SETTING THE STANDARDS
15
YEARS

Lab Tests: The First 33-MHz 486s PAGE 131

BYTE

MAY 1990 A McGRAW-HILL PUBLICATION

Mainstream Amiga

New Amiga 3000: Mac II power, multitasking, multimedia . . . at a Commodore price

Desktop Supercomputing

Техника PAGE 262

New Battery Technology for Laptops

Smoother VGA

Inside Tape Backup Systems

REVIEWS

4 386SX Laptops
5 New Trackballs
7 Updated TIGA Boards
Opus Desktop Tower

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MAY 1990 BYTE SQL SERVERS • AMIGA 3000 • GLOBAL TEXT DISPLAYS Volume 15, Number 5

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PC MAGAZINE EDITOR'S CHOICE 2·14·89

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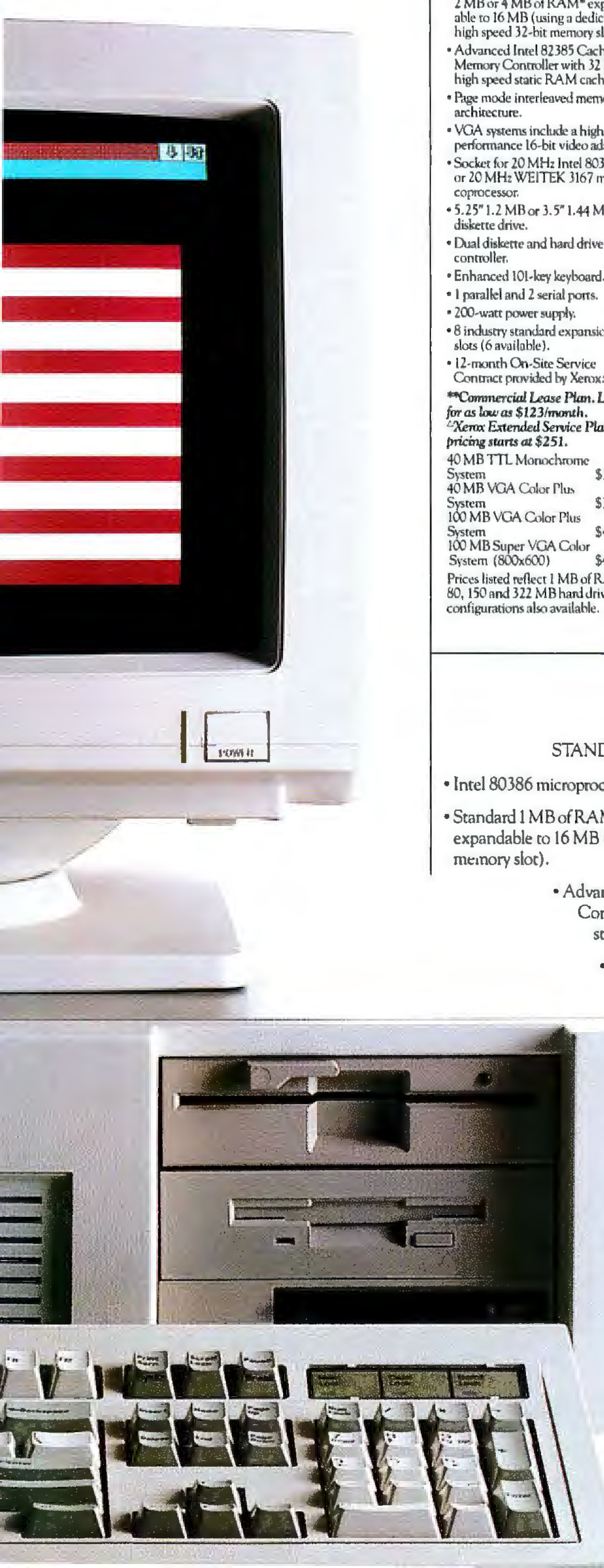

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PC MAGAZINE EDITORS' CHOICE

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- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- Socket for 25 MHz Intel 80387 or 25 MHz WEITEK 3167 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 8 industry standard expansion slots (6 available).
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Prices listed reflect 1 MB of RAM. 80, 150 and 322 MB hard drive configurations also available.

