one system going down for a single user, if a PC network goes down, it can inconvenience as many as 100 users.

North: I think that it's mostly smoke and mirrors. The real benefit of RAID 3 and RAID 5 architectures to desktop computing is going to be felt only when the array processor—that is, the thing that controls what gets written to the disk and does the data massaging—can be made fast enough and cheap enough that it's not a significant fraction of the total storage expense.

DRIVE INTERFACES

What's going to happen with drive interfaces?

North: In the next year or two, IDE [Intelligent Drive Electronics] and SCSI will be the interfaces of choice. Most of the drive manufacturers either have eliminated or are rapidly phasing out any kind of development efforts on ESDI, the only other player.

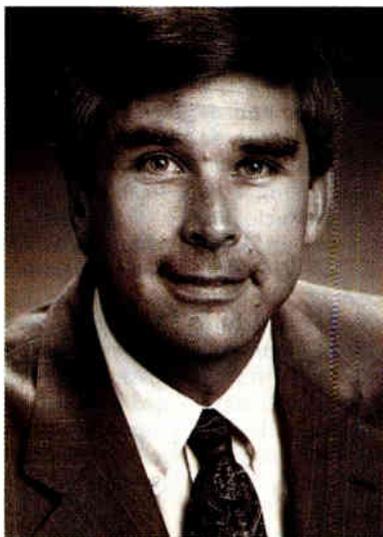
Porter: ESDI is certainly becoming a very small part of it. IBM has gone to SCSI-2 basically across the board on almost all its new announcements from the last year and a half: on PS/2s, RISC System/6000s, and AS/400s. Apple is SCSI, of course, in the Mac. And in the meantime, most of the AT-type systems are using IDE-AT.

North: The IDE interface will probably continue to be the dominant interface at the 100-MB and below level, maybe even at 200 MB and below. It is easy to integrate, offers reasonable performance, and is very well documented. For multi-user systems or servers, where it's reasonable to expect the need for storage continually to grow, SCSI is clearly the winner. From an expansion and overall

performance point of view, SCSI wins hands down.

How will SCSI be improved?

North: SCSI-2 has a bunch of new commands in it, but that's not really the bulk of it. What will happen with wide SCSI



CHUCK MORAN
Vice president of marketing and sales for Insite Peripherals

and fast SCSI isn't ironed out yet. Wide SCSI takes the 8-bit bus and doubles it or quadruples it to 16 or 32 bits. With fast and wide SCSI, we can get up to 20-MBps or even faster data transfer rates from a single drive. The bad news is you've got to find someplace to put all those wires.

Are there any other interfaces that may emerge?

Rothchild: Not in the near future. IBM may come out with an optical drive that plugs directly into a Micro Channel slot, as they

do now with a few of their hard drives. I wouldn't be at all surprised to see an interface like that.

North: If you look not much more than two years ahead, you'll see fiber-optic links at the drive level. It's still pretty much blue sky technology; there's a lot of technological hurdles. But in all areas of data communication, optical gives wide bandwidth in a small package.

HIGH-CAPACITY FLOPPY TECHNOLOGY

Are the new 4-MB floppy drives and media going to take root? Or will a higher-capacity alternative like 20 MB be the next big success?

Larsson: I wish I knew. As for Sony's standpoint, we are now in full production of 4-MB drives and media, and unless we believed in 4 MB, we wouldn't go into production. We also have around 20-MB technology available.

Porter: IBM has decided. Most of the other makers of IBM-compatible PCs plan to follow suit. It's a given that 4 MB will be very widely used within a couple of years and will eventually substantially replace the lower-capacity systems. It's

no sweat for anybody because it is downward compatible. Since a 4-MB drive can read 1- and 2-MB disks—you know, 720 KB or 1.44 MB to speak in formatted terms—it's one of the most painless migrations in a medium type that the industry will ever be presented with.

Chuck Moran: The 4-MB floppy disk, which formats down to 2.88 MB, is not the capacity increase that users need today to satisfy their applications. Had this been introduced like it was supposed to be more than two years ago, the 4-MB system would have received a warmer reception.

That's not to say that it won't find a niche and won't succeed—and I think it will—but it's not going to be what it could have been a few years ago.

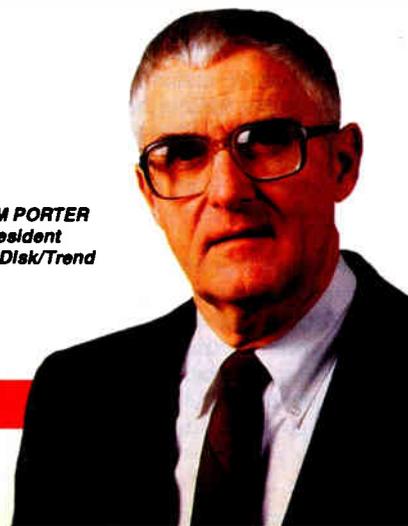
What's beyond 4 MB?

Peterson: It is physically possible to step up to 20- and 40-MB capacities and still maintain read/write compatibility. That drive can definitely be built, and of course we've seen it achieved in the Brier and Insite products.

Porter: The 20-MB and later the 40-MB drives are likely to be widely used. The problem there is that IBM has not settled the standards argument. It's probable that the leading type at the moment is the Insite drive, with an optical recording track and magnetic recording. Brier is taking a more specialized approach, a niche approach.

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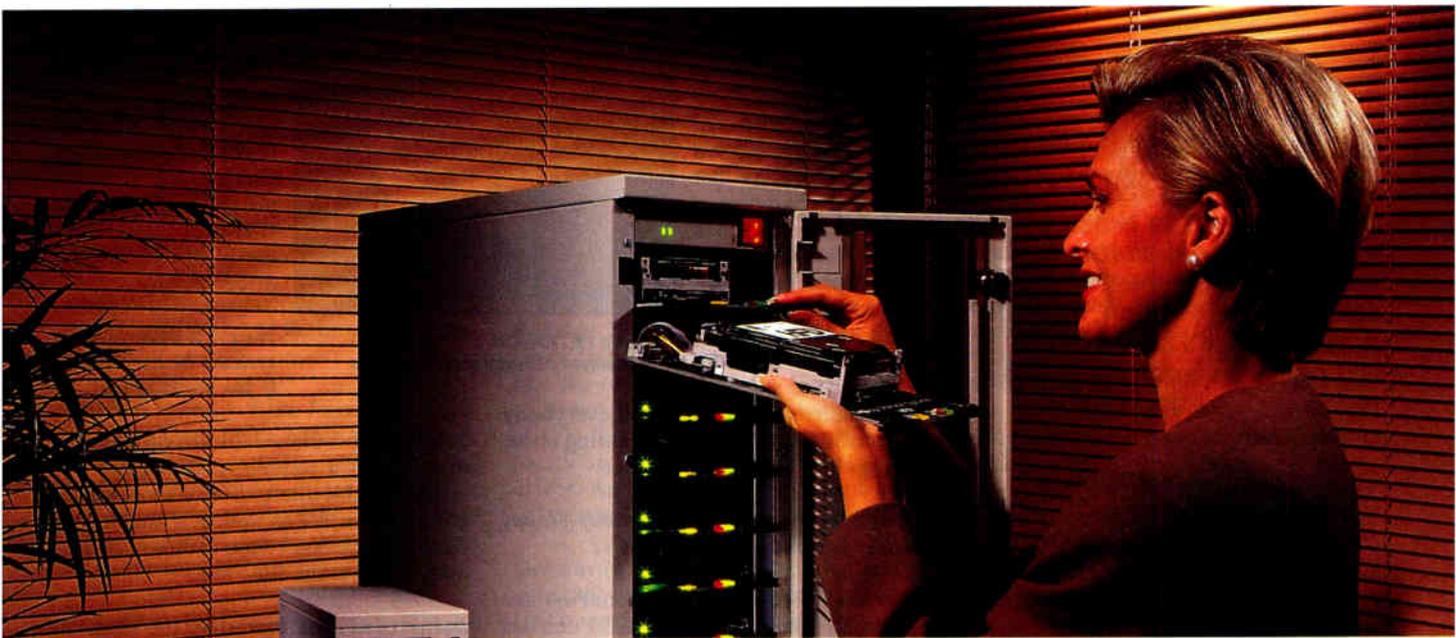


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TECHNOLOGY FORECAST

Rothchild: On 3½-inch next year, we'll be looking at two different capacities. The first generation is 128-MB single-sided, and we should be seeing the first of the second generation, which will be double that. They'll be single-sided also, but twice the density because they use what's called M-CAV [modified constant angular velocity] format, which adds extra sectors to the outer radii. Access times in 1992 will be running between 20 and 35 ms.

Green: The generation after that will be somewhere in the 400-MB range, also single-sided.

Rothchild: The next jump for 5¼-inch is to a gigabyte per side; we're about a year or two from that. That may require shorter-wavelength lasers. The shorter the wavelength, the smaller the spots you can make on the disk, and the tighter the track pitch.

How big will optical disks get?

Rothchild: The capacities possible this decade could be anywhere from a 40-times improvement up to a few-hundred-times improvement. Conservatively, this decade you could be looking at 20 gigabytes per side on a 5¼-inch disk and several gigabytes per side on a 3½-inch disk.

I mention per side because eventually you will see double-sided 3½-inch disks, even if you do not see double-headed

drives. People are talking now about introducing double-sided 3½-inch media by next year. And two-headed 5¼-inch drives have been shown privately in Japan.

The size of choice will be 3½-inch, but 5¼-inch won't die. It'll be in an upscale niche market. Because all 5¼-inch disks today are double-sided, and double-headed drives will be feasible in the 5¼-inch a lot sooner than they will be in a 3½-inch, eventually 5¼-inch is going to replace some of the applications that currently are being addressed by 12-inch WORM.

Is WORM doomed by rewritable optical?

Green: I don't think WORM is doomed, but its growth is certainly going to be stopped by multifunction drives. In the technique that Sony and HP have developed, you use a rewritable optical medium with special encoding and protection to make it write-once. But in a lot of peoples' eyes, write-once means an ablatable medium, so there will be a need for what people perceive as true WORM until they feel comfortable with the new multifunction technology.

Tell me more about these multifunction drives.

Rothchild: There's the sampled servo drive made by Pioneer, and the Sony/HP, which is continuous composite, and the Panasonic, which is not M-O at all but phase change. Even though the initial sales have been disappointing, there'll be a lot more of these introduced because for most drive makers it now seems obvious that it's the way to go. Long-term, say by 1995, we would expect that the multifunction drives will equal and pass sales of dedicated rewritable only. And once you've got a multifunction drive, there's no reason whatsoever to continue to make a write-once drive. Write-once drives may be doomed, but not the write-once medium. It will go on in multifunction drives.

What changes will occur to optical media in the future?

Rothchild: Direct overwrite. That'll be the next big deal. Currently on M-O, it can take up to five disk revolutions for a write operation. You can do it in one revolution with direct overwrite, which exists today in the phase-change technology and has been demonstrated publicly on M-O but won't be available commercially for one to two years. The next big

change in the medium will be when we go from the current infrared or red lasers to blue, or a wavelength of roughly 400 nanometers. That's coming later in this decade. It will require a very different medium.

Peterson: I really think phase change is the medium we'll end up with, principally because it's lower cost. Also because it allows direct overwrite. But we have to get through the mythology over how many times you can overwrite: The reality is you don't do it very many times. Even 100,000 is a huge number in a specific area.

What else is on the horizon?

Peterson: The real product in my opinion is CD-ROM rewritable with a phase-change medium. You're looking at a \$300 to \$400 drive and a medium under \$10. That's going to be the real product, in terms of something really opening up the volume.

Rothchild: A number of companies are developing rewritable CDs. Sony demonstrated them over a year ago, in fact even showed one in a battery-powered portable to really rub it in that they've got the technology developed. Long-term you can expect this to be a consumer product.

How soon is this going to happen?

Peterson: Very soon. Two years. It's being actively worked on right now. I'm going to make a prediction here: Some people would say that 3½-inch optical might be the next software distribution step, but I'm going to say it'll be a small-form-factor rewritable CD. It could be the next floppy disk.

Rothchild: It's not a question of development of technology, it's a question of the copyright issues and when to bring this on the market. When the copyright issues are solved, you can expect everybody and his grandmother in Japan to jump in with recordable CDs.

Is there a future for dye polymer media, like Tandy's THOR?

Rothchild: I think THOR is dead as an optical technology. Tandy has got some severe technical problems to overcome. No one has ever successfully introduced an erasable dye polymer technology. The Tandy technology is supposedly good for a few hundred erasure cycles, which on an audio disk is perfectly fine. You



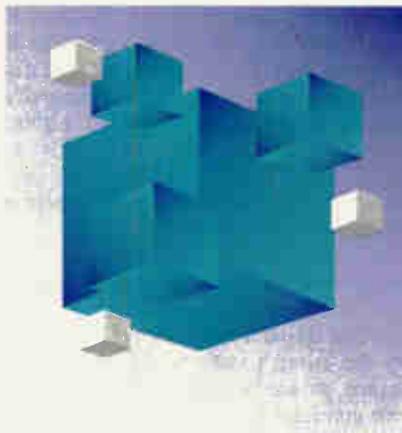
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What's happening with optical cards?

Rothchild: It is almost impossible to predict whether optical cards are going to be a major industry or not. The whole concept behind the Drexler Technology card system is cheap and dirty: low capacity, low performance, and low price on the reader/writers and cards. At the moment, they range from 2 to 3 MB. Other companies have proposed cards with up to 500 MB. Canon has taken a license from Drexler and has a 2-MB card using its own medium. There's a consortium of five companies in Japan that also took a license to second-source. The optical card is taking off initially in Japan, primarily for medical records, and there's a major test going on in hospitals in Italy and England. Mass production is likely to come in the next one to two years from the Japanese.

Will optical cards be a computer storage medium?

Rothchild: Possibly for software distribution. But I think 3½-inch optical and CD-ROM are more viable because they have much faster access times and data rates. Almost all of the optical cards work on an x-y axis read and write.

Dan Sternglass: I don't think it's mass storage for a portable. It's data distribution. The ability to carry multimegabytes on a thin, flexible card that goes in your wallet—there are definitely niches for that, but it's not portable PCs.

Rothchild: We'll see some further development of optical cards, but I would have to say at this point it's not mainstream. It's certainly not in the small computer market.

How do optical cards compare with IC memory cards?

Sternglass: There's a tendency among people who are familiar with the Drexler card to ask how we can compete with that. For certain types of applications, we don't compete. The difference is that the memory card is entirely electronic and can be interfaced using a single ASIC [application-specific integrated circuit]. It's ideal for high-speed random access at low power.

But if you want to carry your medical life history around with you and read it on a desktop computer at the hospital,

you don't care how much power it takes or how big the reader is. I'm sure that flash memory will never get that cheap in cost per megabyte. But the laser cards are serial, they're slow, and they require a bulky and relatively high power read/write device.

TAPE BACKUP

Tape backup is a hot area right now. Do you think there will be a clear market winner between QIC, 8-mm, and DAT?

Peterson: I don't know that there will be a shakeout. I think that there is a very clear market segment for all of them. There's a lot of overlap and lots of reasons why each technology has found a home. I would give helical scan the winner's cap for the capacity race at this point, but longitudinal tape still has the performance characteristics.

But the real volume tape product now is QIC, and that isn't going to change. I see 4-mm [DAT] coming in second. Teac's digital data cassette is still ahead of 8-mm, but it's a pretty close race. The 8-mm will continue to grow and will displace digital cassette in the hierarchy. But there isn't a case where one's going to win out over the other.

How will these tape formats be improved in the future?

Johnston: DAT will go higher in density, and it will also go higher in capacity. The transfer rate is not at all limited by the current state of the art; for instance, we are going faster today, and we can continue to go even faster without impacting the mechanical technology.

Peterson: There are two basic factors that will enable DAT to move up in capacity: making the track pitch smaller, and putting in longer tapes. Ninety-meter tape is now being announced, and there will be 120-meter tape within this two-year period. I have no problem seeing 4-mm make a few more substantial capacity steps. There's an awful lot of R&D going into 4-mm, so I have to give it some credibility. In 8-mm, you've got 5 gigabytes now, and they're talking

about an 8-gigabyte step and a 15-gigabyte step.

Johnston: Exabyte has a distinct advantage over DAT in real estate, or area of the tape. If the bits per square inch were the same, you'd just physically store more data on 8-mm tape. In QIC, on the

other hand, they have a much greater problem in their technology because it isn't helical scan, it's longitudinal. So the physical area of the tape is greater than the other two, but utilization of the surface area of the tape is not as efficient.

Peterson: QIC has got a plan that says it's going to 6 gigabytes in the 1993 time frame on full-size data cartridges, and 2 gigabytes in the same time frame on mini cartridges. Will they achieve that? I've got reason

to believe that they are finally getting there, a year or two late from what they have previously said.

Are any new tape technologies coming along?

Johnston: That's quite unlikely. DAT is not tapped out, nor is helical-scan recording in general. It can continue to grow in capacity as well as performance. Maybe optical tape, but it's a technological push to get it to work. In maybe 15 or 20 years, if they get it straightened out, that may be viable as well.

Peterson: I don't see any new tape technology around the corner, except the Philips digital cassette and optical tape. And I don't think the digital cassette will be used for data applications.

SILICON STORAGE

Flash memory and IC cards have gotten a lot of attention recently. What kind of role are they going to play in the future?

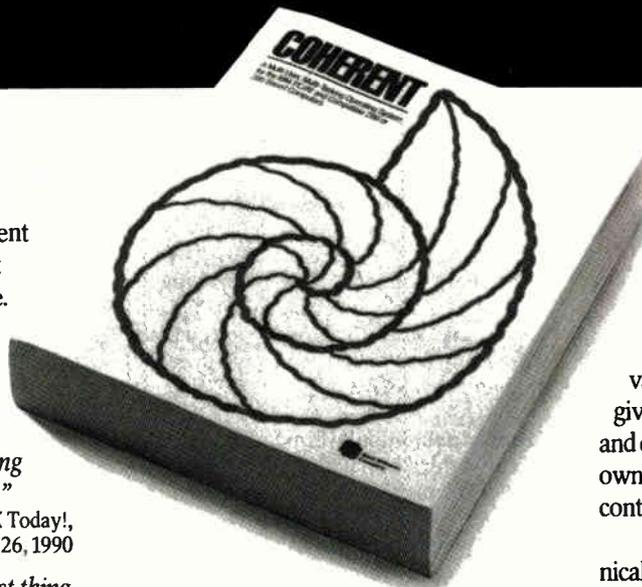
Johnston: Silicon memory is going to become more prominent. It will still be much more expensive than magnetic systems, of course, but it will have the advantage of increasing performance in the



ROSS JOHNSTON
Founder and vice president for planning and development of R-Byte Corp.

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system. But the likelihood of having silicon replace magnetics is very, very low.

Porter: The semiconductor fans have been showing price-per-megabyte curves for semiconductor stuff crossing over magnetic for the last 10 years. They've been 100 percent wrong in the past, and they're going to be 100 percent wrong in the future. Let's project that in two or three years you have 10-MB flash memory cards. Those are going to cost you—I don't care what these guys are telling you—from five to 10 times more than the magnetic disk drive.

Sternglass: I don't think anybody realistically thinks that the cost per megabyte of memory is going to approach the cost per megabyte of hard disk. That's not the issue at all. The question has to do with what the word *performance* means to the end user. Performance has a lot of components to it: the weight of the machine, the size of the machine, the battery life. Speed per se is not the selling point with memory card systems: It's usually the light weight, which derives from the low power consumption and smaller batteries.

How cheap will silicon memory get?

Sternglass: There will be major price competition. Intel is not the only flash memory maker. I believe that \$100 a megabyte to the end user will be attainable in 1992, which is somewhere between 30 percent and 40 percent of what it is today.

Porter: The big hazard for the flash memory guys will be the next generation of 1.8-inch disk drives, which will be available in a year. The 2-pound computer will be mostly equipped with 1.8-inch 20-, 30-, and 40-MB hard drives.

Sternglass: Jim Porter made a pretty good point that the 1.8-inch drives are coming, and they're small and light. But they have essentially no lower power consumption than the 2½-inch drives. Maybe 20 percent or 30 percent, but not an order of magnitude, like the memory cards. The reason you would go to a memory card in the first place is because you want to reduce the power consumption of the system so you can throw out several pounds of nickel-cadmium batteries and replace them with a couple of AA batteries.

What other opportunities lie in the future?

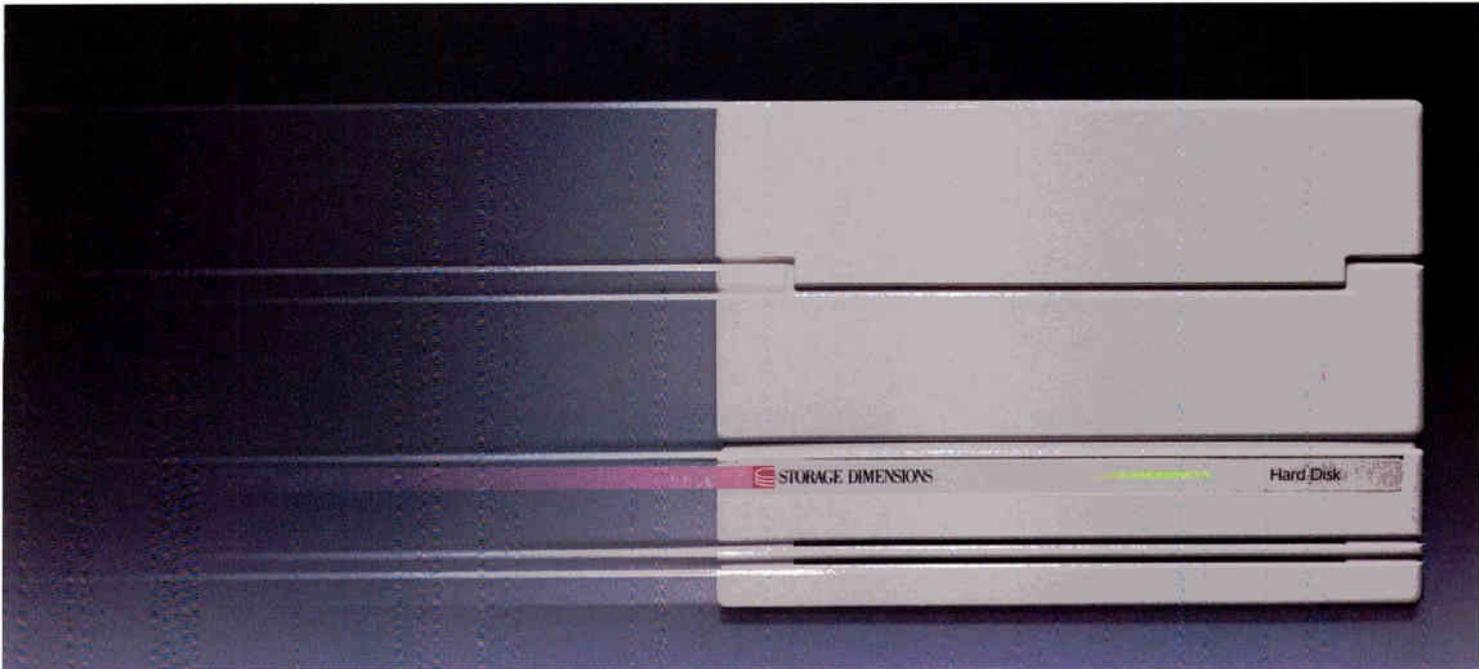
Peterson: One of the messages I have for the industry is to look at the opportunities downsizing brings for noncomputer applications. Take one simple example: We are starting to see disk drives in the integrated printer/fax, document-imaging-type machines. We are seeing tape drives in copiers now for image capture. There are all sorts of interesting noncomputer applications that are going to grow out of all of this, so that people need to go into this with their eyes open and to look for opportunities everywhere. ■

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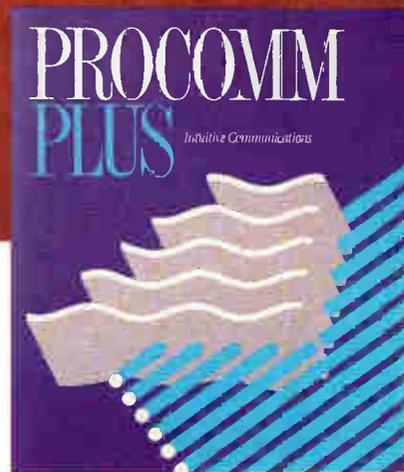
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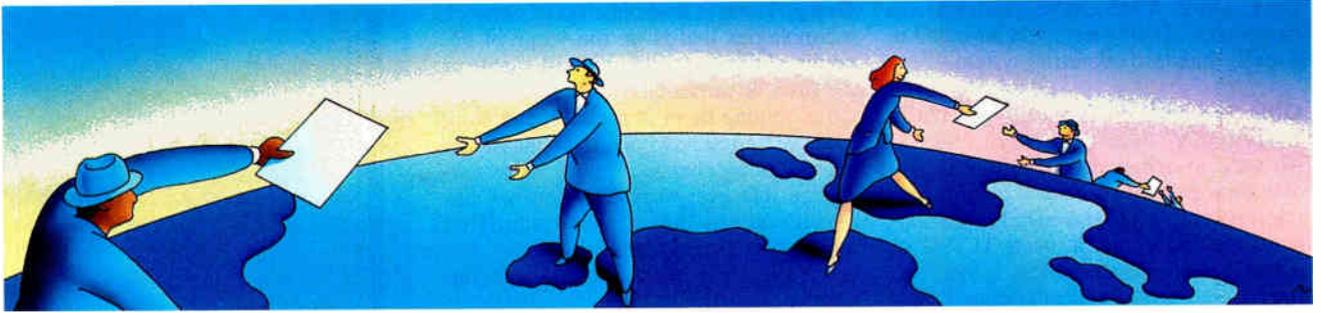
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Networking: Promises and Problems

Are we a stone's throw from global interoperability, and if we are, what might be the consequences?

SHARON FISHER

The whole is greater than the sum of its parts." Indeed. Other articles in this special issue focus on the tools that individuals can use; this one, instead, focuses on bringing individuals and their ideas together. Or, as marketing people would say, on *synergy*.

Networking people tend to be both visionary and pragmatic: visionary because they have the charter to bring to fruition the sort of future that we've seen in science fiction, and pragmatic because they still have to work with what we have today. Linking two systems requires knowing about and dealing with the faults of each.

At the same time, networking people have to be aware of the way in which their inventions can be used to repress: Remember, Orwell could not have had a 1984 without networks. Nearly every participant in this article brought up the issue of privacy, as well as how networking could be used to increase citizens' participation in government. Another, more mundane, issue is that of junk mail and filtering the increasing amount of data that universal networks could bring.

For this article, I asked a cross section of industry experts questions about networking activities today and for the future. Their responses reflect some of the promises and problems of linking people and information together worldwide. Note that not all of the participants tried to answer all of the questions.

What problems are keeping us from true interoperability, and how can these problems be solved?

Esther Dyson: Progress. If we stopped improving things, we could make everything interoperate fairly quickly, but people keep on innovating and improving instead of working on interoperability. It's the fight between continuous local improvements and global, static interoperability. We get continually better systems with the local im-

provements, but incompatibility and inconvenience are the price.

James P. Gray: True interoperability requires semantic convergence—that is, the meanings of messages transmitted across the network must match. The formats can be translated at application programming interfaces or at gateways, but no matter what, the meanings have to match. The good news is that this is happening across a wide spectrum of services in computing today; the bad news is that it is happening incrementally and, hence, not as quickly as we would like.

For example, IBM's Common Program Interface for Communications (CPI-C) allows programs to use OSI [Open Systems Interconnection] or SNA [Systems Network Architecture] without change, mail systems are increasingly able to interoperate, and many components of networks can be shared already, such as LANs. I think we are getting good results out of what is, after all, a very large, distributed computation involving all of the computer systems designers in the world. But patience is required. Complete interoperability won't happen overnight.

Robert M. Metcalfe: Interoperability is best achieved through *real* standards. Novell's IPX network protocols, for example, have been useful standards, but they are de facto standards, the evolution of which is not subject to due process.

DoD's [Department of Defense] TCP/IP network protocols have been useful standards for twice as long, but they are reaching their technological limits and lack international acceptance. IPX and TCP/IP must now give way to OSI.

The needed movement toward real standards is inexorable, but slow. Users can accelerate interoperability by demanding real standards; vendors can accelerate interoperability by shipping real standards. Each will move forward a little at a time. A key factor will be the general availability of OSI in our various operating systems—DOS, Macintosh,



ROBERT M. METCALFE
Principal Inventor of Ethernet
and founder of 3Com

Unix, OS/2, VMS, MVS, and VM, to name a few. If only we could have OSI in a really standard operating system.

Olof Soderblom: What do you really mean by true interoperability? What do we need to achieve? You're making an assumption that we are not achieving true interoperability. If you pick the components that you know fit, using TCP/IP or some logical network, there is, in fact, interoperability. If you're aiming toward "everything talks to everything on every protocol," you'll never get there. Interoperability is not an end in itself.

What's left to be discovered in networking? Or are we just going to spend time in the future linking what we already have?

Dyson: Aside from making brilliant, clever discoveries, someone has to do the dirty, uninnovative work. Two things require a lot of cleverness but no genius: automating network support and installation, and interoperability.

If you can specify how to install and run something, you should be able to do so automatically and provide a usable interface so that network administrators don't need to be professionals. I call this hypothetical tool "Janetor"; it is an expert system and scripting tool that contains modules for every known network system (both wide area and local). The right modules load automatically, and it converses with users in intelligible menus. It takes only a few questions to hook up anything and to find out what any given user wants to do, and then Janetor makes it happen (within limits of installed equipment, security, privacy, and budgets). Of course, each vendor has to supply Janetor with the appropriate information on interfaces, protocols, and installation routines.

As for interoperability: If you're willing to tolerate slow performance, there's always a way for two systems to work together, although not necessarily well. Since we won't ever get everyone to agree on standards (thank goodness), we should probably work harder on facilities for interoperability (Janetor, for example).

Gray: There is a whole class of network technologies that is on the verge of becoming important and that will enable us to build a universal service network. Chief among them is packet technology to serve "circuit-switched" applications. The looming change requires us to recognize that every use of a network has service needs that can be quantified along these axes: speed, delay, jitter, bit-error rate, data-loss rate, cost, and connection setup time.

If we recognize this, the next item to consider is what kind of network is able to provide a universal service. Clearly, the answer is networks that have the greatest transmission efficiency. Two techniques for attaining this that the industry is keying on are fixed-length cells and variable-length packets.

My guess is that the latter will be the right answer when a suitable bound is placed on the maximum length of the packets.



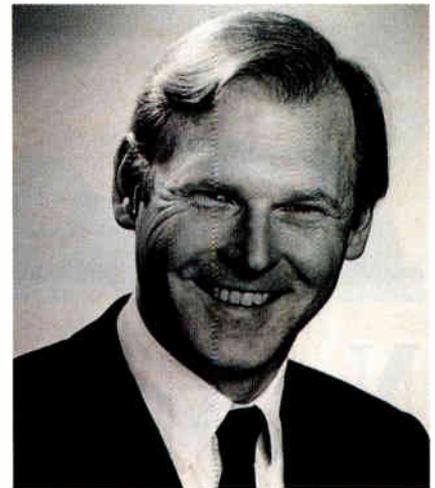
JAMES P. GRAY
Manager of SNA studies at IBM

Metcalf: This may not be what you were looking for, but against a backdrop of increasing speeds we must, again, converge on standards and then invest in a worldwide information infrastructure.

Here is my view of past and future computer networking history:

- 1970s—Wide-area (as in ARPANET among minicomputers)
- 1980s—Local-area (as in Ethernet among personal computers)
- 1990s—Internetwork (hubs, bridges, routers, gateways)
- 2000s—Interenterprise (especially standards-based EDI)
- 2010s—Infrastructure (huge government investments toward "superhighways")
- 2020s—Ubiquitous (into homes, as computers disappear into the woodwork)

Soderblom: There's a big void that has to do with high-bandwidth wide-area networks. The problem we're running up against is very high bandwidth LANs that want to talk to very high performance mainframes, but the bandwidth required isn't available. We're talking



OLOF SODERBLOM
Vice chairman of Willemijn Holding BV

about hundreds of megabits. I am convinced the mainframe is here to stay and will be the major source of computing power for the foreseeable future.

What's the biggest technological hurdle today that needs to be solved?

Dyson: Complexity and scale. I don't think there's one missing algorithm that could solve everything. We just need to keep improving. Standards help, but they also impede progress.

Gray: Without a doubt, the biggest unsolved technical problem today is seamless interoperability at the transport level. But progress is being made, as evidenced by the work the XOPEN Consortium is doing to help define an interface (XOPEN Transport Interface) to be used for software communications.

Metcalf: Getting "multimedia" into our computer networks, the problem being the very large, time-sensitive bandwidths required.

Soderblom: Solving [problems] in a cost-efficient way. I think we know what the problem is, but we don't know what the solution is.

What social issues are going to crop up with increased networking, and how can they be solved?

Dyson: Social issues will overwhelm us as networks infiltrate everything we do. They'll probably be blamed for homelessness, illiteracy, drug abuse, as well as abuses of privacy, poor manners, whatever. But specifically, issues of pri-

vacy, both at work and for consumers, become significant. With more information, more access to it, and better tools for sifting through all of it, privacy will have to be protected by law and by convention, rather than by physical reality. For example, you can't look through walls, and sorting through card files and paper forms is painful work, but you can easily do a computer search. The solution, in part, is careful laws to control access and effective ways of enforcing them.

Other issues will include the access of the poor to information networks and all the benefits they bring. These are in fact social and economic issues, but now they concern information and communication instead of bread or housing.

Another issue that concerns me is the effectiveness of filtering. As an example, if right-wingers read only right-wing news, how are they ever going to change their minds about anything? (But I don't want them to be forced to read John Kenneth Galbraith, either.)

Also, advertising has been a great force behind mass media, education, and access to information. As advertisers get better and better at targeting customers, who will subsidize the public's access to information? What effect will all this have on democracy, on voting patterns, on people's knowledge of and interest in the government's activities? In general, the happier people are, the less interest they take in their government (unless they're paralyzed with fear). Will everything be controlled by special-interest groups? How can communications contribute to voting patterns, to expressing opinions, to public education—and not to indoctrination?

I think markets will work fine for dissemination of information in the commercial sphere, but I'm worried about increased segmentation of our society—without wanting the government to control the proliferation of networks, which I think can best be accomplished through market forces.

Gray: Privacy and limited government are two of the [important social issues]. We have created a vast cyberspace with our technology. It can be used beneficially (in the way that, say, the interstate highways and roads in general have increased the effective freedom of individuals) or detrimentally, to repress individuals. One hopeful technology trend is the lower cost of cryptographic technology and the potential for public key crypto systems to decentralize the security of the planetwide network.

Mitch Kapor: Privacy. Freedom of speech. What constitutes good citizenship in cyberspace? The EFF [Electronic Frontier Foundation] is working on these issues.

Metcalf: What new form of democracy is required? Ours is 200 years old and was designed when it took weeks and even months for information to move across the country. How should we govern ourselves in a world where our president can ask the American people, say, their take on an issue, and then get their accumulated answers live, for all to see, as he talks to them on TV?

Soderblom: That's not really a network problem, but an application problem: What do you use networking for, and how do you use it? It's not really a problem of networks. The important social issue is the consequences of people not having to go to their offices. Certainly society right now is built upon people having to get from one place to another, and that will change.

Of the various hot new technologies that are getting a lot of attention these days, which one will be the most useful to users?

Dyson: Overall, tools for understanding, classifying, and automatically dealing with text and images will be of most use to people. They will help us deal with the floods of information we will create (using those same text tools, in many cases). They'll help people to overcome the increasing complexity of the world around them, for starters. (For example, feed the scanner all your receipts and financial records, and it will automatically do your taxes for you.)

All this really has to do with creating explicit models of the complexity around us, so that ordinary people can interpret and handle it intelligently. There will be more use of shared knowledge.

Gray: I think that electronic desktop conferencing has the potential to be the next "must-have" application. The replaceable costs are large, and the incremental costs of the required desktop upgrades are coming down each year. The takeoff could happen as early as 1992, but before 1995 for sure.

Metcalf: Sorry, but my answer after 20 years is still... E-mail. The X.400 mail and X.500 directory standards will bring long-awaited ubiquity. EDI, graphics, images, voice, and video are creep-

ing into E-mail, and as they do, E-mail will remain the number-one application of computer networks.

With more and more access to more and more information, how will we learn to deal with it?

Dyson: First, filtering services won't look just at words, but at all kinds of criteria like the ones you use in real life. Who wrote it? Who else read it and liked it? How many other people have cited it? Who published it? Does it have good illustrations? How many other people was it sent to? Who else is in the reader group? Does it cite other people whose work I know? How much does it cost? How much do I care about the topic? I want to read more articles with the same profile as this one, but with a little more/less on a particular aspect.

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What effect will all this [networking] have on democracy?

ESTHER DYSON
President of
EDventure
Holdings



on top in the center. (Apple has such a project.)

Gray: Thomas Sowell wrote a great book on this subject, *Knowledge and Decisions*, published by Basic Books in 1982. His basic point is that societies are defined by their information flows. Further, information has costs and benefits exactly like tangible items do. We can then see that the concept that we can be awash in information is false. We are not, and will not be, awash in information—we may be awash in data, in junk mail, if you will, but we won't be awash in information.

In fact, as the costs of collecting data and turning it into information are gradually worked into the global network, various mechanisms that are latent today will come into use to protect each of us from being flooded by junk mail. Crypto may help here: If you don't send a secret code with your mail, one that I have previously given you, perhaps my personal mail daemon will file your letter in the electronic trash can. Another aid, coming to a market near you soon, is a mail reader/sorter that watches what you do with mail and gradually copies your behavior—sorting the junk mail to the bottom of the pile, and maybe eventually automatically discarding mail from a list of addresses.

Kapor: Information-filtering tools will be developed to help screen out any unwanted information. Intelligent agents will be deployed across the network to search for and retrieve any interesting information.

Also, entrepreneurs will discover that there is a market for information [brokers,] whose primary function will be to assemble bundles of useful information for people who are too busy to assemble [the information] for themselves.

Metcalf: The ability of computers to filter information will always lag by a bit, but only by a bit, their ability to generate information. Yes, we will always dread junk mail. I urge that you not lose sleep over this problem.

Soderblom: Expert systems. There will be an interface between information and the human being—intelligent selection mechanisms and a preselection process.



MITCH KAPOR
Founder of Lotus Development

How can we get the "have-nots"—countries without reliable telecommunications equipment, plus the poor and the uneducated all over the world—access to networks and networked information?

Dyson: We have to invest in them, not give them things. By investing, we will have a vested interest in our success. And the biggest investment we can make in people is education.

To businesses, educated people represent markets, customers, and workers.

Businesses just have to be encouraged to see it that way. After all, the rich communities we live in are getting more and more saturated with stuff; it takes huge efforts (advertising) to get us to buy things. Poor people, if you can provide them education and jobs to earn money, will gladly spend that money to buy goods and information; they don't yet have too much.

Gray: First, let's make some distinctions that are blurred by the question. For example, individuals can have low incomes, countries can have low aggregate incomes, and businesses or individuals who have good incomes can be located in countries with low aggregate incomes. The poor individuals, for example, are concerned with how they may increase their personal incomes, while the poor countries may be concerned with how they can attain rapid economic growth. Each concern leads to different detailed questions and answers.

Technology is providing an increased range of choices, however. For example, satellite systems provide point-target communications, which can help to bootstrap overall economic development. Indonesia is an example of a country that has deployed a data communications infrastructure by using satellites.

Once some linkage to the global network is available, opportunities for trade

in knowledge are created. For example, businesses in India now offer programming services that are delivered by network to customers in the U.S. Of course, wise economic policies and political stability are necessary prerequisites for technology to take hold and bring real benefits. Countries such as Japan, Korea, Taiwan, and Singapore have succeeded by applying the same methods that Europe, the U.S., Canada, and others applied earlier: free markets within the context of stable law, private-property rights, and stable money.

Metcalf: Let's get them fed and educated first. Getting networks to the third world has to be far down on our list of problems. No, I do not think that telecommunications holds any real early potential for solving problems that have, for example, endured Christian charity for two thousand years. I find more hope in the demise of communism than in the rise of networking.

Soderblom: Satellites. Not that they're a particularly good way of networking, but it's a cheap way of installing a wide-area network.

If you could work on any sort of networking problem right now, what would you want to work on?

Dyson: In my own way, I already am. The problem is getting effective telecommunications capability into Central and Eastern Europe, so that other kinds of businesses will be willing to go [into these regions] and invest and prosper. (This is my own particular area of interest, but the world needs individuals working on specific problems they care about, not spurious global solutions.) The way I'm doing so is by providing information about what's happening, helping people to find each other, and in general oiling the joints of the invisible hand. As usual, technology is the smallest part of the problem. Inertia and uncertainty are the real issues.

Gray: Right now, the teams I spend the most time with are working on two closely related problems. First is interoperability, especially of transport networks. This could be called the multiprotocols transport network problem. Second is the creation of networks able to carry any class of traffic whatsoever, including digitized HDTV at 20 Mbps to and from the desktops of everyone in the network. We might call this the universal desktop problem.

Kapor: I'm working on increasing access to the Internet by ordinary computer users. This includes policies that promote increased access, easier-to-use tools, and public education about the subject.

Metcalf: I really can work on any sort of networking problem right now, and I am choosing to work on understanding and communicating the early history of computer networking as a guide to the momentous events ahead. ■

PARTICIPANTS

■ **Esther Dyson** is president of *EDventure Holdings*. She also writes *Release 1.0*, a newsletter that covers the computer business (especially PCs) with primary focus on software and software design, text manipulation, legal issues, and the transformation of AI into a commercial technology.

■ **James P. Gray** has contributed to microprocessor architecture and to several portions of *SNA*. He holds a B.E. in electrical engineering and a Ph.D. in communications theory from Yale. He was named an IBM Fellow and manager of *SNA* studies at IBM.

■ **Mitch Kapor** is founder of *Lotus Development*. With John Perry Barlow, he also founded the *Electronic Frontier Foundation*, an organization committed to making sure that the *Bill of Rights* applies to the field of electronic communications.

■ **Robert M. Metcalfe** is the principal inventor of *Ethernet*, the local-area networking technology on which he shares four patents. He worked for *Xerox Palo Alto Research Center*, founded *3Com*, and received the *Association for Computing Machinery's Grace Murray Hopper Award* and the *IEEE Alexander Graham Bell Medal*.

■ **Olof Soderblom**, a native of Sweden, holds several patents, most notably for the token ring. He is vice chairman of *Willemijn Holding BV*, with primary responsibility for the token-ring licensing program, and chairman of *Compass Holding BV*, with responsibility for corporate and product development.

Sharon Fisher is a San Francisco-based freelance writer specializing in data communications. You can contact her on BIX as "sharonfisher."

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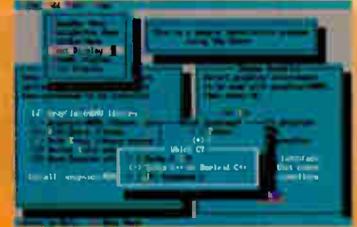
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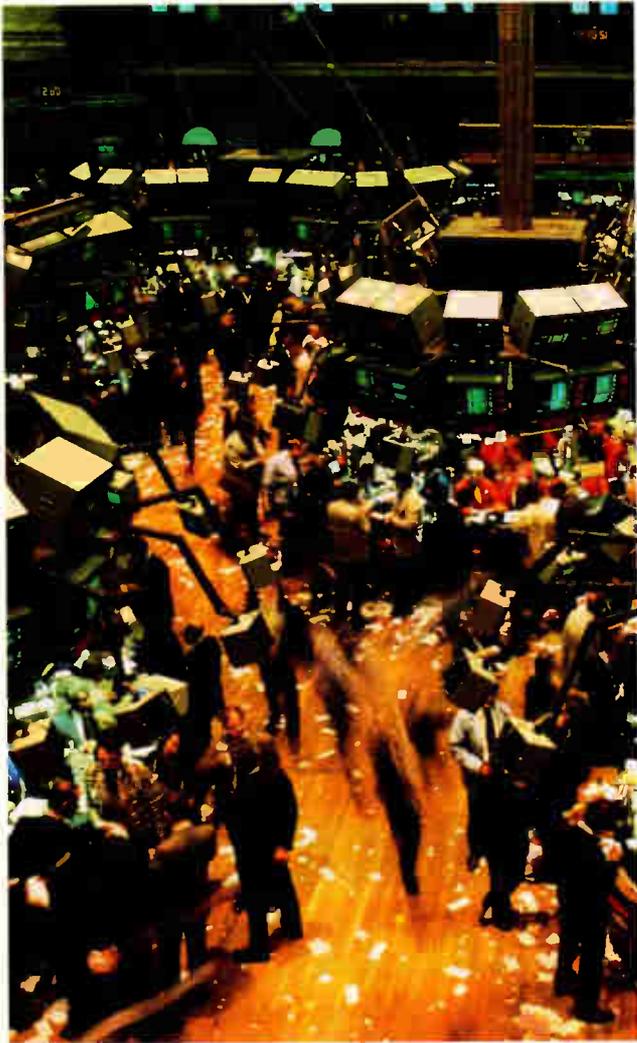


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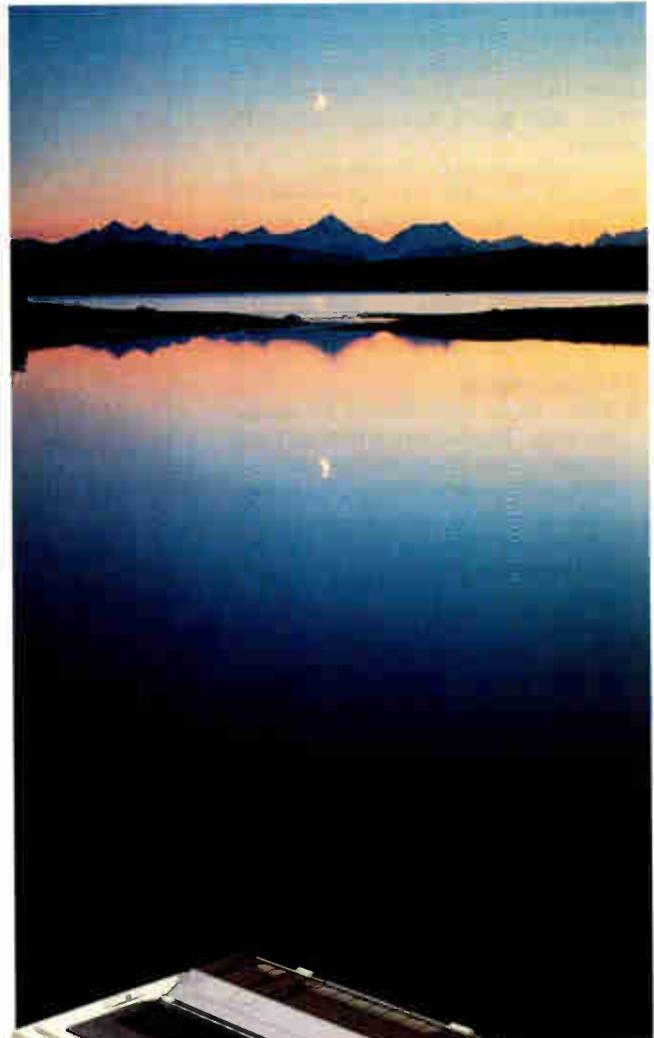
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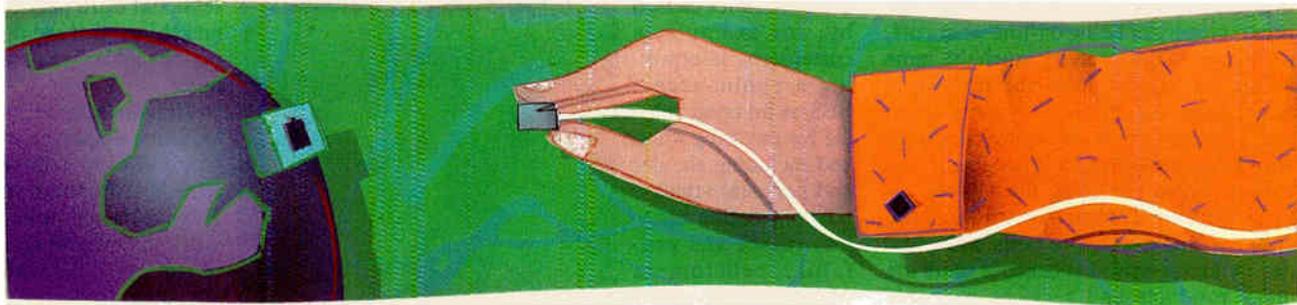
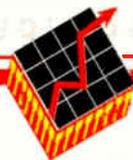
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Are On-Line Services Delivering?