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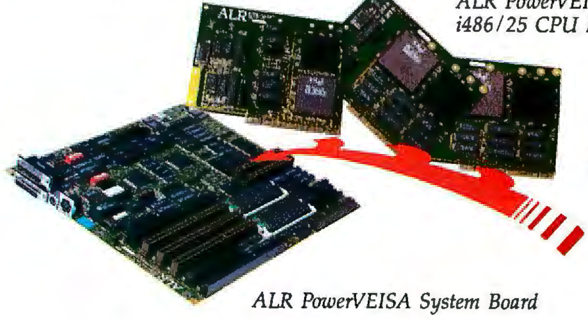

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EXPERT ADVICE

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S P O T L I G H T

Desktop Supercomputers and Техника

Two researchers discover supercomputer power that's free for the taking, and we discover a staff member's hidden past

Dave Gelernter and Jim Philbin have a radical mission: They want to make parallel programming as easy as conventional programming. They believe that with Linda—a "coordinating language" that can provide parallel-processing capabilities to any conventional language—they can accomplish their goal.

Dave Gelernter conceived of Linda while he was a graduate student at the State University of New York at Stonybrook in 1982. In fact, Linda formed the basis of his Ph.D. thesis. The reaction to Linda from the parallel-processing community was immediate and unanimous. Says Gelernter, "People thought it was elegant and beautiful, and that it was totally unimplementable."

By the mid-1980s, that unanimity of opinion was shattered. "In late 1985, the first paper describing an actual Linda implementation appeared," says Gelernter, "and people were shocked."

After that, says Gelernter, Linda polarized the parallel-processing community. As he puts it, Linda advocates are arrayed against a host of "navel-gazing computer scientists out of touch with reality." Behind the humor lies the core premise of Linda. As Jim Philbin puts it, "You shouldn't need a Ph.D. to write a parallel program."

The reason behind the controversy is that Linda consists of just six statements, and yet can add parallel processing to any conventional language. "Most people in academia think you have to create parallel languages from scratch," says Gelernter. "Linda lets you use the language you're used to."

Gelernter and Philbin are betting that Linda will make a big splash in the commercial world. In the near term, that means Hypercomputer Linda and new C-Linda implementations for machines such as the Intel and NCube hypercubes. It also means new versions, such as Ada-Linda and C++ Linda.

Both Gelernter and Philbin foresee a bright future, for Linda and for parallel processing in general. Gelernter sees a future where not only parallel processing, but also distributed databases and distributed processing using heterogeneous machines, will become much more widespread and important. Linda can handle all these things. As Gelernter puts it, "It's a boom time for the Linda business."

For more on Linda, see the article "Spending Your Free Time" by David Gelernter and James F. Philbin. It begins on page 213 of this issue.

Every once in a while, we discover something interesting that we hadn't known about one of our staff members. For example, our features editor recently decided to do an article about the problems involved with computing in non-roman languages (those that have different alphabets and writing styles from English). On checking with the staff, he found that technical editor Ben Smith had once been involved in a lengthy project to create an Arabic computer system. Ben is also the only person we know who "just happens" to have Cyrillic fonts on his home Macintosh. Indeed, Ben is *very* familiar with the issues involved in non-roman computing—probably more familiar than he ever wanted to be.

Ben's article in this issue, "Around the World in Text Displays," explores the challenges of computing in Cyrillic, Hebrew, Arabic, Chinese, and Japanese, and how the tasks are handled differently on a PC compatible and on a Macintosh. ■

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What's more, these products are based on the Microsoft Windows environment, an approach that's not only inherently easy to use, but rapidly becoming the industry standard.

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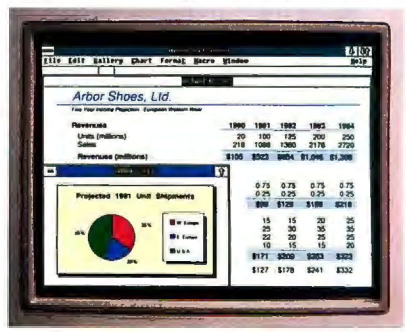

Beyond sharing the same overall physical appearance, these applications also share similar commands. So when you've mastered one, you'll have a solid understanding of the other as well.

And surprisingly, using Microsoft Excel and Word together requires very little brain power. All you need is a 286/386 computer with 2 megabytes of random access memory. Also known as RAM.