For the most part, yes, but it usually depends on your interpretation of what's being offered

MICHAEL A. BANKS

On-line service usage is at an all-time high in both the number of users and the amount of time spent on-line. Just as personal computers have become an integral element in the daily lives of almost everyone in the U.S. and most other industrialized nations, on-line services promise to touch almost everyone.

When will this happen? Probably not by the end of the century, and perhaps not for a couple of decades. But on-line services are no longer the province of techies and the

“plug-and-go” users who dial up database services as a part of their workaday chores. The word is out on on-line services, and they are rapidly becoming identified with personal computers.

Thanks to the computer virus scares of the late 1980s and more recent adverse and somewhat misleading publicity in business and consumer publications involving BBSes and other commercial services, even the non-computer-using public is at least aware of on-line services—and they're curious. The high profile of on-line services, coupled with the decreasing cost of hardware, software, and the services themselves, form the foundation of a trend that will culminate in on-line services' being as popular as personal computers.

The Way of the Future

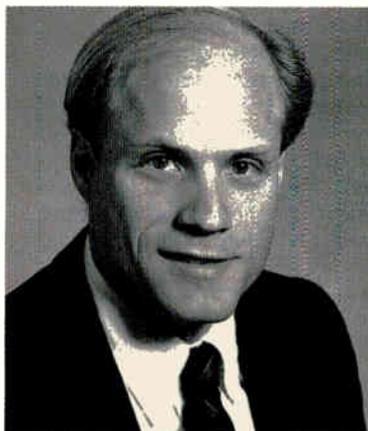
In the late 1970s and early 1980s, the only people who used on-line services were those who used the big database and information-retrieval services for

research—and the more technically oriented, who were after free software and being on-line for its own sake. This is less true today. A minority of dial-up modem users are logging on to research obscure technical databases; to get specialized information, like commodities prices; to download the latest from on-line newswires; and to do their banking and shopping.

On-line services and industry experts still attempt to project a serious image—though not as heavily as they used to. The flashy ads and press releases nowadays are more likely to tout the latest on-line game or full-text newspaper or magazine database than time-delayed commodities quotes. The myth of seriousness is gently perpetuated, but the grass-roots constituency of the on-line world—those who sit at home in front of their computers with their modems keeping the telephone lines singing every night—seem to be more interested in games, communicating with other users, and researching information for personal or vocational reasons than they are in checking grain prices.

Steve Case, CEO of Quantum Computer Services, agrees that the on-line world is not what it was first projected to be. In talking about America Online, one of Quantum's services, he says, “It is not the kind of on-line information service that was envisioned five years ago.” Case sees the real value, at least for consumer services, as in how interactive a service is (i.e., how much of a service involves two-way communication and user interactivity). The interactive elements can range from game-playing to real-time conferencing to messaging—anything that gives a user feedback. “With an interactive service,” Case says, “the value increases in proportion to the number of people using a product.”

It comes down to this: On the commercial services, people devote far more on-line time to what the 1980 image of telecomputing would have considered less-than-serious activities. And they devote that time in large part to analogs of more



RUSTY WILLIAMS
Vice president of sales and marketing for Delphi

informal real-world activities. Once the initial novelty of being on-line wears off, people go on doing pretty much the same things that they'd do in the real world (e.g., checking the news, researching, and chatting and exchanging messages with acquaintances and colleagues). The reason people are doing these tasks on-line is because it offers more convenience and ease and a lot more bells and whistles. Another reason is because there are many products and services available that have no off-line counterpart.

Delivering on Their Promises?

Amid growing awareness of on-line services and their increasing utility and accessibility, it is prudent to question whether on-line services are delivering on their promises. What are these promises? What do on-line service users want? What about the future of on-line services?

To answer these and other questions, I spoke with several people in the business—including on-line service managers, information providers, and consumers. A clear consensus emerged from the discussions, along with some interesting

are sometimes caused by, for example, a customer's interpreting a public-access BBS as an open vehicle for anything up to and including slander and personal attacks, not to mention tasteless drivel and profanity, customers would do well to examine exactly what a service promises in its user agreement and how others use the service.

Inferences, Perceptions, and Reality On-Line

Popular perceptions often get in the way of a clear interpretation of what a service is promising. This is why GENie's director of marketing Neil Harris says, "It depends on who made the promises," referring to his statement about the predictions made by analysts and others in the early 1980s: "On-line service customers often have preconceived notions of what an on-line service should be and infer 'promises' therefrom."

This points to a larger truth: Customers should pay attention to the stated promises of on-line services rather than to inferences or popular perceptions.

Customer Feedback

Customer surveys support this idea. According to Rusty Williams, vice president of sales and marketing at General Videotex, "On-line services have lived up to their promises, and in many ways exceeded them. We recently conducted a survey on Delphi, which was developed by the Videotex Industry Association, to collect information about user satisfaction industrywide. Of course, many people had suggestions for additional features, but on the whole, they were very happy with the [service's] value."

Martha Griffin, communications program manager at Prodigy, also agrees that service finds a high level of customer satisfaction in surveys: "We've done surveys of customer satisfaction, and the satisfaction level of our members is around 95 percent."

Richard Ream, Dialog's vice president of worldwide sales and service, reports that his service makes extensive use of customer surveys. "We run surveys and focus groups, both through pro-



RICHARD REAM
Vice president of worldwide sales and service for Dialog

fessional third parties and things that we do on our own," Ream notes.

Sharon Magee, a longtime employee of CompuServe whose title is CompuServe Evangelist, emphasizes the importance of surveys. "As with any other industry," Magee says, "the only way to determine whether you are delivering what customers need and expect is to stay close with them. CompuServe has, for years, held focus groups around the country, and there's our feedback section."

The people who make up an on-line service's audience is a determining factor in what they expect and what they infer to be promises. Ream says, "I think so much depends on the audience. For the information specialist, Dialog is definitely delivering on its promise and expectations. We have come out with some really important key features, and we pay attention to the marketplace and stay close to it."

Patricia McParland, a marketing communications specialist at NewsNet, concurs. "We're appealing to a market that is kind of segmented," McParland explains. "People are coming from all angles. The need that NewsNet has responded to [has made us] a timely information service, as opposed to an archival database. This has been a gradual evolution since 1982. We started strictly as a newsletter database with 15 newsletters. Now we have more than 500."

Jay Scheth, director of marketing for SprintMail's international value-added networks, states, "I think that services like SprintMail are delivering on their promises, without question." Like others, Scheth cites his service's growth and customer-survey responses as indicative of success in delivering on its promises.

Growth and Changes

Every on-line service has several direct competitors. For instance, NewsNet competes with services such as Dialog, IQuest, and Dow Jones News/Retrieval Service. SprintMail's head-on competition includes BT Tymnet's Dialcom, MCI Mail, AT&T Mail, and a host of other E-mail services. However, the



MARTHA GRIFFIN
Program manager for Prodigy

concepts on the current and future state of on-line services.

Promises are implicit in advertisements for on-line services, but services advertise no more than they can deliver—most deliver quite a bit more. What's promised is, of course, open to interpretation, as evidenced by the daily spats between customers and on-line service management. Documentation and on-line service content imply certain promises, and this is the source of some misinterpretation. In view of the problems that

competition for these larger services isn't suffering; all of them seem to be enjoying growth in a market where there's plenty of room for everyone. But there is a definite feeling in the industry that some services are experiencing proportionally larger growth rates than others.

The situation is similar among the consumer-oriented on-line services. Sharon Magee cites CompuServe's growth as evidence of the service's delivering on its promises. The promises change as the market evolves to what users want and services strive to adapt to the changing market.

Martha Griffin emphasizes Prodigy's commitment to delivering on its promises. "The promise that we make at Prodigy is [to provide] a service with something for everyone in the family—a service that can be personalized," she says. "Although we now have nearly 1 million members and are still growing fast, each one of those members can create his or her own personal service." She refers here to Prodigy's Findword feature, which looks up products related to a topic and presents a categorized menu from which the customer can select the desired product.

Patricia McParland says that NewsNet has a strong commitment to keeping up with changes in the marketplace as a means of delivering on its promises. "Now the emphasis is on having a 'current awareness' database," she explains. "We've added a lot more newswires; we [now] have 20, almost all of which are real time." *Real time* means that news is available to subscribers only minutes after the newswire posts it. "We're marketing to a combination of information specialists, corporate librarians, and researchers," McParland continues, elaborating on the need to deliver timely information.

At Quantum, Steve Case notes that "the market is evolving in a pretty predictable manner. People expect these services to take off, but it takes a while, like any kind of media." Quantum seems to proceed carefully, bringing in innovations only after considering whether they are what the company should be doing to fulfill its promises.

What the Users Say

It's easy to let on-line service industry spokespersons explain that their companies are doing everything correctly and that their services are delivering. But what do the users say? After all, the users are the ones who pay the bills and must justify their time and monetary costs.

From a user's perspective, the comments of industry expert Jerry Pournelle echo those of an overwhelming majority of users polled: "On-line services are delivering what they promise. We're still learning management methods, so that on-line communications don't dissolve in 'flame wars,' but that's shaking down, too. Most of the on-line outfits do deliver more than the customers know—there are often unused features hidden behind poor documentation or balky user inter-

faces."

Some of the on-line service growth is probably due to the effects of the recent price competition among consumer on-line services. GENIE's new flat-rate pricing produced "an explosion in usage," says Neil Harris. Delphi and BIX also report that new flat-rate or alternative pricing structures have been successful, and CompuServe is putting together its own version of flat-rate pricing for a tier of services. Steve Case, who helped pioneer flat-rate pricing for consumer services, opines that prices are almost bottoming out.

"The pricing thing has gone as far as it's going to go," he notes. "Things will slow down. The market is not going to grow because of pricing; now the market growth is going to be driven by value."

Are Customers Getting What They Want?

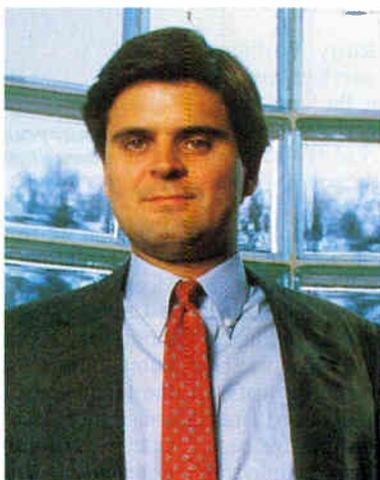
Value—services received for money paid—is certainly an important issue for customers. And it's quite separate and distinct from on-line services' delivering what they promise. At first glance, the distinction between the two may seem nonexistent. However, on-line services are very sensitive to what their customers want. In fact, to a great extent, customer demand shapes what on-line services of-

fer in terms of products, services, and how they are accessed. It's almost a natural phenomenon—if customers don't use a service or product, it doesn't generate revenue and usually disappears; if a product is popular, it generates revenue and stays.

Customer feedback and demand often help create some new products. Magee says this happens frequently on CompuServe. "Ideas for many products have come directly from customers. We receive 200 to 300 suggestions from customers per week," she notes. She relates one instance in which demand forced a new product into being. "We used to have a genealogy section within another forum. It was really popular, so we decided to spin that out into a forum on its own." The genealogy forum has been an unqualified success.

GENIE takes the approach of adding as many new services as possible in response to customer demand. "There are lots of new services coming up every month," Harris enthuses. "We're looking for more information services, more topics for special-interest roundtables, and, of course, support for new computers and software companies."

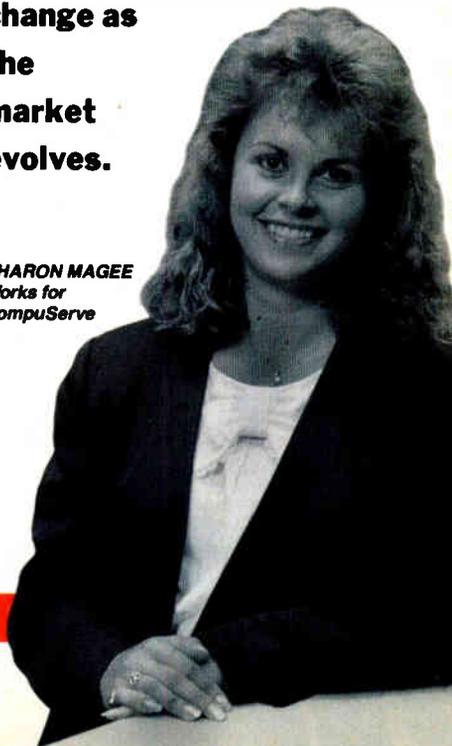
Dialog's Ream reports, "We certainly have strong content and support for the information professional, and [we] have a well-deserved reputation in the areas of documentation, search aids, training, and so forth. I'm comfortable that we are



STEVE CASE
CEO for Quantum Computer Services

The promises change as the market evolves.

SHARON MAGEE
Works for
CompuServe



meeting the [users'] needs. Everyone would like more predictable pricing, or whatever it may be, but I feel really good about how we are doing in our core market."

Dealing with the information end-user market is another matter. "When you move toward the professional end user, you have someone who wants to come into contact with the information and not the service," Ream says. "I think people feel guilty that they know information is out there and know it's important but can't quite figure out how to get their hands on it. Getting unnecessary information, or more than you expected or wanted, is really no more acceptable than getting no information."

Here Ream brings up a problem that all on-line services have to deal with—the accessibility of information and a service's need to present itself as a service rather than as a "computer network." This is partly because the on-line service market—computer users, in general—is far less technically oriented than it was five or even two years ago. That, in turn, is due to the technology's becoming easier to use as it becomes more ubiquitous.

At NewsNet, McParland gets lots of customer feedback regarding making the service easier to use. "One thing that would make customers satisfied," she says, "is a common command language. That's the area in which I see on-line

databases headed eventually, because that's the number-one question or complaint I hear: 'Why can't I use the same kind of commands as on Dialog or Mead Data?'" Customers on other services echo this complaint, and it is certainly one reason front-end software such as GENie's Aladdin and Dialog's Dialog-Link exist—to make accessing a service as easy as possible. Or, to echo Ream's idea, to contact the information rather than the service.

General Videotex's Rusty Williams maintains that on-line services are, in general, delivering what the customers want. "The variety of services available is amazing," he remarks. "Whatever you may need, it is likely you'll find it somewhere on-line."

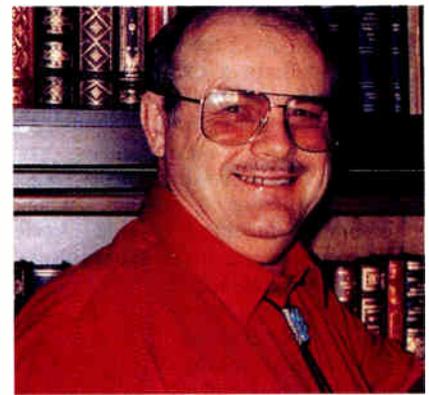
However, like others, Williams sees some problems for modem users in finding what they're after. "The challenge for potential customers is understanding the steps involved in locating and using the service they want. Issues like pricing structures, accessibility, and navigation methods all need to be understood first. These are considerable hurdles for people who are looking to conserve time and effort in the first place. The recent changes in pricing and service design by many on-line services have helped simplify this process somewhat, but there's still lots of room for improvement."

Williams echoes the thoughts of on-line service managers with regard to making things easier. "The more we can simplify and standardize, the more likely it is we'll finally reach the mass-market potential," he says.

Jerry Pournelle is less enthusiastic in this area. When asked if on-line services are delivering what customers want as opposed to what the services promise, he replies, "Nothing does. Everyone wants more from almost every service." But, he adds, on-line services are delivering "some of it." He notes that there are roadblocks to on-line services' getting everything that they'd like on-line. In particular, he says that "information utilities haven't yet solved the problems of intellectual property, but they are working on it."

On-Line Ideals

Given that on-line services are delivering on their promises and providing most of what customers want (although with a few problems), I asked on-line service managers what they thought the ideal business situation would be. Steve Laliberte, BIX's director, is interested in having more consistent business practices among on-line services. "I would



JERRY POURNELLE
Science fiction writer and senior contributing editor for BYTE

hope that we would see an Audit Bureau of Circulation report for on-line services," he says.

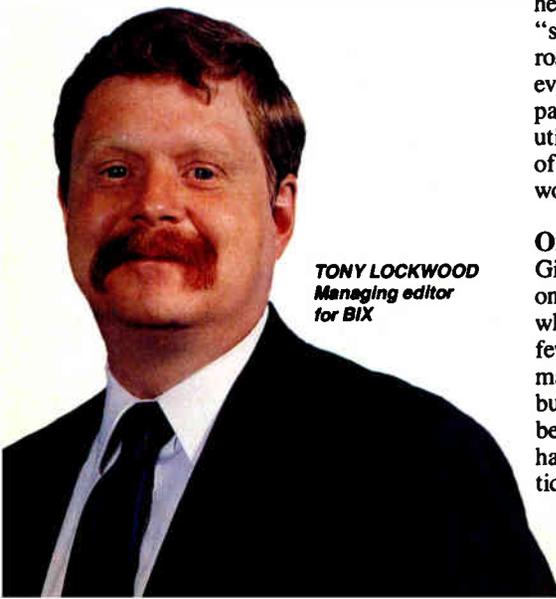
Commenting on an element that almost everyone sees as a major issue, Williams states, "I'd like to move away from the technology side of on-line services and concentrate on the programming side. I purposely choose the term *programming* to draw an analogy to television. Ideally, we would sell our services much like cable television options: There would be universal access to services, and the interface would be standardized. People would look solely at the substance and price of a service to make their purchase decision. To continue the analogy, we'd have people choosing between SportsChannel and HBO rather than thinking about stop bits and file compression."

Williams is not alone in preferring that customers move away from the "computer network" orientation and concentrate more on the content than the on-line media. Prodigy's Griffin sees a similar need. "We would like to see people think of Prodigy as an information appliance, as something routine in their daily lives," she says. "[We'd like to see it become] common not only in homes and offices, but also in public institutions such as libraries, hotels, and hospitals."

There is, however, a major problem in getting people who are new to modems or computing to look at on-line services. "It's an unknown, and when something is an unknown, people are less willing to try it," Griffin explains. "But once they try it, members tell us, it becomes a part of their lifestyles, and we would like to see that phenomenon broaden."

Magee elaborates on the concept: "I think the challenge of an on-line service is being able to use your computer to log onto this big entity—the entity being

50 million kids are coming up behind my generation; all of them are learning about computers.



TONY LOCKWOOD
Managing editor for BIX



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As for what Case would like to see in the personal computer communications arena, he says that he'd like to see “some expansion of recent trends: the growing awareness of on-line services, modems bundled with every computer, and lots of portable computing devices for communication.” It is a safe bet that everything Case lists will happen eventually.

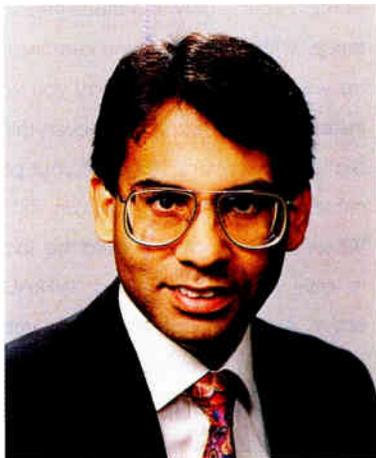
Magee thinks that putting modems and communications software in the hands of computer buyers will help legitimize on-line services. “Every PC should come with a modem and an on-line service, which would be thought of on the same level as a word processor,” he explains. “Basic PC software would be databases, word processors, spreadsheets, and information services.” Ream sums it up: “I think in some ways the number-one need is to increase the value and awareness of information, building the awareness that the personal computer is an important device for compiling, storing, and accessing information.”

The Future

The preceding comments imply some obvious directions for the future of on-line services: easier access, more consumer-oriented products, and a continuing effort to educate the masses to the benefits of modem use. Our experts see these and many other changes in the next 10 to 20 years. Harris claims that on-line services will continue to be “bigger, easier to use, faster, and with more to do for a lower price. We have more members joining now than ever before, and a lot fewer leaving.”

CompuServe, which already holds a record for offering more front-end programs for more kinds of computers than any other service, is going to continue to work on making access easier, according to Magee. “CompuServe’s effort in the next couple of years will be to improve the GUI and automate the access,” she says. Laliberte sees on-line graphics presentation in the future, but he doesn’t believe that it is an end in itself. “I think

that services will get more specialized and more visual,” he notes. But at the same time, he says, “There will be a greater concern for the quality of the information and the interaction.”



JAY SCHECH
Director of marketing for SprintMall

Delphi, a strong text-based service, is moving into the front-end business, but it is not worried about having a GUI. “With the success of the Macintosh and Microsoft’s Windows, some people talk about ‘text-based’ as if it’s inherently inferior,” Williams notes. “The contrary is actually true. In many cases, a simple text-based interface may be the fastest and easiest method of accessing information. When the information

is what matters, the presentation becomes less important. Most Delphi members use the text-based menus and appreciate the speed and ease of use.”

Case, however, makes it clear that “the future is our kind of service,” referring to Quantum’s front-end-based approach. “You have to have a slick, easy-to-use, broader interface that is reasonably easy to use, but not at the expense of being functional,” he says.

At Prodigy, where using a front end is standard operating procedure, the future lies in part in being flexible. “We are not wedded to a specific technology,” Griffin says. “We are an information and transaction service. Our commitment is to serve our members and to use the best technology available to do that. Presently, the best way is [with] a computer and modem, and we do offer some excellent graphics presentations. However, if we find that multimedia equipment is available in large numbers of households, and if that’s the way the market is going, then that’s the way Prodigy will be transmitted.”

Eventually, we may see one front end that connects with all on-line services. McParland sees the possibility for this, something along the lines of a “complete information center” that would send and receive E-mail and find information on-line without the user’s knowing which services were being accessed—or even if the computer was on-line.

Ream agrees that “the user interface is clearly very important, but there is

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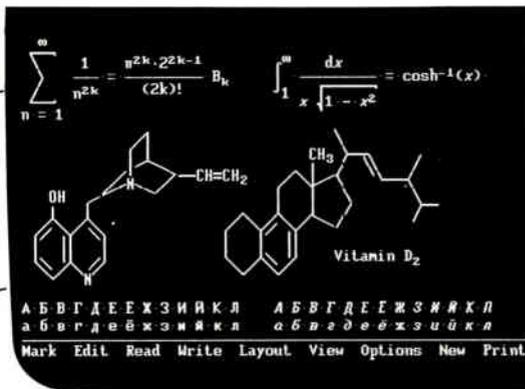
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FORECAST

another dimension called *accessibility*. With the globalization of data networks and the power of on-line services, there is going to be a big change in how services are being used. I think the future is somewhat dependent on our success in being able to deal with 'controlled usage' by businesses and institutions and elec-

**You will see
many more on-line
services being offered
on an international
scale.**

tive usage by individuals. If we continue to service the professional, we'll have a nice usage and continue to grow. If we want to explore the full available potential of the market, we have to be effective in distributed environments."

At NewsNet, McParland envisions market-customized services. "That's a direction in which we're heading now," she says. "We're trying to appeal to searchers by profession, to information professionals, and end users who are computer literate, but not on-line-service literate. To reach all these markets, we have to make it easier for the end user. What I see us doing is having a whole range of different interfaces for a whole range of users."

Ream sees "tremendous opportunity with the change in the Eastern Bloc countries; there's viable opportunity in Russia, too." These are interesting comments from a vice president of a service that has customers in 103 countries and that was able to support a presence in Mexico, where business has been lean and other services have pulled out, during the past 10 years.

Jay Scheth sees an expanding global marketplace, too. He observes, "You'll see many more on-line services being offered on an international scale. There is a deregulation trend that is taking place, in different flavors. Some countries, such as the U.K., are even more deregulated than the U.S. Countries are relaxing their control and allowing the presence of American carriers. We will have 'global one-stop shop' capability with billing from one source."

There is already a solid international

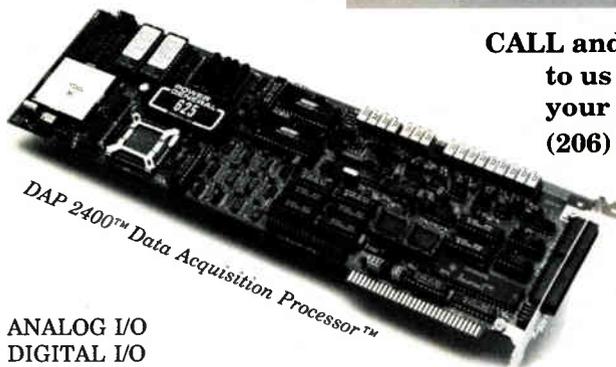
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movement among consumer services. BIX promotes overseas access heavily, and CompuServe, Delphi, and GENie each have gateway arrangements with services in Japan. CompuServe and GE-



STEVE LALIBERTE
Director for BIX

first, taking a public, commercial mail system like CompuServe's and hooking it up with a university/government mail system. I definitely think that's the way everyone's going."

McParland indicates that NewsNet is looking at interconnectivity as a means of distributing information products. "I see us reaching out toward delivering information from NewsNet through our NewsFlash clipping service to someone who doesn't have a computer," she says, "through fax and FM sideband, as well as through any E-mail system set up with X.400 interconnections."

New technology should bring increased line and transmission speeds not only to modem users but also to new products. Magee thinks that faster transmission will "have some impact on the kinds of information we can deliver. It's been almost impossible to do complete software package delivery, for instance, but with faster speeds, size becomes less of a factor." She believes the transition to 9600-bps transmission will take a relatively short time. "The migration from 300 to 1200 bps took about two years—2400 was more like a year. The transition to 9600 should take less time. A lot of it has to do with the price of the hardware, though."

Harris concurs. "We've just launched 9600-baud service using the V.32 standard. Next year, we'll add V.42 also, which makes the service even faster. As more and more people move up in speed, all sorts of things become possible—you might see multimedia come to on-line services before long. A few years back, 80 percent of our usage was at 1200 baud or slower. Today, 80 percent is at 2400, and it won't be long before it moves up another notch or two."

Almost everything depends on on-line services' being "legitimized" in the marketplace, a trend that Lockwood believes is well on its way. "This industry is going everywhere," he claims. "There are 50 million kids coming up behind my generation; all of them are learning about computers and telecommunications. They'll get on-line like my generation uses the TV."

"Perhaps an AT&T spokesperson said it best when she was asked who she thought would use AT&T's new modem/terminal/telephone: 'It took 20 years for the Touch-Tone phone to catch on,'" Lockwood continues. "It may take 20 years, but on-line systems are here for good, and we're taking over."

Jerry Pournelle is equally enthusiastic. "On-line services are rapidly becoming indispensable," he affirms. "John

McCarthy talked about the upcoming Information Utilities back in the early 1970s; it looks as if the 1990s will see them happen. All told, they have a great future." ■

PARTICIPANTS

■ *Steve Case joined Quantum Computer Services in 1985. He served as executive vice president until early this year, when he was named CEO.*

■ *GENie director of marketing Neil Harris has been with the company for five years.*

■ *Rusty Williams, vice president of sales and marketing, joined Delphi in 1986 and has been involved in the management of regional services, joint marketing programs, and national promotions.*

■ *Martha Griffin is Prodigy's communications program manager.*

■ *On-line veteran Richard Ream is Dialog's vice president of worldwide sales and service. He is active in promoting international telecommunications and innovative information products.*

■ *Sharon Magee has been a CompuServe employee for eight years and works out of the company's Atlanta regional office as a CompuServe Evangelist.*

■ *Patricia McParland is a marketing communications specialist for NewsNet. She is currently working on several projects related to alternative delivery of on-line news and information.*

■ *Jay Scheth is director of marketing for SprintMail's international value-added networks. He is particularly interested in the potential for customized on-line news and information services.*

■ *Jerry Pournelle is a science fiction writer and a regular columnist and senior contributing editor for BYTE.*

■ *Steve Laliberte is director for BIX.*

■ *Tony Lockwood is managing editor for BIX.*

Michael A. Banks is the author of The Modem Reference (Brady Books/Simon & Schuster, 1991) and more than two dozen other nonfiction books and novels. He can be reached on BIX as "mike_banks."

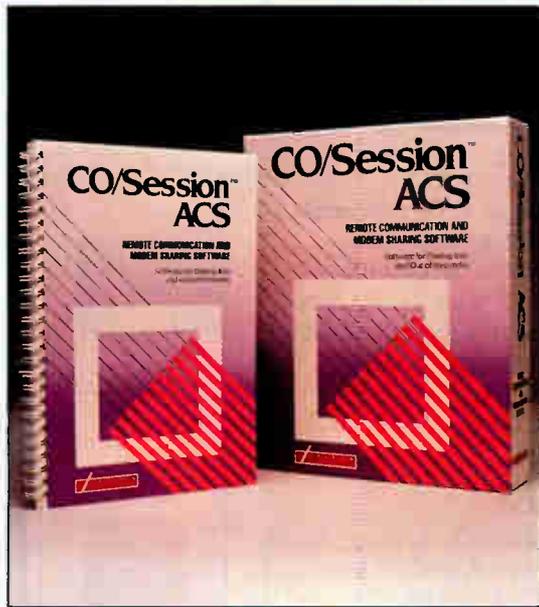
nie have set up direct-dial access from a variety of European countries, and they are gearing up for further expansion of these services.

Some of the consumer services' incoming gateways include customized services designed for use in other countries; for example, Delphi's Argentina service and GENie's German service both feature versions in the countries' native languages. An outgoing gateway to Japan's PC-Van from GENie does the reverse, providing American callers with 7-bit English and 2-byte kanji and hiragana characters.

In addition to customizing for international use, there's a trend toward customizing for specific markets. Ream notes that Dialog has to "present that end user with really a sort of 'wizard behind the curtain' technology." BIX's managing editor Tony Lockwood sees quite a bit of custom services in the future of on-line services. "Most electronic services are taking the 'be everything for everybody' track," Lockwood says. "In the coming years, niche markets will develop."

Interconnectivity on the home front is in the future, too. On this issue, Magee says, "I think interconnectivity is an important issue. We [CompuServe] recently completed an X.400 agreement with AT&T Mail, which was the first of what will probably be multiple interconnections. Our Internet gateway was kind of a

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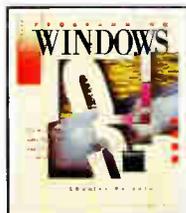
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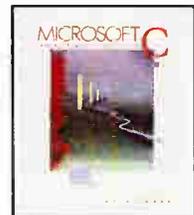
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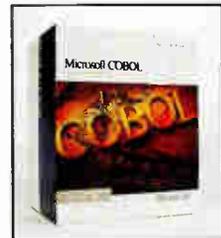
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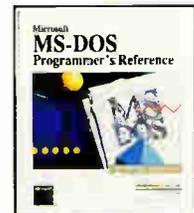
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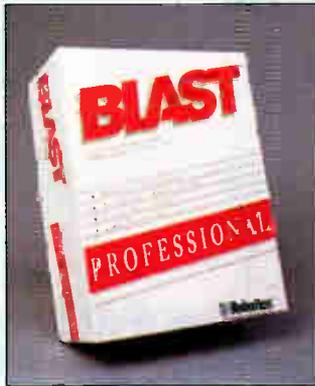
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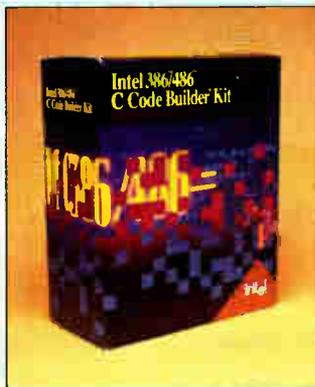
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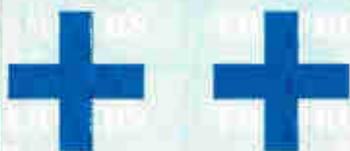
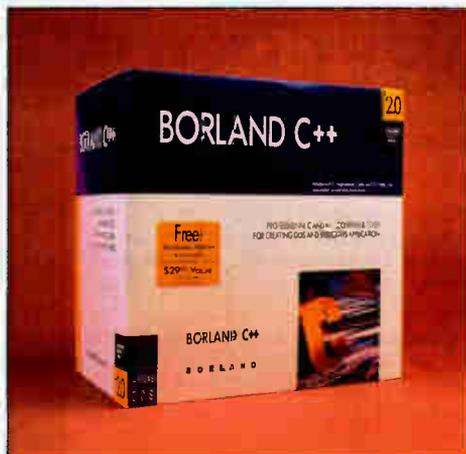
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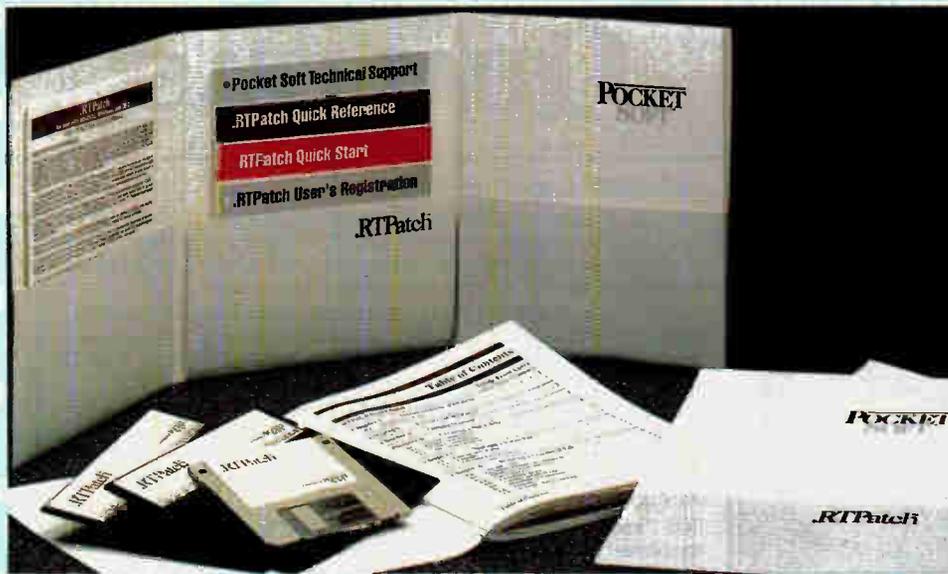
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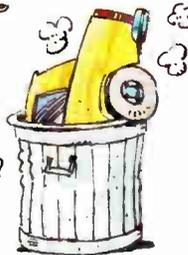
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B. Replace the car?

C. Add new spark plugs?



ANSWER: B is preferable, but C is the logical approach.
LOGIC: A tune-up costs less than replacement.

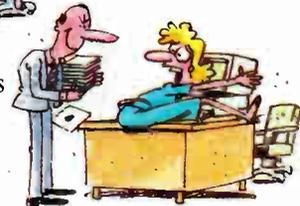


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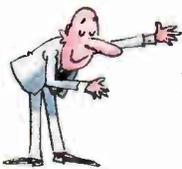
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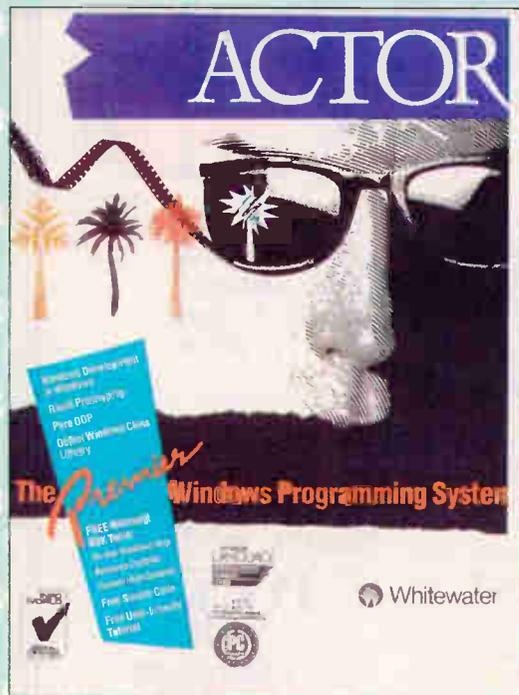
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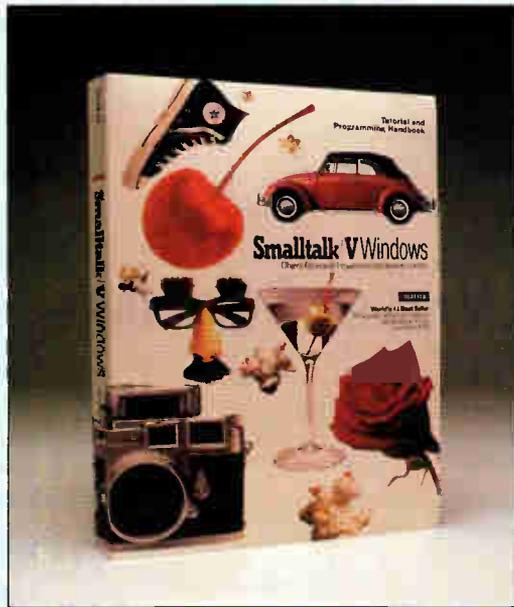
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Surveys Say...

Do we see common threads in personal computing's future?

GENE SMARTE

During the course of each year, BYTE takes the pulse of both readers and non-readers to gauge opinion and day-to-day realities in this dynamic industry. Most of the information we accumulate makes pretty interesting reading, because it lets us know what other folks are thinking and doing. It also provides another factor in BYTE's editorial equation, so we anxiously await the results of each poll and survey to see how you and we are doing. As part of our Outlook '92 issue, we thought we'd share some key results of several surveys the magazine has conducted this past year.

As usual, we can't claim that these surveys speak authoritatively for *all* the millions of personal computer users out there. Those who pitched in their two cents, however, paint an enlightening and often entertaining picture of computer-related activities at this exciting time. We've provided little annotation, so you can draw your own conclusions.

Comdex Operating-System Polls

Beginning in the spring of 1988 and continuing through the spring of 1991 (so far), BYTE has put this question to Comdex attendees who stop by the BYTE booth: "Which operating system/user interface will become the dominant force in the personal computer industry by the end of the next five years?" Some trends have begun to emerge; others remain murky. Windows 3.0 was added to the Extended DOS category in the fall of 1990; its impact is evident in the spring 1991 poll. The table summarizes the results of these polls. Note that the totals often do not add up to 100 percent, owing to multiple responses given to some questions.

Comdex Technologies Poll

At the 1991 Spring Comdex, BYTE combined forces with other members of McGraw-Hill's TechNet publications group, *Data Communications*, *LAN Times*, *UnixWorld*, and *BusinessWeek*. We took this opportunity to include new questions about key technologies along with our traditional operating-system/user-interface question. Here, then, are the results when 4400 Comdex attendees were asked to "check only one."

Which of the following technologies will have the greatest practical impact on computing at your company in the next five years?

Multimedia (video, graphics, and sound): 34%
 Portability (laptops and notebooks): 27%
 Wireless communications (LANs, wide-area networks, and cellular modems): 18%
 Object-oriented programming: 15%
 Voice technologies (input, synthesis, and annotation): 10%
 Pen input: 6%

Which LAN operating system will be dominant by the end of the next five years?

NetWare 386: 55%
 LAN Manager: 28%
 IBM LAN Server: 12%
 Banyan Vines: 4%
 TOPS: 2%

Which workstation CPU architecture will be the most prevalent by the end of the next five years?

Intel: 68%
 SPARC: 12%
 Mips: 12%
 Motorola: 8%

A Fenestrated Survey

While *fenestra* may refer to windows in Latin, Windows 3.0 is not Greek to the industry, as this survey found out. The Windows 3.0 User Survey asked a cross section of BYTE readers about their involvement with Windows. The one qualification for participation was that they had to have access to Windows 3.0 at their workplaces; they did not have to be using it. Of the readers we contacted, 49 percent met this qualification. Here are the highlights:

- 69 percent currently use Windows at work and have been using it for an average of seven months (as of April); 15 percent plan on using it within the next year; 15 percent are not using it; 49 percent use Windows' multitasking capabilities.
- 68 percent run Windows-based word processing, spreadsheet, and/or database programs, and 44 percent plan to replace their character-based programs.
- 54 percent of the WordPerfect users would reconsider Windows as soon as WordPerfect for Windows is ready. The Lotus 1-2-3 and dBase IV users were not so inclined to move, with only 30 percent and 27 percent, respectively, willing to reconsider.
- Hardware upgrades are delaying the use of Windows for 30 percent of those

COMDEX OPINION POLL RESULTS

Which operating system/user interface will become the dominant force in the personal computer industry by the end of the next five years? Results are in percentage. (N/A=Not applicable.)

	Spring 1988	Fall 1988	Spring 1989	Fall 1989	Spring 1990	Fall 1990	Spring 1991
DOS alone	30	18	14	18	23	18	6
Windows/Extended DOS	N/A	31	30	31	32	39	56
Unix/Xenix	24	23	22	18	21	16	18
OS/2	32	16	20	16	13	12	12
Macintosh	4	3	3	3	2	2	2
None	9	8	10	13	<9	12	9

surveyed. A minimum recommended configuration is a 386SX and 2 megabytes of RAM, but most users have a 386DX and 4 MB of RAM.

• Most users rated Windows' features between excellent and average, with the exceptions of speed and network-specific functionality, which they rated average.

BYTE Outlook Issue Survey

In the spring of 1991, BYTE mailed a survey form loaded with questions about

technologies and products, current and future, to a cross section of its readers. The results are quite diverse, yet some points show up regularly. Because of the diversity of answers (respondents could write in any answer they wanted), we don't have the space to publish each response. I'll try to summarize the most popular replies. Some pet peeves also emerged, as you'll see.

BYTE thanks all of you who completed the four-page survey. That alone

says something about how involved you are with your computing environments. In addition to responding to the questions asked, however, some of you added pages of details that outlined why you felt this or that way and why things were or were not important to computing environments large and small.

Interestingly, we have received several very detailed pleas for improved keyboard design. Whether carpal tunnel syndrome, inconvenience, annoyance, or combinations of these and other perceived deficiencies are behind these requests, we don't know. It is important to note, however, that the keyboard is today's primary tactile interface, and if lengthy unsolicited comments on what's right and wrong with keyboards arrive in disproportionate share, improvements might be worthwhile. We thank you all for sharing what concerns you most.

Which technologies do you feel will be most important for the next five years, and why?

In the hardware category, the clear winner was optical storage—CD-ROM and WORM (write once, read many

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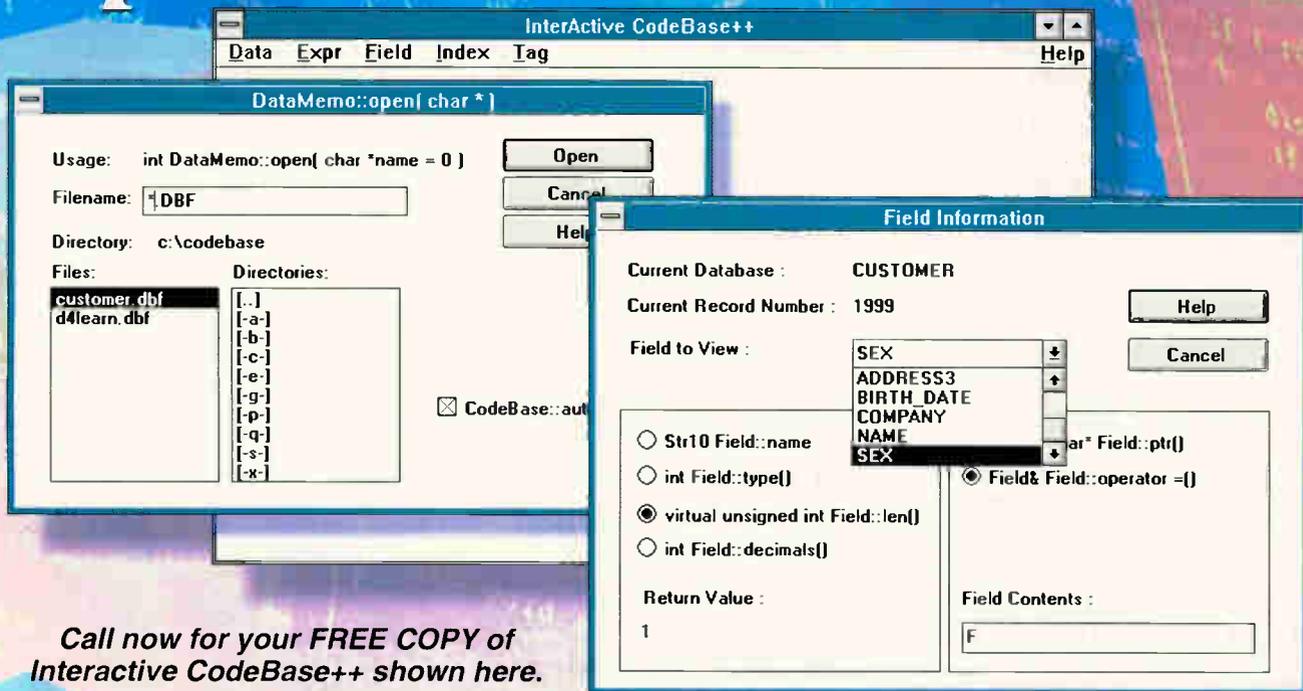
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times)—with fiber-optic networking also mentioned. Multimedia (the hardware parts) also garnered a large share of the voting, as did image processing, color flat-panel displays, handwriting and voice processing, and lower-cost and color laser printers. These were all tied to increased processing speed brought about by faster, denser chips.

For software, object-oriented programming showed up in a clear majority of the responses, followed by user interfaces. Many respondents felt that AI, including neural networks, will begin to be a factor in software capabilities. More mundane trends will include desktop publishing perhaps becoming more common than word processing, and optical character recognition uses accelerating. Other respondents noted that diverse software and interfaces might begin to work together more seamlessly.

Which specific types of products and services do you feel are needed most in the next five years, and why?

A couple of clear winners emerged here. First, standardization, in which programs run transparently across platforms and operating environments, is a prize that many see as crucial. Second, support has been found wanting; people can't seem to get their questions answered. Coupled with the perceived lack of support is a cry for better computer education in the classroom. The third theme was better large-scale database structures and communications accessibility.

Regarding existing products, which in the following categories do you now use and plan to retain?

We divided this question into several categories. Under computer systems, the dominant platform cited was the 386 with lots of RAM and big hard disk drives, but that system was followed closely by similarly equipped 286s and Macs. While the 486 and 68040 technologies were acknowledged, many respondents noted that costs had not quite come down enough. In the peripherals category, 24-pin and laser printers dominated, along with 2400-bps modems.

For applications software, a diverse group of word processors, databases, and integrated packages was listed. As noted in the Windows survey and in comments with this survey, people need good reasons for leaving their old software. The development software category found C, C++, and assembly language prevalent. Pascal and BASIC showed up occasionally, too. Finally, DOS with Windows

dominated the operating-system category, although Unix and the Mac OS also were sprinkled in there.

Describe products that could use existing technology and are not being manufactured that you'd like to see and why.

This question was the first of three that gave the survey respondents a chance to express their ideas of the future. Others reviewing this data might uncover a trend here and there, but to me the diversity of the answers is the biggest trend.

Which technologies do you feel will be most important for the next five years? In the hardware category, the clear winner was optical storage—CD-ROM and WORM, with fiber-optic networking also mentioned.

Many asked for products to be less expensive, considering that if a product is not affordable, it's the same thing as not being manufactured. Others had very esoteric requests, especially for more universal and disability-specific solutions to working with computers. Still others mentioned wanting products that we knew existed, highlighting the bigger problem of finding what you need even when it's already available. And, finally, we found that what one person wanted as a solution could cause problems for others; a lot of subjectivity is ricocheting around in these responses.

Here are some of the responses, quoted verbatim and without comment:

"A floppy drive with a 1.44-MB cache that is filled [copied from disk to cache] when the [drive] latch is closed."

"Diagnostic programs [for] car, TV, dishwasher. Enter the symptoms and get an analysis and repair instructions."

"As heat is a major enemy of inte-

grated circuits, it seems obvious that a PC should have one or more thermometers built into its design, with the data reported to an I/O port and a TSR (or even part of the operating system) that would issue warnings if the temperature was too high or too low."

"Operating systems which track a user's habits and anticipate commands or uses and execute the command unless instructed not to. The same would hold true [for] applications."

"Combination laser printer/copier/fax machine."

"Self-configuring hardware and software that is brand (architecture) independent."

Before finishing up with a look at what the survey respondents think personal computing will be like in five years, I have one more task. Progress usually leaves some casualties in its path, so we asked the following question:

Which present-day products do you feel will disappear in the next five years?

The answers to this question were predictable: The 8-bit machines are gasping, and the 286 is not far behind. Also fading are low-capacity and slow hard disk drives, as well as slow (below 2400-bps) modems. Dot-matrix printers also are on the endangered list, along with floppy disk drives and monochrome displays. Text-only-based software products have a fair chance of disappearing, too. Some verbatim replies follow:

"Next [computer] (sorry, Ross Perot)."

"Macintosh and mainframes."

"IBM PCs should disappear but won't."

"Vanilla DOS machines—good riddance! (wishful, I know)"

"Software that does not let the user share data across many software packages and operating platforms."

"Turntables for LPs."

Please comment on how you envision personal computing evolving in five years. For example, typical system capabilities (e.g., sizes, speeds, portability, mass storage, and display type), networking, communications, costs, software capa-

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Fig. 1

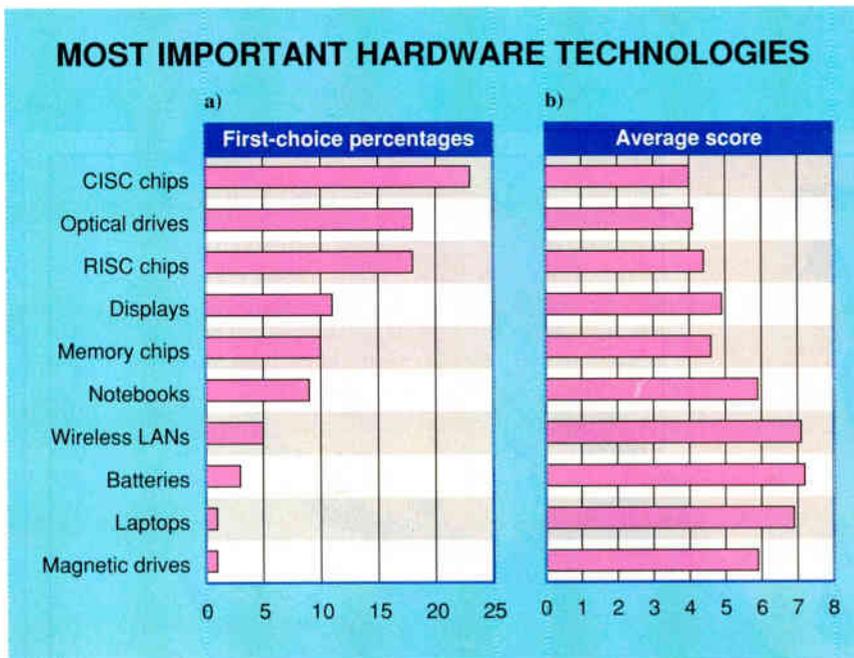


Figure 1: (a) BIX's survey of the most important hardware technologies for the next five years. Each column represents the percentage of number-one picks for that topic. (b): Alternative hardware technologies' ranking, in which the total points for each category were counted, with the lowest overall score the most important, and the highest score the least important.

bilities, dominant languages, operating systems, and so forth.

Now we turn to the crux of this survey, the final question. Here is where we hoped to get the goods on the future and share it with everyone. Some responses looked too far into the future, expressing hope for a 100-million-instruction-per-second machine the size of a pack of cigarettes, with voice actuation, real soon (i.e., now). Most, however, were quite practical in their expectations.

As you might expect, the trends under way today will continue. Everyday desktop systems will be more powerful; the 386/486 will be commonplace, with future 80x86 processors leading the pack. RAM will range from 8 to 16 MB, with optical drives securing a stranglehold on mass storage. Street prices will average around \$2500. Networking and file sharing will be much easier as a result of improved and standardized communications. The user-interface picture is not as clear, although everyone seems to agree that it ought to be better. Portables will almost equal desktop systems in power and convenience.

The survey respondents speak:

"Everyone will be using Windows 3.0 and hating it. DOS will never die. OS/2 will become the CP/M of multitasking systems. Unix will never die—it will mutate away!"

"GUIs will have to become much more efficient for experienced users. Most users will remain computer illiterate, proficient only in word processing or some specific canned application. All activities will be centrally controlled."

"Students must own a computer at junior high school level—like a pencil."

"In order to get computers to the mass public, they must be small, powerful, cheap, running software to do everyday things like purchasing, payments, financial transactions, entertainment, recording, and so forth, easily without [a] keyboard."

"The limits will always be pushed until we have a Cray on a wristwatch."

"More standards will be developed to let various vendors' stuff interact. More good cheap software. More BBS usage. More viruses."

"Neural computing may be important in voice and handwriting recognition. Languages that support/enhance these functions would evolve."

"Desktop systems will be relegated to secretarial, clerical, and specialized

workstation applications. Personal computers will be pocket-size organizers [having] icon-oriented user interfaces with no manuals. A user will not have to use a keyboard to be a power user."

"I see operating systems evolving into a single standard (over the next 20 years)."

"Telephone, TV, video, and sound will be successfully integrated at a consumer-level cost."

"As far as software goes, it is almost too difficult to imagine, but I certainly look forward to the advancements."

Reader Survey on BIX

Along with mailing out written surveys to BYTE readers, we also conducted a survey on BIX. The cost of telecommunications coupled with the possible quagmire of data reduction from too many comments forced us to shorten and modify the written survey before we presented it on BIX. We did try to pose the same general questions within the format available, and, for the most part, the answers from the two surveys track well.

Please rank from 1 to 10 which hardware technologies you feel will be most important for the next five years (1 is most important; 10 is least important).

- Microprocessor (CISC) chips
- RISC chips
- Memory chips
- Magnetic drives
- Optical drives
- Displays
- Batteries
- Laptop computers
- Notebook computers
- Wireless LANs

There are at least a couple of different approaches to interpreting the results of the voting. First, if you count only the votes for the technology ranked number one, you can produce the chart shown in figure 1a. In it, 23 percent of the respondents name complex-instruction-set computer (CISC) chips as the most important hardware technology in the next five years. Optical drives and RISC technologies tied for second place, receiving the next largest number of "most important" votes. Certainly, optical drives were a heavy winner in the earlier poll results. The "most important" voting tabulations continue, with those responses receiving the fewest "most important technology" votes trailing to the right. Although most respondents use

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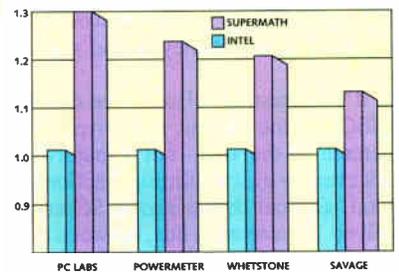
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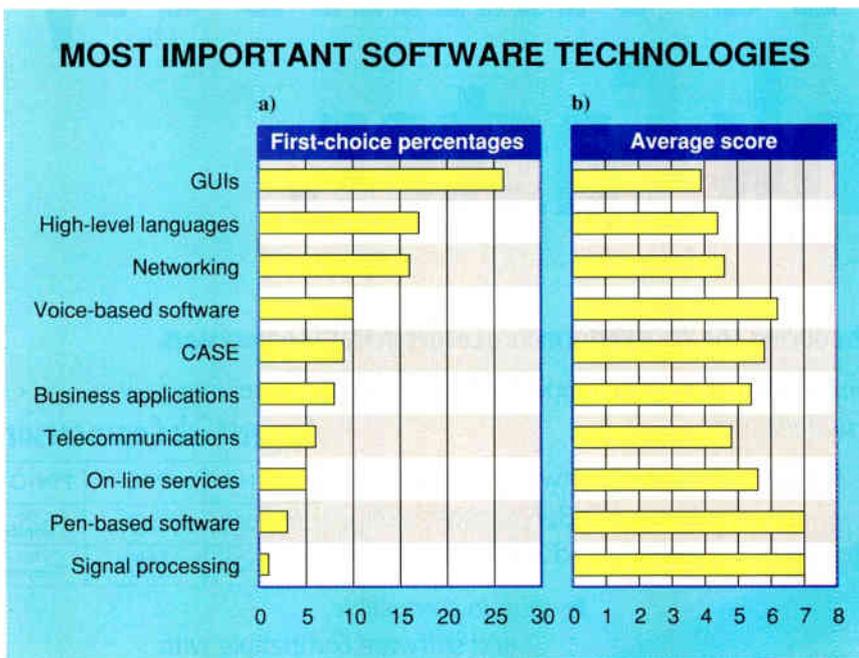


Figure 2: (a) BIX's survey of the most important software technologies for the next five years. Each column represents the percentage of number-one picks for that topic. (b): Alternative software technologies' ranking, in which the total points for each category were counted, with the lowest overall score the most important, and the highest score the least important.

magnetic drives today, it would seem that most thought they would not in the future.

It's interesting, also, to see that while CISC was the winner, it received only 23 percent of the vote—not a majority and not even an overwhelming fraction of the total. Optical drives and RISC each received 18 percent. Thus, between the top three, the responses equal just 59 percent. One conclusion is that few of the respondents felt that only one technology was key.

As a second way of looking at the voting results, you could count the total points for each category, with the lowest overall score the most important, and the highest score the least important. You then get a slightly different picture of the survey respondents' responses, as shown in figure 1b. This interpretation minimizes the results of one category's getting most of the votes for the number-one ranking, along with a majority of, say, votes for the number-nine ranking.

As figure 1b illustrates, displays and memory chips swap positions. But they were close neighbors (11 and 10 percent, respectively). Magnetic drives, however,

leap from last place to sixth, perhaps meaning that while that technology is not near the top of the respondents' "most important" list, it is a very real factor in the equation. There is some other small-scale jostling at the far right, with wireless LANs and battery technology bringing up the rear instead of laptops and magnetic drives. Note, too, that the average score ranges from 4 to 7, reinforcing the earlier conclusion that a single technology might not be the "most important."

Please rank from 1 to 10 which software technologies you feel will be most important for the next five years? (1 is most important; 10 is least important.)

- High-level languages
- Pen-based software
- Voice-based software
- GUIs
- Signal processing
- Business applications
- Telecommunications
- On-line services
- CASE
- Networking

Figure 2a plots the "most important" software voting using the highest number of votes for the number-one ranking. GUIs have a commanding lead, with 26 percent of those surveyed ranking it as the most important software technology. High-level languages and networking tie for second in the software category, indicating, along with the GUIs' importance,

that humans need to talk to computers and computers need to talk to each other. While we hear interesting things about pen-based computing, the survey takers were unimpressed, picking voice-based software by a margin of 3-to-1 over pens.

Figure 2b uses the "average vote" criteria. The first three categories remain the same, but voice technology takes a big dive from fourth place to eighth, CASE goes from fifth to seventh and telecommunications from seventh to fourth, and business applications and on-line services move a notch or two. Following the hardware category's trend, the average scores also are very close for software technology.

The promise of things such as shared files, workgroups, near-universal (or at least companywide) data access, E-mail, and other network attributes is attractive. However, we wondered if, in spite of the LAN hoopla, those users on networks were coming out ahead of those on their own little nonnetworked personal computing islands. So, we asked the following question:

Do LANs now provide more individual effectiveness than stand-alone personal computers?

Nearly 70 percent of the respondents said yes. So, those networkphobes remaining might give interconnection a try when the opportunity presents itself.

Another networking question that surfaces from time to time is whether networking might be some sinister plan to recentralize control of all personal computing. We asked the following, admittedly provocative, question to see what you thought:

Do you view networking as a possible threat to reconsolidate computing under an MIS department?

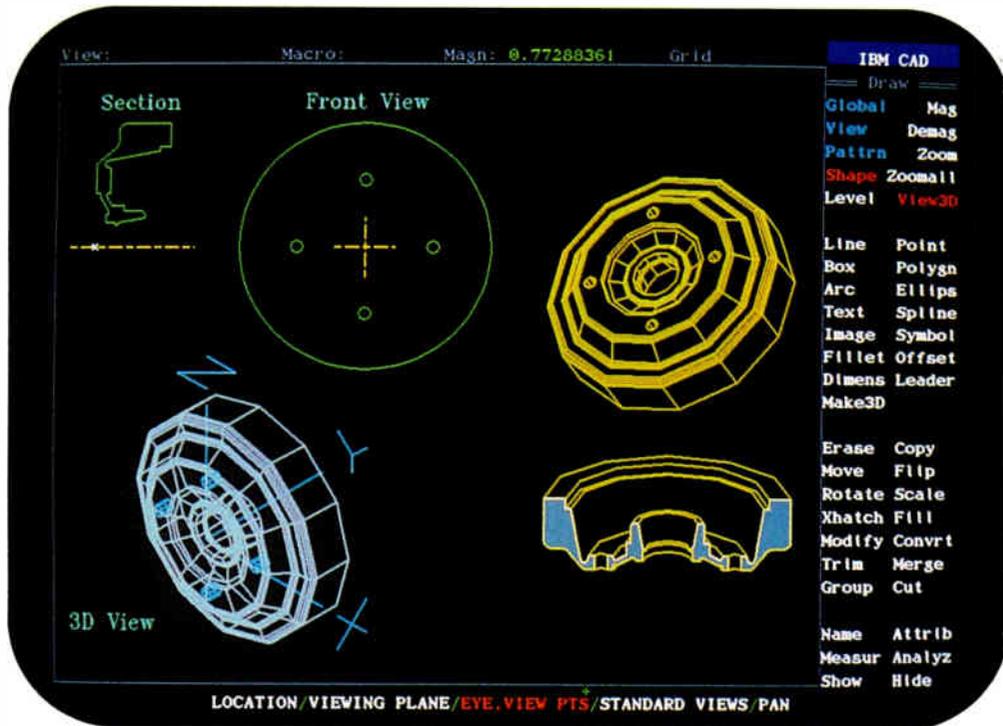
Little more than a third of the respondents thought that, indeed, networking was a potential threat to personal computing independence. The fact that almost two-thirds did not, coupled with nearly 70 percent rating an increase in self-effectiveness as indicated in the previous question, doesn't mean it isn't so. But the vast majority is unconvinced.

Finally, we wondered which, if any, microprocessor would dominate the personal computer industry in the next two years. So we asked you to answer this question:

Which microprocessor do you feel will power your principal personal computer system in two years? Select one only from the following list as they appear.

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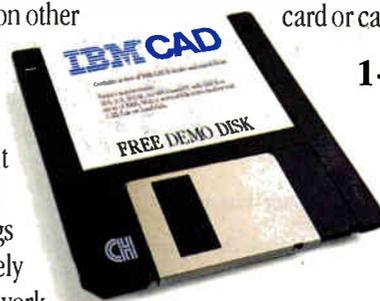
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Circle 21 on Inquiry Card.

World Radio History

- 68000
- 68020
- 68030
- 286
- 386SX
- 386
- 486
- 860
- RISC

Figure 3 shows the responses to this question. Unfortunately, the 68040 was inadvertently omitted from the list. (Thanks to those who contacted us about the error; unfortunately, it was too late to redo the survey.) The 68030 made such a strong showing that we are itching to find out which (030 or 040) will lead and whether the 030's score was so high because the respondents couldn't vote for the 040. We'll have the 040 in the next survey. In any event, it looks like the processor wars will continue, to the benefit of all of us.

A Grain of Salt

While the foregoing may make for interesting reading, please don't cash in your insurance policy to start a new business

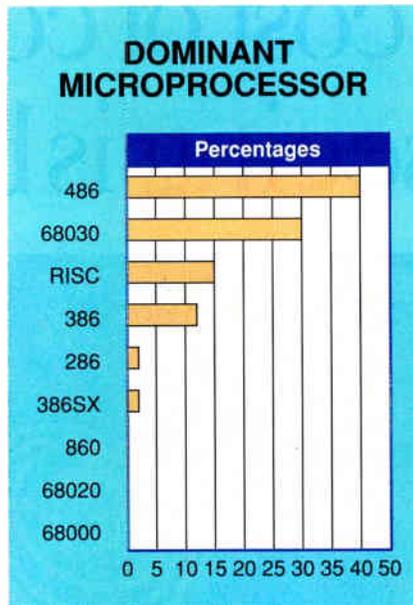


Figure 3: The answers to the BIX survey question, "What microprocessor do you feel will power your principal PC system in two years? Select one only from the following list."

based on these results. For that matter, don't do anything hasty based on any poll or survey, unless you're sure of your statistical and methodological prowess or can count on someone else's.

We hope that we have accurately documented some important trends; we know we have tried to maintain our nonplatform-specific objectivity to provide a possible look at the future. Polls and surveys from various sources can either corroborate or conflict ("lies, damned lies, and statistics"), and we will probably only know what the truth was via hindsight. Nonetheless, you have spoken, and we take note of it. ■

ACKNOWLEDGMENTS

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Gene Smarte is BYTE's senior editor for special projects. Located in Irvine, California, he can be contacted on BIX as "gsmarte."

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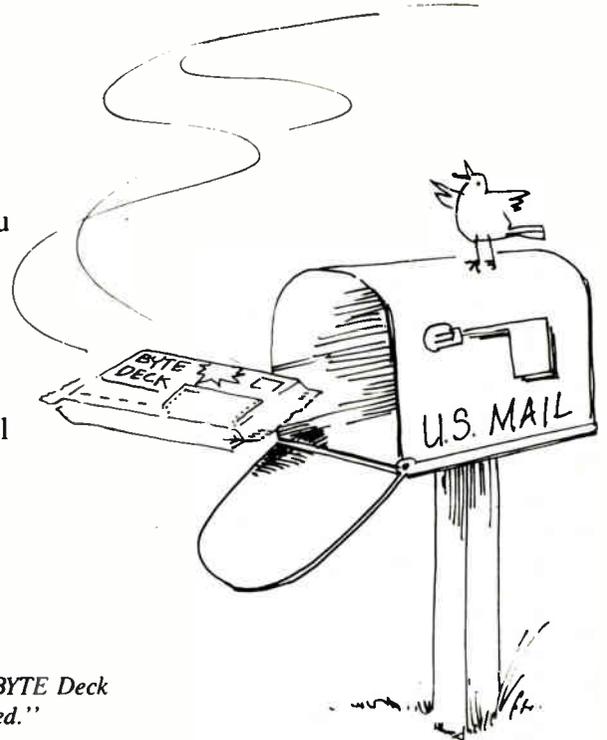
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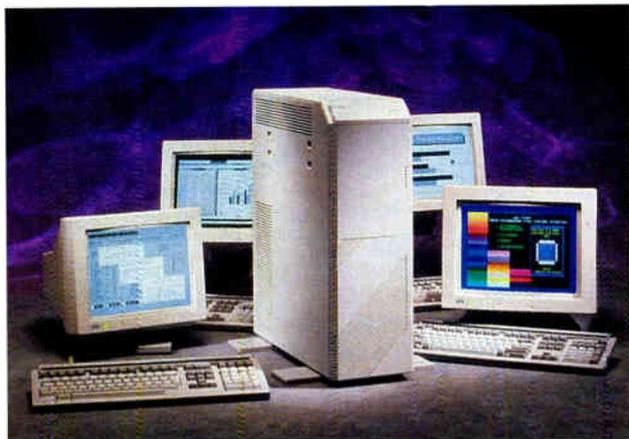
Price: \$5999 to \$9399.
Contact: Wyse Technology, 3471 North First St., San Jose, CA 95134, (408) 473-1200; fax (408) 473-2080.
Circle 1430 on Inquiry Card.

486 Power and Expansion Built In

A high-end workstation and file server, the upright 486/33Ei-T has 10 32-bit EISA expansion slots, six



The Hertz 486/33Ei-T is a high-end workstation/file server.



The expandable Decision 486/33T offers flexibility in a tower.

of which are master EISA slots. The 486/33Ei-T's desktop counterpart, the 486/33Ei-DT, comes with eight 32-bit EISA expansion slots, six of which are EISA master slots.

Both workstations feature SCSI hard disk drives that range in size from 380 MB to 8 gigabytes and have access times of less than 4 ms. The units also have an external cache socket and SCSI or ESDI cached controllers. The 486/33Ei-T and the 486/33Ei-DT support the Weitek coprocessor; have two cooling fans; and include two parallel ports, two serial ports, and a mouse port.

Price: \$8320 to \$29,245, depending on configuration.
Contact: Hertz Computer Corp., 325 Fifth Ave., New York, NY 10016, (212) 684-4141; fax (212) 684-3658.
Circle 1432 on Inquiry Card.

Lightning Fast and Cool

By integrating a solid-state cooling module that lowers operating CPU temperatures to between 0° and 4°C, the Lightning 486/50 lets the 33-MHz 486 chip run at 50 MHz. With a 50 percent increase in performance and no loss of reliability, according to the company, the machine uses separate processors to speed up graphics, numeric, and disk-intensive operations.

The Lightning 486/50 offers one graphics accelerator for Windows-based applications, one for 2-D CAD programs, and one that operates at 25 MFLOPS for high-resolution 3-D modeling and photo-realistic rendering.

Price: \$8955 to \$30,000, depending on configuration.
Contact: Lightning Computers, 557 Howard St., San Francisco, CA 94105, (800) 347-4486 or (415) 543-3111; fax (415) 543-3532.
Circle 1433 on Inquiry Card.

A 486/50 with Storage Choices

You can use the Compaq Deskpro 486/50L Model 510 as a network server or a multiuser host running highly technical applications. The unit includes an EISA expansion bus and a 510-MB hard disk drive with an average access time of 12 ms. You can configure the machine to store more than 2 gigabytes.

Price: \$13,999.
Contact: Compaq Computer Corp., P.O. Box 692000, Houston, TX 77269, (800) 345-1518 or (713) 370-0670.

Circle 1434 on Inquiry Card.

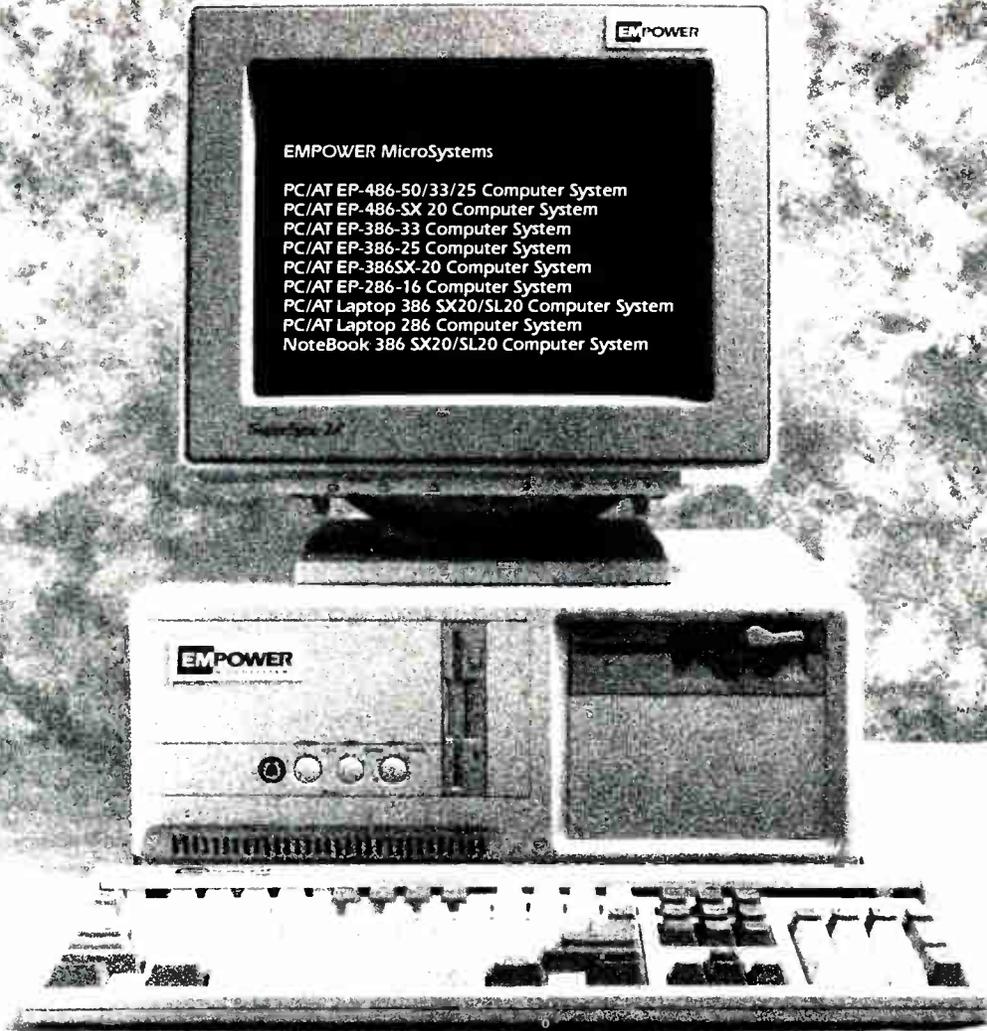
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A six-layer circuit board, a 45-MB hard disk drive, and eight 16-bit expansion slots give power and versatility to the Klonimus 486/33. The unit comes with 2 MB of RAM plus 8-KB first-level cache and 64-KB second-level cache RAM, as well as shadow RAM.

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Weitek 4167. It has an ISA bus and 16-bit, 256-KB color VGA with a monitor.
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Contact: QSI Corp., 95 Rockwell Place, Brooklyn, NY 11217, (718) 834-4545; fax (718) 834-5318.
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 World Radio History

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Based on the 960 RISC microprocessor, the LaserPrinter 4 StarScript lets you print complex graphics and is compatible with the LaserJet IIP and the Epson FX-850. Resident on the printer are 35 outline and 14 bit-mapped fonts. Serial, parallel, and AppleTalk interfaces are standard.

Price: \$1995.

Contact: Star Micronics America, Inc., 420 Lexington Ave., Suite 2702, New York, NY 10170, (212) 986-6770; fax (212) 286-9063.
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Price: ColorScript 10p, \$6995; ColorScript 30si, \$12,995.
Contact: QMS, Inc., 1 Magnum Pass, Mobile, AL 36618, (800) 631-2692.

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For 24 images per minute or 12 images per minute when printing on two sides, you may want to consider the 2030 LED Printing System. A tabletop printer, the 2030 Model 1 provides emulations in PostScript, LaserJet and LaserJet IID, IBM 3287 and 3812-1, DEC LNO3 Plus, and AFP/IPDS Group 4. With a duty cycle of 120,000 pages per month, the 300-dpi 2030 Model 1 handles a variety of paper sizes and weights. A floor model is also available.

Price: \$19,800 to \$36,300.
Contact: Siemens Nixdorf Printing Systems, 5500 Broken Sound Blvd., Boca Raton, FL 33487, (407) 997-3100.

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Based on an AMD 29000 RISC CPU controller backed up with 10 MB of RAM, the Phaser III PXi runs Adobe PostScript Level 2, which adds color extensions to the PostScript language. The print engine has 300-dpi resolution and is able to produce more than 8 million colors. You can print a page in 2 minutes, depending on the complexity of the image and the desired print quality.



The Phaser III PXi's intelligent multitasking interface has automatically switchable parallel, serial, and AppleTalk ports. The print area of the Phaser III PXi can be as large as 12 by 18 inches, permitting full-size 11-by-17-inch bleeds.

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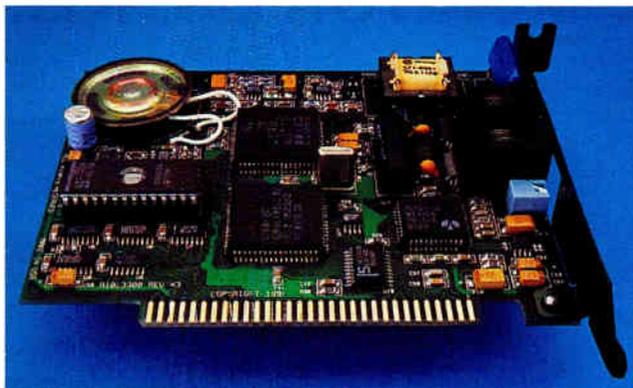
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Contact: Practical Peripherals, 31245 La Baya Dr., Westlake Village, CA 91362, (800) 442-4774 or (818) 706-0333; fax (818) 706-2474.
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Price: \$499.
Contact: Digital Data Systems, Inc., 775 Franklin Rd., Suite 100, Marietta, GA 30067, (404) 425-5700.
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A Modem/Fax Board for DOS and Windows

The Complete Modem, a three-quarter-length data modem/fax board, works with DOS and Windows 3.0. A 2400-bps modem and 9600-bps fax, the board requires 512 KB of RAM; a VGA, EGA, CGA, or Hercules-compatible graphics adapter; and a standard analog phone line with an RJ-11 or RJ-14 connection.

Price: \$199.
Contact: The Complete PC, 1983 Concourse Dr., San Jose, CA 95131, (408) 434-0145.
Circle 1442 on Inquiry Card.

LAN Fax Server on a Board and a Phone Line

EtherFax combines hardware and software to let you send and receive faxes over your LAN. Compatible with NetWare, EtherFax requires a fax board and a dedicated phone line to serve as many as 64 LAN users. The system administrator configures the faxes and routes them to the appropriate person on the LAN. For file security, each fax

can be accessed only by the administrator, the originator, and the recipient. Operating at 9600 bps, EtherFax works on a PC host server with 640 KB of RAM.

Price: \$995.
Contact: National Semiconductor Corp., 2900 Semiconductor Dr., M/S 25-155, Santa Clara, CA 95052, (800) 538-8510.
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A Fax System on a Board

The Unix-based DigiFax System consists of software, one or two fax modems, and a buffered parallel port on a communications board. Its features include multipoint broadcasting, delayed scheduling, and automatic generation of



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DigiFax's software multiline capability lets you use up to eight fax cards at once in a PC. It interfaces directly with word processing and spreadsheet programs and includes scanner support, letting you incorporate graphics and handwritten material into your document. Troff/Nroff and TIFF support as well as HP LaserJet emulation are also part of the system.

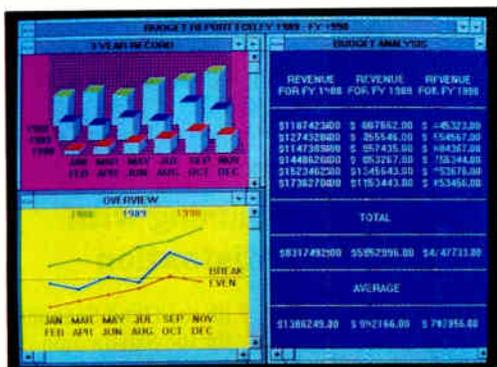
Price: Single-channel, \$995; multichannel, \$1495.
Contact: DigiBoard, 6400 Flying Cloud Dr., Eden Prairie, MN 55344, (612) 943-9020; fax (612) 943-5398.
Circle 1439 on Inquiry Card.



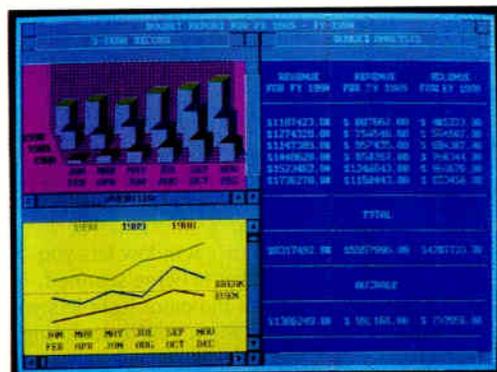
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PROCEDURE main
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  bar_graph
  line_graph
  budget_a
  stop_program
RETURN
> PROCEDURE set_database
> PROCEDURE bar_graph
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Simplifies GUI development

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

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

Bind in existing routines

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

Half Price Introductory Offer

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

offer expires November 14, 1991

Add it all up and you have a very low-cost, easy-to-use structured language for developing Windows and MS-DOS applications¹. To see for yourself how powerful GFA-BASIC is, just ask for our free demo disk. Call 1-800-766-6GFA, or write GFA Software Technologies, Inc.; 27 Congress St.; Salem, MA 01970; Fax (508) 744-8041.

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

Circle 560 on Inquiry Card.

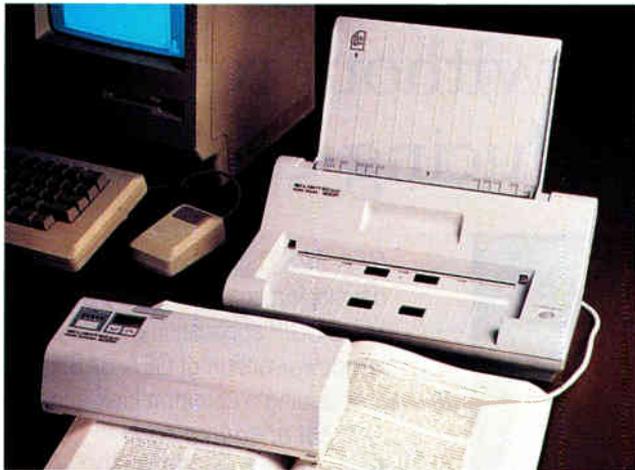
A Convertible Character

Available for the Mac or the PC, Character scans black-and-white text or graphics at the rate of 1 to 2 minutes per page. You can use Computer Friends' Character as a hand-held scanner, or you can attach the paper feeder to scan up to 10 pages at a time. The 8½-inch-wide window allows for one-pass scanning.

The PC version of Character is optionally bundled with Ocron's Perceive OCR software, and the Mac version comes complete with Read-It by Olduvai. According to Computer Friends, the scanner is compatible with all OCR software.

Character features 64 shades of gray and output resolutions of up to 400 dpi. Both versions come with image-processing packages and system interfaces. The PC version requires Windows 3.0. **Price:** PC version, \$599; Perceive software, \$99; Mac version, \$899.

Contact: Computer Friends, Inc., 14250 Northwest Science Park Dr., Portland, OR 97229, (800) 547-3303 or (503) 626-2291; fax (503) 643-5379. **Circle 1446 on Inquiry Card.**



Character is a desktop and hand-held scanner.

Photo-Quality Images on Your Monitor

Film scanners from Leaf Systems acquire image data at a range of 16 bits per color per pixel to provide sharply detailed images on PC or Mac systems. The Leafscan 35 and 45 scan transparencies and negatives, and the 45 can accommodate 4- by 5-inch formats. The PC version requires Windows 3.0.

The scanners produce resolutions of up to 4800 dpi and save images as TIFF files. A typical 2000- by

2000-dpi color-image scan produces a 12-MB file in about a minute.

Price: Leafscan 35, \$9995; Leafscan 45, \$22,995. **Contact:** Leaf Systems, Inc., 250 Turnpike Rd., Southborough, MA 01772, (508) 460-8300; fax (508) 460-6470.

Circle 1447 on Inquiry Card.

A Scanner for All Reasons

The Scan 300/Color offers flexibility to those who use their scanners in a variety of ways. The scanner's flatbed configuration and removable lid let you easily scan books, oversized documents, and large images. You can add an optional document feeder that enables the machine to scan multiple pages unattended.

The 24-bit Scan 300/Color scans color, gray-scale, halftone, or line-art images of resolutions from 72 to 300 dpi. You can scan up to 16.8 million colors or 256 shades of gray, and there are 255 contrast and brightness settings. Scan 300/Color is capable of reducing images up to 25 percent or enlarging them up to 400 percent. The PC-com-

patible scanner includes a SCSI adapter board.

Packaged with the scanner is Computer Presentations' file editing program, Color Lab.

Price: \$1995; optional document feeder, \$595. **Contact:** Abaton, 48431 Milmont Dr., Fremont, CA 94538, (800) 444-5321 or (415) 683-2226; fax (415) 683-2151.

Circle 1444 on Inquiry Card.

Scanning with Satisfaction

With the Hand Scanner for the Satisfaction board, Intel brings the paperless office one step closer to reality. Designed by Logitech and Intel, the 256-shade gray-scale scanner attaches directly to Intel's PC-based fax/modem board.

The Hand Scanner scans graphics and text at 100- to 400-dpi resolution. The scanner's window lets you see what is being scanned, and an indicator light lets you know when you're scanning too quickly.

Ansel, Logitech's Windows-based image-editing software, comes bundled with the scanner. Ansel lets you merge multiple scans into full-page images and provides on-screen editing functions.

To use the scanner, you must have the Satisfaction board in place. Because the scanner port is resident on the board, you don't have to give up a PC slot for a controller card.

Price: \$399. **Contact:** Intel Corp., CO3-7, 5200 Northeast Elam Young Pkwy., Hillsboro, OR 97124, (800) 525-3019 or (503) 629-7354.

Circle 1445 on Inquiry Card.



The Leafscan 35 and 45 scan color transparencies at your desk.



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Circle 564 on Inquiry Card (RESELLERS: 565).

World Radio History

NEWS

WHAT'S NEW • PRESENTATION PERIPHERALS

Projector Offers Color at the Right Price

In Focus's new color LCD projection panel displays computer-generated screen images from your PC or Mac for less than \$2700, a price the company says is closer to that of a pseudo-color panel. Using the 1600LC PC Viewer projection panel with a PC or Mac and a standard overhead projector, you can directly project images onto a wall or screen for group viewing. **Price:** \$2695.

Contact: In Focus Systems, 7770 Southwest Mohawk St., Tualatin, OR 97062, (800) 327-7231 or (503) 692-4968; fax (503) 692-4476.

Circle 1452 on Inquiry Card.



Unlike previous projection panels that sought to remove as much birefringence, or refraction, as possible, In Focus's 1600LC optimizes it to display 16 colors from a Mac or PC on a projection screen.

The AirMouse Lets You Walk Like an Egyptian

First there was the air guitar, followed by Air Jordan sneakers. Now comes the AirMouse.

Selectech's AirMouse Remote Control system lets you give a group presentation as you walk around the room. The AirMouse lets you point at the screen and select a function (e.g., select a menu item or open and close files) to control the presentation just as you would with a mouse.

Price: \$595.

Contact: Selectech, Ltd., 30 Mountain View Dr., Colchester, VT 05446, (802) 655-9600; fax (802) 655-5149.

Circle 1453 on Inquiry Card.

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Dr. Alan Solomon has been researching viruses for years. He knows where to look and what to look for. His Anti-Virus Toolkit catches all known viruses and new viruses - in less time. No false alarms. No missed viruses. No slowed performance. No matter how many new viruses are developed.

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This is one show you won't want to miss. So make plans to attend now. And get ready to get down to business at the NORTHEAST COMPUTER SHOW, November 13-15, 1991, at the World Trade Center, Boston, MA. **Call 617-449-6600, ext. 6520. For exhibit space information ask for ext. 4084. Or mail the coupon below.**

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November 13-15, 1991
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World Radio History

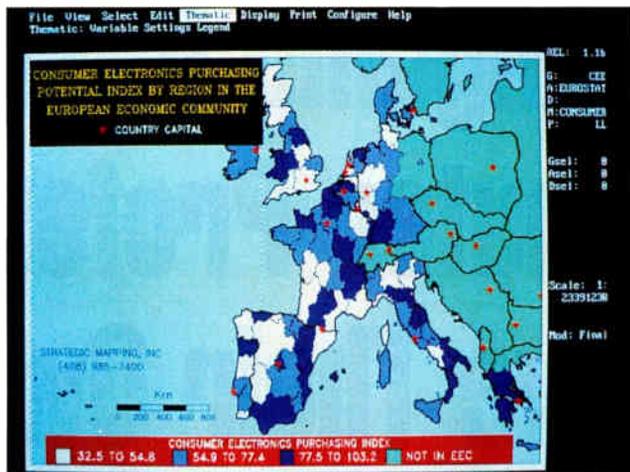
Atlas Pro Plugs the Holes

To fill the gap between its high-end desktop/GIS (Geographic Information System) program and its low-end MapMaker application for mapping and charting, Strategic Mapping has developed Atlas Pro.

The program, which runs on PCs, combines an internal database with map presentation and analysis tools. You can use it to display data on a map and query the database geographically. The program can also import files in dBase, Lotus 1-2-3, or ASCII format.

Atlas Pro can display all records within a certain distance of a given point and, from that, generate maps, charts, and mailing lists. You can edit the database by clicking on a map to open data windows or by toggling to the text-database screen. The program gives you control over many presentation features (e.g., fonts, styles, and page layout), Strategic Mapping says.

Atlas Pro includes a starter kit of data and boundary files. It ships with demographic data from the 1990 census and predrawn, computerized base maps for



Strategic Mapping developed Atlas Pro to fill the gap between its high- and low-end desktop mapping programs. The program is also available in a Mac version.

several types of geography. The package includes business, consumer, and demographic data, with information for 70 variables at the city, county, state, and ZIP-code level. Atlas Pro also includes Arbitron's Areas of Dominant Influence and A. C. Nielsen's Designated Market Areas.