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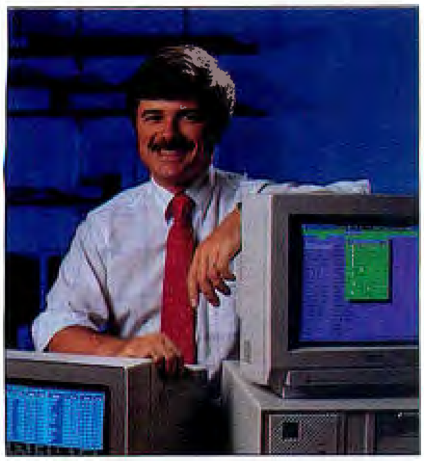

PAPERLESS FAX, AND AN INVITATION FOR YOU

A flood of faxes and BYTE's upcoming 15th anniversary prompt some questions

I like fax machines. I use them a great deal, especially when I need to send something in a hurry to someone without a computer or who doesn't telecommunicate; or when I need to see or send hand drawings, and so forth. Faxes can be an invaluable way to move data around.

But in many instances, faxing makes no sense at all. People seem to fax for the same reason that others climb Mount Everest: just because it's there.

Fax Abuse

Here's an example of fax abuse: Person X uses a computer to create a text message, prints a hard copy, and feeds the paper into a fax machine. At the other end of the line, Person Y's fax churns out more paper. Then, in order for Person Y to do anything useful with the faxed information, he or she (or an unlucky secretary) must expensively rekey the data back into a computer.

Because the information starts and ends inside a computer, the two paper copies and the manual rekeying are wasteful, redundant, and just plain unnecessary.

Plugging a fax board into your computer can help avoid some of the paper-based steps, but this carries other problems. For example, faxes are bit-mapped images, so they're real space hogs: A two-page fax memo can easily consume more than 200,000 bytes of bit-map disk space. And, because it is a bit map, you still have to read the fax image off your screen and separately rekey the pertinent information by hand. What a waste.

Yes, there have been some promising advances involving fax boards and optical-character-recognition software, but we're not there yet. When bit map-to-ASCII software is more common and reliable, that two-page memo will occupy just 4K bytes of disk space, instead of 200K bytes.

A Dream Alternative

Now, imagine a reliable, paperless fax, a simple way to send normal documents in a compact form that can be piped directly into or out of your computer without wasting time or paper or disk space. The format would be standardized so that dissimilar computers (different hardware, different operating systems) still can work with it without hassles, letting anyone directly reuse data sent from anyone else in one step without any rekeying whatsoever.

This paperless faxing would be as convenient as regular faxing, and—let's pull out all the stops—it would also be dirt cheap. The hardware would start at well under $100, and paperless fax software would range from a few hundred dollars down to absolutely free. Paperless faxing obviously won't use any plain or expensive fax paper at all, and let's say that its telecommunications charges would be less than for standard faxing. Paperless fax users will win on every score.

OK, OK; you've figured it out. I'm talking about E-mail. Somehow, in all the hullabaloo about faxing, E-mail seems to have disappeared from some people's consciousness, and it's a shame.

Half the Cost

Take that standard 4000-character, two-page letter: If you fax it coast to coast during normal business hours, it will cost you about 50 cents to transmit—more or less, depending on the vagaries of your specific situation. If it's a paper memo sent to a paper-based fax machine, you'll also generate four pages of hard copy in the process, costing a few more cents. Or, if it's a bit-mapped fax, you will consume over 200,000 bytes of disk space.

Now E-mail the exact same text: It will cost less than half as much to send, about 20 cents. You'll generate no paper; if captured to disk, you'll use just 4K bytes of disk space. Best of all, the information will be in a format you can do something with, instantly, on your computer, with no expensive (labor-intensive) rekeying. That's right: It costs less than half as much, and yet it's even more useful.

Faxing has its place—it's become a vital link in business communication. But when you're sending ordinary text printouts, do yourself, your pocketbook, and your recipients a favor: Try E-mail.

An Invitation

This September will mark the record-setting 15th year of BYTE's publication, and the BYTE editors are busy assembling an extraordinary anniversary issue for you.

We'd like you to help us write this special issue. Share your views with a worldwide audience of over a million and a half sophisticated computer users! Drop us a note and tell us what you think the best and worst developments of the last 15 years have been. What do you want your computer to be able to do 5, 10, or 15 years from now? Where do you think all this technology should lead us over the next few years? How can the computer industry better meet your needs and the needs of your company? What new technologies would you like to see developed? Any computer-related subject is fair game; we want to hear from you!

We plan to edit the replies we receive and print the best in the September issue. Please send your thoughts to me at the address shown on the masthead or via MCI Mail or BIX mail. And what the heck—if you must, you can even fax it.

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

BORLAND INTRODUCES TURBO PASCAL 5.5 WITH OBJECTS

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Turbo Pascal,® the world-standard Pascal compiler, adds Object-Oriented Programming with our new version 5.5. We combined the simplicity of Apple's Object Pascal language with the power and efficiency of C++ to create Turbo Pascal 5.5, the object-oriented programming language for the rest of us.