Price: \$649.
Contact: Strategic Mapping, Inc., 4030 Moorpark Ave., San Jose, CA 95117, (408) 985-7400; fax (408) 985-0859.

Circle 1449 on Inquiry Card.

Extract the Hidden Meaning in Data Sets

The latest version of the Database Visualization Tool (DVT), a program for the PC that makes sense of data stored in dBase, Lotus 1-2-3, and ASCII files, adds threshold capabilities, color settings, and hypermedia functions. The new threshold capability filters out unwanted data in the analysis.

The DVT, when combined with IntelligenceWare's IXL Discovery Machine software, can extract significant information from large databases and display the data in a variety of 2-D and 3-D files. The program finds hidden patterns and correlations.

The program also supports Teradata database computers, Oracle, and DB2.
Price: PC version, \$490; other versions, \$990 to \$50,000.
Contact: IntelligenceWare, Inc., 5933 West Century Blvd., Los Angeles, CA 90045, (213) 216-6177; fax (213) 417-8897.

Circle 1451 on Inquiry Card.

Visual What-Ifs with MapInfo

The new versions of MapInfo for Windows and the Mac offer faster screen draw and redraw and the ability to perform what-if analysis by pointing and clicking at maps of sales territories and other entities.

A new statistics function in version 1.1 calculates the sums and averages of values contained in database fields. With the new function, you can click on several territories and view in a pop-up window the sum and average of annual sales for those territories. As you add or subtract territories (or any other entity of a map with attached data), the statistics are automatically recalculated.

New dot-density maps and graduated symbols more accurately display information. The dot-density feature lets you assign a value to a dot and control how many dots appear on the map. Graduated symbols let you vary the size of a symbol to correspond to the value of the represented data.



Both new versions can locate an intersection when you enter the names of the cross streets.

Price: \$995.
Contact: MapInfo Corp., 200 Broadway, Troy, NY 12180, (800) 327-8627 or (518) 274-8673; fax (518) 274-0510.

Circle 1450 on Inquiry Card.



The Database Visualization Tool automatically displays database files in 2-D and 3-D graphics using numeric and nonnumeric data.

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Circle 38 on Inquiry Card (RESELLERS: 39).

World Radio History

The ONES to WATCH

• BYTE editors look at trends for 1992 in four key product categories

The first half of *Outlook '92* examined 10 major industry categories from lofty viewpoints. In this half, we delve into the four *product* areas that BYTE believes will have the greatest impact on users and computer buyers in the coming year: desktop systems, windowing applications, notebook computers, and network management tools.

We chose these four categories after looking at technological developments and trends that exist within real and potential markets. Prices for desktop systems, be they DOS-, Unix-, or Mac-based, are falling across the board. In terms of bang for the buck, users are in for great deals. GUIs on all platforms continue to be popular, and applications continue to take greater advantage of what graphical interfaces offer.

Growth projections for notebook computers are phenomenal. If you travel, you will likely be using one in the coming year. Finally, with the proliferation of LANs, it's becoming ever more important for network managers to have better tools to do their jobs.

The Road Map, Please

With a few exceptions, this Product Perspectives section is arranged as follows: Each topic is treated separately, with a written analysis that explains the trends. Each analysis is accompanied by one or more Product Guides, Company Information boxes, or both.

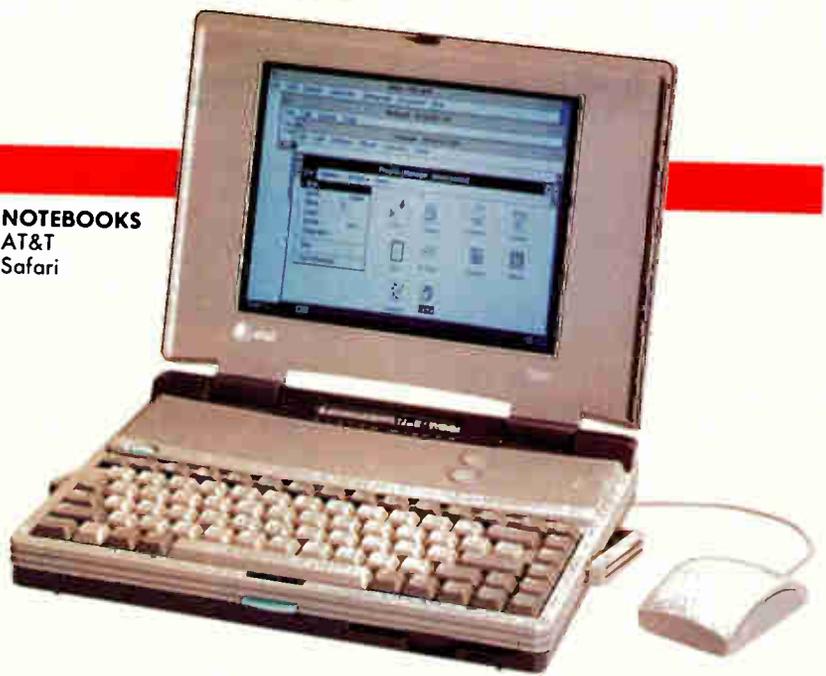
Although the articles look at the topics from mostly practical angles, they include information on the technologies behind the products as well. Where appropriate, discussions of marketing issues, installed base, and user needs are included.

The Product Guides provide tabular compilations of product attributes, and you can use them to make fast comparisons among many competing products. Once you've read the corresponding article, you'll better understand the significance of the features included in the tables and how they might affect



DESKTOP PCS/Gateway 25 MHz 486 Cache

NOTEBOOKS
AT&T
Safari



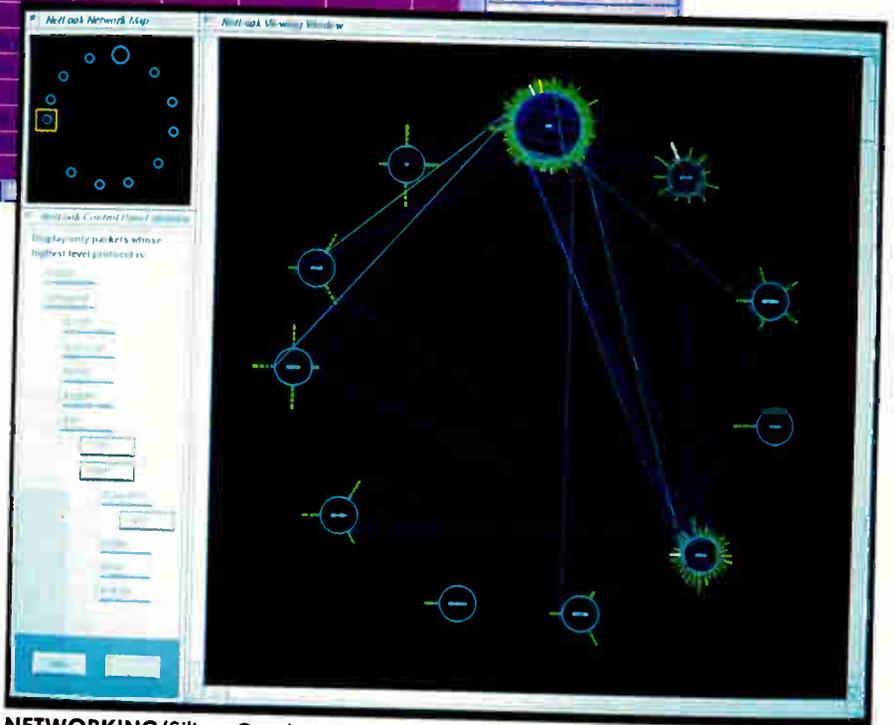
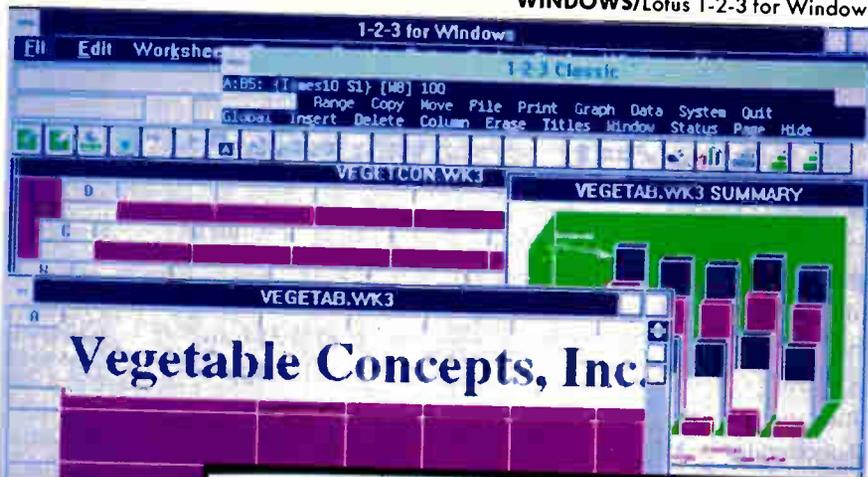
you. Please note that the data in these tables came from the manufacturers in most instances, and not from personal evaluation by BYTE editors. Where applicable, we've provided multiple tables to make it easier to find, for example, Macintosh-related products. The Company Information listings provide addresses and phone numbers for vendors in each product category.

Because of the diverse nature of available products, neither the network management article ("Trends in Network Management") nor the X Window System section of the windowing applications article ("Windowing: Not by DOS Alone") includes Product Guides with detailed feature comparisons. Instead, the Company Information listings for these sections include product names and prices to help you better survey the market. These are intended to show a representative cross section of available vendors and products.

Each article includes products that the BYTE editors believe embody the trends and technological advances you're likely to see over the coming year and whose existence will affect new generations of products for years beyond. We've labeled them as the "Ones to Watch." To identify them in the tables and listings, look for the Ones to Watch icon:

Special recognition goes to BYTE Lab Assistant Selinda Chiquoine, who coordinated our product information gathering; to editorial staffers Peggy Dunham, Linda Ryan, and June Sheldon, who fact-checked the product listings; and to Anne Joch, who copyedited the Product Perspectives section. ■

WINDOWS/Lotus 1-2-3 for Windows



NETWORKING/Silicon Graphics NetVisualizer

PC Magazine caught us speeding.

"PacificPage XL beats HP on LaserJet PostScript printing"

PC Magazine, June 25, 1991

FASTEST PRINTING SPEED. LOWEST PRICE.

PacificPage XL is fast. So fast, that PC Magazine has cited it for exceeding the speed limit of Hewlett-Packard's PostScript® Cartridge by more than six times.

If by chance the speed doesn't sell you, the low price will. Because it's the one feature of PacificPage XL that doesn't exceed HP's cartridge.*

How do we get it to work so fast? It's really quite simple. We've taken our award-winning PostScript language emulation cartridge called PacificPage P•E, and combined it with a high speed accelerator board that installs easily into your LaserJet IIP, III, IIID or IIIP printer memory slot. LaserJet printing speeds are boosted by the fast Intel i960™ RISC processor that's mounted on the board alongside 2 MB of printer memory.

"An Intel i960 RISC processor on the accelerator board helps the PacificPage XL print graphics more than six times as fast as the HP PostScript Cartridge."



"PacificPage XL provides the fastest PostScript printing available on a desktop."

Do you use a shared printer? If you do, you'll definitely want the speed of PacificPage XL. Because output is printed so fast, other users won't have to wait for their jobs to print.

Make a quick price/performance comparison and you'll see — PacificPage XL is the smart choice!

35 POSTSCRIPT COMPATIBLE FONTS

Acquiring stylish, professional looking output is easy with PacificPage XL. Because we've included 35 fully scalable Apple LaserWriter equivalent fonts. These high quality Bitstream designs provide you with the tools you need to create output that shines. For even greater versatility, PacificPage XL supports Bitstream's Speedo fonts and Adobe Type 1 and 3 fonts.

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- SWISS NARROW
- DUTCH
- ZAPF CALLIGRAPHIC
- GEOMETRIC
- REVIVAL
- CENTURY
- CHANCERY

Zapf Dingbats
!@#%&~!@#%&

Symbol
←→ΔΦΓ∞YNX≠

Each typestyle comes in normal, bold, italic and bold italic treatments except for Chancery, Zapf Dingbats, and Symbol.

"The native 35 PostScript compatible fonts in PacificPage XL are Bitstream designs, some of them superior to Adobe's version."

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Today, many HP LaserJet users are lead to believe that only true Adobe PostScript gives true PostScript capabilities. The truth is, PacificPage XL provides exactly



PostScript file output from Apple LaserWriter IINTX.

PostScript file output from LaserJet III with PacificPage XL.

"PacificPage XL swiftly and accurately renders some test EPS files that other interpreters distort and had no trouble with any of the large and complex images used for testing."

the same graphics capabilities for your LaserJet as Adobe PostScript. Exactly. So you can pay more for a name and get less for your money. Or you can pay less and, in addition to speed, get all of PostScript's powerful graphics functions. If you can create it, PacificPage XL can print it. We're so sure of it that we give you our money back guarantee of satisfaction.



For more information or a dealer near you, contact Pacific Data Products, 9125 Rehco Road, San Diego, CA 92121, (619) 597-4610, Fax (619) 552-0889.



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DESKTOP PCS



Workstations have traditionally been considered high-ticket items. To expand their base, workstation vendors have decided to target the high-end DOS and Mac markets with fast, competitively priced Unix boxes. Usually based on a RISC CPU, these systems often provide superior performance to even the best DOS and Mac units.

Micro Express's ME 486-ISA/LC: This \$2999 system distinguishes itself among the price leaders with its standard 8 MB of RAM and two-year warranty.

Although the Mac faces little competition on its own turf, systems on other platforms have begun providing similar performance for running applications in a graphics environment at a lower price. Consequently, Apple has introduced new lower-cost models and slashed prices on its existing high-end line.

The forces that are driving the price/performance ratio in the consumer's favor should continue into the coming year. What follows are views from BYTE editors Alan Joch, Tom Yager, and Tom Thompson on exactly what system buyers can expect in 1992.

DOS SYSTEMS / Alan Joch

The PC Juggernaut

Like late-night TV ads that chant "But wait, there's more," desktop system choices in the coming year could leave your head spinning. If you're buying a system for yourself or plan a block purchase to power an office suite, your choices range from venerable and economical units to ones with full-blown multiprocessing power. But wait . . .

Last year, 386 system prices dropped by as much as 30 percent. Next year, when vendors are expected to ramp up systems based on Intel's 50-MHz 486 chips, 386 systems will fall even farther into the low end of the price spectrum. In between, you'll see more choices of CPU vendors, CPUs with integrated or disabled coprocessors, and better components to rev up graphics output and overall system performance.

Fortunately, plowing through all the choices and CPU confusion can help you find sophisticated desktop systems at impressive price points. As table 1 shows, today's midrange systems—25-MHz 486 systems with some respectable components like Super VGA hardware and Intelligent Drive Electronics (IDE) hard

The Buyer's Market Continues

Falling prices and rising horsepower will make 1992 a good year for consumers

Whether it's for yourself or for your company, nothing beats getting more performance for the money. It is great news, then, that the trend in the desktop system market has been falling prices and rising horsepower. This news holds true across the three major computing platforms: DOS, Macintosh, and Unix.

Intense competition, rapid advances in technology, and increasing demand for more performance drive this trend. On the DOS side, the recent recession forced many system buyers to look more closely at lower-cost PCs from second- and third-tier vendors. The result has been dramatically lower prices from major vendors such as IBM and Compaq.

PRODUCT GUIDE: DOS-BASED SYSTEMS

Table 1: Today's midrange PCs must efficiently run GUIs, graphical spreadsheets, and other power-draining applications as a matter of course. Fortunately, this class of hardware is becoming more economical than ever. These 45 systems all sell for less than our \$7000 price limit (many cost less than \$5000). Our sample configuration, which represents a standard platform for today's sophisticated business user, consists of a 25-MHz 486 CPU; 4 MB of RAM; a 100-MB (or next higher size) IDE hard disk drive; a Super VGA card with 1 MB of memory; a noninterlaced Super VGA monitor with 1024-by-768-pixel resolution; a floppy disk drive; and one parallel and two serial ports.

System	List price	Case size (inches; W×H×D)	Bus type	On-board memory (std./max.)	Motherboard	ROM BIOS	Number of slots (8-/16-/32-bit)	Hard disk drive supplier
Abtech 486/25	\$2595	20×27×8	ISA	4 MB/64 MB	VEGA	AMI	0/8/0	Conner
Acma 486/25 ISA	\$2495	21×6.5×16.5	ISA	4 MB/16 MB	FTC	AMI	0/8/0	Quantum
Acma 486/25 EISA	\$4295	21×6.5×16.5	EISA	4 MB/64 MB	FTC	AMI	0/2/6	NEC
ACT 486/25 ISA	\$3615	8×15×19 (tower)	ISA	4 MB/16 MB	AIR	AMI	0/7/1	Seagate
ACT 486/25 EISA	\$4515	8×15×19 (tower)	EISA	4 MB/64 MB	AI	Phoenix	0/0/8	Seagate
ALR BusinessVEISA Model 120-5	\$6093	15×6×17	EISA	1 MB/17 MB	ALR	Phoenix	0/2/4	Multiple suppliers
ALR MPS Model 120-5	\$6592	15×6×17	MCA ¹	5 MB/17 MB	ALR	Phoenix	0/4/2 (2-32-bit proprietary)	Multiple suppliers
Amax 486/25	\$3535	16.75×25.25×7.5	ISA	4 MB/16 MB	Amax	AMI	0/8/0	Quantum
AMI 486/25	\$2690	7.5×21.5×16	ISA	4 MB/32 MB	Novacor	AMI	2/5/0	Conner
AMKLY 486/25E Model 125	\$6900	17×6×16.5	EISA	4 MB/16 MB	AMKLY	Phoenix	0/0/6 (EISA)	Conner
APS 486-25 MHz	\$3295	16×7×16	ISA	4 MB/64 MB	AMI	AMI	2/6	Maxtor
Arche Legacy 486-25	\$5671	17×16.25×17	ISA	4 MB/16 MB	Arche	Arche	1/7 ² /0	Conner
Ares 486-25 Sonic	\$2995	8.5×18.5×18	ISA	4 MB/32 MB	Ares/Technology Power	AMI	0/7/1	Quantum
Atico 486-25	\$3395	8×25×17	EISA	4 MB/64 MB	Mylex	AMI	0/0/8	Conner
Austin 486/25 WinStation	\$3590	21×6×16	ISA	4 MB/32 MB	Austin	AMI	1/6/0	Seagate
Blackship 486/25	\$3195	21×16.5×6.5	ISA	4 MB/16 MB	ECS	AMI	0/0/8	Conner
CompuAdd 425	\$4095	16.25×4×15.5	ISA	4 MB/32 MB	CompuAdd/TI	Phoenix	2/3/0	Maxtor or Seagate
Cube 486/25	\$3990	13-in. desktower/ 24-in. tower	ISA	4 MB/32 MB	ICC	AMI	2/6/0	Conner
Datacomp DCC 486/25	\$2595	17.25×6.5×15.75	ISA	4 MB/32 MB	DEICO	QUADTEL	2/6/0	Quantum
Datacomp DCC 486/25E	\$3295	17.25×6.5×15.75	EISA	4 MB/32 MB	AMI	AMI	0/0/8	Quantum
Dataworld Data 486-25sec Desktop	\$3119	21.5×6.5×16.5	ISA	4 MB/16 MB	Dataworld	AMI	1/6/1	Conner
Dell System 425E	\$6199	21.1×6.4×17.6	EISA	4 MB/16 MB	Dell	Phoenix/Dell	0/2/6 (EISA)	Quantum
Dyna Micro Work Master 486	\$4195	Six choices	ISA	4 MB/16 MB	AIR	AMI	2/5/1	Conner
Elitech Model 4250	\$3675	16×6.5×16.5	ISA	4 MB/16 MB	Elitech	AMI	1/6/1	Toshiba
Gateway 25 MHz 486 Cache	\$2995	21×6×16.5	ISA	4 MB/16 MB	Micronics	Phoenix	0/8/0	Western Digital
IBC Emcat 486/25	\$5780	21×6×16.5	EISA	4 MB/64 MB	IBC	IBC EMC	0/7/3 (proprietary)	
Iverson 486/25	\$2825	9.5×19.5×26 (tower)	ISA	4 MB/64 MB	Alptech	Award	1/6/1 32-bit	Seagate
Jaco JCP486-25	\$3295	Full-size tower	ISA	4 MB/16 MB	AIR	AMI	0/8/0	Maxtor
Leading Technology PC Partner QX	\$3999	17.5×6.5×17	ISA	2 MB/16 MB	VTI	AMI	2/6/0	Western Digital
Link/Sceptre File Server 486/25	\$6499	8.2×26.3×18.3	ISA	4 MB/64 MB	Sceptre	AMI	1/6/1	Seagate
Micro Express ME 486-ISA/LC	\$2999	15×7×16.25	ISA	8 MB/32 MB	Micronics	Phoeni	2/6/0	Conner
New MMI 425	\$3350	16.5×6×21	ISA	1 MB/8 MB	DTK	DTK	1/6/1	Maxtor
Northgate 486/25	\$4499	21.25×6.5×16.75	ISA	4 MB/16 MB	Northgate	AMI	1/6/1	Seagate
PC Brand 486/25	\$2626	19.5×16.5×6.5	ISA	1 MB/16 MB	PC Brand	AMI	1/6/1	Toshiba
PC House 486/25	\$2995	Medium tower	ISA	4 MB/32 MB	Micro Q	AMI	0/6/2	Seagate
Polywell Poly 425i	\$3425	21×6.75×16.5	ISA	4 MB/32 MB	Polywell	AMI	0/8/0	Maxtor
Reply Model 321486-25	\$6994	14.2×5.5×16.5	MCA	MB/16 MB	Reply	Reply	0/0/5	Conner
SAI 486E-25	\$3150	Standard AT size	EISA	4 MB/64 MB	AIR	Phoenix/AMI	0/0/8	Conner
Swan 486/25	\$3735	1×6×1	ISA	4 MB/16 MB	Micronics	Phoenix/MCI	0/8/0	Conner
Tangent Model 425i	\$3290	21×6.3×16.5	ISA	4 MB/32 MB	Tangent	AMI	0/7/1 ³ bit	Quantum
Tatung TCS-9000T	\$4195	21.3×6.5×1	ISA	2 MB/16 MB	Tatung	Phoenix	2/5/1	Quantum
Touche Enterprise 486/25 Model 5550T	\$4399	7.5×24×17.5	EISA	4 MB/32 MB	AMI	AMI	1/6/1	Multiple suppliers
Ultra-Comp Ultra-Max 486-25	\$3595	21×5.75×16.5	ISA	4 MB/16 MB	Micronics	Phoenix	0/0/8	Maxtor
Zeny Zen 486402	\$3495	16×7×16	ISA	4 MB/32 MB	Zeny	AMI	2/5/1	Maxtor
Zeos 486-25E	\$6495	19×6.5×18.4	EISA	1 MB/32 MB	Mylex	Mylex	0/0/8	Seagate

N/A = Not applicable.

Pricing does not necessarily reflect the standard system. For example, many systems come standard with 1 MB of RAM, whereas they are all priced for 4 MB of RAM and Super VGA with 1MB of RAM.

¹ Micro Channel architecture.

² 8- or 16-bit.

³ 8- or 32-bit.

⁴ 5-year warranty on American-made Polysystems, 2-year warranty on American-made motherboards, 4-year warranty on the Orchid cards, and 1-year warranty on all other makes.

⁵ 3-year warranty: 1 year parts, 3 years labor.

⁶ System configured with CM-1495H monitor and OMNI VGA Plus card.

PRODUCT GUIDE: DOS-BASED SYSTEMS

Controller cache (std./max.)	Floppy disk drives	Video controller	Video RAM (std.)	Maximum resolution (pixels)	Power supply (watts)	Distribution channel	Warranty (years)	On-site service
64 KB/256 KB	1.44 MB & 1.2 MB	Trident	1 MB	1024 x 768	230	Direct	1	Option
N/A	1.44 MB & 1.2 MB	Tseng Labs	1 MB	1024 x 768	250	Direct, mail order	1	Option, TRW
512 KB/4 MB	1.44 MB & 1.2 MB	Tseng Labs	1 MB	1024 x 768	250	Direct, mail order	1	Option, TRW
N/A	1.44 MB & 1.2 MB	Diamond SpeedStar	512 KB	1024 x 768	200	Mail order, dealers, VARs, reps	1	1-year, Texas Instruments
N/A	1.44 MB & 1.2 MB	Diamond SpeedStar	512 KB	1024 x 768	200	Mail order, dealer, VARs, reps	1	1-year, Texas Instruments
N/A	1.44 MB & 1.2 MB	Paradise (WD)	256 KB	800 x 600	145	Resellers, retail, CompUSA	1	Option
N/A	1.44 MB	Paradise (WD)	512 KB	1024 x 768	145	Distributors, retail, dealers	1	Option, Intel
N/A	1.44 MB or 1.2 MB	Impression	1 MB	1024 x 768	250	Resellers, dealers	1	Option, Memorex, Telex
128 KB/256 KB	1.2 MB or 1.44 MB	Trident	256 KB	1024 x 768	230	Direct	1	N/A
N/A	1.2 MB or 1.44 MB	Trident	1 MB	1024 x 768	200	VARs, system integrators	1	Option
N/A	1.44 MB & 1.2 MB	Focus	1 MB	1024 x 768	230	Direct	1	1-year
N/A	1.2 MB	Arche/Tseng Labs	256 KB	1024 x 768	200	Distributors, resellers, VARs	2	90-day
64 KB	1.2 MB or 1.44 MB	Diamond SpeedStar	1 MB	1024 x 768	250	Direct	2	TRW, included
128 KB	1.2 MB	ATI	128 KB	1024 x 768	250	Mail order	1	N/A
32 KB	1.44 MB or 1.2 MB	Tseng Labs	1 MB	1024 x 768	200	OEMs, distributors	1	1-year with option
64 KB	1.2 MB & 1.44 MB	Diamond SpeedStar	1 MB	1024 x 768	200	Direct	1	1-year, GE
N/A	1.44 MB or 1.2 MB	CompuAdd	1 MB	1024 x 768	145	Direct, retail	1	1-year
32 KB/64 KB	1.44 MB & 1.2 MB	Tseng Labs	1 MB	1024 x 768	230	Direct, dealers	1	1-year with option
64 KB	1.44 MB & 1.2 MB	Cardinal	256 KB	1024 x 768	200	Direct, VARs	2	Option, Bell Atlantic/Sorbus
64 KB	1.44 MB & 1.2 MB	Cardinal	256 KB	1024 x 768	200	Direct, VARs	2	Option, Bell Atlantic/Sorbus
8 KB/128 KB	1.2 MB	Orchid ProDesigner	1 MB	1024 x 768	200	Direct, mail order	1	1-year
N/A	1.44 MB or 1.2 MB	Paradise	256 KB	1024 x 768	230	Direct, CompUSA, VARs	1	1-year, Xerox
512 KB/12 MB	1.44 MB & 1.2 MB	Orchid Pro IIS	1 MB	1024 x 768	275	Dealers to OEMs	1	1-year, Int. Auto.
32 KB	1.44 MB & 1.2 MB	Diamond Computer	1 MB	1024 x 768	200	Direct, dealers, VARs	1	N/A
64 KB	1.44 MB & 1.2 MB	Diamond SpeedStar	1 MB	1024 x 768	200	Mail order	1	1-year
N/A	1.2 MB	Paradise	1 MB	1024 x 768	230	VARs, OEMs	1	Option
N/A	1.44 MB or 1.2 MB	Trident	1 MB	1024 x 768	250	Direct, distributors	1	1-year
32 KB	1.2 MB	Diamond SpeedStar	1 MB	1024 x 768	220	Direct, OEMs	1	N/A
N/A	1.44 MB & 1.2 MB	Focus	1 MB	1024 x 768	200	Distributors, retail, resellers	1	1-year, GE
N/A	1.44 MB & 1.2 MB	Trident	1 MB	1024 x 768	250	Dealers, distributors	1	N/A
N/A	1.44 MB & 1.2 MB	Micro Express	1 MB	1024 x 768	220	Direct, mail order	2	Option
64 KB/256 KB	1.44 MB or 1.2 MB	Boca	256 KB	1024 x 768	220	Direct	1	TRW option
64 KB	2 1.2 MB or 1.44 MB	Orchid	1 MB	1024 x 768	230	Direct	1	1-year
32 KB/128 KB	1.44 MB or 1.2 MB	Trident	1 MB	1024 x 768	200	Mail order	5 years prorated	90-day with option
64 KB/256 KB	1.44 MB or 1.2 MB	Trident	1 MB	1024 x 768	200	Direct	1	1-year, PC House
64 KB	1.44 MB & 1.2 MB	Orchid Pro IIS	1 MB	1024 x 768	220	Resellers, direct	1 ⁴	Option
N/A	1.44 MB	Chips & Technologies	512 KB	1024 x 768	200	Direct	1	Option
64 KB	1.44 MB or 1.2 MB	Diamond SpeedStar	1 MB	1024 x 768	200	Direct, dealers	1 ⁵	3-year
64 KB	1.44 MB & 1.2 MB	Tseng Labs	512 KB	1024 x 768	200	Direct	2	2-year
64 KB	1.44 MB or 1.2 MB	Orchid ProDesigner	1 MB	1024 x 768	270	Direct	1	Option, TRW
N/A	1.44 MB & 1.2 MB	STB	1 MB ⁶	1024 x 768	220	Direct	1	120-day with option
64 KB/256 KB	1.44 MB & 1.2 MB	Orchid ProDesigner IIS	1 MB	1024 x 768	300	Mail order	2	Through TRW
N/A	1.44 MB & 1.2 MB	Orchid ProDesigner	1 MB	1024 x 768	220	Mail order	1	1-year (within 100 miles)
N/A	1.44 MB or 1.2 MB	Tseng Labs	1 MB	1024 x 768	230	Direct	1	1-year
2 MB/8 MB	1.2 MB & 1.44 MB	Diamond SpeedStar+	1 MB	1024 x 768	300	Direct	1	TRW option

disk drives—will sell for between \$3000 and \$4000, roughly what you would have paid for a 33-MHz 386 with VGA just a year ago.

Certainly, PC system vendors are establishing prices that garner market share in tough economic times. Recently, even IBM and Compaq have instituted price cuts that are meant to chip away at their reputations for setting the upper limits on price. But PC vendors face competition from more than just one another. More economical Unix workstations are giving system buyers pause when charting price/performance, while Macintosh prices are bending under similar competitive pressures. More on Unix and the Macintosh later. First, a look at the DOS world.

Dueling CPUs

For traditional DOS applications, the 386 will remain a workhorse for many applications. Consumers satisfied with Windows 3.0 can use a 386 system to run an ever-increasing array of Windows applications and continue to feel free from the shackles of 286 memory constraints. Many people in this group still won't need the 486's integrated FPU or boosted processing power. In fact, those who can live with 16-bit I/O performance can continue to take advantage of 386SX economy. For example, when IBM announced a new line of SX PS/2s, it maintained the viability of existing SX models by doubling RAM and the capacity of the standard hard disk drive without increasing the system price.

Life would be grand for Intel if it weren't for complications wrought by Advanced Micro Devices. As the BYTE Lab has shown (see "The 486SX Falls Short," June BYTE), the battle for economy-minded midrange buyers is somewhat murky. The 40-MHz Am386 entered the market as the first alternative 386 chip (look for more during 1992), prompting Intel to push the 486SX as the midrange price champion. At press time,



systems based on the 486SX, with its disabled FPU, performed in the same range as the Am386 systems but outpriced them by a third to a half more.

For its part, Intel will continue with its strategy to move beyond the 386 by selling the 486 family as the chips of the future. Intel will try to do this partly by luring system vendors with low 486 chip prices, which have fallen regularly over the last year. Also, Intel will expand the power of its high-end chips. Systems with the 50-MHz 486 should begin showing up in quantity early in 1992. Vendors should be ready to ship upgrade boards and full systems once Intel provides commercial quantities of stable chips. As

Atico's 486-25:
This EISA system's Mylex motherboard, 128 KB of disk cache, and 250-W power supply make a nice bundle for only \$3395.

this issue went to press, a dozen companies had announced intentions to support the faster 486, including IBM, Compaq, AST Research, and NCR.

The 50-MHz processor also includes support chips: an external cache controller (82495DX) and static RAM devices designed to work with the 486/50 and the 82495DX.

Intel is also reportedly working on a version of the 486/50 that will run twice as fast internally as externally. Current CPUs require a clock that runs twice the speed of the CPU. The newer 486 will require only a 50-MHz clock and will be a drop-in replacement in current 486/25 system designs.

Component Considerations

Of course, processors aren't the whole story. System vendors will continue to add more sophisticated

Acma's 486/25 ISA:
At \$2495, not only is it the lowest-priced system on our list, it also offers features you might not expect to find in a price leader, including 4 MB of RAM standard, 1 MB of video RAM on its Tseng Labs Super VGA card, and a 250-W power supply.

components to boost performance and turn the heads of buyers who are seeking the most for their money.

As many people have already learned, even the fastest processors can't overcome data bottlenecks from hard disk drives. More companies will, as a matter of course, include software or hardware caching on their systems.

In addition, IDE hard disk drives and controllers are becoming standards in midrange and high-end systems. The reason for this is clear: IDE drives combine ESDI speed with SCSI intelligence. Also, the IDE controller is integrated in the hard disk drive's circuitry, freeing a system expansion slot that would otherwise house a conventional hard disk drive controller.

Also look for Super VGA cards and monitors to brighten an increasing share of desktop systems. Prices for Super VGA boards with a megabyte of memory are dropping below \$400 and going lower. For Windows and other graphics-based programs, this means not only thousands of more colors, but sharp, flicker-free screens when the boards are teamed with noninterlaced monitors running at 70 Hz or better.

Big Blue aficionados should also be on the watch for more Micro Channel motherboards with integrated XGA, IBM's latest graphics standard, which offers 1024- by 768-pixel resolution and downward compatibility with VGA.

A new wrinkle has been introduced by desktop systems designed for multimedia; the systems may help prove or disprove the viability of multimedia as a





in the business. AT&T will be looking to finally make its mark in desktop systems with its expected acquisition of NCR. Initial reports point to AT&T's letting NCR set the technology pace by guiding new introductions. Similarly, Compaq

Datacomp's DCC 486/25E:

Although not the lowest-priced EISA system, this computer comes with a two-year warranty, 4 MB of RAM, and a 64-KB disk cache for \$3295.

may continue to wrestle with its reputation as an upper-limit price setter by further discounting system prices, a trend that began in 1991.

Finally, in what may be computing's answer to the unification of East and West Germany, the continued, albeit furtive, advances of IBM and Apple could provide a year's

commercial market in the coming year. Tandy became the first system vendor to ship multimedia systems—desktop models that carry a CD-ROM drive, video cards, and multimedia-extended Windows, among other features. IBM and others will be offering “one-stop shopping” for multimedia systems in the months ahead, aiming their products at the training and desktop-presentation markets.

32-bit Programs

If IBM has its way, OS/2 will come into its own in the next year with version 2.0, which will run 16- and 32-bit OS/2 applications simultaneously with DOS and Windows programs; the latter two should run faster than in native mode. But look for the chill between Microsoft and IBM to continue in the months ahead when Microsoft releases an

application programming interface that lets Windows run 32-bit operations, perhaps at the expense of the OS/2 market.

Each of these developments could be the final impetus to spur those who have delayed upgrades from 286 machines to the 32-bit 386 and 486 architectures.

Picking and Choosing

In most years, attention focuses on a handful of small companies aiming to produce a spark of innovation that can make their systems stand out from the pack. Next year, however, it may be most fun to watch some of the biggest names

worth of rich speculation and, perhaps, technological breakthroughs.

In the end, if current trends persist, 1992 should be a buyer's market where performance is the hottest commodity.

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UNIX SYSTEMS / Tom Yager

Unix: Status and Speculation

Unix has long endured an unjustified stigma. Until recently, when people heard the word *Unix*, they thought of huge, noisy minicomputers on raised floors in bone-chilling rooms. Advances in hardware and software technology have allowed Unix to grow from a highly specialized scientific and engineering platform to a general-purpose multitasking operating system.

For all the progress Unix has already made, it, and the companies that support it, now stand on the brink of more sweeping change, as seen in the moves toward standards, heterogeneous networking, and high-performance low-cost workstations. In this discussion, I'll indulge in a bit of speculation about where all these changes might leave the Unix market, including potential consumers of Unix, in the coming year and beyond.

The Year Ahead

Sun Microsystems, the undisputed workstation champ, is (perhaps ironically) largely responsible for kicking off a round of clone wars with its decision to

Gateway 2000's 25 MHz 486 Cache:

A low-priced (\$2995) system with 64 KB of disk cache standard, along with a competitive amount of system and video memory.



PRODUCT GUIDE: UNIX-BASED SYSTEMS

Table 2: The Unix workstations in this table are representative samples of current technology. All systems listed here cost less than \$15,000 fully configured and have in common two factors: Unix as the primary operating system and a standard graphical interface.

System	CPU/speed (MHz)	Least costly configuration				Price	Least costly color configuration with hard disk drive		
		Disk/diskless	Std. disk size	Mono/color	Std. memory (RAM)		Configuration	Memory	Price
Altos System 400	386SX/20	Disk ¹	88 MB	Color	4 MB	\$4821 ²	Same	Same	Same
Altos System 700	386/33	Disk ¹	88 MB	Color	4 MB	\$7589 ²	Same	Same	Same
Altos Series 1000 Model 1820-486SX	Intel 486SX/20	Disk ³	210 MB	Mono	8 MB	\$10,000 ²	Altos Color	8 MB	\$10,200
CompuAdd SS•1+	SPARC/25	Diskless	N/A	Mono	8 MB	\$5495	SS•1+ Color, 210-MB hard disk drive	8 MB	\$7695
Data General Avilion AV100	Motorola 88100 RISC/16.7	Diskless	N/A	Mono	8 MB	\$3995	None	N/A	N/A
Data General Avilion AV210	Motorola 88100 RISC/20	Diskless	N/A	Mono	8 MB	\$5950	Model AV310 CD, 332-MB hard disk drive	8 MB	\$11,995
Data General Avilion AV410	Motorola 88100 RISC/20	Diskless	N/A	Color	16 MB	\$13,995	AV410 Color with 332-MB hard disk drive	16 MB	\$15,090
DECstation 3100	MIPS RS2000/16.67	Diskless	N/A	Mono	8 MB	\$4995	104- & 209-MB hard disk drives, 1.4-MB floppy disk drive	16 MB	\$12,995
Futura Mercury 1000i	486/33	Disk	200 MB	Mono	8 MB	\$7015	Mercury 1000 with VGA, 200-MB hard disk drive	8 MB	\$7250
HP Apollo 9000 Model 425e	68040/25	Diskless	N/A	Gray-scale	8 MB	\$5490	200-MB hard disk drive	8 MB	\$9490
HP Apollo 9000 Model 425t	68040/25	Diskless	N/A	Gray-scale	8 MB	\$8990	Model 425t CRX, 200-MB hard disk drive	8 MB	\$14,990
HP Apollo 9000 Model 720	HP PA RISC/50	Diskless	N/A	Mono	16 MB	\$11,990	Model 720 CRX, 210-MB hard disk drive	16 MB	\$20,990
IBC Personal Workstation System 100	386/33	Diskless	N/A	Mono	8 MB	\$7800	System 100 color, 239-MB hard disk drive	8 MB	\$9295
IBC Personal Workstation System 200	486/33	Diskless	N/A	Mono	8 MB	\$8500	System 200 color, 239-MB hard disk drive	8 MB	\$9995
IBM RISC System/6000 Powerstation 320	RS6000/20	Disk	160 MB	Mono	8 MB	\$13,507	16-MB hard disk drive	8 MB	\$15,697
Mobius Protege PWS/425cf	486/25	Disk	110 MB	Color	8 MB	\$5990	Same	Same	Same
Mobius Protege PWS/433cx EISA	486/33	Disk	210 MB	Color	8 MB	\$11,490	Same	Same	Same
Nextstation	68040/25	Disk	105 MB	Mono	8 MB	\$4995	Nextstation Color, 400-MB hard disk drive	16 MB	\$12,495
Opus Personal Mainframe 5120	SPARC/25	Diskless	N/A	Mono	8 MB	\$7995	Model 5120 Color, 207-MB hard disk drive	8 MB	\$9995
Solbourne 4000-8-M	SPARC/33	Diskless	N/A	Mono	8 MB	\$8995	Model 4000-8-F-P1, 200-MB hard disk drive	8 MB	\$12,995
Sun Sparcstation ELC	SPARC/33	Diskless	N/A	Mono	8 MB	\$4995	207-MB hard disk drive, no color	8 MB	\$6295
Sun Sparcstation IPC	SPARC/25	Disk	207 MB	Mono	8 MB	\$7995	207-MB hard disk drive, GX accelerator	8 MB	\$9995
Sun Sparcstation IPX	SPARC/40	Disk	207 MB	Gray-scale	16 MB	\$11,995	207-MB hard disk drive, GX accelerator	16 MB	\$13,495

¹ Comes standard with 150-MB tape drive.

² Prices are estimated by Altos; actual pricing depends on VAR configuration.

³ Comes standard with 525-MB tape drive.

N/A = Not applicable.

license its SPARC RISC technology to any company that can pay. Now Intel, Motorola, and Mips have formed (or are otherwise involved in) consortia that devise and publish hardware and software standards. Among other things, these standards ensure that software written for one vendor's system will run on any other vendor's system based on the same technology. That's no pipe dream: Software written for Sun's Sparcstation will run, *today*, without modification on an Opus System 5000, CompuAdd SS1, or any one of a number of other SPARC sys-

tems. And soon workstations will appear that adhere to the latest revision of SPARC International's specification, which will accommodate multiprocessor systems.

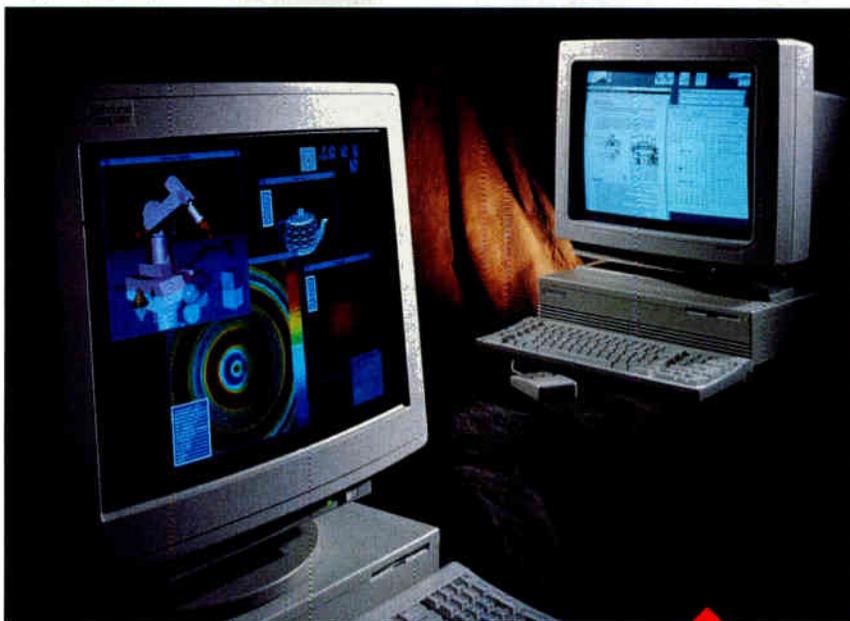
Things are hopping in the operating-system field as well, as a planned convergence of different flavors of Unix takes place in the form of System V release 4.0 (sometimes referred to as V.4). This Unix will bring together what is best about the operating systems now known as System V release 3.2, Berkeley Standard Distribution, Xenix, and SunOS. It

will also include the X Window System and TCP/IP networking (including Remote File System and Network File System file sharing and Sun's Remote Procedure Call client/server interface). For developers, this confluence of technologies means that the lowest common denominator to which applications must be written, compared with what previously existed, has just advanced into the stratosphere. This paves the way for a whole new era in graphics, client/server, and other distributed applications.

If nothing else, V.4 will bring unity to

Operating system type, version	Networking
Altos Unix Sys. V/386 3.2 release 2.0	TCP/IP, NFS, RFS
Altos Unix Sys. V/386 3.2 release 2.0	TCP/IP, NFS, RFS
Altos Unix Sys. V/386 v5.3 et3	TCP/IP, NFS, RFS, DOS server
SunOS 4.1	TCP/IP, NFS
DG/UX 5.4	Asynch., TCP/IP, NFS
DG/UX 5.4	Asynch., TCP/IP, NFS
DG/UX 5.4	Token Ring, Asynch., TCP/IP, NFS
DEC ULTRIX	TCP/IP, NFS
OS/2, SCO Xenix	TCP/IP, NFS option
HP-UX 8.0 or Domain/OS 10.3	TCP/IP, NFS
HP-UX 8.0 or Domain/OS 10.3	TCP/IP, NFS
HP-UX 8.01	TCP/IP, NFS
AIX 3.0	NFS, NCS, TCP/IP, X.25
SCO Unix 3.2 within Open Desktop 1.1	TCP/IP, NFS, LAN Mgr.
SCO Unix 3.2 within Open Desktop 1.1	TCP/IP, NFS, LAN Mgr.
ISC Unix 3.2 or SCO Open Desktop or AT&T V.4	NFS, TCP/IP
ISC Unix 3.2 or SCO Open Desktop or AT&T V.4	TCP/IP, NFS
Mach/Next OS	TCP/IP, NFS, Next proprietary
SunOS 4.1	NFS, TCP/IP
OS/MP 4.00a (deriv. of SunOS 4.0.3)	TCP/IP, NFS
SunOS 4.1	NFS, TCP/IP, PC-NFS, TOPS
SunOS 4.1	NFS, TCP/IP, PC-NFS, TOPS
SunOS 4.1	NFS, TCP/IP, PC-NFS, TOPS

a disheveled, struggling PC Unix market. Even though the 486 is very well suited to running Unix, buyers are showing a preference for non-Intel workstations because of a lack of standardization and also because most traditional workstation vendors bundle complete operating systems with their machines at no extra charge. PC Unix will still have to fight that battle after V.4's introduction: Sun (one of the companies that worked on V.4) plans to make V.4 standard on its SPARC machines and will license it to makers of SPARC-compatible systems.



The Future of Workstations

When all these changes, along with some others, are added together, it bodes well for those who are still limping along on technology too weak to support them. Today, it's possible to purchase a fully configured Sun workstation for less than a comparably equipped Compaq or IBM 486 PC. And when I say "fully configured," I mean 8 MB of memory, a 200-MB SCSI hard disk drive (minimum), Ethernet, a high-resolution monochrome display, a Unix operating system with X, and networking and development tools (see table 2). Want E-mail? It's in there. A high-resolution GUI? Standard. Multitasking? That, too. File sharing, advanced file systems, backup utilities, you name it: Those things that DOS users have grown accustomed to paying for with PCs are part of nearly all the workstations sold today, and the list of standard features grows constantly. What can those who are now thinking about Unix expect over the next year or two? There are no clear-cut answers, but I'll close this discussion by sticking my neck out to make a few predictions.

CD-ROM will become standard fare. Compared with quarter-inch tape, CD-ROM is less expensive, more reliable, and easier to ship and store; it holds more data and can be directly mounted as a random-access Unix file system. Expect, too, to see the 8-MB base memory standard go away. Graphical interfaces and networking are demanding, and I think 16 MB will become the new base. Similarly, as more features are packed into standard software offerings, standard

disk sizes will rise; I expect to see standard hard disk drives settle into the 330- to 400-MB range during 1992.

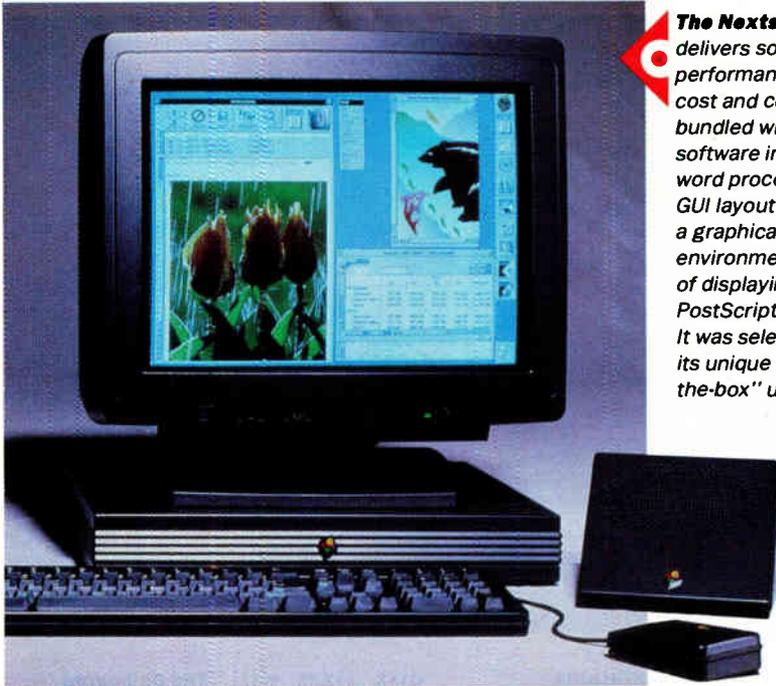
Monochrome monitors will begin to disappear, replaced by smaller color monitors. Someone will release a 16- or 24-bit graphics system (that runs X) in a low-cost configuration, and the competition will rush to get their answers on the market. The \$5000 color workstation will become a common sight, and Unix software prices will start falling to PC pricing levels.

It won't all happen in 1992, but more major PC and Mac software vendors will jump on the Unix bandwagon. Lotus, Ashton-Tate, Microsoft, Adobe, and others are already there. Developers will be drawn by Unix's stability (compared with Windows) and the ease with which software can be made available on a wide variety of hardware types.

Hardware and software vendors alike will have two key objectives in 1992: heterogeneous networking and ease of use. By the end of the year, it will be much easier to connect PCs, Unix workstations, and Macs to the same network and share files and data. Distributed applications will begin to appear, and more capable Unix systems will take their


**The Solbourne
4000-S-M**

is a high-performance SPARC system suitable for both compute- and file-I/O-intensive operations. The standard color configuration includes a 2-D graphics accelerator. This system was selected for its unique price/performance value.



The Nextstation delivers solid performance at a low cost and comes bundled with software including word processing, a GUI layout tool, and a graphical environment capable of displaying PostScript files. It was selected for its unique "out-of-the-box" usability.

add-on software. With its marketing savvy, Sun might just carve itself a niche in the fast-growing PC Unix market.

The other workstation vendor to watch is Next. It's left the sluggish, disappointing cube in the dust in favor of a fast, sleek design. The new unit (the Nextstation) has speed, a much improved operating system, and, at long last, color. While everyone else is figuring out how to build ease of use into their systems, Next will be filling orders. I see the Nextstation as the only workstation that can, starting now, draw users away from Windows-based PCs and the Mac.

The other thing that the Nextstation has going for it is not so obvious: Developers positively love it. Every Nextstation comes with a complete set of development tools, and there is simply no better environment for building graphical applications. Even if a company cannot define a clear Nextstation market for its new product, chances are that the development staff will browbeat management into letting it build something on the Next.

People who are now using the Next are nothing short of gaga over it, and their lust is justified. I think 1992 will be the year that Next lands solidly on the map, and it'll be leading a pack of workstation vendors that will make trouble for PCs and Macs.

places as "process servers," lifting the burden of demanding applications off the shoulders of the PCs and Macs in the office. System and network administration will become much simpler (it will approach automatic), and front ends will be devised that swaddle Unix-fearful users.

Who will the leaders be in 1992, and how will they get there? I expect to see Sun maintaining a lead and increasing it by, among other things, making its systems fit in seamlessly with networks of PCs. The faltering economy gave Sun a breather during which it could shuffle its priorities, spin off a couple of new divisions, and get its whole "open computing" story straight. In 1992, a fresh-faced, more aggressive Sun will emerge, reaping the benefits of licensing (such as a huge installed base) while still keeping the best new technology to itself. Expect Sun to make waves in both the high and low ends

The new Sun Sparcstation ELC and IPX offer increased performance over their predecessors (the SLC and IPC) while holding the line on cost. The IPX is Sun's least expensive color system that includes accelerated 2-D graphics. The ELC is a very low-cost, diskless, monochrome workstation. These systems were selected for their solid performance, excellent operating system and GUI, and good value for the money.

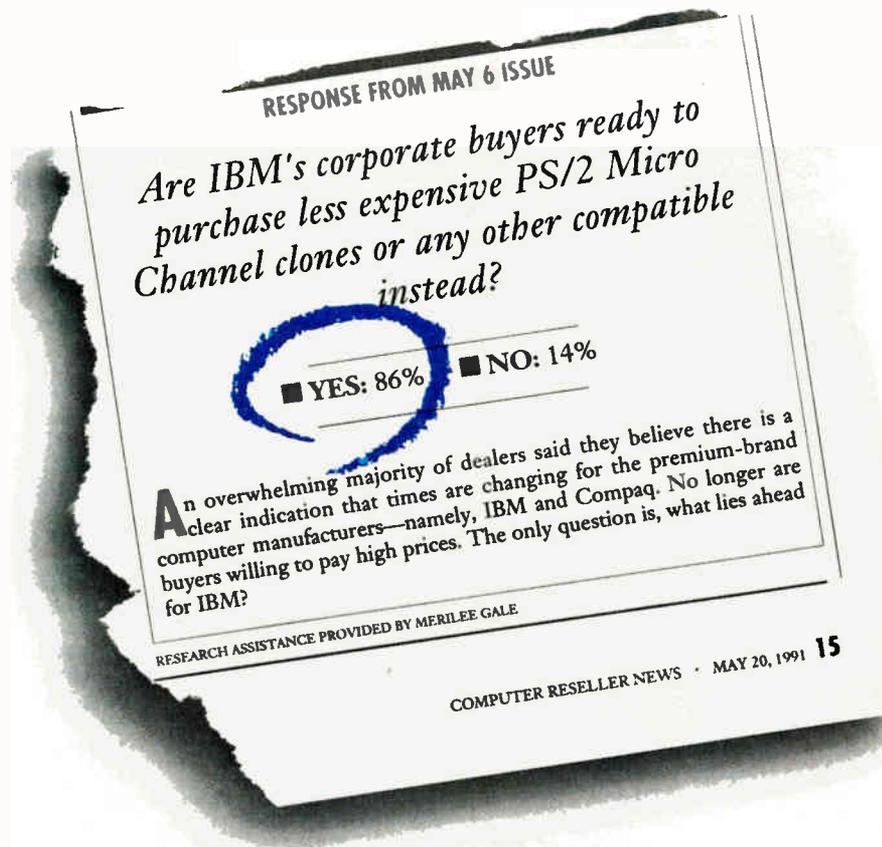
of the workstation market in 1992 by introducing several new products. Expect, too, that Sun will take a stab at the applications software market, much the way Apple's Claris has done so successfully.

In addition to stocking shelves with SPARC software, Sun's Solaris (V.4 Unix with Sun extensions) will be made available for Intel-based PCs, among others. Sun has always been revered for the quality of its operating system and



continued

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 (818) 575-0007
 fax: (818) 575-1500
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 (486/25 ISA, 486/25 EISA)
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 fax: (415) 623-0818
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Advanced Logic Research, Inc.
 (ALR)
 (BusinessVEISA Model 120-5,
 MPS Model 120-5)
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 Irvine, CA 92718
 (800) 444-4257
 (714) 581-6770
 fax: (714) 581-9240
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 San Francisco, CA 94121
 (415) 769-3795
 fax: (415) 522-0913
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Amax Engineering Corp.
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 fax: (415) 651-3720
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AMI International
 (AMI 486/25)
 2393 Qume Dr.
 San Jose, CA 95131
 (408) 432-1790
 fax: (408) 432-0677
Circle 1080 on Inquiry Card.

AMKLY Systems, Inc.
 (486/25E Model 125)
 60 Technology Dr.
 Irvine, CA 92718
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 fax: (714) 727-9521
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 EISA)
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 (713) 946-0731
 fax: (713) 946-3117
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 fax: (512) 250-5760
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Cube Computer Corp.
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 Suite 210
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 (703) 848-0788
 fax: (703) 848-0704
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Dataworld
 (Data 486-25ec Desktop)
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 Pico Rivera, CA 90660
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 (213) 695-3777
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100, Personal Workstation
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(415) 493-7777
fax: (415) 856-9820
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Next Computer, Inc.
(Nextstation)
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Solbourne Computer, Inc.
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(303) 772-3400
fax: (303) 772-3646
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Sun Microsystems, Inc.
(Sparcstation ELC, IPC, IPX)
2550 Garcia Ave.
Mountain View, CA 94043
(800) 821-4643
(800) 821-4642 in California
(415) 960-1300
fax: (415) 969-9131
Circle 1230 on Inquiry Card.

Sportscasters are happy if they're correct on more than half of their predictions. The way things stand now, I feel pretty confident about everything I've said, but there's one thing about this business that you can *always* count on: Things change quickly. Thankfully for long-term Unix fans, our days of languishing in a minority seem to be coming to an end. The private club was nice for a while, but I am looking forward to a more crowded dance floor in 1992.

Tom Yager is a BYTE technical editor, manager of the BYTE Unix Lab, and author of the book Unix Program Development (Addison-Wesley, 1991). You can contact him on BIX as "tyager."



MAC SYSTEMS / Tom Thompson

More Bang, Less Buck

It used to be that the Macintosh was an expensive computer—a *very* expensive computer. The situation was such that in a number of cases it was less expensive to buy a PC with a hard disk drive and use Sitka's TOPS software for file sharing than to purchase a Mac Plus and a hard disk drive to act as a file server. That situation has changed, to the benefit of everyone.

Three Macs—the Classic, the LC, and the IIsi—now represent the low-range Mac product line. For slightly less than the price of a bare-bones Mac Plus with only an 800-kilobyte floppy disk drive and 1 MB of RAM, you can now buy a fully loaded Mac Classic with a 1.44-MB Superdrive, a 40-MB hard disk drive, and 2 MB of RAM. A Mac LC with a color monitor, 2 MB of RAM, and a 40-MB hard disk drive goes for less than what it costs to buy a stripped Mac SE with only an 800-KB floppy disk drive and 1 MB of RAM. Even the file-server example no longer applies: You can get a stripped Mac Classic and a third-party 100-MB hard disk drive for about \$1500.

If you're on a tight budget and need a big display or better performance than the LC can provide, the Mac IIsi is the way to go. A list price of \$4897 nets you a 20-MHz 68030-based Mac with 3

MB of RAM and a 40-MB hard disk drive. You have your choice of an optional NuBus or Direct Slot connector for expansion boards. Choose a connector and spend the \$249. Even if you don't need an expansion board right away, you will want the bundled 68882 math coprocessor for number crunching.

But prices have come down even for the mid- and high-range Macs. Early in the year, the prices of the Mac IIfx, IIfci, and Mac SE/30 tumbled by as much as 30 percent.

For example, the price of a Mac SE/30 with 4 MB of RAM and an 80-MB hard disk drive fell from \$5569 to \$3869. A fully loaded (4 MB of RAM, 160-MB hard disk drive) IIfx's price dropped by 20 percent, hacking about \$2300 from the original price and bringing the current list price to \$8669.

Mac IIfci:

A list price of \$7097 buys you a powerful 25-MHz 68030-based Mac with 5 MB of RAM and an 80-MB hard disk drive. On top of that, the IIfci has a svelte desktop footprint, three NuBus slots, a 68882 math coprocessor, and built-in 8-bit color video.



A gallery of low-cost Macs

(left to right): The 20-MHz 68030-based Mac IIsi, sporting a 13-inch AppleColor monitor; the 16-MHz 68020-based Mac LC, using a 12-inch RGB monitor; and the 8-MHz 68000-based Mac Classic, with a black-and-white monitor built in. The Mac IIsi can use either a NuBus or a 68030 Direct Slot expansion board. The Mac LC has a single 68020 Direct Slot for expansion boards.

For those of you still using Mac SEs and IIfxs, the upgrade prices have fallen as well, allowing you to protect your hardware investment without going broke. For instance, \$999 currently converts an 8-MHz 68000 Mac SE high-density floppy disk clunker into a feisty 16-MHz 68030 Mac SE/30. Likewise, transforming your 16-MHz Mac IIfx into a 25-MHz IIfci with built-in video will set you back only \$1499.

Apple introduced the low-end Macs to grab market share. Given the phenomenal sales volume of these machines, it just may succeed. But let's hope the company keeps this long-term market growth plan in mind when it introduces the new 68040-based Macs and notebook computers. Aggressive prices are a sure ticket to success for Apple. ■

Tom Thompson is a senior technical editor at large. You can contact him on BIX as "tom_thompson."

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FACT: Computer Shopper compared 3 systems in its July cover feature. **TOUCHE** beat NORTHGATE and DELL in the overall total speed test for performance! Shopper also said, "**TOUCHE**'s system operated quietest... **TOUCHE** obviously offers the fullest expansion of the three systems... **TOUCHE**'s ESDI edged out NORTHGATE'S IDE drive and DELL'S slower IDE" Of all three systems **TOUCHE** was the least expensive. Shopper also said, "In fit and finish **TOUCHE** offers among the best we've seen."

FACT: Our AMI partnership enabled us to begin shipping 386 to 486 upgradable systems in 1989... 2 years before NORTHGATE even announced theirs! Northgate President Art Lazere is quoted in PC WEEK 06/03/91, "Upgradable is the wave of the future..." Unfortunately anyone riding the NORTHGATE wave is sunk when it comes to upgrading their 386 systems. Now that everyone wants a 486 anyway, what good is that to customers that bought Northgate systems for the past 2 years? Only GATEWAY knows when their upgradable system will ever become available.

FACT: **TOUCHE** was first to offer a 386 caching motherboard because AMI was the first to design a caching 386 motherboard.

QUALITY

We take great pride in the fact that we include a 2 year replacement part warranty on every component. Gateway, Northgate, and Dell include only a 1-year warranty. After you buy a **TOUCHE** you'll never need to worry which component might fail after only 1-year of use! Even more importantly replacing failing parts can be extremely expensive. Investigate the cost of repairing your IDE or ESDI hard drive. There goes a whopping \$300-\$400! Maybe you'll get it back in working condition after 3 or 4 weeks. We won't even try to guess what happens when their motherboard fails! You simply can't afford to buy any system which offers you only a 1-year warranty!

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WHO YA GONNA CALL?

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World Radio History

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

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

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



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

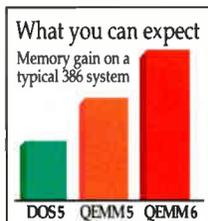
QEMM 6.0 Stealth technology 'remaps' ROMs, freeing-up as much as an additional 115K to be used by your favorite programs.

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

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

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

Either way, QEMM-386 v6



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

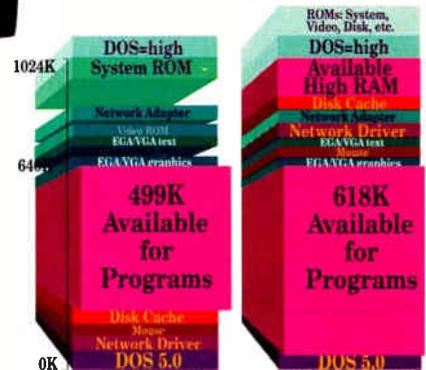
finds more memory for your programs than any other memory manager. Period.

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

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

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

Of course, not every PC has 115K of extra high memory, but



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

every PC can benefit from 'Squeeze'—our new feature to manage all those TSRs that need more memory at start up and less when they're resident. Their memory allocation is temporarily increased at start up, then squeezed down when it's no longer needed.

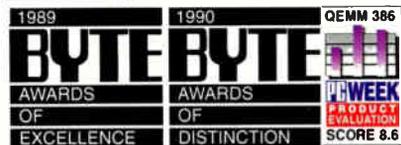
QEMM automatically uses idle VidRAM to produce a further 96K gain on EGA and VGA-equipped systems when running character-based programs.

486 performance memory messages faster, our new QEMM.

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

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

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



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

Don't leave DOS without us. QEMM provides an additional 8-24K of conventional memory to Windows 3 enhanced mode—maximizing memory to help make everything run better.



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

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

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

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



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New DESQview-386 A performance bonanza for demanding users.

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

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Priority Service customers: call for special pricing. Upgrade pricing good through 12/31/91.

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WINDOWING



WINDOWS 3.0 / Stan Miastkowski

The Promise Fulfilled

Whether you think Windows 3.0 is a great leap forward or part of a conspiracy to extend the life of a tired old operating system, there's no denying its dominance in the computer industry for the past year

1-2-3 for Windows: 1-2-3 for Windows uses Lotus's SmartIcons software, which lets you automate and fine-tune the user interface. But die-hard fans of the original interface, fear not: It appears as a 1-2-3 Classic menu choice.

and a half. In May 1990, Windows 3.0 hit the streets with a whole raft of ready-to-run applications. As of this July, about 1500 retail Windows 3.0 applications had become available, according to a Microsoft spokesperson I talked to. That number, of course, doesn't take into

sands of Windows 3.0 applications developed for specialized markets.

Microsoft claims to have sold millions of copies of Windows 3.0 since its release. Although there's been a lively debate over how many of these copies are actually being used, the point is that applications developers have, with few exceptions, climbed aboard the Windows 3.0 bandwagon.

Is this activity mere hype or a sign of genuine innovation? In a way, it really doesn't matter. Windows 3.0 has given us a *consistent* way to interact with our computers. Of course, the details of that interface are the subject of incessant grousing among users and developers. Like it or not, we've become active users of mice (or other pointing devices). Windows 3.0 is the shining example of the IBM-developed-and-pushed Common User Access. (For more information on how users are reacting to Windows, see "Surveys Say..." on page 143.)

In the main, developers of Windows 3.0 applications have stayed close to the defined interface. Those occasional applications from developers determined to do their own thing have usually died a quick death in the marketplace.

The discipline of the Windows 3.0 interface is slowly but surely spawning

Not by DOS Alone

Whether you like it or not, a windowing application is probably in your future

These days, when someone mentions the word *windows*, most people think of Microsoft. But windows neither begin nor end with the popular DOS version. In fact, the Macintosh made windows popular in 1984 with the first widespread use of the GUI concept. Today, most Unix workstations are based on the X Window System, a widely accepted graphical interface that was developed at MIT. Capabilities and tastes notwithstanding, some sort of windowing environment seems to be in most of our futures.

The main attraction of windowing applications is their ease of use. It is much simpler to learn one consistent command structure that, in general, applies to a range of applications than it is to learn separate command structures for each application you use. The GUIs themselves, with their graphical orientation,

are intuitive, which cuts down on training time. Businesses that pay significant sums for software training see GUI-based applications as a means of saving time and money.

In this article, three BYTE editors take a closer look at software for windowing environments. For DOS-based Windows 3.0 and Macintosh environments, we look at three general-purpose areas: word processors, databases, and spreadsheets. Each is represented in the accompanying Windows 3.0 and Macintosh Product Guides (see tables 1-6). The disparity of products and product capabilities available for the X environment ("shrink-wrapped" X applications just began appearing within the last year) prevented us from making a useful Product Guide, but we do provide a listing of vendors in the word processing, database, and office productivity categories.

a generation of more computer-literate users. Make no mistake, understanding the nuances of the Windows 3.0 interface isn't as easy as Microsoft's big-bucks marketing juggernaut would have us believe. The learning curve is relatively steep, but it's a single learning curve. The elegance of the Windows 3.0 interface is that once you've learned it, you can pick up nearly any off-the-shelf retail Windows application and begin to use the package immediately. For large corporations, the savings in software training and support are considerable—over both the short and long term.

What the Pros Use

In an informal poll of serious Windows 3.0 users who belong to the IBM Windows conference on BIX, Word for Windows, Excel, and PageMaker were repeatedly mentioned as the most used Windows 3.0 applications. It's no mere coincidence that the first two are Microsoft applications: The folks who actually developed Windows 3.0 are also the ones who have so far "gotten it right" when it comes to developing Windows 3.0 applications.

Are these and other popular Windows 3.0 applications revolutionary? Manufacturer marketing hype to the contrary, the answer is no.

The term *evolutionary*, although overused, is a better word for today's most popular Windows 3.0 applications. Even rabid Windows 3.0 users still run plain-vanilla DOS applications from within the Windows 3.0 environment. This may simply be a function of user inertia; once used to an application, most of us are reluctant to discard it. It will be interesting to see what happens as the most tried-and-true DOS applications appear in their Windows incarnations. Lotus 1-2-3, WordPerfect, and Paradox are prime examples.

The Task at Hand

One feature that's sure to become more important in the near future is Windows' multitasking capability. As the 386 and 486 push out the aging crop of 286-based systems, more and more users will discover the advantages of running concurrent applications. Corporate users are already using Windows 3.0 multitasking,

often for client/server applications on company LANs.

As multitasking becomes more common, Windows' *cooperative* multitasking could become problematic, because Windows is really just a fancy shell wrapped around DOS—and DOS was never designed for multitasking. In order for Windows 3.0 applications to do multitasking, they must be "well behaved"—that is, written in strict compliance with Microsoft's programming guidelines. That, unfortunately, is not always the case.

The issue of compliance raises the subject of OS/2, which was designed from the ground up as a true *preemptive* multitasking operating system. The debate over whether OS/2 will ever replace DOS is beyond the scope of this article, but IBM's promise that the soon-to-be-released OS/2 2.0 will "run Windows applications better than Windows" points to some interesting times ahead.

Do It Yourself

One of the most interesting trends to develop since Windows 3.0's introduction

PRODUCT GUIDE: WINDOWS 3.0 DATABASE APPLICATIONS

Table 1: A number of new vendors are using the Windows platform to make their entry into the PC market. This listing includes both relational and flat-file Windows database managers. (● = yes; ○ = no.)

Product	Price	Minimum RAM	Hard disk space required	Minimum CPU	Mouse required?	Other versions	Popular file formats supported	SQL support?
Ace AceFile	\$295	2 MB	3 MB	286	●	DOS	Lotus 1-2-3, Symphony, ASCII, dBase, hot-links Excel, Word for Windows, Ami Pro, Windows DDE protocol	○
Blyth Omnis 5	\$1000	1 MB	1 MB	286	●	Mac	DIF, SYLK, DBF, WKS	●
Coromandel ObjectRetrieve	\$495 ¹	200 KB	1 MB	286	○	DOS, Unix	ASCII	●
GenSoft dBFast for Windows	\$495	1 MB	1 MB	286	○	DOS, Mac	DBF	○ ²
MDBS M/4 Windows	\$995	50 KB	300 KB	286	○	DOS, Unix,	None	●
Raima DB Vista III	\$695	640 KB	80 KB ³	286	○	DOS, Unix, VMS, OS/2, Mac	ASCII	●
Software Products WindowsBase	\$495	2 MB	640 KB; 2 MB recommended	286	●	None	DBF, VMS, OS/2	●
Software Publishing SuperBase 2	\$345 with sample files	640 KB	2.4 MB	386SX	○	None	ASCII, WKS, WK1, Excel, DIF, PCX, EPS, TIFF	○ ⁴
Software Publishing SuperBase 4	\$695	640 KB	1.2 MB	386SX	○	None	ASCII, WKS, WK1, Excel, DIF, PCX, EPS, TIFF	○ ⁴

¹ Price is for version that supports binary objects.

² SQL support available only through DDE.

³ Requirement given is for application; developer environment requires 2 MB.

⁴ Product lets you embed SQL commands, but to use them you must purchase SuperBase SQL Library (\$495).

PRODUCT GUIDE: WINDOWS 3.0 WORD PROCESSING APPLICATIONS

Table 2: Word processing represents a large part of the potential Windows applications market. By the time you read this, all the major word processing vendors will have Windows versions available. The size of the Windows market opens up opportunities for new players, such as DeScribe. The possible result: The current DOS-based favorites might not be ranked the same in the Windows environment. (● = yes; ○ = no.)

Product	Price	Minimum RAM	Hard disk space required	Minimum CPU	Mouse required?	Other versions	Popular file formats supported
DeScribe Word Processor	\$495	2 MB	2 MB; 8 MB recommended	386SX	○	PM	ASCII, DCA, DisplayWrite, Excel, Framework 3.0, WK1, Word, MultiMate, WordPerfect, XyWrite, PFS: First Choice, PFS: First Write, WordStar, Professional Write, GEM, PCL, PIX, PIC, CGM, PCX, WMF, TIFF
Lotus Ami Pro	\$495	1 MB	5.5 MB	286	○	NewWave	ASCII, DCA, WordPerfect, DisplayWrite, WordStar, MultiMate, Word, Word for Windows, RTF, WKS, WK1, WK3, Excel, DBF, SuperCalc, DIF, EPS, PIC, PCX, CGM, HPGL, WMF, TIFF
Microsoft Word for Windows	\$495	640 KB	3.2 MB	286	○	Mac	WordPerfect, MultiMate, DisplayWrite, WordStar, Works, ASCII, WKS, WK1, WK3, HPGL, PCX, TIFF, PIC
NBI Legacy	\$495	640 KB	3.8 MB	286	●	None	ASCII, WordPerfect, Word, DisplayWrite, MultiMate, RTF, DIF, PIC, DRW, HPGL, CGM, EPS, TIFF, PCX, WMF, WKS, WK1
Software Publishing Professional Write Plus	\$249	1 MB; 2 MB with grammar checker	4 MB	286	○	DOS	CGM, PCX, PIC, Word, DCA, Professional Write Plus, MultiMate, WordPerfect, Professional Write, OfficeWriter, WordStar, WordStar 2000, ASCII, RFT, EPS, TIFF, WMF, Excel, SuperCalc
Symantec JustWrite 1.0	\$199	2 MB	4 MB	286	●	None	Ami, Ami Pro, ASCII, Word, MultiMate, Professional Write, Professional Write Plus, RTF, Q&A Write, Word for Windows, WordPerfect, WordStar, XyWrite
WordStar Legacy	\$495	1 MB; 2 MB recommended	4.3 MB	286	○	None	WordStar, WordStar 2000, WordPerfect, ASCII, DIF, RFT, MultiMate, Professional Write, PFS: First Choice, PIC, DRW, HPGL, CGM, EPS, WMF, TIFF, PCX, BMP, DCA, RFT

Note: IBM Signature and WordPerfect for Windows are still under development; no pricing or system requirements are available for these products.

has been the appearance of application development tools. This trend is sure to continue. Until very recently, developing Windows 3.0 applications was a job for the truly dedicated. First of all, you needed to lay out several thousand dollars for a Windows Software Development Kit and the tools to use it. Then you needed to be an advanced C programmer with lots of time to learn the intricacies of programming for Windows. Even if you fulfilled these prerequisites, the job wasn't easy: Witness the many major applications developers whose products were delayed while teams of programmers wrestled with the black art of Windows programming.

Things are improving—slowly. You no

longer have to dedicate your life to C to develop Windows applications. Although the market is flooded with high-ticket development tools designed mainly for serious corporate developers, Borland's introduction of a Turbo Pascal version complete with Windows programming tools has brought Windows 3.0 programming closer to the user. More recently, we've seen the introduction of Microsoft's Visual Basic and Within Technologies' Realizer. Both let you develop Windows 3.0 applications using an extended version of the old familiar BASIC.

The trend toward accessible Windows 3.0 programming tools will continue. But be warned: It still isn't easy. Despite the advertising claims of quick and easy

Windows applications development, the reality is that you simply can't sit down and pop out an application as you can for DOS. That begs a more important question: Should you? There's a wide range of Windows 3.0 applications available now. Many more will be available in the future. And increasing competition continues to drive down prices. For the foreseeable future, Windows 3.0 applications development is likely to be confined to those who need applications that aren't otherwise available.

On the Horizon

Windows 3.1, which should become available by the end of the year, will include Microsoft's Object Linking and

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PRODUCT GUIDE: WINDOWS 3.0 SPREADSHEET APPLICATIONS

Table 3: The list of Windows spreadsheet products mirrors that of the DOS world. The spreadsheet market is an expensive one in which to carve out a profitable niche, so the current favorites are likely to remain so among Windows users. (● = yes; ○ = no.)

Product*	Price	Minimum RAM	Hard disk space required	Minimum CPU	Mouse required?	Other versions	Popular file formats supported
Bell Atlantic Thinx	\$495	1 MB	2 MB	286	●	None	WK1, DBF, XLS, DRW
Informix Wingz	\$499	2 MB	1.5 MB	286	●	Ultrix, OS/2, SunOS, Excel, Mac	WKS, WK1, WK3
Lotus 1-2-3 for Windows	\$595	2 MB	5 MB	286	○	DOS, Mac, ALL, Unix, PM	WK1, WK3, WKS, WKR, FMT, VMS, SunOS, FM3, VM, MVS
Microsoft Excel	\$495	1 MB	3 MB	286	○	OS/2, Mac	ASCII, WKS, WK1, DBF, SYLK, DIF, DBF2, DBF3, DBF4

* Quattro Pro for Windows is still under development; Borland has not released pricing or system requirements for this product.

Embedding technology. This will have a profound effect on Windows applications. OLE has the potential to deliver on the long-delayed promise of fully integrated applications. Going way beyond Dynamic Data Exchange, OLE will enable applications to communicate fully with one another.

For example, take the process of inte-

grating graphics, a spreadsheet, or a database with a document prepared by your favorite word processor. If you're using the Windows Clipboard, this is a cut-and-paste chore. Once you have integrated your data, changing it is a hair-tearing exercise. With OLE, you'll be able to click on whatever data you want to update or change and be taken directly

into the corresponding application.

The caveat is that Windows applications will have to include OLE capabilities. This requirement opens the door for a new generation of applications that could very well encourage even the most recalcitrant Windows naysayers to join the fold.

Windows 3.1 will also include the

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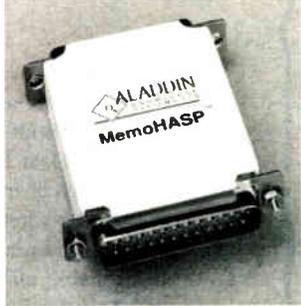
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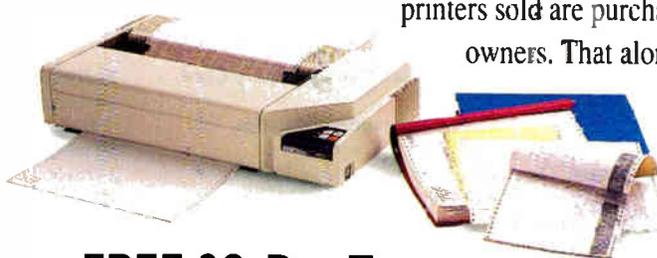
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(DeScribe Word Processor)
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Sacramento, CA 95834
(916) 646-1111
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IBM Corp.
(Signature)
Old Orchard Rd.
Armonk, NY 10504
(800) 426-2468
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Lotus Development Corp.
(Ami Pro)
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
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Microsoft Corp.
(Word for Windows)
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(Professional Write Plus)
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Borland International, Inc.
(Quattro Pro for Windows)
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Apple-developed TrueType outline font technology. In many current Windows 3.0 applications, what you see on the screen isn't necessarily what you get from the printer. TrueType will change that. More important, documents will be portable between the Macintosh and Windows environments.

Sound and Pictures

And there are even more advanced applications coming over the horizon. Microsoft's recently introduced Multimedia Development Kit for Windows promises the integration of hi-fi sound and high-resolution full-motion video with the Windows environment (see

"Multimedia Window Dressing," page 48, August BYTE). But so far, the word *promise* sums up the situation. The lack of any real progress is largely a function of industry confusion over what, exactly, multimedia is and, more important, who will buy it.

Finally, there is the PenWindows

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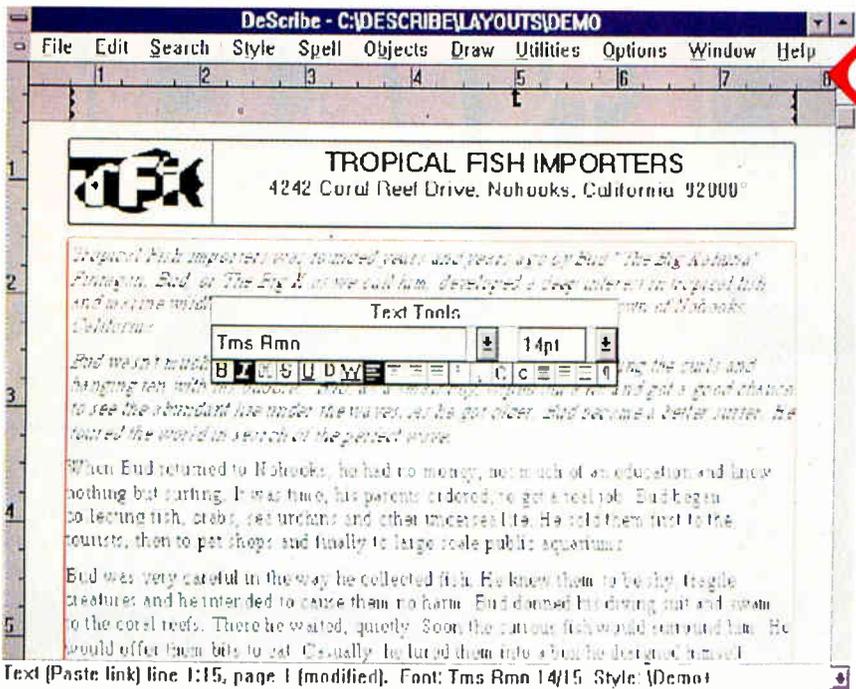
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DeScribe first coined the term word publisher with an OS/2 package that combined the best features of a word processor and a desktop publisher. DeScribe Word Processor 3.0 is the company's first product for Windows. Besides speed and performance improvements, it includes a raft of new features (e.g., extensive drawing capabilities) that ease the preparation of all sorts of documents.

pushpins and drag-and-drop capability. In fairness, Motif has some unique advantages, too, such as keyboard shortcuts for menus and a self-managing file-selection dialog box. In the end, though, I think it comes out about even; neither is any harder or easier to work with than the other, because both of them rely on the X Toolkit. That gives them nearly identical programming interfaces.

The battle, according to some experts, is over: Motif is every-

operating environment from Microsoft. Pen-based computing is in its infancy, but it's sure to spawn a huge new market, mainly in vertical segments that have been left in the dust by the PC revolution.

Its advantages and disadvantages aside, Windows has opened up the applications market, generating excitement and innovation in the PC software market. The next year will see a continued avalanche of Windows applications. Many will be simple ports of existing applications shoehorned into the Windows interface. Some, however, will be stand-out applications that begin to take full advantage of the promise of Windows.

Stan Miastkowski is BYTE's senior editor for new products. He can be reached on BIX as "stanm."

X WINDOW SYSTEM / Tom Yager

Setting a Standard

Considering its handicap upon entering the market, the X Window System, the graphical environment that Next's Steve Jobs once dubbed "brain damaged," has come a long way. It remains the only universally implemented graphical interface system, available on everything from Unix workstations to PCs, Macs, and Amigas. It's even available for the Next (but not from Next).

X empowers developers to create ap-

plications that run on one machine and converse with the user through any other machine, all transparently. It defines a clear, publicly available standard (even the source code is publicly available without a license fee) that allows anyone to create new hardware or software that's guaranteed to work with all other properly implemented X products. Unlike the Windows, OS/2, and Mac interfaces, X came out of the gate ready to be networked and gave a lot of us our first taste of distributed computing.

Despite X's impressive history, new applications are still appearing rather slowly as software vendors wait to see how X will catch on in the broad marketplace. There's hope that some recent and coming developments will change that.

The Great Debate

Since their introductions, Open Look and Motif have been at odds with one another. Both are X layers that provide user-interface elements (e.g., buttons and scroll bars) for programmers and window management facilities for users. Motif got the market's attention first and introduced many workstation users to three-dimensional shading and effective use of color.

Open Look's appearance, at the time of its introduction, was sick in comparison, and potential users and developers couldn't get over how much better Motif looked. Today, Open Look, too, has 3-D shading, and it also has a number of things that Motif doesn't have, such as

where, and Open Look is not. Even Sun, the strongest proponent of Open Look, must compete against a number of third-party Motif implementations on Sun's own machines. The move to put Motif on Sun workstations was spurred by Sun's weak, nonstandard X/Open Look implementation, Open Windows 1.0. Even with the more stable Open Windows 2.0, some vendors, claiming that Open Windows 2.0 has some serious flaws, still insist that their software be run under Motif.

Sun may have been a little slow to come around, but it now seems to realize that X is no small issue and that Open Look won't sell itself. Open Windows 2.0 sweetens the pot with X11/News, a combined X- and PostScript-compatible graphical interface server. Applications can be written to use a combination of X and PostScript functions. What PostScript compatibility brings to the party is what X has desperately needed from the beginning: scalable fonts and graphics. All fonts in X's current release (X11.4) are bit maps. The software has a lot of them (over 150 on the machine I'm using to write this), but they are bit maps of fixed size. If you want a size that's not included, tough; X doesn't even include a facility to scale a bit map.

Enter Sun's News, with its PostScript-compatible graphics server. With it, you can display text in a number of fonts, at any size and at any rotation. The graphics are scalable, and everything is directly printable. What you see on-screen in the

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COMPANY INFORMATION:

X WINDOW APPLICATIONS

WORD PROCESSING

ArborText, Inc.
535 West William St.,
Suite 300
Ann Arbor, MI 48103
(313) 996-3566
The Publisher 3.0.4b.....\$3495
Circle 1007 on Inquiry Card.

Elan Computer Group, Inc.
888 Villa St., Third Floor
Mountain View, CA 94041
(415) 964-2200
Avalon Publisher (SPARC) . \$995
Elan/Express (SPARC).....\$495
(PC Unix).....\$295
Circle 1008 on Inquiry Card.

Electronic Book Technologies, Inc.
1 Richmond Sq.
Providence, RI 02906
(401) 421-9550
DynaText (floating license, five simultaneous users)... \$2500
Circle 1009 on Inquiry Card.

Frame Technology Corp.
1010 Rincon Cir.
San Jose, CA 95131
(408) 433-3311
FrameMaker 3.0 (single user).....\$995
(floating license).....\$2500
Circle 1010 on Inquiry Card.

Image Network
140 South Whisman Rd.
Mountain View, CA 94041
(415) 967-0542
Xruff (base price, single user) .. \$795 (full single-user package with all fonts).....\$1300
Xpage.....\$260 and up
Circle 1011 on Inquiry Card.

Interleaf, Inc.
9 Hillside Ave.
Waltham, MA 02154
(617) 290-0710
Interleaf 5 (single user, Unix).....\$1795
Circle 1012 on Inquiry Card.

Island Graphics Corp.
4000 Civic Center Dr.
San Rafael, CA 94903
(415) 491-1000
Island Write, Draw, and Paint (single user).....\$995
Island Draw and Paint (single user, color).....\$695
Circle 1013 on Inquiry Card.

Odesta Corp.
4084 Commercial Ave.
Northbrook, IL 60062
(708) 498-5615
ODMS (15 users).....\$27,000
Circle 1014 on Inquiry Card.

SoftQuad, Inc.
720 Spadina Ave.,
Suite 200
Toronto, Ontario,
Canada M5S 2T1
(416) 963-8337
SoftQuad Publishing Software 2.9 (SPARC, single user).... \$995
Circle 1015 on Inquiry Card.

DATABASE MANAGEMENT

Empress Software, Inc.
6401 Golden Triangle Dr.
Greenbelt, MD 20770
(301) 220-1919
Empress RDBMS 4.0 (single user, SPARC) ... \$2800
(with Empress 4GL).....\$4200
Circle 1016 on Inquiry Card.

RSW, Inc.
131 Rathburn Way
Santa Cruz, CA 95062
(408) 429-6229
/rdb (single user).....\$1295
/rdbX (with Xve visual table editor).....\$1295
Circle 1017 on Inquiry Card.

OFFICE PRODUCTIVITY

Access Technology, Inc.
2 Natick Executive Park
Natick, MA 01760
(508) 655-9191
20/20 (spreadsheet).....\$595
Circle 1018 on Inquiry Card.

Aldrich Computer Services, Inc.
212 Bridge St.
Yuba City, CA 95991
(916) 673-6571
As-Admin (college administrative information).....\$70,000
Circle 1019 on Inquiry Card.

Applied Information Systems, Inc.
500 Eastowne Dr.
Chapel Hill, NC 27514
(919) 942-7801
Xess (engineering/scientific spreadsheet, single license). \$595
Circle 1020 on Inquiry Card.

Applix, Inc.
112 Turnpike Rd.
Westborough, MA 01581
(508) 870-0300
Alis (office automation).....\$1295 and up
Asterix (desktop productivity).....\$695
Circle 1021 on Inquiry Card.

BBN Software Products
150 Cambridge Park Dr.
Cambridge, MA 02140
(617) 873-5000
BBN/Slate (multimedia document communication, SPARC).....\$995
Circle 1022 on Inquiry Card.

The Bristol Group, Ltd.
P.O. Box 910
Londonderry, NH 03053
(603) 437-3700
IsoFax (fax management, single user, SPARC).....\$995
Circle 1023 on Inquiry Card.

CrossWind Technologies, Inc.
6630 Highway 9, Suite 201
Felton, CA 95018
(408) 335-4988
Synchronize (time management).....\$100 per user
Circle 1024 on Inquiry Card.

Gecko Software
261 Hamilton Ave.,
Suite 303
Palo Alto, CA 94301
(415) 327-8982
Gecko Meeting (group scheduler, six-user license) \$1000
Circle 1025 on Inquiry Card.

Hunter Systems
2225 East Bayshore Rd.
Palo Alto, CA 94303
(415) 965-2400
XDOS Applications (Unix implementations of DOS applications):
DataEase Database Management System.....\$1495
MultiMate Advantage II ... \$595
Quattro.....\$299
Word 5.0.....\$595
XyWrite III Plus.....\$1295
Lotus 1-2-3.....\$695
Circle 1026 on Inquiry Card.

Informix Software, Inc.
16011 College Blvd.
Lenexa, KS 66219
(913) 599-7100
Wingz (spreadsheet, SPARC).....\$699
Circle 1027 on Inquiry Card.

Quality Software Products
5711 West Slauson Ave.,
Suite 240
Culver City, CA 90230
(213) 410-0303
Exclaim (OSF/Motif-based spreadsheet).....\$695
Circle 1028 on Inquiry Card.

Quest Systems Corp.
2700 Augustine Dr.,
M/S 242
Santa Clara, CA 95054
(408) 496-1900
XDeskManager (stand-alone).....\$495
XOfficeManager (stand-alone).....\$495
XCorporate (stand-alone)...\$895
Circle 1029 on Inquiry Card.

Soft-tek International, Inc.
1999 North Amidon,
Suite 340
Wichita, KS 67203
(316) 838-7200
Tactician (spreadsheet interface to major DBMSes, SPARC, single user).....\$245
Circle 1030 on Inquiry Card.

Uniplex Integration Systems, Inc.
150 West Carpenter Frwy.
Dallas, TX 75039
(214) 717-0068
Uniplex II Plus (business software, single user).....\$1225
Advanced Office System (Uniplex add-on).....\$475
Advanced Graphics System (Uniplex add-on).....\$310
Uniplex Data Link.....\$310
Circle 1031 on Inquiry Card.

V-Systems, Inc.
39 Brookhollow Dr.
Santa Ana, CA 92705
(714) 545-6442
*VSI*Fax*.....\$1595
Circle 1032 on Inquiry Card.

WordMarc International Corp.
940 East Meadow
Palo Alto, CA 94203
(415) 813-8989
WordMarc Composer Plus (word processor and desktop publisher, SPARC, single user).....\$595
Circle 1033 on Inquiry Card.