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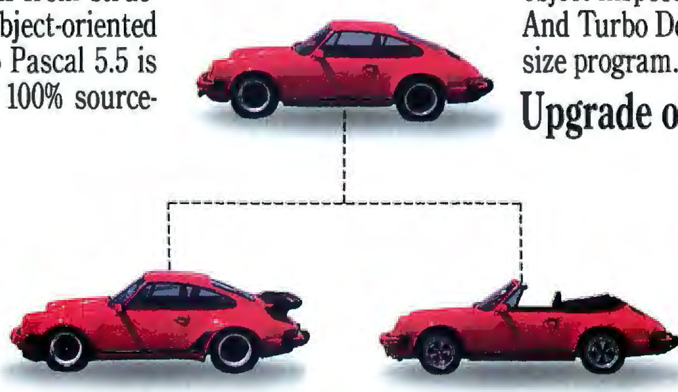
A fast object lesson

Object-oriented application programs more closely model the way you think. Objects contain both data and code. As in a spreadsheet cell, the value and the formula are together. Objects can *inherit* properties from other objects. For example, a Porsche Carrera inherits most attributes from the base model 911, but it also sports a whale tail.

Turbo Pascal 5.5's object-oriented extensions give you code that's easier to change, extend, and support.



Inheritance provides powerful modeling capabilities by allowing objects to inherit attributes from other objects.

Turbo Pascal 5.5 Professional with Turbo Debugger® and Turbo Assembler®

The award-winning Turbo Debugger now includes an object inspector and hierarchy browser. And Turbo Debugger can debug any size program.

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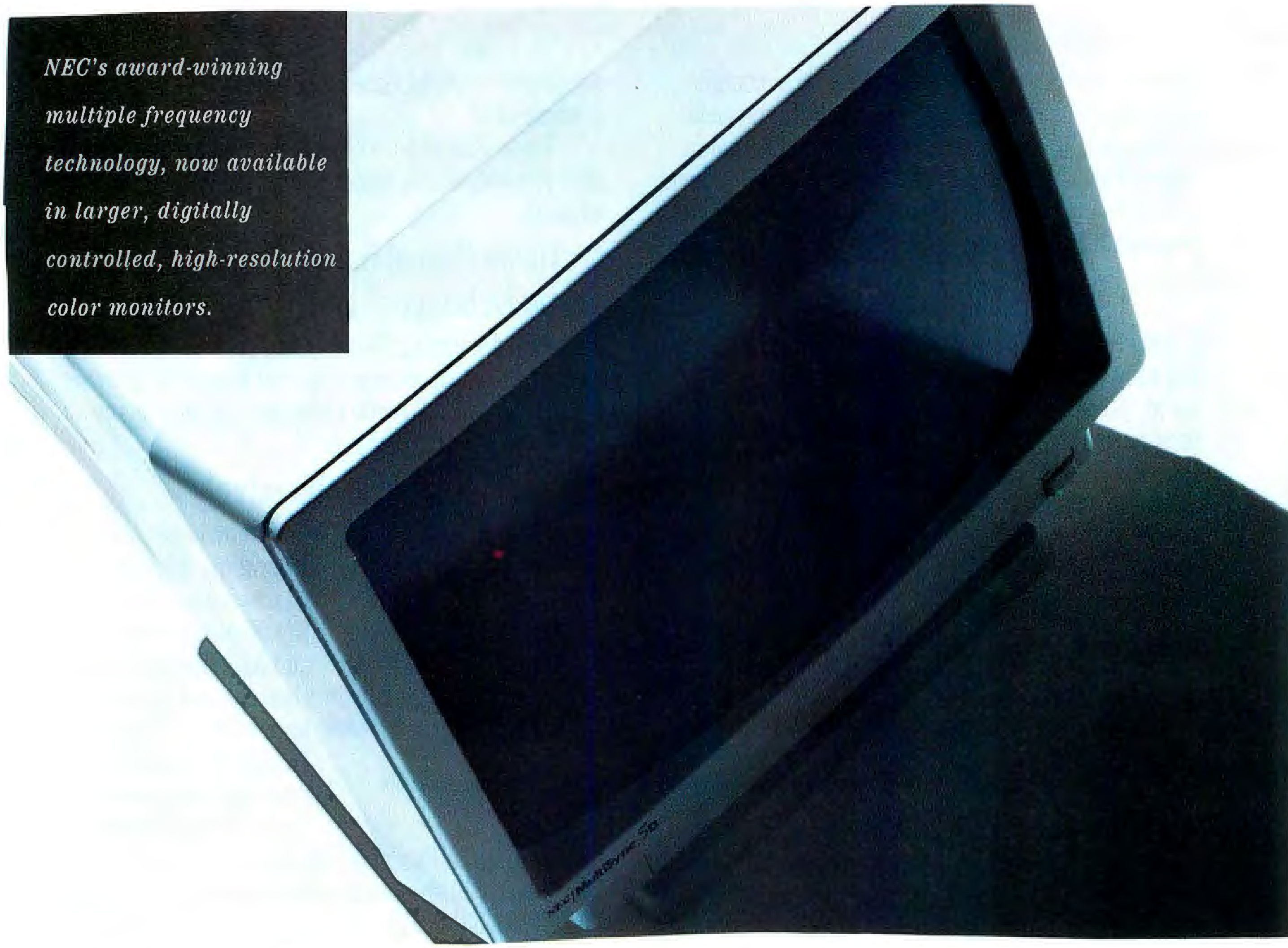

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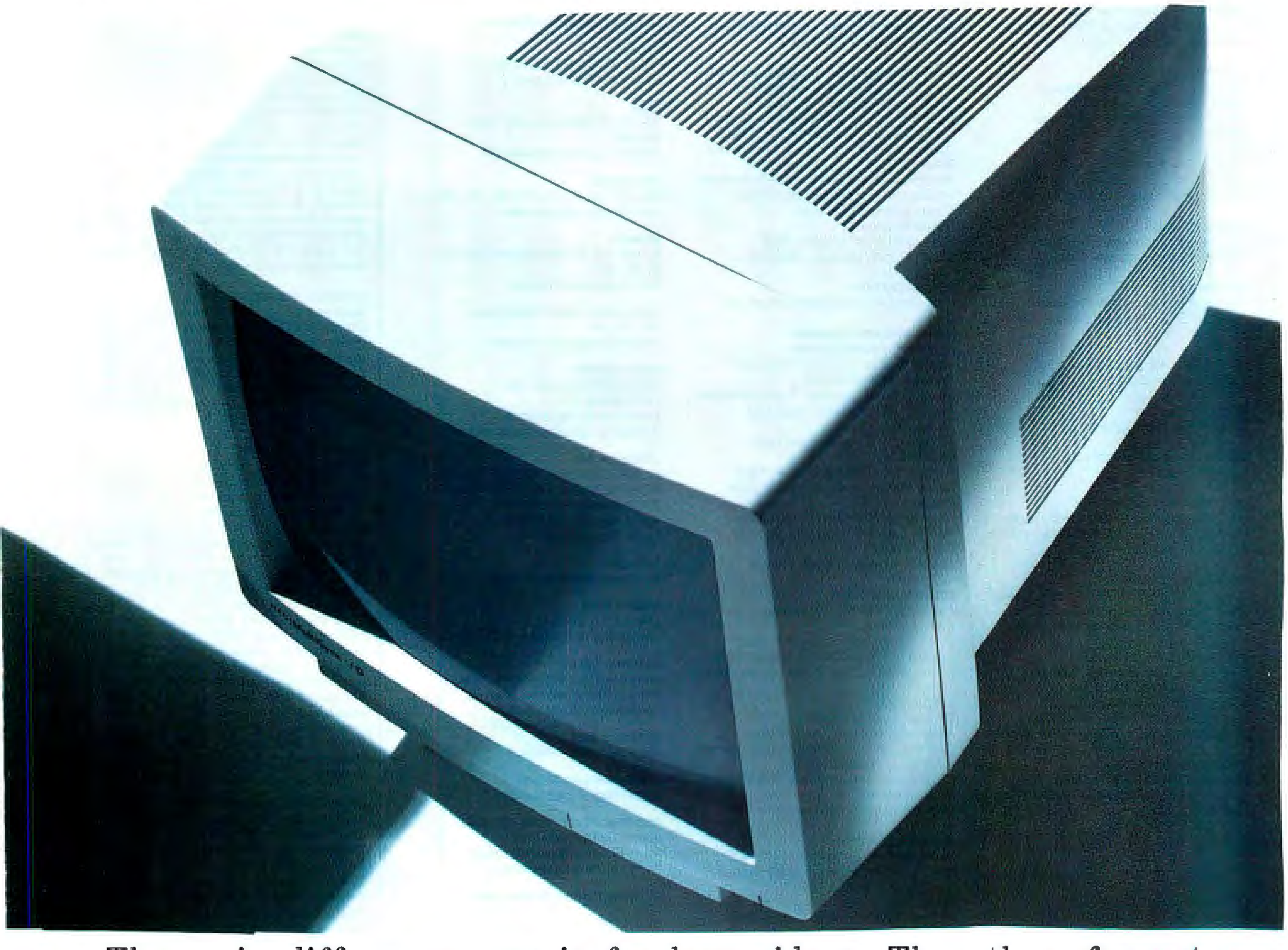