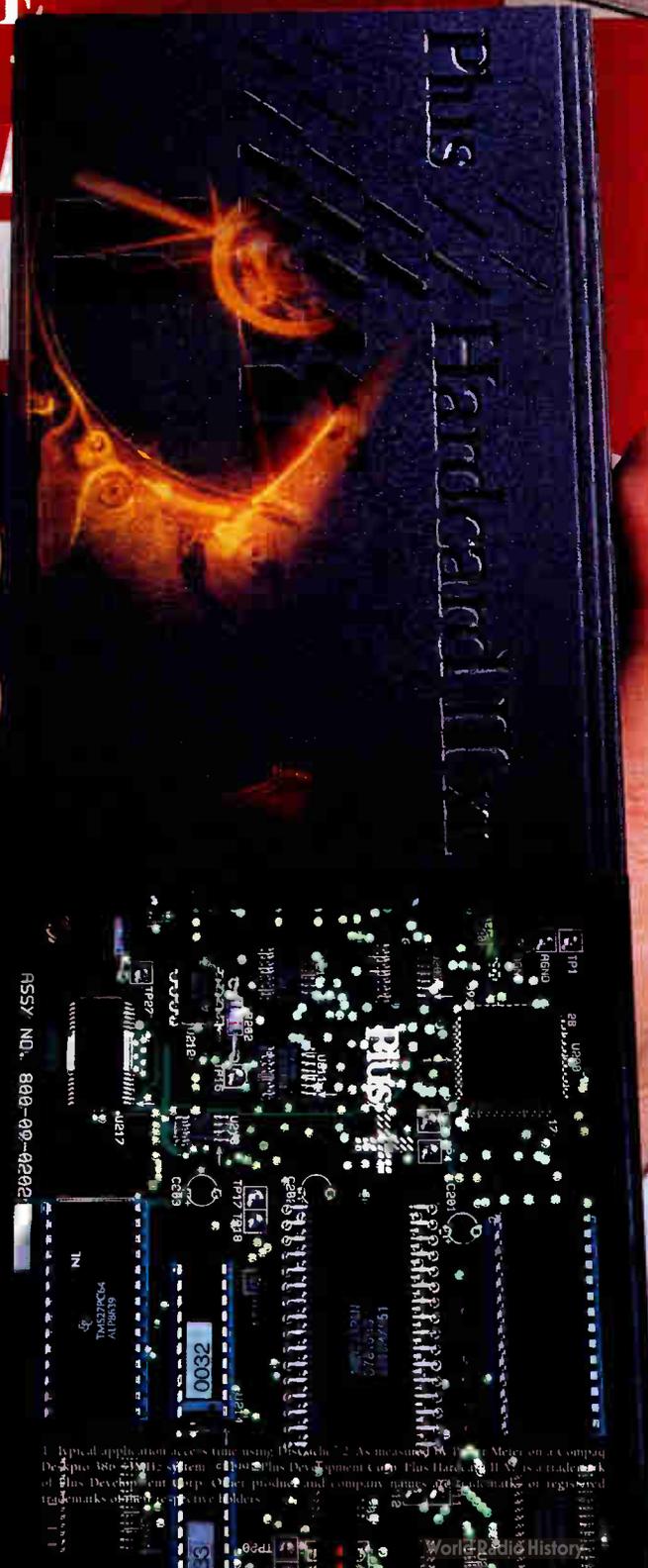


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Presenting Hardcard II XL™. A hard drive with 9ms effective access time¹ designed for 286/386 systems.

Now here's the news. *The New York Times* says Hardcard II XL offers "more speed than regular drives for a comparable price."

And the numbers confirm this. Hardcard II XL runs up to 9 times faster than a typical 28ms drive, thanks to a staggering 1.4 MB per second sustained transfer rate.² With 50 or 105 MB capacity, you have enough room to run Windows™ 3.0.

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*PC Magazine service and reliability survey ranked Plus Development #1. September 25, 1990.

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PostScript previewer is close to what appears on paper. Sadly, News has been slow to appear in applications. Frame-Maker, a very popular technical desktop publishing package, will reportedly be among the first to take advantage of the News server's PostScript capabilities.

News may not single-handedly save Open Look from obscurity, but perhaps it will drive those developing X to get the standard server to do at least as much as GeoWorks (an inexpensive PC graphical environment that includes scalable text and graphics). MIT may never have imagined that X would be considered a potential market force, but that possibility exists now. I think MIT's corporate sponsors, companies like Digital and IBM that are married to X, will force the system into shape as a more commercially viable product.

The X Factor

Political and technical wrangling aside, I must rush to point out that I very much like X. It provides the earliest evidence I know of that fierce adversaries can get together and create something truly good. I won't wax eloquent about X's roots; it's gone way beyond its original charter. But now that X has established itself, it's interesting to see how it has affected the market.

Its earliest effect was the unification of Unix workstations behind a single graphical interface standard. This helped to plant the idea that networks of mixed-vendor workstations might be a good thing, and the concept blossomed (along with the workstation market). Now X is taken for granted as standard software on most Unix workstations, and the low cost of implementation has helped bring down the price of high-performance graphics systems.

X is taking hold in other areas, too. Sales of PC and Windows X-server software, for instance, are brisk, and Quarterdeck is banking on X to help keep Desqview on the map. X has become an important tool in the recent push for cross-platform connectivity.

Without X's networking capabilities, there would be no X terminals. By bringing together only the most essential graphics, CPU, networking, and software resources, these terminals epitomize what's best about X. They are, by any reasonable definition, computer systems, but X terminals provide user I/O

services only to applications that are running on other machines. Because hard disk drives, operating systems, and the like can be left out, X terminals can be inexpensive and compact. There's still some question about whether color X terminals, which can cost \$5000 or more, can reasonably compete against low-end diskless workstations as prices continue to fall.

Accompanying this article is a list of X applications vendors. The ones listed are only a representative sample from three product categories: word processors, database managers, and office productivity tools. The list was taken from the *Export Catalog*, a document published by Network Computing Devices (an X terminal manufacturer) and updated regularly. The complete catalog can be obtained by contacting NCD at (415) 694-0650.

Tom Yager is a BYTE technical editor. You can contact him on BIX as "tyager."

MACINTOSH / Tom Thompson

Behind-the-Scenes Innovation

For Apple, the major event of this year was, of course, the release of System 7.0. It revamped the Mac's GUI to bring a point-and-click consistency to desk accessories and the Control Panel. It also provided a mechanism that lets you add fonts or sounds without restarting the Mac. However, the most crucial improvements System 7.0 brought to the Mac weren't dancing about in windows on the screen, but quietly and effectively operating behind them.

AppleTalk Phase 2, 32-Bit Quick-

Draw, and the Communications Toolbox—formerly separate add-on modules that expanded the Mac's network capabilities, provided high-quality imaging, and enhanced external I/O—were integrated into System 7.0. Next, built-in peer-to-peer file sharing allows the easy exchange of information without requiring a file server. Finally, as an integral part of System 7.0's design, there's Interapplication Communication (IAC)—the ability of Mac applications to share information, or request services from other applications, even if those applications reside on computers across an AppleTalk network.

IAC supports two tiers of use: workgroup functions and "hybrid applications." A workgroup typically consists of a small group of people whose jobs require them to work with one another and to share documents that are constantly being revised. System 7.0's Publish/Subscribe mechanism provides an easy way to distribute and track changes in such documents.

Setting up the arrangement is simple and intuitive: It requires only a menu selection, clicking and dragging on the portion of the document you want to publish, and then typing the name of an edition file. Other users "subscribe" to the document through a menu selection that lets them pick the edition file. We will see many Mac applications rapidly adopt this Publish/Subscribe capability so that they can fit into workgroup situations. In fact, some are already appearing: Microsoft Excel 3.0 has it, as does Claris's Resolve, Adobe Photoshop 2.0, and a beta version of Claris's MacWrite Pro.

However, IAC is not limited to Publish/Subscribe. A special set of high-level events called Apple events lets applications launch other applications, query them for information or process



Ray Dream's Designer is a solid modeling-cum-ray-tracing application. It has the ability to hand off the computationally expensive ray-tracing portions of a job to other networked Macs. It does this by using System 7.0's built-in file sharing and Apple event mechanisms.

Designers using low-end color Macs can construct framework models that they submit to a single Mac IIx or a 68040-based Mac. As shown in the screen, a user can select any networked Mac running a copy of Designer.

Why ONE OF AMERICA'S MOST THOUGHT-PROVOKING ENGINEERS NOW USES THE DESIGN TOOL THAT THINKS.

Two years after the Voyager completed its record-shattering, around-the-world flight, you could still find its designer, Burt Rutan, working at a drafting table with pencil and paper.

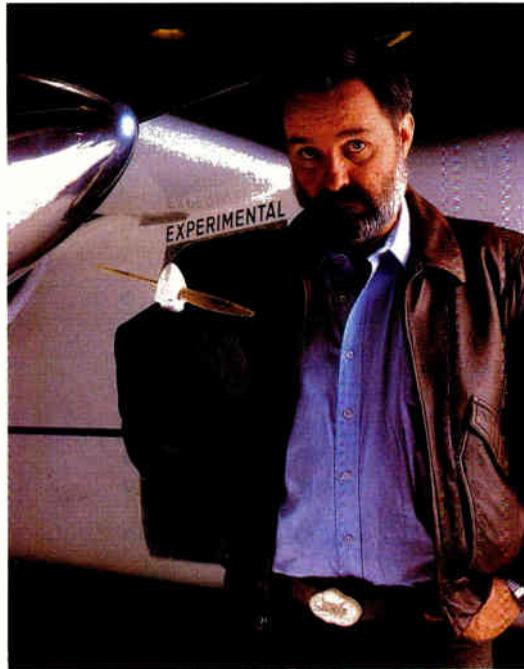
Hardware wasn't the problem. He had computers. His company could buy any design system worth owning. What kept Burt grounded was software. CAD so clumsy, it squashed creativity. Or so weak, it simply couldn't do his job.

Maybe that's why the first time he sat down to design with Ashlar Vellum, Burt compared the exhilaration to flight. Vellum is the first CAD program with a built-in autopilot.

INDUSTRIAL-STRENGTH CAD THAT THINKS.

From GD&T symbols to NURB splines to DXF and IGES file format translators, Vellum has every professional design and drafting tool your job demands. But its real breakthrough is an expert system called The Drafting Assistant™ (Pat. Pending)—built-in intelligence that instantly makes every designer more productive. Even on enormously complex jobs.

Engineering drawings courtesy of Burt Rutan/Scaled Composites, Inc.



Burt Rutan. Inventor. Engineer. Another Vellum user with no intention of going back to the drawing board.

Instead of fighting the keyboard, or guessing about alignment, Vellum

pinpoints and spells out every logical design point for you, right on the screen.

Draw a simple line and the mid-points, endpoints, and construction lines appear automatically. Click the mouse and you get precise alignment to 16 decimal places, in a fraction of a second.

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Before Vellum, using CAD for conceptual design was like trying to draw in the dirt with a backhoe.

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needs to change? Simple. Just change the dimensions and the geometry updates as you watch. Or change the geometry and all the dimensions update perfectly.

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For more information, a free video, a trial version, or the name of an authorized Ashlar reseller near you call 408-746-1800.

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PRODUCT GUIDE: MACINTOSH DATABASE APPLICATIONS

Table 4: Listed here are some of the popular Mac database applications. (● = yes; ○ = no.)

Product	Price	Minimum RAM	Hard disk space required	System 7.0-compatible?	Popular file formats supported
Acius File Force 1.1	\$395	1 MB	1.5 MB	●	SYLK, DIF, text
Acius 4th Dimension 2.2	\$795*	1 MB	1.3 MB	● savvy	SYLK, DIF, text
Baseline Publishing Database 1.51	\$130	1 MB	1.5 MB	●	Tab- and/or comma-delimited, returns, custom export, Excel, FileMaker, Full Impact, FullWrite, Double Helix, More, Word, Works, WordPerfect, WriteNow, 4th Dimension
Blyth Omnis 5 1.2	\$1000	640 KB	1 MB	●	DIS, SYLK, dBase, DBS, Lotus, WKS, tab- and/or comma-delimited, character-kerned
FoxBase Plus/Mac 2.01	\$495	1 MB	3 MB	●	ASCII, DBS, X commands
Odesta Double Helix 3.5	\$695	1 MB	1 MB	●	ASCII, DIS, SYLK
Oracle for Macintosh 1.2	\$199	2 MB	6 MB	●	Any ASCII, DB2, SQL/DS, RMF
ProVue Panorama 2.0	\$395	1 MB	1 MB	●	ASCII
Software Discoveries RecordHolderPlus	\$150	512 KB	500 KB	●	Text, ASCII
TSP Filevision IV 1.1	\$295	1 MB	430 KB	●	Any text; allows you to create custom export files

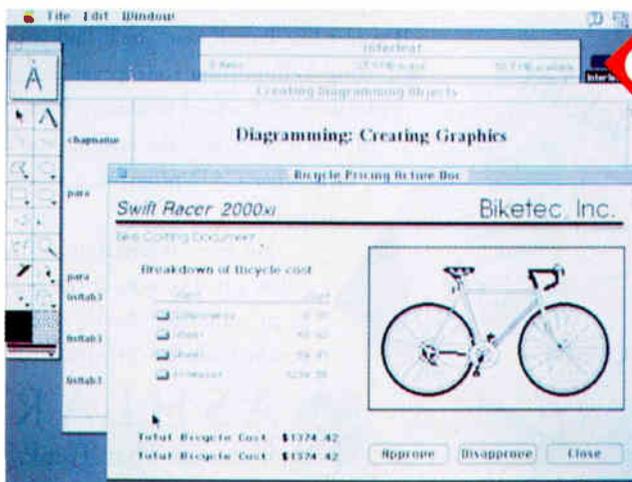
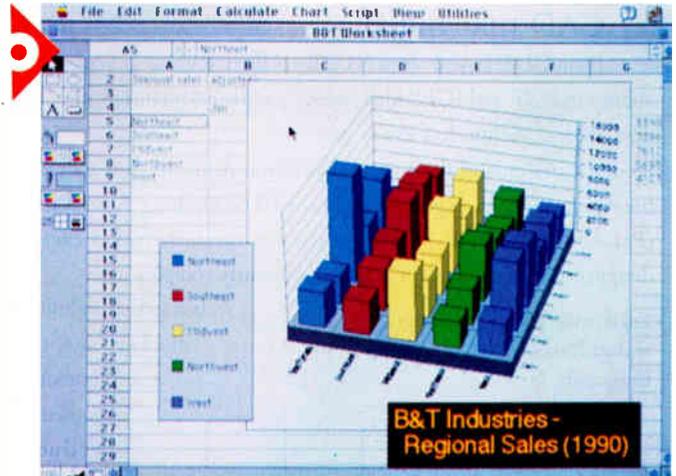
* Run-time price: four-pack, \$395; single-pack, \$125.

data, and terminate them when the work is done. In this way, Mac applications can augment their capabilities by simply passing certain tasks off to other applications that are better suited for the work.

For example, a word processor might pass a request for a charting operation to a graphics application, have a spreadsheet compute a balance, or use a database to retrieve a mailing list. As with Publish/Subscribe, these second-tier IAC applications function across an AppleTalk network. Such applications become more capable by melding the strengths of other ones, producing the hybrid applications mentioned earlier.

Also new behind the scenes is System 7.0's Data Access Manager, which will

Resolve uses System 7.0's Interapplication Communication to trigger scripts that compute the quarterly budget, plot the weekly sales figures, and print the shareholders' statement figures. Like Designer, Resolve can thus off-load heavy-duty number-crunching jobs onto a more powerful Mac.



Interleaf 5, an electronic publishing package, uses Interleaf's own Active Document technology and Apple's System 7.0 features to create and manage documents that use dynamic data. Active Document technology is Interleaf's Lisp-based programming environment that lets you access, evaluate, and act on a document's information. The Active Document shown here describes a bicycle down to its individual parts, displaying and tracking the current prices for each part. You can check on the bicycle's cost before approving the design for manufacturing. Interleaf 5 uses System 7.0's Data Access Language, a high-level Structured Query Language-based language used by Mac database applications to query remote databases for information. In the case of the bicycle project, the Active Document uses DAL to access an Oracle database on a remote VAX for the part information. The combination of Interleaf's Active Document technology and System 7.0's DAL mechanism allows managers to accomplish the nearly impossible: document and track designs whose information is in a state of flux.

GENERIC CADD. FULL-TIME CADD AVAILABLE FOR PART-TIME WORK.

Finally, there's a full-powered CADD package for those who need to create professional designs, but don't want to spend a lot of time and money producing drawings. Generic CADD 5.0 is an affordable tool for the busy professional who only wants CADD part of the time.

GENERIC CADD HAS EXCELLENT COMMUNICATION SKILLS.

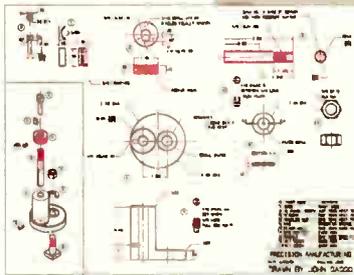
Whether you're selling a concept to your client, reporting to your management, passing roughs to the drafting department or just fine-tuning your own ideas, Generic CADD allows you to communicate faster. Clearer. Cleaner. And you can try out design alternatives you'd probably skip if you had to draw them by hand.

Revisions? Make them in minutes, not hours.

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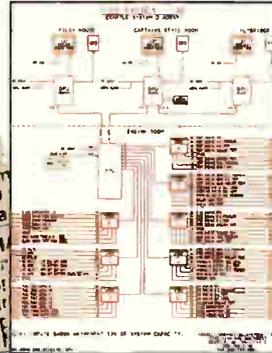
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PRODUCT GUIDE: MACINTOSH WORD PROCESSING APPLICATIONS

Table 5: Some representative Mac word processors. MacWrite Pro is System 7.0-savvy: It will be able to use Publish/Subscribe and Interapplication Communication. (● = yes; ○ = no.)

Product	Price	Minimum RAM	Hard disk space required	System 7.0-compatible?	Popular file formats supported
Claris MacWrite Pro	\$249	1 MB	1.6 MB	● savvy	MacPaint, PICT, Color PICT2, TIFF, EPSF, Acta, AppleWorks, DCA, Word, Works, Write, WordPerfect, WriteNow
Claris MacWrite II	\$249	1 MB	735 KB	●	Word (Mac and IBM), WordPerfect, (Mac and IBM), DCA, RTF
DeltaPoint Taste 1.02	\$149	2 MB	2 MB	●	AppleLinks, Works 2.0, MacWrite, Word, WordPerfect, WriteNow
Microsoft Word for Macintosh 4.0	\$395	512 KB	1.6 MB	●	Excel, Word, Works, WordPerfect for PC, RTF, DCA, MacWrite, ASCII, PageMaker
New Horizons WordMaker 1.0.2	\$125	512 KB	425 KB	●	MacWrite
Paragon Nisus 3.06	\$395	1 MB	1 MB ¹	●	MacWrite, Word; with XS module, Claris XTND capability
Power Up Letter Writer Plus	\$89.95	1 MB	None	●	MacWrite 5.0 Plus, text files
T/Maker WriteNow 2.2	\$199 ²	512 KB	800 KB	● 24-bit mode	Word, Write, MacWrite, RTF, AppleShare, TOPS, PageMaker, Letraset Ready-Set-Go, QuarkXPress, Springboard Publisher
WordPerfect for Macintosh 2.0.1	\$495	1 MB	20 MB	●	TIFF, EPS, PICT, GIF, WPG, Word
Working Software QuickLetter 1.1.5	\$49	512 KB	165 KB	●	Imports MacWrite, Word, text; exports MacWrite, text, stationery

¹ 2 MB with MultiFinder; 4 MB with System 7.0.
² Includes Grammatik Mac 2.0

PRODUCT GUIDE: MACINTOSH SPREADSHEET APPLICATIONS

Table 6: Some of the popular Mac spreadsheets. Resolve 1.0 and Excel 3.0 can utilize System 7.0's Publish/Subscribe mechanism to transmit changes in the spreadsheet to other documents. (● = yes; ○ = no.)

Product	Price	Minimum RAM	Hard disk space required	System 7.0-compatible?	Popular file formats supported
Bravo MacCalc 1.2D	\$139	512 KB	200 KB	●	Lotus 1-2-3, SYLK data
Claris Resolve 1.0	\$399	1 MB*	1.25 MB	● savvy	Excel, Wingz, Lotus 1-2-3, DIF, SYLK, text
Informix Wingz 1.1A	\$399	1 MB	2.5 MB	No	DIF, SYLK, Lotus 1-2-3, text
Microsoft Excel 3.0	\$495	1 MB	3 MB	● savvy	BIFF, SYLK, text, CSV, WKS, WK1, WK3, DIF, dBase, DBF2, text and CSV for Windows, DOS, OS/2, template
Occam Muse	\$695	2 MB	2 MB	●	WKS, SYLK, text, DBS, WK1, fixed field

* 2.5 MB if using System 7.0.

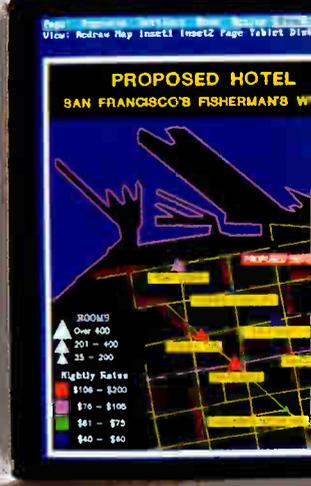
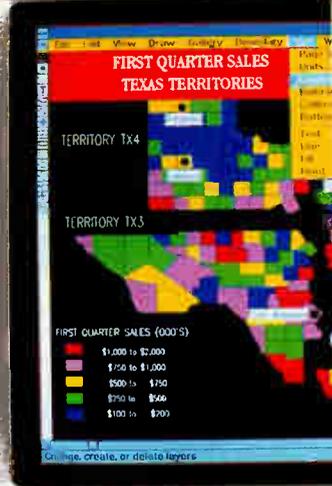
allow any application to inquire and receive information from remote databases. The DAM uses the Data Access Language, which is a Structured Query Language-based mechanism used to communicate with these databases. An application that knows nothing about conversing with a database will use a *query document* to accomplish this. The query document frames a variety of application requests into the appropriate

DAL questions. The query document also describes to the application how to understand the results passed back from the database. An initial user creates these query documents, but once they are made, anyone using the application can use them to access the database. A demonstration of the Interleaf 5 application from Interleaf showed how DAL communicated to a VAX and then updated the document's information on the fly.

Distribute the Work

It's possible that a tightly integrated suite of Mac applications on several computers, communicating via AppleTalk, become a gestalt, where the whole is greater than the sum of its parts. Some early examples of Apple event use seem to bear this out. For example, a beta version of Ray Dream's Designer, a solid-modeling and ray-tracing application, can hand off a heavy-duty processing job

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COMPANY INFORMATION:

MACINTOSH DATABASE APPLICATIONS

DATABASE

Acius, Inc.
 (File Force 1.1, 4th Dimension 2.2)
 10351 Bubbs Rd.
 Cupertino, CA 95014
 (408) 252-4444
 fax: (408) 252-0831
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Baseline Publishing, Inc.
 (Database 1.51)
 1770 Moriah Woods Blvd.,
 Suite 14
 Memphis, TN 38117
 (800) 926-9676
 (901) 682-9676
 fax: (901) 682-9691
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Blyth Software, Inc.
 (Omnis 5 1.2)
 1065 East Hillsdale Blvd.,
 Suite 300
 Foster City, CA 94404
 (800) 346-6647
 (415) 571-0222
 fax: (415) 571-1132
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Fox Software, Inc.
 (FoxBase Plus/Mac 2.01)
 134 West South Boundary St.
 Perrysburg, OH 43551
 (800) 837-3692
 (419) 874-0162
 fax: (419) 874-8678
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Odesta Corp.
 (Double Helix 3.5)
 4084 Commercial Ave.
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 (708) 498-5615
 fax: (708) 498-9917
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Oracle Corp.
 (Oracle for Macintosh 1.2)
 500 Oracle Pkwy.
 Redwood Shores, CA 94065
 (800) 345-3267
 (415) 506-7000
 fax: (415) 595-0630
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ProVue Development Corp.
 (Panorama 2.0)
 15180 Transistor Lane
 Huntington Beach, CA 92649
 (714) 892-8199
 fax: (714) 893-4899
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Software Discoveries, Inc.
 (RecordHolderPlus)
 137 Krawski Dr.
 South Windsor, CT 06074
 (203) 644-9225
 fax: (203) 644-2081
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TSP Software
 (Filevision IV 1.1)
 4790 Irvine Blvd.,
 Suite 105-294
 Irvine, CA 92720
 (714) 731-1368
 fax: (714) 832-8568
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WORD PROCESSING

Clarix Corp.
 (MacWrite Pro, MacWrite II)
 5201 Patrick Henry Dr.
 Santa Clara, CA 95052
 (800) 325-2747
 (408) 987-7000
 fax: (408) 987-7440
Circle 1048 on Inquiry Card.

DeltaPoint, Inc.
 (Taste 1.02)
 2 Harris Court, Suite B-1
 Monterey, CA 93940
 (800) 367-4334
 (408) 648-4000
 fax: (408) 648-4020
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Microsoft Corp.
 (Microsoft Word for Macintosh 4.0)
 1 Microsoft Way
 Redmond, WA 98052
 (800) 426-9400
 (206) 882-8080
 fax: (206) 883-8101
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New Horizons Software, Inc.
 (WordMaker 1.0.2)
 206 Wild Basin Rd.,
 Suite 109
 Austin, TX 78746
 (512) 328-6650
 fax: (512) 328-1925
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Paragon Concepts, Inc.
 (Nisus 3.06)
 990 Highland Dr.,
 Suite 312
 Solana Beach, CA 92075
 (800) 922-2993
 (619) 481-1477
 fax: (619) 481-6154
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Power Up Software Corp.
 (Letter Writer Plus)
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 fax: (415) 349-1356
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T/Maker Co.
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 Mountain View, CA 94041
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 fax: (415) 962-0201
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WordPerfect Corp.
 (WordPerfect for Macintosh 2.0.1)
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 Orem, UT 84057
 (800) 321-4566
 (801) 225-5000
 fax: (801) 222-4477
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Working Software, Inc.
 (QuickLetter 1.1.5)
 P.O. Box 1844
 Santa Cruz, CA 95061
 (800) 229-9675
 (408) 423-5696
 fax: (408) 423-5699
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SPREADSHEET

Bravo Technologies, Inc.
 (MacCalc 1.2D)
 P.O. Box 10078
 Berkeley, CA 94709
 (415) 841-8552
Circle 1034 on Inquiry Card.

Clarix Corp.
 (Resolve 1.0)
 5201 Patrick Henry Dr.
 Santa Clara, CA 95052
 (800) 325-2747
 (408) 987-7000
 fax: (408) 987-7440
Circle 1035 on Inquiry Card.

Informix Software, Inc.
 (Wingz 1.1A)
 4100 Bohannon Dr
 Menlo Park, CA 94025
 (800) 438-7627
 (415) 926-6300
 fax: (415) 926-6593
Circle 1036 on Inquiry Card.

Microsoft Corp.
 (Excel 3.0)
 1 Microsoft Way
 Redmond, WA 98052
 (800) 426-9400
 (206) 882-8080
 fax: (206) 883-8101
Circle 1037 on Inquiry Card.

Occam Research Corp.
 (Muse)
 42 Pleasant St.
 Watertown, MA 02172
 (617) 923-3545
 fax: (617) 926-3262
Circle 1038 on Inquiry Card.

to a more powerful Mac on a network. Using a Mac II, you might build an object in Designer and then request a remote Mac IIx to perform the ray-tracing computations. Designer saves this wireframe file in a shared folder and then

sends an Apple event to a copy of Designer running on the chosen IIx. This Apple event tells the remote IIx where the request came from and what to do. The IIx then processes the wireframe file, drops a PICT image into the shared

folder, and sends an Apple event to the local Mac II, informing you that the job is done. The same event also instructs the local copy of Designer to open and display the image file. All you do is make the request from a menu selection;

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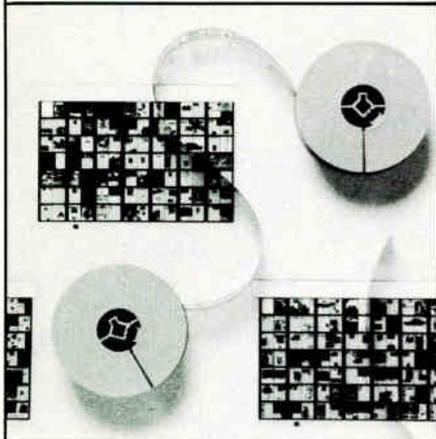
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World Radio History

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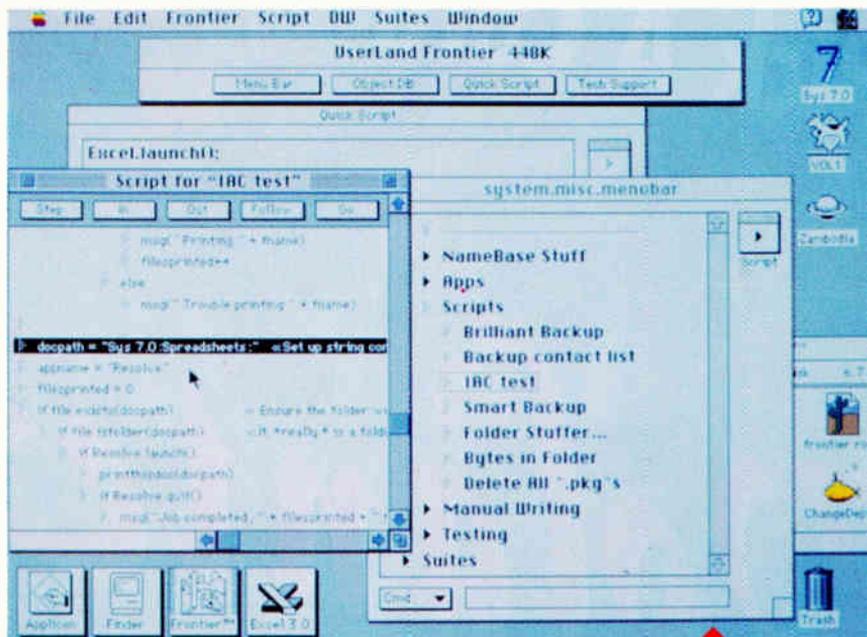
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several minutes later, a window opens with the end result.

In another example, an expert user might write several scripts in Resolve, a program that uses Informix Software's scripting technology. These scripts might draw graphs, compute the quarterly budget, or process tax-related accounting information. A copy of Resolve, running on a IIfx or a 68040-based Mac, would handle incoming requests. The contents of the Apple event would trigger the appropriate Resolve script and then return the result.

In the future, you can expect to see networked high-powered Macs acting as process servers, fielding computationally expensive jobs from all over the network. Each server will have an "object brew" of software capable of dealing with any possible demand. While IAC isn't smart enough yet to scout out idle Macs to handle distributed network computations as some Unix networks can, it's off to a good start, and you can expect it to improve.

The Script's the Thing

One of the major complaints with the Mac OS has been that there's no easy way of making it perform custom tasks (deleting all files with the Temp extension, for example) or automate routine tasks (such as backing up your files every evening). Not any longer. After consultation with UserLand Software and Simple Software, two scripting-language developers, Apple released its Open Scripting Architecture. OSA provides a standard by which scripting

applications can communicate and drive Mac applications. The architecture is based on System 7.0's Apple events, which means that scripting applications will work only with System 7.0-savvy applications.

Now, using a scripting application such as UserLand's Frontier, you can write scripts that might, say, take all the word processing files you modified today and copy them to a file server. Or another script might have a word processor search your E-mail inbox and print out new messages. This lets Mac users write batch scripts to handle an army of chores. While critics might argue that this proves that a GUI is a failure in some sense, for those of us who are looking for a way to get our jobs done, scripting is an answer to a big problem. ■

 In a way, **Frontier** is a last frontier: a command-line interface for writing scripts on the Mac. UserLand's Frontier provides a C-style scripting language rich with variables, looping constructs, and control statements. Under System 7.0, it also can generate Apple events to launch and control Mac applications.

ACKNOWLEDGMENTS

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Tom Thompson is a BYTE senior technical editor at large. You can contact him on BIX as "tom_thompson."

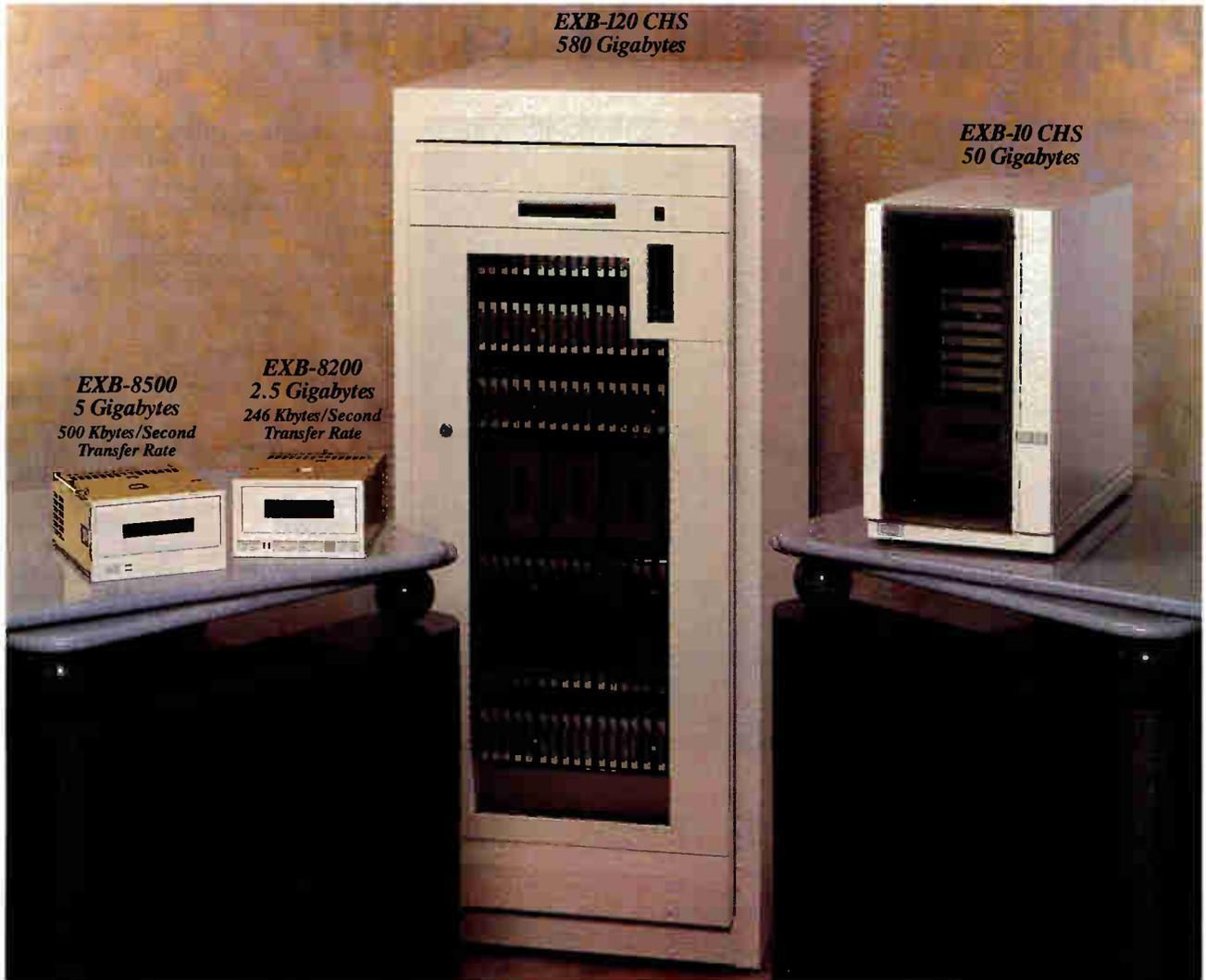
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PORTABLE COMPUTING



ties should be readily available. Expansion slots are usually limited to proprietary modem or memory cards, although external expansion buses are relatively common.

Sacrifices in the keyboard and video are also made, but vendors are beginning to address these.

Built for Comfort

Don't expect to see dramatic reductions

Zenith introduced the first Intel 386SL-based notebook, the **Mastersport 386SL**. The *Mastersport* takes full advantage of the SL's capabilities, allowing most users to work through the day without a recharge.

in the size and weight of notebook PCs during the coming year. On average, they may shrink a fraction of an inch in height and depth, and they may lose a few ounces. A popular "small" notebook size is 11⁷/₁₀ by 8¹/₂ by about 1³/₄ inches. Further reductions are limited by the

"human interface," that is, the keyboard and the display.

Vendors are finding that in the notebook class, customers are more interested in ease of use and features than in getting the smallest possible size. A keyboard that is less than standard width—about 11¹/₄ inches—requires reducing the size of the key caps, putting them closer together, changing the layout, or doing a combination of these. One keyboard change you will see less of is the elimination of separate PageUp, PageDown, Home, and End keys. Some notebooks require that you press a function-key combination to access these keys. But on some applications, this arrangement is awkward, at best. Users are complaining, and vendors seem to be listening.

The popularity of Windows 3.0 is driving the demand for bigger and better notebook displays. The best LCD screens now feature a 10-inch VGA display with 64 levels of gray, courtesy of new video chip sets from Chips & Technologies (C&T), Cirrus Logic, and others. Only a handful of vendors offer this display now, but most of the premium models coming out in the next few months will have it. No notebook PC currently has a color display. Expect to see a few com-

Notebooks Coming of Age

Improved capabilities and longer battery life make notebooks more and more attractive

MICHAEL NADEAU

Notebooks are hot. Dataquest predicts that notebook sales will mushroom from nearly \$700 million in 1990 to more than \$13 billion in 1994. That's more than twice the projected figure for laptop sales. With numbers like these, it's safe to say that if you aren't already using a notebook PC, you most likely will be shortly.

What makes these little systems so attractive? When you're traveling, they give you access to processing power that is equivalent to that of most desktop PCs. You can have your contact list, agenda, word processor, spreadsheet, database, and communications/fax capability in one 6- or 7-pound package. You can access, process, and output the same business information you do at the office and

sacrifice little or no functionality. That spells productivity.

What Is a Notebook PC?

Unlike more traditional laptop PCs, notebooks are intended for use in a mobile environment. Designed to fit easily inside a briefcase, notebooks generally weigh less than 8 pounds and typically measure 12 inches wide by 10 inches deep by 2 inches thick.

To maximize luggability, notebooks must make certain trade-offs. Expansion is limited. RAM capacity rarely exceeds 5 megabytes. Typical hard disk capacity is only 20 MB, but drive vendors are rapidly improving the 2¹/₂- and 3¹/₂-inch disk drives used in notebooks. By next year, 60-, 80-, and even 100-MB capaci-

mercially available next year, but prices will be high (probably in the \$7000-\$9000 range) and sales slow. The color notebook's time will come, but not until manufacturing yields on the screens are high enough to keep costs down. That is not likely to happen in 1992.

The battery will remain a large factor in determining the size and weight of notebook PCs. For the coming year, the battery will account for 1½ to 2 pounds of weight and at least an inch, probably in depth, of size. On the brighter side, power management is improving rapidly enough to offset the penalties of battery bulk.

The 8-Hour Workday

Wouldn't it be great if you could use your notebook all day on battery power and just recharge it at night? For a few models, that might be possible in 1992. One reason: Intel's new 386SL CPU.

The 386SL was designed to address the power conservation needs of battery-powered systems. The 386SL integrates all cache, bus controller, and memory controller circuitry in one chip. A companion chip, the 82360SL, contains circuitry for all I/O, power management, real-time-clock operation, timers, interrupt and DMA control, and nonmaskable interrupts. With this two-chip set, you need only add main memory and graphics, keyboard, and floppy disk drive controllers to have a complete system—a total of seven chips.

Reducing the system chip count is just a tiny part of the SL's power-saving capabilities. In a nutshell, the SL chip set frees system resources from having to handle power management chores. With a BIOS written for the SL, control of power to various system components works independently of your operating system, applications, and main memory. This arrangement not only is more efficient, it also ensures that the power management functions will not cause compatibility problems by, for instance, grabbing a piece of memory that is being used by an application.

In constant use, where the power management does not get a chance to power down com-

Intel's 386SL CPU integrates functions of several chips onto one piece of silicon. Its advanced power management capabilities will be a boon to notebook users, but vendors will be slow in introducing SL-based units, which must be designed from scratch.

ponents, an SL system runs no longer on a battery than an SX-based system does. But in normal use, the efficiencies of the SL's power management provide as much as 33 percent more battery operation. And Intel estimates that a typical SL system will survive for more than 1000 hours in suspend mode, in which everything but the memory holding your application is shut down.

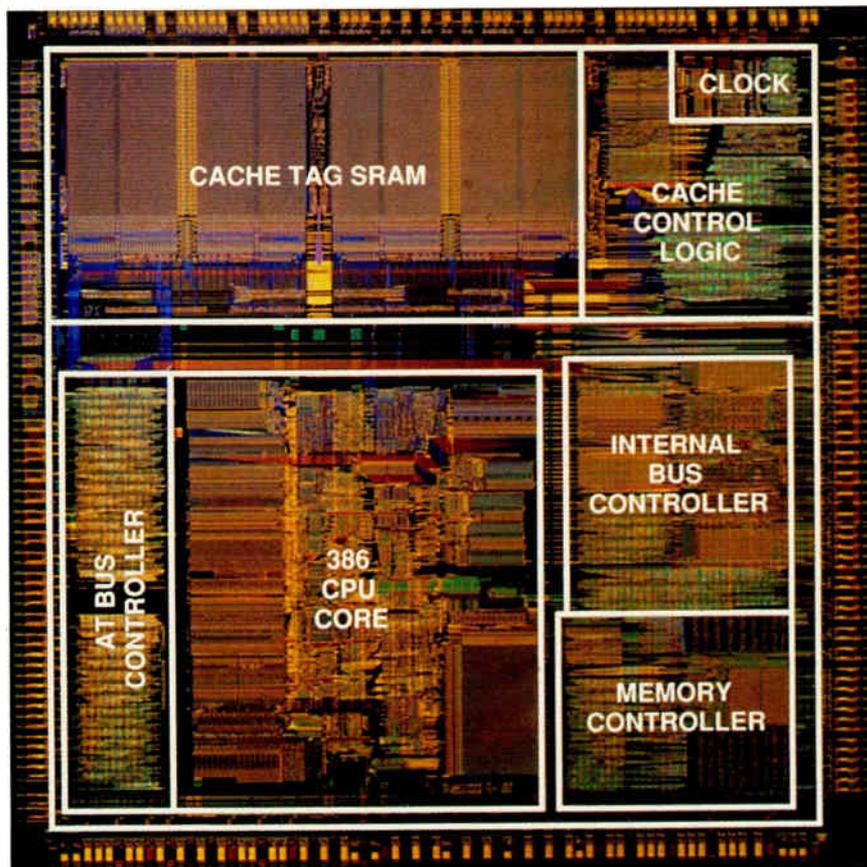
By the time you read this, several SL-based notebooks will be shipping, even though using the SL requires vendors to build a system from scratch. By the end of 1992, most notebook vendors will have an SL system offering. Without the resources of the major players, however, smaller vendors will be hard-pressed to bring SL systems to market in a timely manner. They will have help, however. Traditional OEM sources will produce a wide variety of SL models for sale under other brand names, for instance.

Small vendors will also get help from companies such as Phoenix Technologies, best known for its system BIOS business. Designing a BIOS capable of managing the 386SL is a difficult task, one that is already delaying some SL-

based systems from entering the market. Phoenix is well positioned with its BIOS expertise, working relationship with Intel (it should be noted that Intel is working closely with all the most popular BIOS vendors), and established customer base to help system vendors quickly design a viable 386SL notebook. And it has.

The PhoenixBIOS Lap386SL (you'll never see it sold under this name) is built around the Phoenix SL Superset: two VLSI devices that include a cache controller, memory controller, peripheral subsystem, and CPU. Embedded in the SL Superset is the power management support software, which allows full suspend and resume capabilities, as well as standby operation. Also built in is a great deal of flexibility for configuring the system at both the vendor and user level. The vendor, for example, has the option of modifying the BIOS source code, while the user can reset parameters for, say, component time-outs.

But the 386SL is not the only low-power CPU in town. Advanced Micro Devices' (AMD) 386SX clone also has power conservation features, although not



PRODUCT GUIDE: NOTEBOOK COMPUTERS

This Product Guide lists 89 286, 386SX, 386DX, and 486 notebook PCs. BYTE defines a notebook PC as weighing less than 8 pounds and measuring no more than 12 inches wide by 10 inches deep by 2 inches high. Some systems listed here might exceed one or more of these dimensions but are close enough to the desired form factor to warrant inclusion. (● = yes; ○ = no.)