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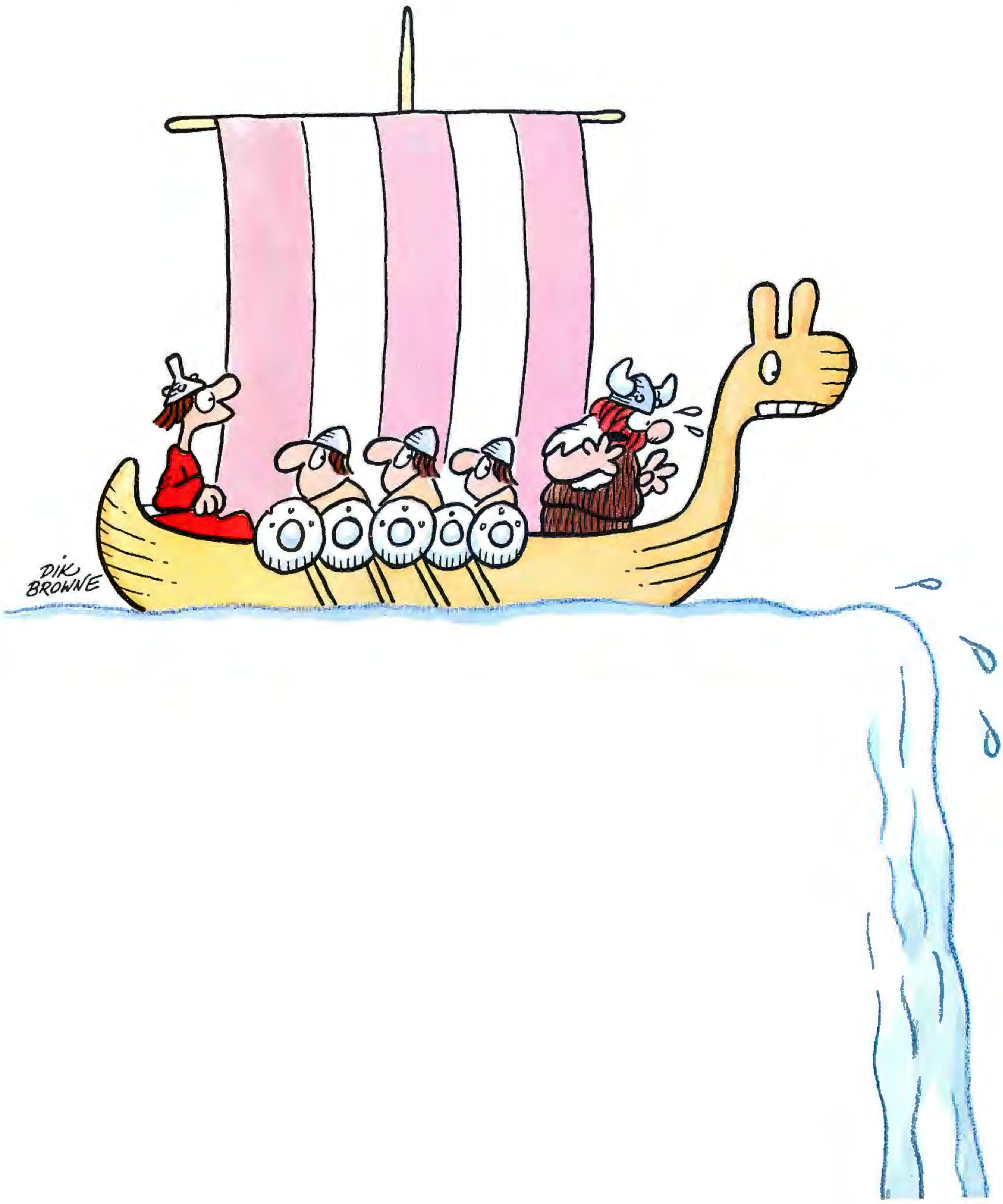

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MICROBYTES

Research news and industry developments shaping the world of desktop computing

Image Compression Chip Cuts Space and Time

In a development that could make graphics less of a hog when it comes to devouring computing resources, C-Cube Microsystems (San Jose, CA) has built a compression/decompression processor that can squeeze data, on the fly, by as much as 25 times. C-Cube, founded by former Weitek and Radius engineers, says that its custom VLSI processor can compress a 25-MB graphics image to 1 MB in 1 second or a 1-MB video frame in $\frac{1}{30}$ second, allowing for real-time compression of graphics images.

With this kind of compression power, the chip could significantly alleviate some of the processing and storage demands of such applications as multimedia, desktop video, and color desktop publishing. According to marketing manager Mauro Bonomi, there has been tremendous interest in the chip among manufacturers of computer equipment as well as makers of consumer electronics goods.

The single-chip CL550 uses the proposed Joint Photographic Experts Group (JPEG) standard compression algorithm, supported by IBM, DEC, and NEC. The basic compression technique involves discarding data in the graphics image describing frequencies that are invisible to the human eye. Thus, with compression ratios of 10 to 1 for screen images and 25 to 1 for print images, the difference in visual quality is hardly noticeable (although quality degrades progressively as the compression ratio is increased).

The advent of data compression processors as standard equipment in computers and devices such as digital cameras and VCRs has major implications for graphics technology. One of the big stumbling blocks to transferring and manipulating high-resolution color images or full-motion video is the sheer size of the data files required to store those images. In 24-bit color, an 8½- by 11-inch image at 300 dpi requires 25 MB of storage space. One second of full-motion video at 30 frames per second requires as much as 30 MB of storage. The ability to squeeze the graphics data by as much as a factor of 25 means faster transmission rates and much smaller memory, storage, and bus bandwidth requirements.

The CL550 will ship to OEM customers later this year. The 27-MHz version costs $155 in quantities of 10,000, while the 10-MHz version is $95 in quantities of 10,000.

C-Cube is now selling a software version of the JPEG compression algorithm, called the Compression Workshop, for the Mac II for $550. A 30-to-1 compression of a 30-MB image takes about 1 hour using the software algorithm on the 68030 processor of the Mac IIx. It takes 1 second on the CL550, C-Cube says.

—Nick Baran

TrueType vs. Adobe: A Royal Mess for Users?

Now that Microsoft and Apple have released more details about their outline font technology for creating smooth, scalable characters on screen and paper (formerly called Royal and now called TrueType), the advantages are still not obvious and are months away from being real.

Many users are asking if there is something "better" about TrueType that makes it functionally better than Adobe fonts. Looking at the Adobe Type 1 font format and the technical information available on TrueType, it's hard for users to see where either font design has a significant advantage over the other. Both use a set of points to describe the outline of a character. Both use "hints" (instructions that make characters look good, particularly at low resolution, such as on a monitor or impact printer), although they take different approaches. One apparent difference is that a portion of the TrueType hinting mechanism is

continued

NANOBYTES

TrueImage, Microsoft's page-description language that will include TrueType outline fonts, will first materialize in Apple laser printers. But Microsoft officials won't say exactly when. Even though the party line is "1990," one official told us that it could easily be **1991 before TrueImage printers are available**. Microsoft says that the TrueImage PostScript interpreter will be available "this year." It's based on the PostScript clone that Microsoft got when it acquired Bauer last year. If you want TrueType in your current LaserWriter, you'll be able to download it, according to Microsoft vice president Steve Ballmer.

IBM announced at Seybold Seminars '90 that it will support the **Adobe PostScript font format** on its operating systems that comply with the Systems Application Architecture: OS/2, OS/400, MVS, and VM. The company said that it based its decision "on a review of customer requirements and preferences." Having developed a tendency to bet on several horses, IBM said that it would also offer TrueType for OS/2. An Adobe representative at Seybold said that IBM's commitment to PostScript and Adobe font formats "is the clincher."

Albert Wong, the man who put the "A" in AST Research, is back with a new company that's offering memory-expansion boards for Compaq Deskpro computers. However, **Amkly Systems** (Irvine, CA) plans to offer a full-fledged desktop computer by the fourth quarter, Wong said. "We plan to include software and an interface that will make it easy to get started, things like radio buttons in a HyperCard stack," said a company official. The Amkly computer, according to people familiar with the machine, will be an EISA-based system.