	Base price	CPU/MHz	Dimensions (W x D x H, in inches)	Weight w/battery (lbs.)	RAM (std./max., in MB)	Hard disk drive (std./max., in MB)	Floppy drive standard?	Math socket?	Video (pixels; gray scales)
Acer AnyWare 1120NX	\$3195	386SX/20	11 x 8.5 x 2	7.4	1/5	20/60	●	○	640 x 480 VGA; 32
ALR Venture/16	\$2795	386SX/16	12.2 x 8.6 x 2.1	7.5	1/5	20	●	●	640 x 480 VGA; 32
Altima LSX	\$2999	386SX/20	11 x 8.6 x 2	6.3	1/5	40	●	●	640 x 480 VGA; 32
Amax EZ-Lite SX-16	\$3495	386SX/16	11 x 8.5 x 2	6.4	1/5	20/40	●	●	640 x 480 VGA; 16
American Mitac 3025D	\$2195	386SX/16	11.6 x 8.7 x 2.3	7.5	1/2	20/40	●	●	640 x 480 VGA; 16
Andrex Voyager SX	\$2495	386SX/20	11.7 x 8.25 x 1.9	6.2	1/5	20/60	●	●	640 x 480 VGA; 32
AST Premium Exec 386SX/20	\$2995	386SX/20	11.4 x 9 x 2.25	7	2/8	20/60	●	●	640 x 480 VGA; 32
AT&T Safari NSX/20 ³	\$5399	386SX/20	12 x 9.5 x 1.8	7.3	2/8	40/80	●	●	640 x 480 VGA; 32
Austin 386/SX Notebook	\$2295	386SX/20	11.7 x 8.5 x 2	6	2/4	20	●	●	640 x 480 VGA; 32
Bondwell B330SX	\$2700	386SX/25	11.1 x 8.5 x 2.2	6.3	1/5	60	●	●	640 x 480 VGA; 16
Chaplet Halikan NBA386SX	\$2995	386SX/20	11.7 x 8.7 x 2	6.5	1/5	20/60	●	●	640 x 480 VGA; 16
Commax Ultrathin 386SX/20	\$3295	386SX/20	10.25 x 8.25 x 1.25	4	1/4	30/60	● (ext.)	○	640 x 480 VGA; 32
Compaq LTE/286	\$3499	286/12	11 x 8.5 x 1.9	6.7	640KB/4.6	20/40	●	●	640 x 200 CGA; 4
Compaq LTE 386s/20	\$4399	386SX/20	11 x 8.5 x 2.2	7.5	2/10	30/60	●	●	640 x 480 VGA; 16
CompuAdd Companion SX	\$2995	386SX/20	11 x 8 x 1.8	5.7	2/6	20/40	●	●	640 x 480 VGA; 32
CompuAdd 316NX	\$1995	386SX/16	11 x 8.5 x 2.1	7	1/5	30/60	●	●	640 x 480 VGA; 64
Cordata CPC-9100	\$3599	386SX/20	12 x 10 x 1.8	6.5	1/5	30/60	●	●	640 x 480 VGA; 32
Darius 386 Notebook-20	\$3999	386SX/20	12 x 10 x 1.8	6.5	1/5	30/60	●	●	640 x 480 VGA; 16
Darius 386 Notebook-20B	\$2895	386SX/20	11.8 x 8.3 x 2	6.7	1/5	20/40	●	●	640 x 480 VGA; 16
Dataworld NB-320SX	\$2650	386SX/20	11 x 9 x 2.5	7	2/16	20	●	●	640 x 480 VGA; 32
Dauphin 500-SX	\$2595	386SX/20	11.7 x 8.3 x 1.9	7	1/8	40	●	●	640 x 480 VGA; 32
Dell System 212N	\$2399	286/12	11 x 8.5 x 2	6.4	1/5	40/60	●	●	640 x 480 VGA; 16
Dell System 320N	\$3399	386SX/20	11 x 8.5 x 2	6.4	1/5	40/60	●	●	640 x 480 VGA; 16
Epson NB3s	\$3995	386SX/16	11.7 x 8.5 x 1.7	5.8	1/5	20/60	●	●	640 x 480 VGA; 16
Everex Tempo LX/20	\$2999	386SX/20	12 x 10 x 2	6.9	1/5	20/60	●	●	640 x 480 VGA; 16
First Computer 386SX-20	\$2199	386SX/20	11.7 x 8.5 x 2	6.5	1/3	20/40	●	●	640 x 480 VGA; 16
Fora NBS-386S	\$2995	386SX/16	11 x 8.6 x 2	6.4	1/5	20/40	●	●	640 x 480 VGA; 16
Fora NBL-386S/20	\$3495	386SX/20	11 x 8.6 x 1.4	4.5	1/4	30	● (ext.)	●	640 x 480 VGA; 32
Grid 1720 ³	\$3495	286/16	12.2 x 10 x 1.7	6.9	1/5	20	●	●	640 x 400 CGA; 16
Grid 1750	\$3795	386SX/20	12.2 x 10 x 1.7	6.7	1	60	●	●	640 x 480 VGA; 16
Hertz 386/SX Notebook	\$2195	386SX/16	12 x 10.4 x 1.9	7	1/5	20	●	●	640 x 480 VGA; 32
Hyosung NPC II	\$2495	286/12	11.4 x 9.8 x 2.25	6.9	1/2	20/40	●	●	640 x 480 VGA; 16
Hyundai Super-NB386Sc	\$2995	386SX/20	11.7 x 8.2 x 1.8	7	1/5	20/40	●	●	640 x 480 VGA; 16
ITC 386 PEP ³	\$4519	386SX/16	12 x 11.25 x 2.5	7.9	2	40	●	○	640 x 480 VGA; 16
Leading Edge N3/SX	\$2599	386SX/16	11 x 9 x 2	6.9	1/5	20	●	●	640 x 480 VGA; 32
Leading Edge N3/SX20	\$2999	386SX/20	11 x 9 x 2	6.9	1/5	30/60	●	●	640 x 480 VGA; 32
Leading Technology PC Partner XL	\$2495	386SX/20	11.7 x 8.7 x 2	6.5	1/8	40	●	●	640 x 480 VGA; 16
Librex 286 Notebook	\$2999	286/12	11.7 x 8.4 x 2	6	1/3	20/40	●	●	640 x 480 VGA; 16
Librex 386SX Notebook	\$4299	386SX/20	11.7 x 8.4 x 2	6	4	20/60	●	●	640 x 480 VGA; 16
Link 386SX20	\$2999	386SX/20	11 x 8.7 x 2.4	7	1/5	20/40	●	●	640 x 480 VGA; 16
Micro Express NB5620	\$1999	386SX/20	11.8 x 8.3 x 2	6.8	1/5	20/60	●	●	640 x 480 VGA; 16
Modern Computer NoteStar NP-902	\$1600	286/12	12.2 x 9.5 x 2.1	7.7	1/8	20/60	●	●	640 x 480 VGA; 32
Modern Computer NoteStar NP-903	\$2800	386SX/16	12.2 x 9.5 x 2.1	7.7	2/8	40/60	●	●	640 x 480 VGA; 64
Myoda Notebook 386SX	\$2899	386SX/16	11 x 9 x 2	6.9	1/8	20	●	●	640 x 480 VGA; 32
NEC UltraLite 286F	\$2799	286/12	12 x 8 x 2	7	1/5	20	●	●	640 x 400 CGA; 8
NEC UltraLite 286V	\$3199	286/12	12.2 x 9.5 x 1.7	6.5	1/5	20	● (ext.)	○	640 x 480 VGA; 16
NEC UltraLite SX/20	\$4899	386SX/20	11.5 x 8.6 x 2.4	7.5	2/10	40/60	●	●	640 x 480 VGA; 16
Northgate SlimLite	\$2999	386SX/20	11.75 x 8.25 x 2	6.2	3/5	20/40	●	●	640 x 480 VGA; 32
Notebook Computer 486Notebook Workstation 486-T20	\$4495	486SX/20	11 x 8.5 x 1.4	4.5	1/8	20/100	○	○	640 x 480 VGA; 16
Notebook Computer 486Notebook Workstation 486-T33	\$6795	486/33	11 x 8.5 x 1.4	4.5	1/10	40/100	○	○	640 x 480 VGA; 16
Ogivar Internote 286	\$2999	286/12	12.3 x 10 x 2	7	1/5	20	●	●	320 x 200 VGA; 32

Battery type and life (in hours) ¹	External ports ²	Number of keys	DOS included?
NC, 3	P, S(2)	87	●
NC, 3	P, S(2)	82	●
NC, 2.5	P, S, V, K	80	●
NC, 2.5	P, S, V	80	●
NC, 3	P, S	84	●
NC, 2	P, S, K, V	84	○
NC, 3.5	P, S, V, K	82	●
NC, 6	P, S, V, K, E	82	●
NC, 7	P, S(2)	83	●
NC, 4	P, S, V, K	81	●
NC, 2.5	P, S, K, V, E	81	●
NC, 1	P, S, V, MS	79	●
NC, 3.5	P, S, V, K, D	80	○
NC, 3.5	P, S, V, KP	81	●
NC, 3	P, S	79	●
NC, 2	P, S, V, KP	80	●
NC, 3	P, S, V, K	84	●
NC, 2	P, S, V, K	84	●
NC, 2	P, S(2), V, K, D	83	○
NC, 2.5	P, S(2), V, K	80	●
NC/alk., 3.5	P, S, V, K, D	84	●
NC, 4	P, S, V, D, KP, K	85	○
NC, 3	P, S, V, D, KP, K	85	○
NC, 3	P, S, V, KP, D	82	●
NC, 3	P, S	82	●
NC, 2	P, S, MS	81	●
NC, 2.5	P, S, V, K	80	●
NC, 2	P, S, V, D, E	80	●
NC, 2.5	P, S	84	●
NC, 2.5	V, K, P, S	84	●
NC, 2.5	S(2), P, K	82	○
NC, 3	P, S	75	●
NC, 2	P, S(2), V	83	●
NH, 2.5	P, S, V	79	●
NC, 3	P, S, K, V	84	●
NC, 3	P, S, K, V	84	●
NC, 2.5	P, S, K, V, D	80	●
NC, 3	P, S(2), V	82	●
NC, 2.5	P, S(2), V	82	●
NC, 3	P, S, D, V, K, E	80	●
NC, 3	P, S(2), V, K, D	83	●
NC, 4	P, S, K, V, E, D	83	●
NC, 4	P, S, K, V, E, D	83	●
NC, 3	P, S	80	●
NC, 3	P, S	78	●
NC, 2.5	P, S, V	78	●
NC, 2	P, S, V, D	78	●
NC, 3	S, P, V	84	●
NC, 1	P, S, V, E	79	●
NC, 1	P, S, V, E	79	●
NC, 2	P, S	82	●

continued



Toshiba pioneered many of the popular power management features, and its systems, such as the **T2000SX** shown here, provide impressive battery life without the services of Intel's 386SL.

as extensive as the SL's. For example, it is capable of suspended operation, meaning that its clock can be slowed to 0 MHz.

New CPUs from C&T show much promise. Ranging from 286 to 386DX classes, they all feature power conservation features similar to the 386SL's. At the high end, the 38605DX can operate at speeds of up to 40 MHz and provides additional functions not found in Intel's processor while maintaining compatibility. The 8680-series 286-compatible CPU is actually a complete PC on a chip, sans memory. These processors claim superior performance to the 286 while featuring advanced power management capability. C&T expects the 8680 series to be popular in very small systems—from hand-helds to notebooks.

The main question now for both AMD and C&T is market acceptance. System vendors will want to be assured of availability and compatibility, and the CPUs will have to be priced competitively. AMD's chip has been out longer, to date no serious flaw has emerged, and vendors say availability is not a problem. C&T has gone to great lengths to simulate the operation of its new CPUs in the

lab. And all these parts are priced well in comparison to Intel's products. You will see notebook systems using CPUs from both these companies next year, but many vendors will wait and see how the pioneers fare before using them.

Several manufacturers have shown an almost maniacal devotion to squeezing out every possible minute of battery operation. The tricks used are many: shutting off ports when not in use, stopping the processor between keystrokes, using more low-power components, and embedding power management software in the system to monitor it all.

Two vendors are particularly noteworthy on this front: Toshiba and Zenith. Toshiba pioneered power management and is the first major vendor to use nickel-hydride batteries. Nickel hydrides tend to hold power longer, and they don't exhibit the "memory effect" of nickel-

PRODUCT GUIDE: NOTEBOOK COMPUTERS (CONT.)

	Base price	CPU/MHz	Dimensions (W x D x H, in inches)	Weight w/battery (lbs.)	RAM (std./max., in MB)	Hard disk drive (std./max., in MB)	Floppy drive standard?	Math socket?	Video (pixels; gray scales)
Ogivar Internote SX386	\$3249	386SX/20	12.3 x 10 x 2	7	1/5	20	●	●	320 x 200 VGA; 32
Olivetti Notebook V16	\$2800	386SX/16	11 x 9 x 2	7.26	2/6	40	●	●	640 x 480 VGA; 32
Olivetti Notebook A12	\$2300	286/16	11 x 9 x 2	7.26	1/5	20	●	○	640 x 400 CGA; 32
Olivetti Notebook S20	\$3500	386SX/20	11 x 9 x 2	7.25	2/6	60	●	●	640 x 480 VGA; 32
Packard Bell PB286NB	\$3995	286/12	11 x 8.7 x 1.9	6.6	1/8	20	●	●	640 x 480 VGA; 32
Panasonic CF-270	\$3199	286/16	12.2 x 10 x 1.7	6.6	1/5	20	●	●	640 x 480 VGA; 16
Panasonic CF-370	\$4799	386SX/20	12.25 x 10 x 1.75	6.8	1/5	60	●	●	640 x 480 VGA; 16
PC-Ease NB-8800	\$3355	386SX/20	11 x 8.6 x 1.4	4.5	1/4	20/40	● (ext.)	●	640 x 480 VGA; 32
PC-Ease NB-9300	\$5775	386DX/33	11 x 8.6 x 2	9	2/16	40/120	●	●	640 x 480 VGA; 32
Philips Magnavox Metalis/286	\$2699	286/12	11 x 8.5 x 2.1	6.9	1/8	20	●	●	640 x 480 VGA; 32
Philips Magnavox Metalis/SX	\$3199	386SX/16	11 x 8.5 x 2.1	6.8	1/5	40	●	●	640 x 480 VGA; 32
Psion MC600	\$2995	80C86/7.68	12.4 x 8.9 x 1.9	4.3	640 KB	N/A	○	○	640 x 200 CGA; 16
SAI SAIBook	\$2395	386SX/16	11.4 x 8.9 x 2.1	5	2	20/40	●	●	640 x 480 VGA; 16
Saint Croix 386SX	\$2298	386SX/16	12.2 x 9.5 x 2.1	7.7	2/8	20/40	●	●	640 x 480 VGA; 64
Samsung NoteMaster 386S/16	\$2799	386SX/16	11 x 8.5 x 2.1	7	1/5	20/40	●	●	640 x 480 VGA; 64
Sanyo MBC-17NB	\$2999	286/12	12.3 x 10 x 2	7	1/5	20	●	○	640 x 480 VGA; 16
Sanyo MBC-18NB	\$3499	386SX/16	12.3 x 10 x 2	7	1/5	20	●	●	640 x 480 VGA; 16
Sanyo MBC-18NB6h	\$3749	386SX/20	12.3 x 10 x 2	7	1/5	20	●	●	640 x 480 VGA; 16
Sharp PC-6220	\$3995	286/12	11 x 8.5 x 1.4	4	1/5	20	○	●	640 x 480 VGA; 16
Tandon NB/386SX	\$3495	386SX/20	11 x 8.5 x 2.25	6.5	2/16	30/60	●	●	640 x 480 VGA; 32
Tandy 2810 HD	\$2199	286/16	12.2 x 20 x 1.7	6.7	1/5	20/60	●	●	640 x 480 VGA; 16
Tandy 3810 HD	\$3299	386SX/20	12 x 10 x 2	7	1/5	60	●	●	640 x 480 VGA; 32
Tangent 320N	\$1995	386SX/20	11.75 x 8.25 x 2.25	7.1	1/5	20/60	●	●	640 x 480 VGA; 16
Texas Instruments TravelMate 2000	\$2199	286/12	11 x 8.5 x 1.4	4.4	1/3	20	○	●	640 x 480 VGA; 16
Texas Instruments TravelMate 3000	\$3199	386SX/20	11 x 8.5 x 1.8	5.7	2/6	20/40	●	○	640 x 480 VGA; 32
Toshiba T1200XE/20	\$2299	286/12	12.2 x 11 x 2	8.1	1/5	20/40	●	○	640 x 400 CGA; B/W
Toshiba T2000	\$3149	286/40	12.2 x 10 x 1.9	6.9	1/9	40	●	●	640 x 480 VGA; 16
Toshiba T2000SX/20	\$3399	386SX/16	12.2 x 10 x 1.9	6.9	1/9	20/40	●	●	640 x 480 VGA; 16
Toshiba T2000Sx	\$4199	386SX/20	12.2 x 10 x 1.9	6.9	1/10	40/60	●	●	640 x 480 VGA; 16
TransPacific TL 1020SX	\$2375	386SX/20	11.8 x 9.8 x 1.8	6.5	2/5	20/40	●	●	640 x 480 VGA; 32
Twinhead Supernote 386SX	\$2799	386SX/16	11 x 8.5 x 1.9	6.5	2/4	40/120	●	●	640 x 480 VGA; 32
Twinhead Supernote 20C	\$3999	386SL/20	11 x 8.5 x 2	6.2	2/8	40/160	●	●	640 x 480 VGA; 32
Veridata ExecuLite 386S	\$3799	386SX/20	11 x 8.6 x 1.4	4.5	1/4	20/40	● (ext.)	○	640 x 480 VGA; 64
Zenith Mastersport 286	\$2699	286/12	11 x 8.5 x 2	6.6	1/2	30	●	○	640 x 480 VGA; 16
Zenith Mastersport 386SX	\$3999	386SX/20	11 x 8.5 x 2	6.6	2/4	60	●	●	640 x 480 VGA; 16
Zenith Mastersport 386SL	\$4999	386SL/20	12.4 x 8.3 x 1.8	6.8	2/8	60	●	●	640 x 480 VGA; 64
Zeos Notebook 386	\$1995	386/16	12.3 x 10 x 2	7	1/5	20	●	●	640 x 480 CGA; 32
Zeos Notebook 386/SX	\$2295	386SX/20	12.3 x 10 x 2	7	1/5	20	●	●	640 x 480 CGA; 32

¹ NC = nickel-cadmium; NH = nickel-hydrate; alk. = alkaline.

² P = parallel; S = serial; V = external video; K = keyboard; E = expansion bus; MS = mouse; D = disk drive; KP = keypad; SC = scanner.

³ Modem is standard.

cadmium batteries. Zenith is the first to announce a 386SL system, and it worked closely with Intel to take advantage of the CPU's capabilities.

These vendors claim that, for an average workday, you shouldn't need to plug in their most power-efficient models. That's assuming, of course, that you are not typing continuously for 8 hours. Most people work in a series of short periods on a notebook. Systems with good power management shut down when not in use, even if for a fraction of a second.

So, you are still stuck with a bulky battery that needs regular recharging,

but power management is becoming more attuned to the way most people work. Improved power management has a positive side effect, too: It allows notebook-class PCs to be built with CPUs more powerful than the 386SX or SL.

Lean, Mean Computing Machines

The vast majority of notebook PCs will continue to be powered by 286 or 386SX/SL CPUs in the coming year. And their performance will be roughly equivalent to their like-powered desktop siblings. For some people, however, these processors won't cut it for the ap-

plications they run. Engineers, architects, and anyone else running programs that require a lot of processing power have the same system portability needs as everyone else. By next year, they will be able to choose among notebook PCs powered by 386DX (from Intel and AMD), 486SX, and (maybe) 486 CPUs.

Some systems have already been announced (see the table), but none is from a name player. I will go out on a limb and predict that at least one major vendor will offer a high-performance notebook by the end of next year. It will be expensive in terms of price and trade-offs, though.

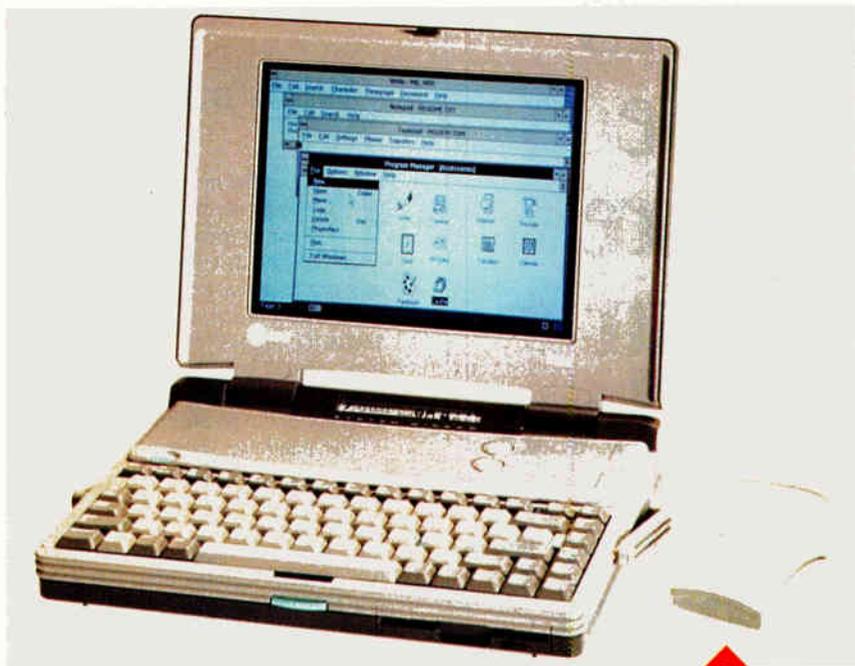
Battery type and life (in hours) ¹	External ports ²	Number of keys	DOS included?
NC, 2	P, S	82	●
NC, 3.5	P, S, V, K, MS	82	●
NC, 3.5	P, S, V, K, MS	82	●
NC, 3.5	P, S, V, K, MS	82	●
NC, 3	P, S	80	●
NC, 2.25	P, S	84	●
NC, 3	S, P, V, K	84	●
NC, 2	P, S, D, MS	80	●
NC, 2	P, S, D, MS, E	82	●
NC, 4	P, S, V, K, E, KP	80	●
NC, 3	P, S, V, K, E, KP	80	●
Aik, 20	P, S, E	86	●
NC, 2	P, S, V, K, SC	80	●
NC, 3.5	P, S, K, V	83	●
NC, 3	P, S (2)	80	●
NC, 3	P, S, V	82	●
NC, 3	P, S, V	82	●
NC, 3	P, S, V	82	●
NC, 5	P, S, D, KP	79	●
NC, 3	P, S (2)	84	●
NC, 3.5	P, S, D, V, K	84	●
NC, 3	P, S, D, V, K	84	●
NC, 3	P, S (2), K, V	83	●
NC, 2	P, S, D, KP	79	●
NC, 2.5	P, S, V, KP, E	79	●
NC, 2	P, S, V, KP, E	82	●
NH, 3	P, S, V, K, E	86	●
NH, 3	P, S, V, K, E	86	●
NH, 3	P, S, V, K, E	86	●
NC, 3	P, S (2)	83	○
NC, 3	P, S (2), V, KP	80	●
NC, 4	P, S (2), E, V, K	84	●
NC, 4	P, S, K, V	79	●
NC, 2.8	P, S, V	80	●
NC, 2.8	P, S, V	80	●
NC, 8	P, S, MS, V, D	82	●
NC, 3	P, S, V	82	○
NC, 3	P, S, V	82	○

Battery life, for instance, will likely be no more than 2 hours, and that's using every practical power conservation trick. But notebook PCs will have entered another market niche.

And these small systems are extending their reach. I've already mentioned the sales projections, but what's probably more indicative of their market impact is the third-party hardware and software industry that has begun to emerge.

The Right Tool for the Job

You don't work the same on the road as you do in your office, and neither should



AT&T designed the Safari NSX/20 to be a communications device as much as a notebook PC. It looks sharp, too.

your notebook. You need peripherals that don't weigh you down and software that works well on the go without usurping too much of your system's resources. Solutions for these needs, designed with portable computing in mind, are available now. Next year, the selection will only get better.

Portable printers, for instance, represent a remarkably innovative part of the industry. In your briefcase, you can carry not only your PC, but a printer capable of high-quality output that will embarrass no one. The technologies used include dot matrix, ink jet, and a variation of the laser engine. Some are color capable.

The market for portable printers is intensely competitive right now, and that is good for the consumer. Six months ago, the Canon BubbleJet was the cat's meow of portable printers. Now, Citizen's new PN48 Notebook Printer with its laser-quality output is threatening to set a new standard. This leapfrogging will continue as the big players in small printers battle for market share.

Windows 3.0 is also driving the demand for portable pointing devices, and you will have choices there—too many. Touchpads, roller pens, trackballs, keymice, and the Isopoint all are claimed to be the best solution to portable pointing. My personal bias: None is as good as a mouse, but a mouse is not often practical for on-the-go use. I have found the touchpads difficult to use, the keymice hard to control, and the Isopoint less than intuitive. The trackballs and roller pens are

more mouselike in terms of feel and accuracy. Which ones will prevail is an open question. A lot of R&D effort is going into each design, and you can expect each to improve in the coming year.

One observation: Although some notebook vendors do it, building a pointing device into the system tends to turn off anyone who prefers another type. Choosing a pointing device is largely a matter of personal preference, and people don't like paying for something they won't use. I predict that while more and more vendors will offer pointing-device options, fewer systems will be designed with one built in.

With only a 20- or 40-MB hard disk drive, you want to be selective about what software and data you keep on your notebook. For this reason, integrated software packages such as Microsoft Works and LotusWorks have become increasingly popular among the portable computing set. Providing word processing, spreadsheet, database management, and other common applications in one package saves system resources, not to mention the cost of buying each function separately.

Software designed exclusively for portable use is beginning to appear. These packages tend to be specialized products that are optimized for one specific task: Expense reporting, scheduling, contact



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What's All the Fuss About Pen Input?

One of the most talked-about new product technologies of the past year is pen-based computing. Without a doubt, this technology represents a very important trend, but it is generating some misconceptions about its impact on the market. The hype would have pen input replacing keyboards. It isn't going to happen, at least not in the foreseeable future.

The pen-based computing market is really twofold: It has a vertical segment aimed at forms-based applications such as product delivery, warehouse inventory, insurance claims, and so on; and it has another segment aimed at enhancing existing systems. This latter segment will have the greatest impact on notebook computing as we know it, and the impact will be felt soon.

Pen technology is good, and some big companies are spending huge sums on R&D to make it even better. Still, the best software is only about 90 percent to 95 percent accurate when it comes to character recognition. Even if it were 100 percent accurate, the fastest writing is still no match for keyboard input when it comes to speed. At best, you can write only about 20 words per minute (in block characters; cursive handwriting recognition is years away). A medi-

ocre typist can do at least twice that.

Having both pen and keyboard input on a notebook PC significantly increases its versatility and is a boon to productivity. For instance, note taking on a portable computer tends to annoy people. The sound of the keys and the bulk of the system distract those with whom you are meeting. Most people still make all their notes on paper and, with luck, later type them in on their systems. But if you could leave your keyboard behind and grab a stylus instead, holding and writing on the screen tablet would be no more distracting than writing in, well, a notebook.

This scenario requires a new type of software that must be able to store your notes, as translated text or the actual screen image, and allow you to order and store them appropriately. If you make note of an upcoming meeting, for example, you should be able to send the information to a scheduling program. Say good-bye to notes on paper.

By the time you read this, you will be able to purchase such a system for not much more than a standard notebook PC. Several companies have working prototypes of the hardware as I write, and companies such as Slate and Pensoft are developing pen-based software.

management, and communications are prime examples. Pen-assisted applications are also beginning to emerge (see the text box "What's All the Fuss About Pen Input?" above). Communications is an area in which you are likely to see interesting innovation during the coming year, particularly in the areas of fax, E-mail, and paging.

A Port in Any Storm

AT&T's Safari NSX/20 notebook has generated a lot of notice for its sleek design and attention to detail. What's not so obvious, however, is that the Safari was designed as a communications device as much as a portable computer. It comes standard with a 2400-bps fax modem, but more significantly, AT&T has designed the Safari to perform as a portable mailbox. The Safari can send and receive E-mail messages via the AT&T Mail service using preloaded Windows-based software. Through AT&T Mail, you can

access other services such as fax, telex, courier, or just plain U.S. mail, not to mention access to on-line, business-oriented databases.

The Safari points to the future of portable computing. Notebook systems are, in effect, your office while traveling. And from a technology standpoint, there is little to keep you from enjoying all the benefits of your office while away. This includes two-way access to corporate LAN resources, staff, and your business contacts using both standard phone lines and cellular communications. From a marketing point of view, it's a different story. Few notebooks offer a modem standard, let alone cellular or fax capability. As notebook users become more sophisticated, however, they will demand more of their systems.

Connectivity to LANs, something early portable users rarely considered, is a requirement for notebooks in many offices today. LAN connectivity solutions

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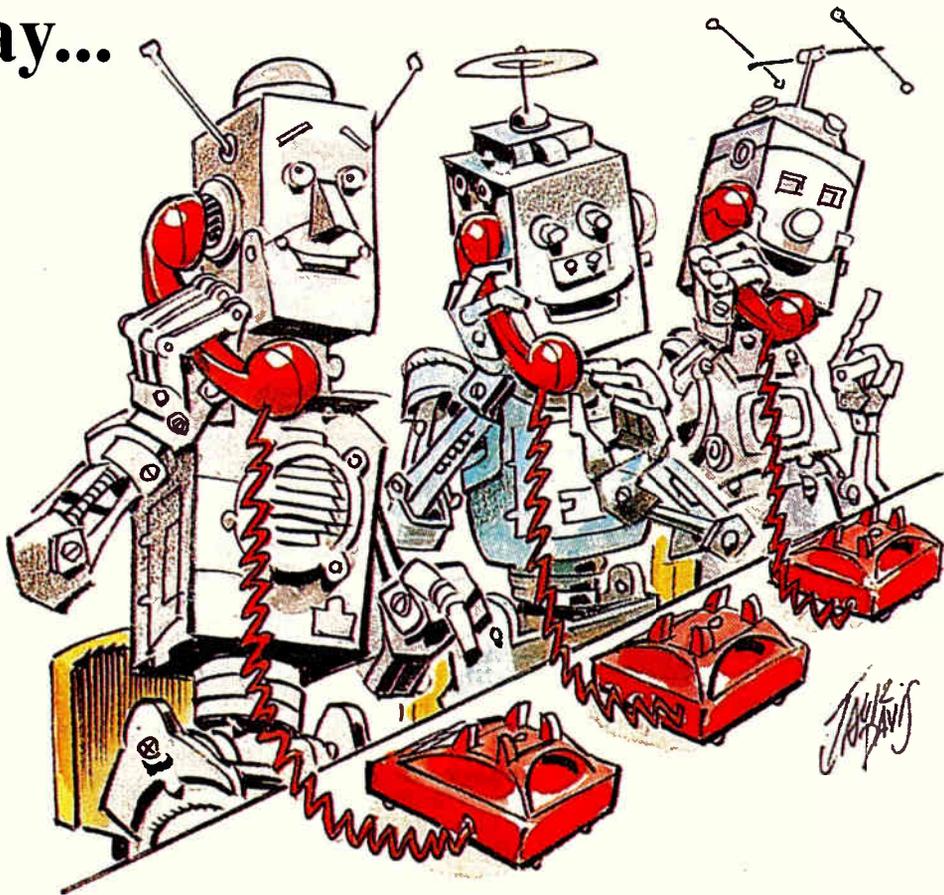
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Advanced Logic Research, Inc. (ALR)
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 Irvine, CA 92718
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 fax: (714) 581-9240
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Amax Engineering Corp.
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 fax: (415) 651-3720
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AST Research, Inc.
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AT&T Computer Systems
 (Safari NSX/20)
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 Morristown, NJ 07962
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Circle 1173 on Inquiry Card.

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 (386/SX Notebook)
 10300 Metric Blvd.
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 fax: (512) 454-1357
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Bondwell Industrial Co., Inc.
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 fax: (408) 732-6050
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Commax Technologies, Inc.
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 San Jose, CA 95131
 (408) 435-5000
 fax: (408) 435-5005
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Compaq Computer Corp.
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 fax: (713) 374-1402
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CompuAdd Corp.
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 12303 Technology Blvd.
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 (512) 250-1489
 fax: (512) 250-5760
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Cordata Technologies, Inc.
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 1055 West Victoria St.
 Compton, CA 90220
 (213) 603-2901
 fax: (213) 763-0447
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Darius Technology, Inc.
 (386 Notebook-20,
 386 Notebook-20B)
 22028 26th Ave. SE
 Bothell, WA 98021
 (206) 483-8889
 fax: (206) 486-2577
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Dataworld
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 fax: (213) 695-7016
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 9505 Arboretum Blvd.
 Austin, TX 78759
 (512) 338-4400
 fax: (512) 338-8421
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Everex Systems, Inc.
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Fora, Inc.
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 fax: (415) 683-0902
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 fax: (408) 733-2638
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 fax: (408) 943-9567
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Intelligence Technology Corp.
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 P.O. Box 671125
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 fax: (214) 380-0508
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Leading Edge Products, Inc.
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 117 Flanders Rd.
 Westborough, MA 01581
 (508) 836-4800
 fax: (508) 836-4501
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Leading Technology, Inc.
 (PC Partner XL)
 10430 Southwest Fifth St.
 Beaverton, OR 97005
 (503) 646-3424
 fax: (503) 626-7845
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Librex Computer Systems, Inc.
 (286 Notebook,
 386SX Notebook)
 1731 Technology Dr., Suite 700
 San Jose, CA 95110
 (408) 441-8500
 fax: (408) 441-7842
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Link Computer, Inc.
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fax: (212) 488-5918
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**Northgate Computer Systems,
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Notebook Computer Co.
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Workstation 486-T33)
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fax: (514) 737-4729
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Olivetti Office USA
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(908) 526-8200
fax: (908) 526-8405
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fax: (203) 929-6948
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fax: (612) 643-3854
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**Samsung Information
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fax: (201) 440-1775
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Sharp Electronics Corp.
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fax: (201) 529-9636
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Tandon Corp.
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301 Science Dr.
Moorpark, CA 93021
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(805) 523-0340
fax: (805) 529-2878
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Tandy Corp.
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1800 One Tandy Center
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(817) 390-3011
fax: (817) 390-2774
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Tangent Computer, Inc.
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(800) 223-6677
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fax: (415) 342-9380
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Texas Instruments, Inc.
(TravelMate 2000,
TravelMate 3000)
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fax: (214) 995-4360
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**Toshiba America
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Irvine, CA 92718
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(714) 583-3000
fax: (714) 587-6034
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TransPacific Distribution, Ltd.
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Twinhead Corp.
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Supernote 20C)
1537 Centre Point Dr.
Milpitas, CA 95035
(408) 945-0808
fax: (408) 945-1080
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Veridata Research, Inc.
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(818) 303-0613
fax: (818) 303-0626
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Zenith Data Systems
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386SX, Mastersport 386SL)
2150 East Lake Cook Rd.
Buffalo Grove, IL 60089
(800) 553-0331
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Zeos International, Ltd.
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Notebook 386/SX)
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Statistics

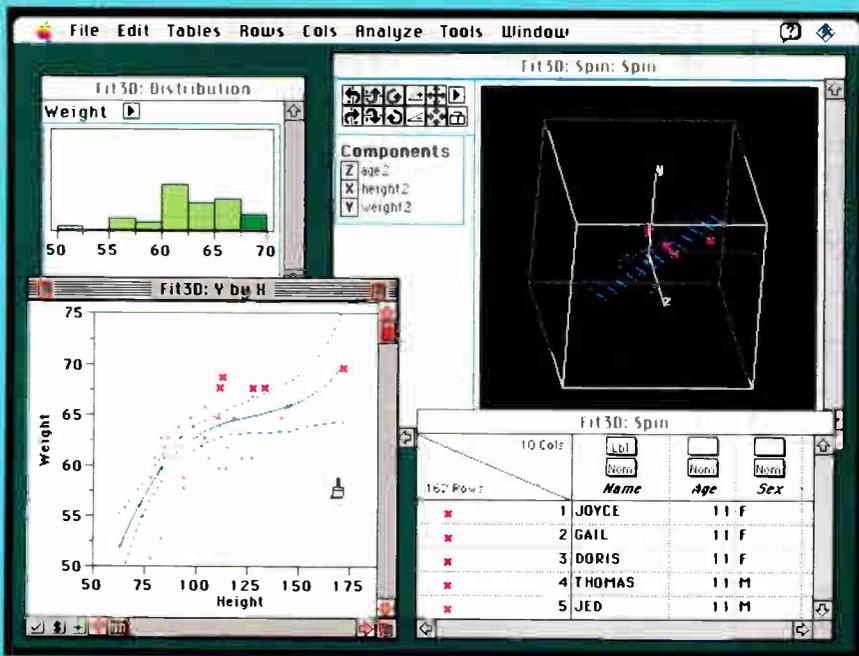
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It was on an early April morning when I found myself crowded into a small conference room to watch a demonstration on JMP, SAS's new statistical graphics package made specifically for the Macintosh. Since I had no idea what a statistical graphics package was capable of doing, I was prepared to watch the demonstration, take notes on meaningless jargon, and then leave knowing little more about how to use a statistical graphics package than I had before.

Indeed, when the demonstration began, my worst fears were realized when I heard such statements as, "With the model leverage plot, there is the model analysis variants table, and, with each effect, there is an analysis of each effect," and "The Y's by Y's platform produces an outlier plot showing the Mahalanobis distance of each point from the multivariate centroid." To make matters worse, several members of the group attending the demonstration would oh and ah over these statements and ask questions that rivaled them in sheer incomprehensibility.

As the demonstration progressed, however, I became fascinated with the number of things JMP offered that judging from the reactions of the more knowledgeable members of the group, were absent in other statistical graphics packages. Even more amazing was the fact that I found myself understanding the function of nearly every feature in JMP, even though I had no idea what the statistical jargon associated with each function meant.

And that, in a nutshell, is the beauty of JMP.

from the University of New Mexico
CIRT Newsletter, June 1990

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for notebooks will proliferate next year. Two years ago, Xircom made a big splash with a little Ethernet LAN adapter that plugged into a portable's parallel port. Now, Xircom has several competitors selling LAN adapters in a variety of flavors: Ethernet, Token Ring, ARCnet, and so on.

The parallel port provided a convenient means of connecting a LAN adapter, but it proved to be a speed bottleneck. Some vendors are now using the external expansion ports. The problem here, though, is that there is no standard expansion connector. For the time being, the faster adapters will be available for only the most popular notebooks.

On Beyond DOS

As I write this, notebook computing is virtually a DOS-only world. That will change in 1992. Apple is expected to announce at least one notebook-class Macintosh system by this fall. Anyone who has ever seen dedicated Mac users lugging around the 17-pound Mac portable as if it were a notebook knows there is a tremendous pent-up demand for the real thing.

Because of Apple's reputation for innovation, particularly in the user-interface area, many DOS notebook vendors are watching that company closely. If Apple lives up to its reputation, innovations on its notebook systems are likely to be implemented on the DOS side before long. After all, without the Mac, we probably would not have Windows 3.0 today.

Tadpole Technology is expected to ship a 6-pound SPARC-based notebook system by this fall. The SparcBook 1 will offer a choice of the SunOS or Unix System V release 4.0 operating system and a claimed performance rating of 18 million instructions per second. Don't expect a lot of company for this Unix notebook. The Tadpole sports only 640-by 480-pixel VGA graphics. LCD screens with the resolutions that most Unix folk are used to are rare and expensive in the dimensions required by the notebook form factor. The Tadpole's display, along with its limited expansion capabilities, will severely limit its appeal. Nonetheless, the demand exists in the Unix world for small, portable systems.

Personal Computing's Last Bastion

With more and more desktop systems becoming networked, portable systems may soon be the only truly personal computers available. Their untethered nature allows users to configure them to match the way they work. With the software and peripheral choices available, a smart professional can build a notebook system that will give him or her an edge over competitors and colleagues. The freedom to do that on a desktop system does not exist for everyone.

Tremendous growth is projected for notebook PC sales through the next few years. A great deal of that growth will be fueled by businesses looking to increase productivity of their mobile employees. Just as significant, but less noticed, is the demand at the grass-roots level: small businesses and savvy professionals seeking that competitive edge. Ironically, these are the same people who were the early adopters of the first personal computers. ■

Michael Nadeau is a BYTE executive editor. You can contact him on BIX as "miken."

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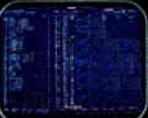
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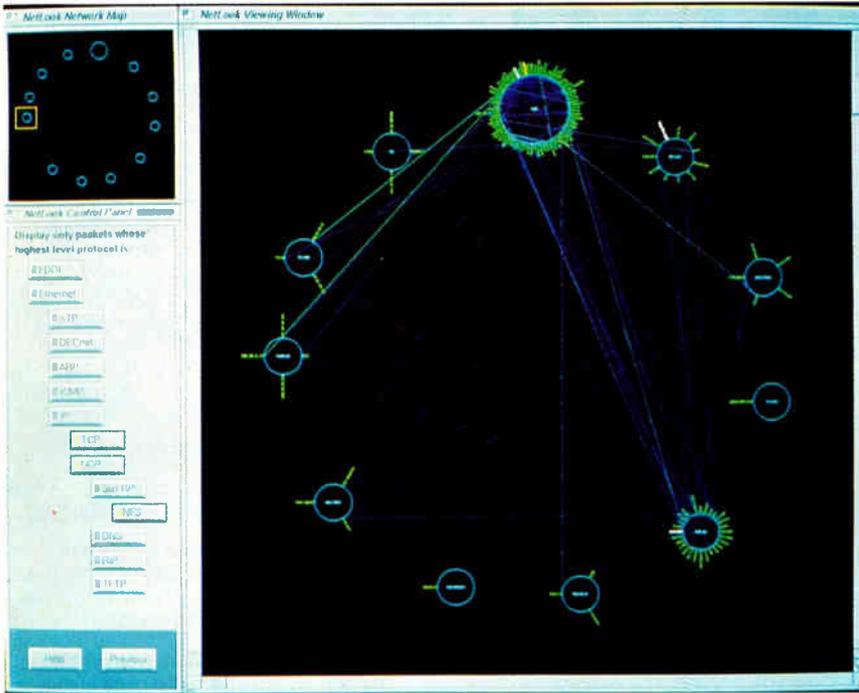
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NETWORKING



Trends in Network Management

Smarter, better-integrated tools are on the way

JON UDELL

What's network management? For me, it's any of the myriad routine or unscheduled activities I'm asked to perform in order to keep BYTE's network running and to keep its users productive. Routine duties include backups, disk management, software upgrades, application development, and—less frequently—planning, implementing, and documenting the network's rearrangement or growth. Unscheduled tasks are even more diverse.

One of the services that I maintain is BYTE's LAN-based X.25 link. From a user's perspective, this service either works or it doesn't. But for me, the "BIX is broken" complaint triggers a complex troubleshooting algorithm. The user might simply have lost the PATH variable that points to the server-resident tele-

communications program. Someone may have accidentally misconfigured that program. The TSR program that links LAN workstations to the X.25 gateway machine may not be running. The gateway PC, or the entire LAN, may have had a hardware or software crash. The packet assembler/disassembler or leased-line modem through which we connect to the host may have failed. The X.25 network, or even the BIX machine itself, could be down.

The tension between the user's binary view of network services, and the network manager's kaleidoscopic view of the layered hardware and software components that sustain those services, defines the challenge of network management in the years ahead. Everyone in the networking business—equipment makers, network operating-system compa-

nies, third-party toolsmiths—agrees that we'll use fewer, more comprehensive tools to manage tomorrow's networks. But those of us who manage networks today face a bewildering array of product offerings.

Researching this article, I uncovered whole categories I'd never considered but that properly belong under the network management umbrella. Because the discipline is still being invented, categories blur and overlap. In the end, I decided to survey the field broadly. In this article, I'll assess the variety and scope of existing network management products, discuss enabling technologies, and focus on how today's disparate management products foreshadow the integrated solutions of tomorrow.

For more information about the companies and products mentioned, see the Network Management Company Information listing.

Silicon Graphics' NetVisualizer exploits the graphics prowess of the Iris 4D workstation to create stunning network maps.

Purchase Planning, Simulation, and Modeling

Although networks grow like weeds once they are established,

they don't just spring up out of the corporate soil. There's always a set of requirements and some plan for meeting them. Emerging now are tools that can help elicit requirements, specify network products and configurations, and evaluate a specification in terms of compatibility and performance.

How about a tool that helps you translate your networking needs into a purchase order? Trilogy's Netbuild, a sales configuration tool, links a "configuration engine" built around the Open Systems Interconnection (OSI) network model to a database containing information about LAN products. Intended for LAN resellers, Netbuild prompts for the number and types of workstations and printers that need to be connected, as well as for the kinds of applications that will be run.

According to Trilogy, the configuration engine resolves constraints and dependencies. It knows, for example, that PCs on an Ethernet segment can't reach a LaserWriter on a LocalTalk segment without the help of a gateway, and so it might recommend NetWare for Macintosh. The end result is a purchase proposal with a complete bill of materials listing adapters, cables, bridges, gateways, and

system software. Netbuild will ship (about the time you read this) with a complete database of Novell products, supplemented with products from "a few other major vendors." Trilogy plans to follow with database additions, and resellers (or companies that buy LAN equipment in volume) can augment the database on their own.

Network management, according to the new religion, should be proactive rather than reactive. When growing a network or planning a new one, why not anticipate performance bottlenecks before they happen? There are several approaches to proactive performance analysis. Most monitors/analyzers can inject packets onto an existing network, so you can get a feel for the effect of extra traffic generated by new nodes.

ProTools' Protolyzer, for example, makes this sort of experiment easy to do. Using its Presentation Manager-based iconic programming toolkit, you can capture traffic between a server and a station you deem typical of some activity (say, writing legal documents with WordPerfect), clone multiple copies of the sample node, and then play the captured data back through all the copies to emulate a combined network load.

You can use this approach with your existing network, but it won't help you evaluate a new one. Moreover, there are methodological flaws. For example, an individual analyzer trying to emulate multiple network devices must serialize the traffic it creates. In reality, workstations contend for access to their medium. Why not model, or simulate, the network's protocols, devices, and interconnections in software? Several products do just that.

Internetix describes its Softbench package (\$995) as "a top-down analytical model calibrated with benchmark data." You might ask Softbench to model a group of 286 and 386 workstations running Paradox under NetWare 2.15 on two Ethernet segments bridged by a 386 server and then examine the effect of upgrading to NetWare 386, or using Token Ring instead of Ethernet, or upgrading 8-bit network interface cards to 16-bit NICs, or bridging with TCP/IP across a backbone.

Internetix targets Softbench for departmental, not enterprise-wide, analysis, and it emphasizes that the results, while useful, are average and approximate. For more complex and more accurate analysis, you might use Internetix's LANsim, a true event-stepped simula-

tor. This DOS-based tool can drive simulations of complex networks using traces collected by Network General's Sniffer.

LANsim abstractly accounts for the lower layers of the OSI model. For application-level traffic that's less amenable to abstract simulation, there's a companion tool called LANAI (for LANsim Analyzer Interface), which can reduce Sniffer data to patterns called *activity blocks*. Given a large sample of packets from a bank teller's workstation, for example, you might use LANAI to extract activity blocks that you'd label "deposit" and "withdrawal" and then include these blocks in a simulation.

An order of magnitude more sophisticated (and expensive) than Softbench is Comdisco's BONES (for Block-Oriented Network Simulator). It's a meta-simulator—an advanced graphical toolkit for building network simulators. Running on a DECstation or a Sun workstation, BONES captures network topology, protocols, and data structures by means of a hierarchical diagram editor. You can take building blocks from a library of primitive models (e.g., queues and timers) or systemic models (e.g., Ethernet, Token Ring, and X.25). You can also add custom-built primitives to the model library—a feature of more interest to designers of protocols and devices than to network managers.

Once you've specified a simulator in this way, BONES writes the C program that implements it. The simulator then runs under the control of a BONES utility that can adjust parameters and attach data-gathering "virtual probes" to various components. As with LANsim, you can elect to drive the simulation with traces collected by a Sniffer or a Hewlett-Packard LANprobe. Finally, a post-processor performs graphical and statistical analyses of the simulator's output.

BONES's extreme flexibility makes it a tool for an elite class of very knowledgeable users. However, Comdisco sees the growing need for general-purpose network simulation tools and will offer a version of the product with a wider selection of canned, pluggable models.

Mapping and Documenting the Network

You can't manage what you can't see, so comprehensive network maps are an essential management tool. It's easy to imagine an ideal scenario: information about wide-area and local network geography, physical and logical topologies, network equipment, and connected sta-

tions living in a central (or distributed) repository. Viewed graphically, the repository is a map of nodes, interconnections, and hierarchies. It's also a database that stores operational statistics, equipment records, and user-support histories. You might navigate the map to locate a failing repeater, or query the database for the set of workstations lacking enough memory for a proposed software upgrade. Either way, you'd be accessing a common repository.

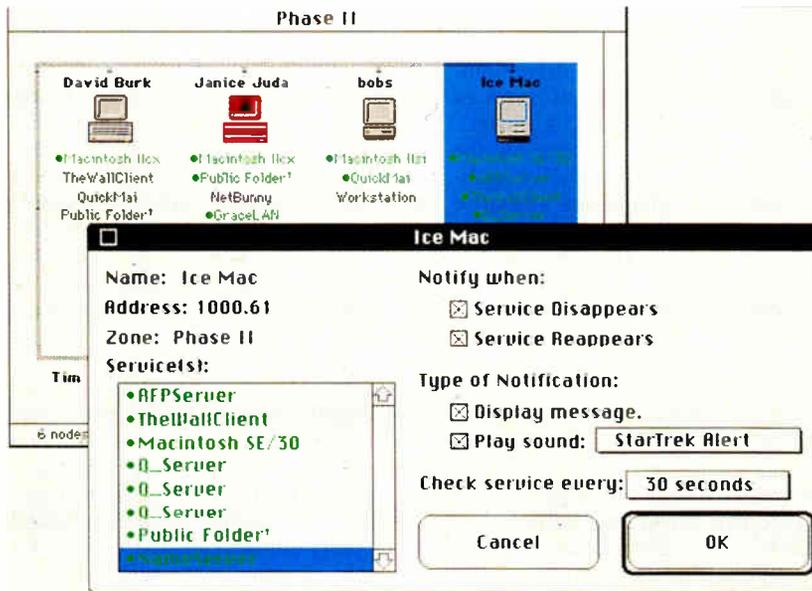
Don't hold your breath waiting for this Holy Grail to materialize. As networks and computing become synonymous, network operating systems will develop, or provide hooks to, unified management repositories into which internal and third-party utilities can feed. Novell, for example, reportedly has such plans under way. In the meantime, managers of small- to medium-size networks who want to cover all the bases must contend with many different mapping, documentation, and reporting tools.

One variety of tool marries CAD and database software to support the management of cabling and communications equipment. IsiCAD's Command 2000 and Network & Communication Technology's Planet are two of these. Both are DOS-based programs that use CAD techniques to depict the cables and network devices in your building; both relate the CAD drawings to databases (dBase and Btrieve, respectively). Once you've fed in the necessary information, you can trace circuits on-screen, calculate cable lengths, track the availability of hub ports, and produce bills of materials, maintenance reports, and leasing schedules.

IsiCAD's Unix-based offering, Command 5000, also features rule-based analysis of network designs—it can ensure, for example, that no thin Ethernet segment runs longer than 600 feet. There's just one problem with this class of software: The map is not the territory. If you rearrange your 10Base-T hubs and the stations connected to them, you'll have to redo the maps accordingly.

Self-Documenting Networks

Since a network is, after all, just a bunch of communicating devices, it's reasonable to suppose that you can make a network document itself. Many network monitoring products do just that. One flavor includes utilities such as Cheyenne's Monitrix, Dolphin's LAN Command, Fresh Technology Group's Net-Vision, Frye's NetWare Management,



LANSystem's LANSight, NetWave's LAN Track, and Thomas-Conrad's TXD (to name just a few).

These programs query workstations and/or servers in order to answer questions like these: Which version of the network software is running? Has any workstation failed to respond recently? How many packets has a workstation sent and received? How many sockets are open? What kind of load is a bridge carrying? How many errors and retransmissions have occurred? Is disk space low on the server?

I'll call these programs "soft" monitors, since they glean information from network operating software, in contrast to what I'll call "hard" monitors, such as Sniffer, LANprobe, Novell's Lantern, and Spider Systems' SpiderProbe, which watch raw cable traffic.

Some soft monitors can draw a map of the logical network, which you can then explore to see what's happening with particular nodes. Monitrix is one such program in the PC realm; AG Group's Net Watchman and Farallon's NetAtlas (included with the PhoneNET Manager's Pack) are two AppleTalk-monitoring programs that draw iconic maps of a Macintosh LAN's zones and nodes. Other soft monitors present text interfaces that you navigate to locate nodes of interest.

No matter how you access the information, however, the picture of the network that a soft monitor paints, though live, is often fleeting. Dolphin's LAN Command is one exception to this rule. With LAN Command (one of the few utilities in this class that works with Net-

BIOS LANs as well as with NetWare), you can build a permanent database that describes users, workstations, and network equipment; the monitoring software will store the statistics it gathers in that database.

Many hard monitors also do network mapping, and they, too, typically focus on real-time snapshots of networks. The Lantern Services Manager is a Windows 3.0 program that illustrates the network devices that Novell's Lantern, an Ethernet monitor, can find. Silicon Graphics' NetVisualizer exploits the graphics abilities of the Iris 4D workstation to create gloriously rich pictures of TCP/IP networks.

Wiring hubs are still another source of network maps. Many hub vendors, particularly those in the 10Base-T business, now routinely offer optional management modules. These are plug-in boards that watch and govern hub ports. The boards are typically driven by Windows or Presentation Manager programs that relate the statistics and controls exported by the management hardware to network maps. In some cases (e.g., BICC Communications' Isoview and NetWorth's EtherManager), these programs also come with databases and can perform asset management.

Only when you enter the rarified sphere of enterprise network management, though, do you begin to see signs of the Holy Grail. Cabletron's Spectrum and HP's OpenView, two of the most advanced platforms for building applications that control multivendor, multi-protocol networks, use object-oriented databases to coordinate open-ended

suites of management applications. Ungermann-Bass's NetDirector, which primarily targets LAN Manager networks, uses SQL Server as its management repository.

The applications that run on these platforms today focus on classic physical-layer network management: visualizing topologies, monitoring throughput, and detecting faults. But the platforms themselves incorporate data repositories and

Net Watchman monitors zones, nodes, and services available on AppleTalk networks. It can notify you when a service stops working, so you needn't wait for users to report problems.

aim to enfold a much wider range of management tools. Monitors operating in such environments will not just pump information into a repository. They will also help to automate the creation and maintenance of the

repository itself.

Managing Hardware, Software, and Human Assets

An increasingly prevalent breed of management tools automatically discovers and records the hardware (and possibly software) assets located at network-connected workstations. PC-oriented examples include Brightwork's LAN Automatic Inventory, Connect Computer's Lanscope Resource Manager, Horizons Technology's LANAuditor, LANSystems' LANSight, and Magee's Network H.Q. Macintosh asset managers include CSG Technologies' Network Supervisor and Pharos's StatusMac.

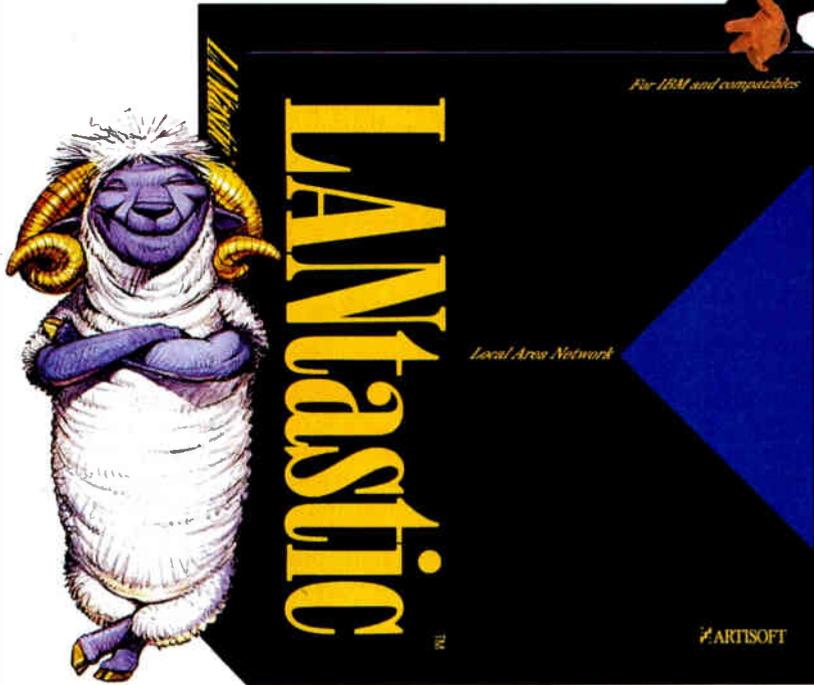
If you've ever had to perform an inventory of computer equipment, you'll know why these products make sense. Manual inventories of hard disk drives, RAM cards, video adapters, and coprocessors can't keep up with the restless, nomadic existence these gadgets lead in many organizations. But the wire through which workstations communicate can also tether them to administrative control.

In the PC realm, these programs gather the same sorts of information as do programs like Dariana's System Sleuth: DOS version and BIOS signature; processor and coprocessor flavors; conventional, EMS, and extended memory; floppy and hard disk drive types and capacities; and video adapter type. Many of these programs, like soft network monitors, will also report the target machine's network shell version and adapter type. Other kinds of expansion boards remain hidden from view on ISA machines, although fuller disclosure may

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Dennis' clientele are people more interested in being experts in their own fields rather than having to become—or hire—experts in an overcomplicated network. They are doctors, lawyers and industrial specialists like a large communications tower producer, a bearing manufacturer and a plastics firm that makes showers and tubs.

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be possible if the workstation has an EISA or Micro Channel bus. Software assets recorded are typically just the AUTOEXEC.BAT and CONFIG.SYS files—critical components that need to be exposed to network administrators.

Some of these programs were developed in hand with remote-control software, such as LANSight and LAN Automatic Inventory. As such, they require TSRs but enable managers to commandeer workstations for remote diagnosis or training. Other programs, like LANAuditor and Network H.Q., specialize in asset management. They run at log-in time, update a database, and then disappear.

Mac asset managers such as Network Supervisor and StatusMac report on Finder, MultiFinder, QuickDraw, and AppleShare versions, Apple Desktop Bus and SCSI devices, and NuBus boards. They're also more aggressive than their PC cousins about cataloging software assets—a task made easier, of course, by well-defined resources embedded within INITs, desk accessories, and regular Mac applications. Because these utilities supply so much information, CSG and Pharos like to point out that they're useful not only for tracking inventory, but also for spotting obstacles to a smooth transition to System 7.0.

Possible obstacles include incompatible INITs, printer drivers, or applications, and Macs in need of memory upgrades or paged memory management units. Pharos tackles the System 7.0 transition in an interesting way. Included with StatusMac is a utility that runs Apple's System 7.0 compatibility checker (a HyperCard stack) against an entire StatusMac database. Those of us responsible for the transition to DOS 5.0 and Windows 3.0 on PC networks can only hope that tools like these will show up in our world soon.

You don't need to be a bean counter to get excited about where this kind of approach might lead. In the realm of physical-layer network management, the most advanced protocol analyzers use rule-based reasoning to ferret out problems and suggest solutions. The same techniques need to be applied to the diagnosis and cure of the myriad software conflicts and configuration errors that can eat up so much of a network manager's day.

Is the misuse of a DOS memory manager a network management issue? Yes, if it prevents someone from accessing the corporate database. Reliable networks can't have weak links. Network management can no longer focus solely on the health of wiring, hubs, bridges, and rou-

ters. The discipline must equally encompass workstations, applications, and users.

Products that enfold users in a network management scheme include Brightwork's LAN Support Center and Blue Lance's LT Helpdesk. Both of these products help network managers organize users' anecdotal problem reports, spot patterns that indicate hardware or

Everyone in the networking business agrees that we'll use fewer, more comprehensive tools to manage tomorrow's networks.

software troubles, and document the fixes. Users are, after all, a valuable source of information about the network's health. Their input, just like the data that software and hardware probes crank out, should be fed into the management repository.

Tool Synergy

Today's soft and hard monitors, asset managers, and user-support systems—even when offered by the same vendor—typically maintain independent, single-purpose databases and don't talk to each other. But the boundaries that separate these classes of products are rapidly eroding. Toolmakers see that network management really is a holistic endeavor. Frye's NetWare Early Warning System (NEWS) represents one of the first concrete examples of what's sure to become a major trend: monitors that can not only spot trouble, but also take action to avert it.

Like many of the soft monitors that watch NetWare servers, NEWS deploys a value-added process (VAP) or NetWare loadable module (NLM) at the server that ships status information to a DOS monitoring console. When a monitored parameter crosses a specified threshold (say, for example, the number of directory entries drops below 500), NEWS can E-mail, fax, or phone an alert to the responsible administrator. That sounds great, until you imagine your NetWare

server calling you at home in the middle of the night.

What administrators really want—and what NEWS provides—is the ability to empower the network to *do something* about the problem it's detected. What power does the NEWS console wield? For each alarm, it can dispatch a responding DOS batch file or program. If directory entries are scarce, for example, you might arrange to launch a scavenger that deletes expendable files.

Many tool vendors say they're moving in this direction. AG Group's Net Watchman, for example, currently monitors AppleTalk networks and sends out alerts when zones, nodes, bridges, or services (e.g., E-mail and printing) head south. Responding to such an alert, a network manager might want to launch one of AG Group's protocol analyzers—LocalPeek or EtherPeek—in order to, for example, test the hypothesis that a mixture of Phase 1 and Phase 2 AppleTalk protocols caused the problem.

Why not have Net Watchman automatically wake up the analyzer and have it start capturing data immediately, so the trail won't be cold when the network manager arrives? That's just what AG Group plans to do, by integrating its tool set with System 7.0's Apple events.

In principle, any networked service—database server, uninterruptible power supply, tape backup system, mail server—should export status information and present a standard control interface. It would be convenient to be able to manage all network services from a single console. More important, such an arrangement would pave the way for automating the management of services and for intelligently allocating the resources that they require.

The ultimate flowering of this strategy—manageable services controlled by a network manager (or a managing application)—will require a common framework. Some vendors of network utilities are rolling their own. Others prefer to wait for emerging network management standards such as SNMP and the OSI Common Management Information Protocol (CMIP) to crystallize.

SNMP, in particular, has gained widespread support among vendors of network adapters, hubs, bridges, and routers. There is no reason why other kinds of network entities—including software services—can't define Management Information Base extensions that provide a reporting and control interface to SNMP managers able to digest the extensions. High-end management platforms like Cabletron's Spectrum, HP's

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OpenView, and Sun's SunNet Manager are all capable of incorporating MIB extensions and thereby monitoring and controlling all kinds of SNMP objects.

Storage Management

Backing up shared disks is one of the classic chores of network management. Traditionally, it's been a boring subject, but recent advances in tape backup devices and software have livened things up quite a bit. As the digital audiotape, Exabyte, and quarter-inch cartridge camps vie for supremacy, tape drive capacities soar and prices plummet. Meanwhile, innovative software products are changing the role that these backup devices play in networked environments. Palindrome's justly acclaimed The Network Archivist (TNA) makes the relationship between primary hard disk storage and secondary tape or optical storage into something akin to the relationship between cache memory and main memory.

With TNA, a dormant file can migrate automatically to tape. In other words, if TNA knows that the file is safely preserved on three separate tapes, and if it sees that no one has accessed the file for

12 weeks (or some other period that you specify), it will (with your permission) delete the file. TNA can leave a zero-length phantom file in place of the emigrated file. If you try to access a phantom file, and if you're running the Palindrome TSR that detects such attempts, the TSR tells you the file's on tape and shows you the command you'll need to recall it.

Clearly, this implementation of tiered storage could improve; it would be nice if immigration were as transparent as emigration. The concept of tiered storage is absolutely sound, however, even if today's file systems and typical off-line storage devices can't support its perfect realization.

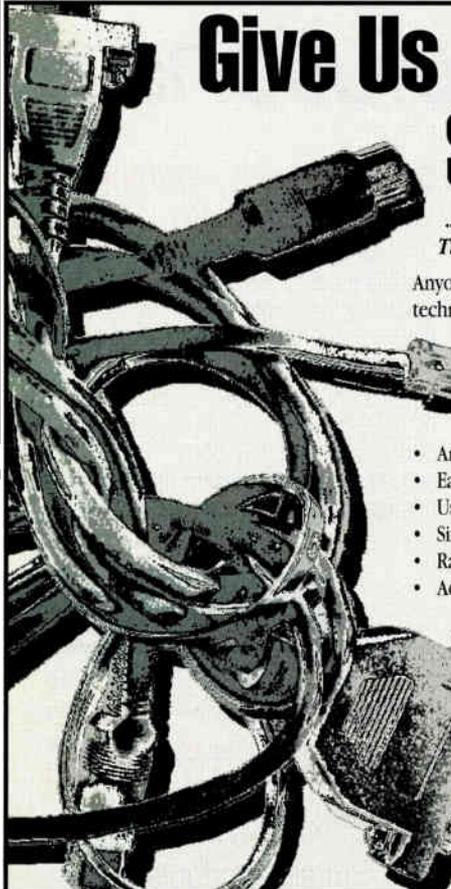
From a manager's perspective, TNA is a tremendous boon. File server space is always at a premium, but no one's got the time to weed out the junk. In most situations, the value of automatic migration far outweighs the occasional hassle of manual restoration. TNA's other great strength is that it frees you from having to plan and execute a tape-rotation scheme. Every time you run TNA, it prompts for the appropriate tape and also tells you

which tapes belong off-site. This simple idea has taken the industry by storm. The ugly truth about backup is that, unless it's a one-button no-brainer, it usually won't get done properly.

One of the reasons TNA isn't a no-button no-brainer is that it runs under DOS and doesn't come with a built-in scheduler. Cheyenne's ARCserve, which is sold separately and also bundled with drives from Gigatrend, Irwin, Tecmar, and others, exploits NetWare's queuing capabilities to schedule backup jobs. (Another benefit of ARCserve's VAP/NLM component is that it can communicate directly with a server-attached tape drive, so transfers from the server's disk to tape create no network traffic.) Sytron's Sytos Plus and Legato Systems' NetWorker use OS/2 and Unix, respectively, in a similar fashion.

While none of these products can yet match the disk-grooming and media-handling features of TNA, the more advanced operating systems supporting them make it easier to automate their use on nondedicated workstations.

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PRODUCT PERSPECTIVES

managing their local disks is rapidly becoming yet another centralized responsibility. And why not? An organization's pool of disks constitutes a single critical resource—its long-term memory. It's in everyone's interest to manage that resource as thoroughly, and as automatically, as possible.

With ARCserve, you can schedule workstation backups just as you schedule server backups. At the appointed hour, the server wakes up an agent TSR at the workstation, which then ships the data to the server and thence to tape. A variety of similar solutions exist for DOS-based LANs. Ultinet's Backman includes a workstation agent called Disk+ that communicates with Sytos Plus running on a LAN Manager server.

Several products (including, with release 2.0, TNA) use Fresh Technology's Map Assist to support peer-to-peer backups between any pair of workstations. Legato's NetWorker can reach out to Unix workstations or to DOS machines running PC-NFS. Mountain Network Solutions says that its Data Management Software, built on a portable communications kernel evolved from an alliance with PeerLogic, will by next year support peer-to-peer backups among DOS, Macintosh, and Unix systems.

For DOS-based LANs, the required TSR agent at each station complicates the task of networkwide storage management. Perhaps because Macintosh INITs are less troublesome, peer-to-peer backup solutions seem to be evolving more quickly in that environment. With Dantz Development's Retrospect Remote, the controlling station can not only back up networked Macintoshes but also restore files to them. Because the controlling station keeps a record of all users' archive sets, Retrospect Remote can save time and space by storing duplicate files just once on behalf of a group of users. Innovations such as these suggest that networked storage management will remain a hot topic in 1992.

Taking the Network's Pulse

Sometime in 1992, according to Forrester Research, network nodes connected through hubs will outnumber the nodes connected by way of unstructured wiring. Yet, while hubs virtually dominate new wiring installations, the large base of older wiring won't disappear anytime soon. These two topological classes, each including Ethernet, Token Ring, and ARCnet equipment, require different approaches to physical-layer management.

A hub is an ideal place to put an SNMP

agent that can monitor and (to varying degrees) control the ports to which workstations are attached. Leading hub vendors such as Cabletron and Synoptics have taken this tack for several years. Recently, though, it has been getting hard to find a 10Base-T concentrator that *doesn't* offer an optional SNMP-compliant management module.

The use of National Semiconductor's new DP83950 Repeater Interface Controller chip along with that company's Systems Oriented Network Interface Controller chip accounts in part for this trend. The RIC is a 12-port 10Base-T concentrator on a chip. Paired with a SONIC chip and integrated with a wiring concentrator, the RIC enables the concentrator to deliver per-port Ethernet statistics and thereby monitor traffic to and from all connected stations.

Traditional network monitors that attach to cable segments are also evolving into modules that plug into wiring hubs. For example, Cabletron's Multi Media Access Center, a "smart" hub that supports Ethernet, Token Ring, and Fiber Distributed Data Interface connections and can activate redundant paths to maintain fault-tolerant operation, accepts a modular version of Novell's Lantern monitor. The next logical step is to put analysis, as well as monitoring, in the hub. LattisNet's Network Control Engine, built around a SPARC processor that plugs into the LattisNet System 3000 multimedia hub, can run both monitoring and protocol analysis applications.

What if you're stuck with unstructured wiring? You won't be able to isolate or reroute devices, but there's still a need to monitor them. One approach is to use monitors/analyzers such as SpiderProbe/SpiderAnalyzer, Sniffer, LANprobe, or Digilog's LANVista 100. These products observe and characterize network traffic, sound alarms when systemic or node-specific errors occur, and decode protocols. Traditionally dispatched to troublesome segments only in response to network failures, they're now increasingly used as permanent distributed listening posts that continuously report to central consoles. That's an expensive ounce of prevention—typically on the order of \$5000 per segment—but more and more organizations critically dependent on their networks find that they can justify the cost.

Of course, not everyone can dedicate pricey hardware to network monitoring. An alternative is a software-only product such as FTP Software's LANWatch, which converts a DOS PC with a standard Ethernet or Token Ring adapter into

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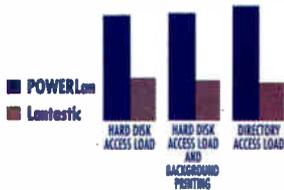
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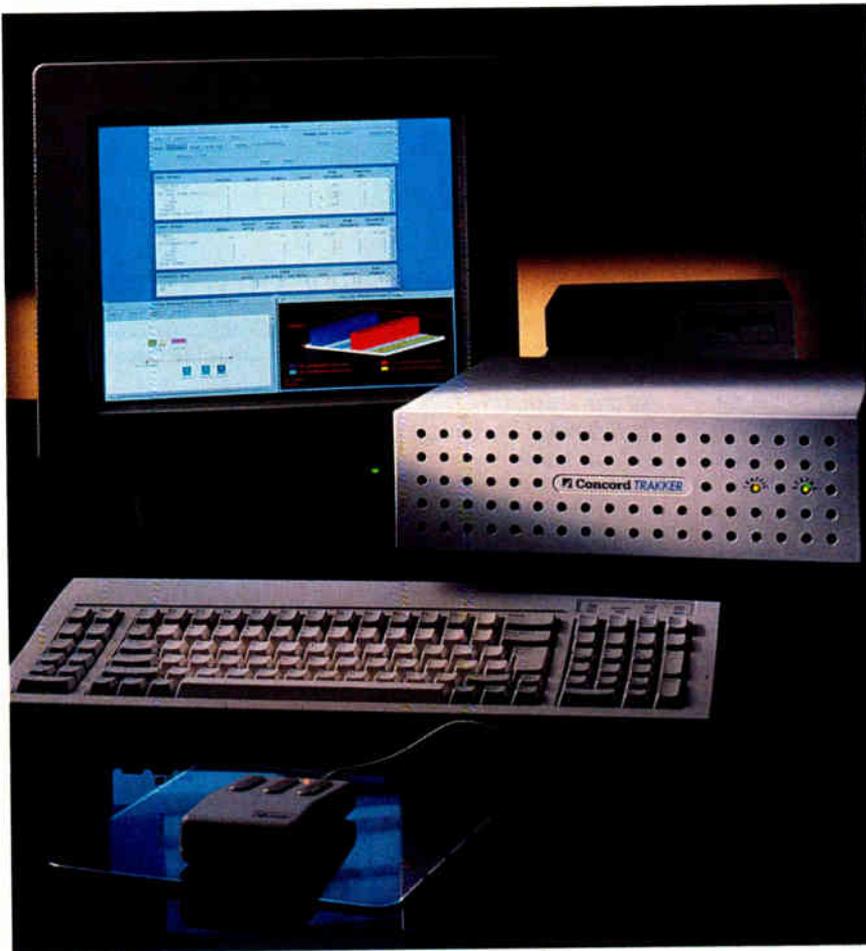
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Expert systems notwithstanding, the complex idiosyncrasies of networks will keep human experts in business for a long time to come. Analytical tools that can assist these experts are advancing on two fronts: toward continuous real-time monitoring and toward protocol analysis that fully comprehends the application-level semantics, of network communication. Concord's Trakker, introduced recently, represents both of these trends.

Trakker's segment monitors incorporate 20-million-instruction-per-second RISC processors with up to 16 megabytes of RAM. Why so much horsepower? Concord says that the units decode "all protocol layers, all the time, in real time." (That's true, in the initial release, for TCP/IP, DECnet, and AppleTalk; decoding of NetWare and LAN Manager protocols stops at the link layer.) Because up-to-the-minute results of application-level protocol analysis are always present in the distributed monitors' buffers,

Trakker's dedicated segment monitors analyze network traffic in real time and report to a central management application based on Sun's SunNet Manager.

available for inspection from the SunNet Manager-based console, there's typically no need to re-create a problem in order to produce data for analysis.

Suppose, for example, that a cer-

tain mount request issued to a Network File System host fails, not because either the client or the server is at fault but because an intervening router is misconfigured. Trakker can instantly confirm that the client did issue a valid NFS mount request, that the server never saw that request, and that during the same period the server did receive and respond to NFS requests from other clients. Ruling out likely NFS problems in this way, an analyst could quickly proceed to isolate the faulty router.

Concord argues that abundant real-time data, coupled with application-layer analysis, helps the network manager see services, and interruptions of service, at a level of abstraction that's appropriate for solving problems such as "BIX is broken." Which reminds me: BIX really is "broken" this morning, and I've got to go find out why. Let's hope things get simpler next year. ■

Jon Udell, a BYTE senior technical editor at large, manages the BYTE editorial LAN. You can contact him on BIX as "judell."

an inexpensive traffic monitor and protocol analyzer.

Another approach to monitoring unstructured Ethernet networks locates intelligence at the nodes themselves. Cabletron offers an SNMP agent (in the form of a TSR) for its own network cards and also for Western Digital and 3Com adapters. The agent can transmit status and throughput data to Cabletron's (or other SNMP-aware) management applications. Racal-InterLan's Roll Call takes a similar tack. SNMP agents running as TSRs ship data to a Racal-InterLan NP600 board located in a NetWare server, which in turn processes the statistics and communicates with a Windows-based management station.

IBM and 3Com also have a proposal for running CMIP on a pared-down protocol stack that DOS PCs could accommodate. Called the Heterogeneous LAN Management specification, it has attracted attention, but no adherents to date.

Diagnosis and Treatment

Networks are proliferating much faster than are folks who can make effective

use of protocol analyzers. Like a software debugger, an analyzer requires you to build up a mental model of the operation of a complex system and then generate and test hypotheses about its behavior. Emerging now are smarter analyzers that incorporate such models and test hypotheses on their own.

HP touts its Network Advisor as one of this new breed. A typical session with Network Advisor, according to HP, may go something like this: Network Advisor's Fault Finder software detects an Address Resolution Protocol broadcast storm, conducts an experiment to locate the station whose misconfigured IP broadcast address caused the storm, and then recommends how to reconfigure the offending station.

Cabletron's enterprise management system, Spectrum, hinges on what the company calls *inductive modeling*. The system incorporates models of all Spectrum-supported network components (hardware and software) and troubleshoots by comparing observed network behaviors with those predicted by the models.

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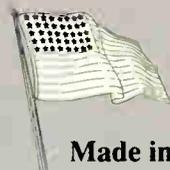
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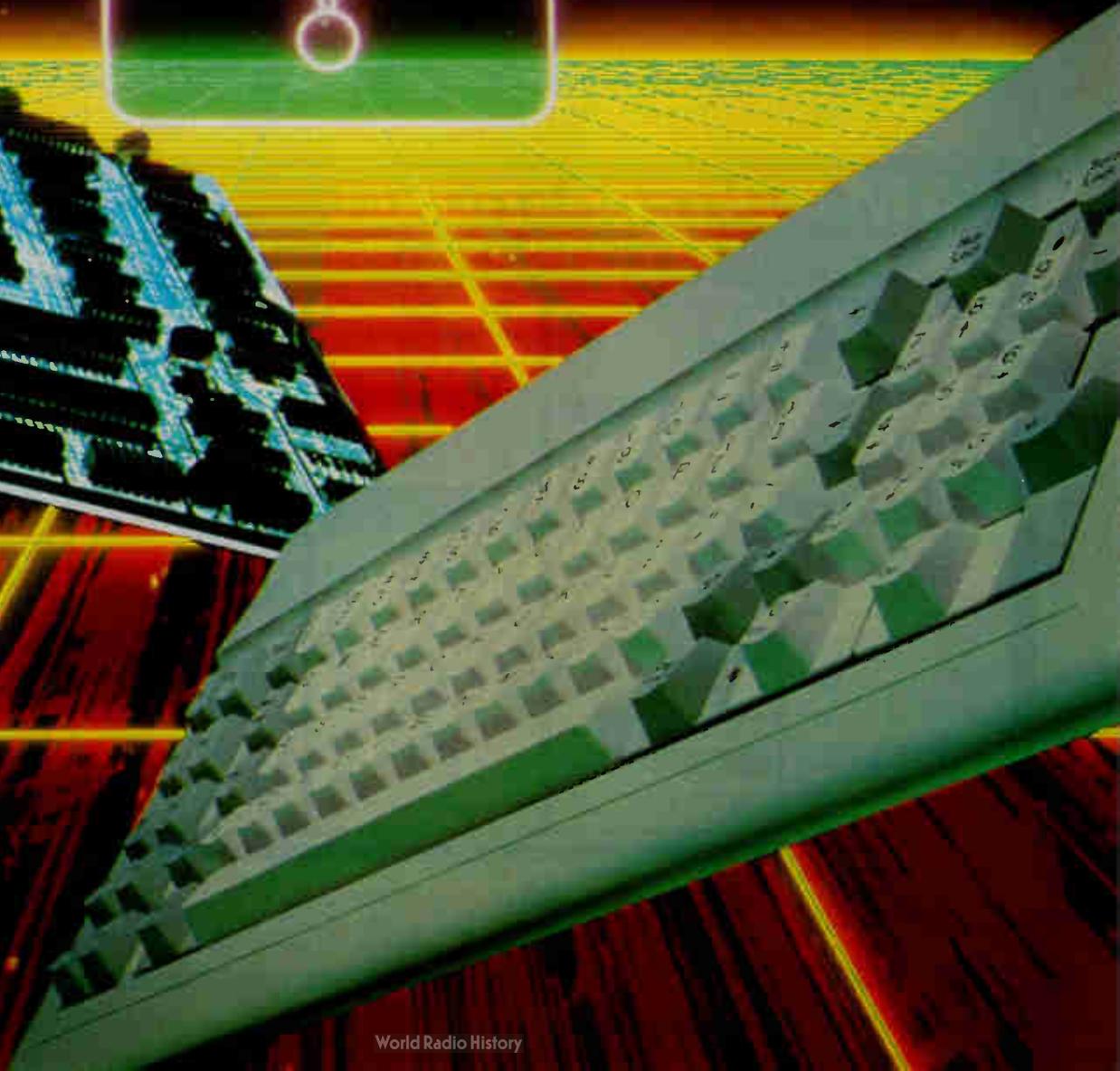
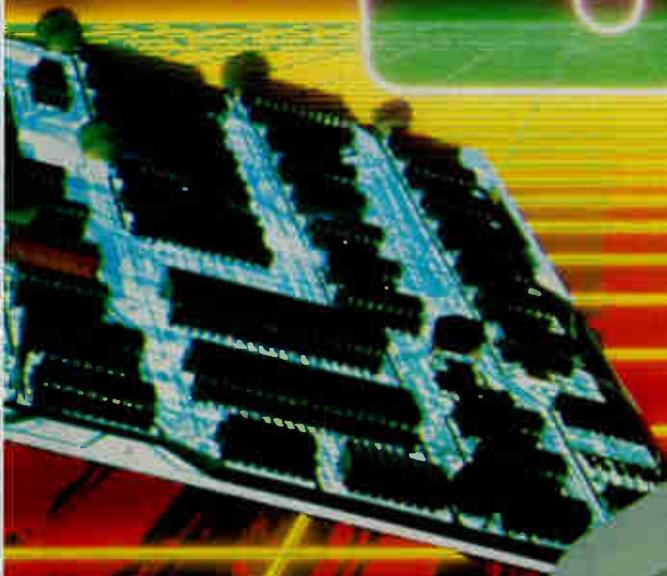
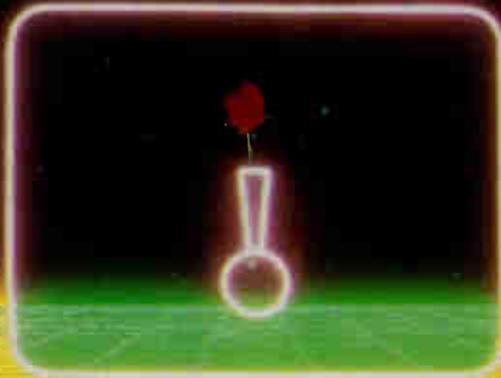
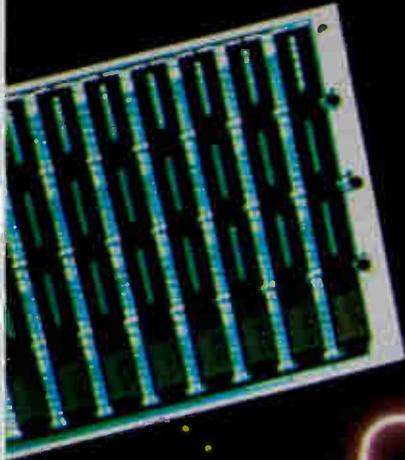
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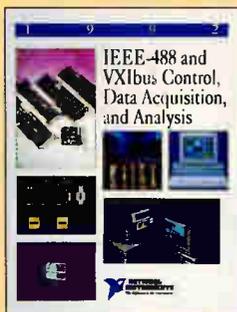
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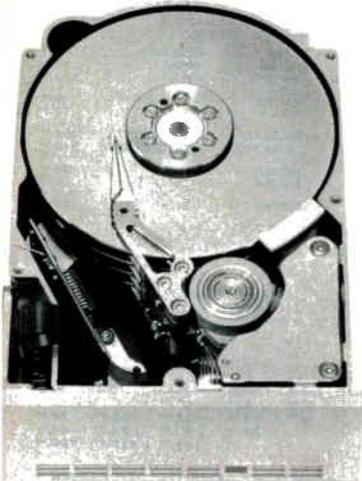
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DESKPRO 386/16	4MB BOARD	115144-001	149.00
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PORTABLE III	512K KIT	107331-001	39.00
PORTABLE III	INTFC BD	107808-001	149.00
PORTABLE III	EXP BD	107811-001	199.00
PORTABLE III	2MB KIT	110732-001	129.00
PORTABLE III	1MB MODULE	110733-001	159.00
PORTABLE III	4MB MODULE	110237-001	499.00
PORTABLE III	1MB BOARD	117081-001	129.00
PORTABLE III	2MB BOARD	117081-002	179.00
PORTABLE III	1MB KIT	107651-001	89.00
PORTABLE III	INTFC BD	107707-001	89.00
PORTABLE III	4MB BOARD	107653-001	499.00
PORTABLE III	4MB EXT BRD	107654-001	179.00
PORTABLE III	1MB MODULE	108303-001	179.00
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DESCRIPTION	150NS	120NS	100NS	80NS	70NS
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64X4	1.95	2.25	2.45	3.95	
256X1	1.35	1.45	1.65	1.85	2.95
256X4		3.95	4.45	4.95	5.45
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PORTABLE 2000SX	2MB BD	PC14-PAB312U	249.00
PORTABLE T1200XE	2MB BD	PC13-PAB306U	169.00
PORTABLE T1600	2MB BD	PC8-PAB302U	159.00
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PORTABLE T3100SX	2MB BD	PC15-PAB308U	159.00
PORTABLE T3100SX	4MB BD	PC15-PAB310U	299.00
PORTABLE T3200	3MB BD	PC6-PA7137U	249.00
PORTABLE T3200SX	2MB KIT	PC12-PAB307U	159.00
PORTABLE T3200SX	4MB KIT	PC12-PAB309U	299.00
PORTABLE T5100	2MB BD	PC7-PAB301U	169.00
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ZENITH MEMORY

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IBM PS/2 MODEL	1MB SIMM	6450603	59.00
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IBM PS/2 MODEL	2MB SIMM	6450604	99.00
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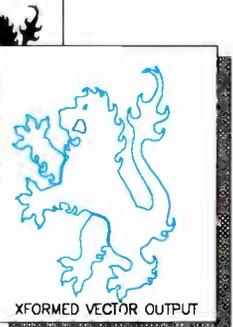
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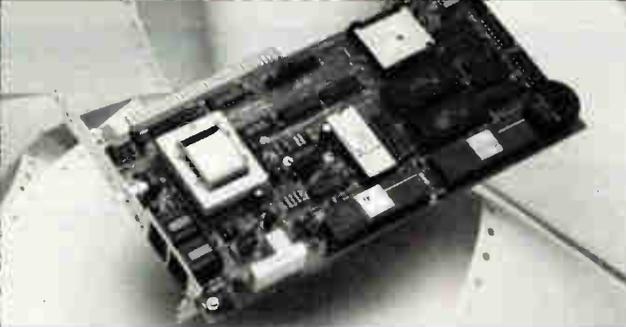
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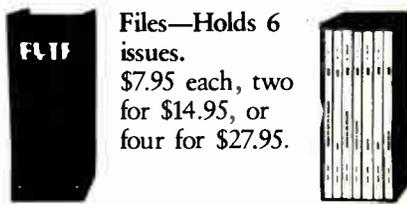
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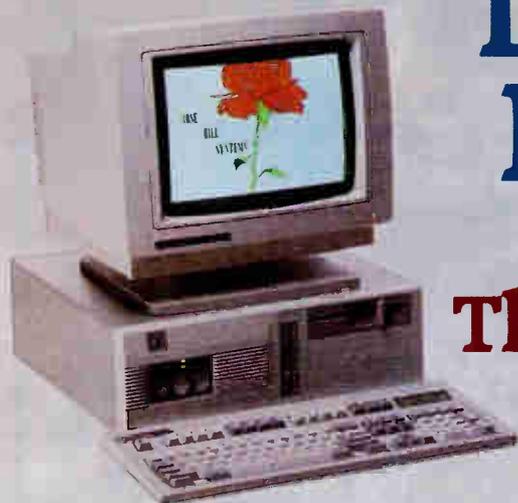
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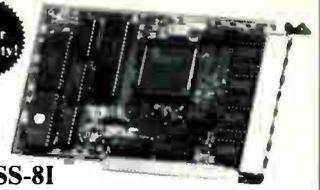
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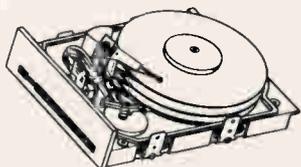


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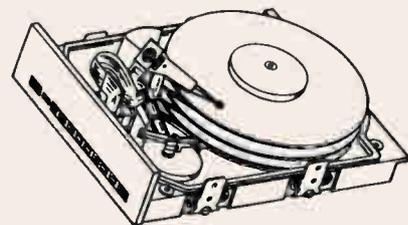
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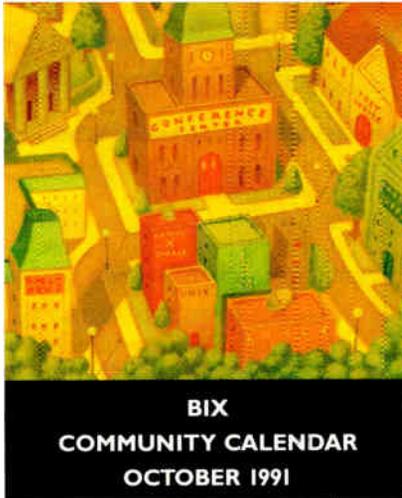
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amiga.arts	Artistry using the Amiga
amiga.int	Developing for the international Amiga
amiga.special	Special guests and events
amiga.dev	Commodore's conference for developers

■ IBM Exchange

Barry Nance, Exchange Editor

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ibm.at	The AT series and workalikes
ibm.ps	The PS/2 series
ibm.os2	OS/2 operating system
ibm.dos	PC/DOS & MS/DOS operating systems
ibm.os.386	Alternative 386 operating systems
ibm.utils	Utility software for IBM computers
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ibm.exchange	IBM Exchange clearinghouse
ibm.listings	Index to program files in the Exchange
ibm.other	Apps, printers, modems, etc.
microsoft	Products from Microsoft

■ Programmers' Exchange

Bill Nicholls, Exchange Editor

ada	The Ada language conference
ai.theory	Artificial intelligence and expert system theory
assembler	Assembly language
basic	Your BASIC conference
c.language	C programming language
c.plus.plus	Discuss the C++ programming language
cad	Computer-aided design
cpm	CP/M conference
editors	The Programming Editors Conference
forth	FORTH programming
fortran	FORTRAN language conference
games	Game programming and design
graphic.pgms	Programming and graphics
hypertext	Hypertext publishing
lisp	LISP language conference
modula.2	Modula-2 language conference
neural.nets	Neural Networks

ood	Object-oriented development conference
os.9	OS-9 conference
pascal	Pascal language conference
pick	The PICK operating system
postscript	Postscript
smalltalk	Smalltalk language conference
soft.eng	Efficient and reliable software design
telecomm.pgms	Telecommunications programs
unix	The UNIX conference

■ Macintosh Exchange

Dr. Larry Loeb, Exchange Editor

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mac.business	Macs in the office
mac.desktop	Publishing with a Mac
mac.external	Information from all over
mac.hack	Technical information about the Mac
mac.hypercard	Using the HyperCard programming environment
mac.news	Up-to-the-minute information
mac.novice	For beginners
mac.products	Listings of new hardware and software
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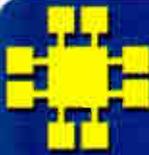
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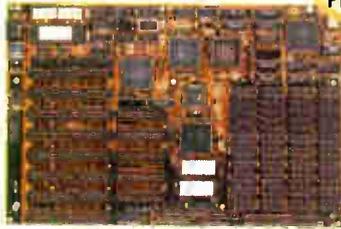
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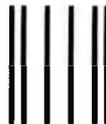
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3 Administration/Management
4 Sales/Marketing
5 Engineer/Scientist
6 Other

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
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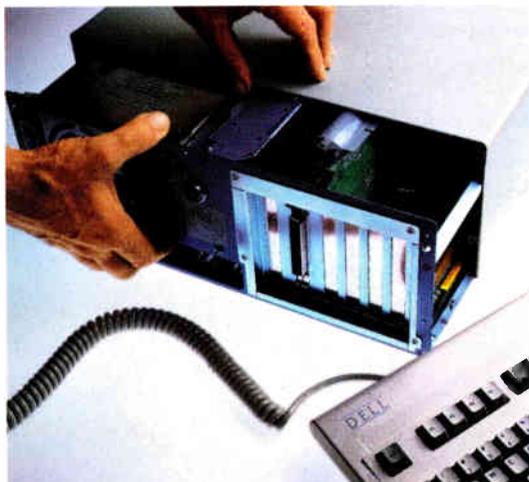
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