NANOBYTES

Object-oriented programming was a popular topic at the recent Software Development '90 conference, judging by attendance at OOP seminars and the number of OOP products on display. (We saw demonstrations of several commercial applications created using SmallTalk, Actor, and Eiffel, but very few using C++.) In talking to programmers, one theme emerged: Most of them want to learn about OOP but haven't made the further step of using OOP techniques professionally. There is considerable concern about compatibility between different object-oriented languages and environments.

Evidence at the Software Development conference is that **OS/2 is arriving**. Most of the major compiler manufacturers, with the notable exception of Borland, now have compilers that produce OS/2 code. **Watcom**, **JPI**, and **Lattice** all announced new compilers supporting OS/2. Conference sessions and classes covering OS/2 programming were also mostly sold out. Realia, which makes Cobol tools, is planning an OS/2 Presentation Manager version of its compiler.

Jensen and Partners International (Mountain View, CA), best known for its TopSpeed programming tools, plans **new Pascal and C++ compilers** for release this summer. TopSpeed Pascal will use the same environment as the company's Modula-2 system and will be fully ISO-compatible. It will have object-oriented extensions, including multiple inheritance. JPI will package it with a translator facility to make the compiler compatible with Borland's Turbo Pascal, as well as library extensions to provide Microsoft compatibility. Other libraries will provide a full DOS/BIOS interface, extended graphics, support for Borland's graphic interface (BGI), and a text window manager and time-sliced scheduler. Details of the C++ compiler were sketchy, but it will be in the same mold as other TopSpeed compilers.

independent of the character's outline, and it generally takes more points to describe a TrueType character. TrueType characters and Type 1 characters (rendered with Adobe Type Manager) look equally nice on the screen.

Microsoft and Apple say that their approach is faster at rendering characters, and some type designers who have been working with TrueType support that claim. (In a demo given by Microsoft, beta TrueType was noticeably faster than Adobe Type Manager at putting a PageMaker document on the screen.) Regardless, neither type of font will be rendered often. The computer or printer will construct a bit map from the font format at the proper resolution and then cache it in memory, using these bit maps until the memory is required for a new typeface or a graphic. A small difference in speed between the Adobe and TrueType interpreters probably won't amount to much, since they won't have to do their jobs frequently. This problem might be more acute on a computer system where the interpreter is displaying typefaces on a computer screen, but a large RAM font cache can eliminate frequent reconstructions of bit maps.

Microsoft and Apple promised originally that their new outline fonts would be part of the Mac's System 7.0 and OS/2 2.0, both due later this year. Microsoft announced recently that TrueType will also be part of its Windows environment sometime this year—not in the "imminently coming" version (the legendary 3.0), but in what will probably be Windows 3.1, said Steve Ballmer, Microsoft vice president of system software. ("If not this year, then next," he said.)

Many of the good things that Microsoft and Apple claim about TrueType are of more benefit to type designers than to computer users who aren't typographers. They say that TrueType fonts are easier to develop; it's easier to convert fonts to the TrueType format than to Adobe Type 1 format; and because TrueType is similar to a low-level programming language, it's more flexible, and hence more appropriate for nonroman characters (kanji, in particular) than a high-level language like Adobe's. In a random sampling of people who work on PostScript fonts and rasterizers, we found many who agreed with the claims about TrueType. However, we also found many who said that they'll stick with the Adobe format because it's proven, it's established, and in some ways it's better.

But right now, all we can compare is something that exists—Adobe's PostScript fonts—against what Apple and Microsoft say will exist. What Apple and Microsoft have to do is deliver something that works—and works reliably. Microsoft's Ballmer agrees. "The most important thing is for us to show this stuff working across all the promised platforms," he said. "That's the whole point of personal computers: Things should just work."

—Tom Thompson and D. Barker

Apple Finally Gives Buyers a One-Year Warranty

It's not quite the Berlin Wall tumbling down, but for buyers of Apple hardware, it's a triumphant moment. Responding to the many critics of its service policies, Apple Computer (Cupertino, CA) has finally changed its warranty. The company announced that all Apple hardware products sold in the U.S. after January 1, 1990, will be covered by a one-year limited warranty. Until now, Apple's often-bashed warranty has covered 90 days. The new limited warranty also provides for U.S. customers to have service performed anywhere in the world. Apple dealers outside the U.S. already offer a one-year warranty.

Customers who bought Apple hardware in the U.S. prior to January 1, 1990, will get six months of AppleCare (Apple's program for out-of-warranty service) free if they contract (between March 19 and May 31) for six months of service.

The promotional price for a year of AppleCare for a Mac SE (with an internal 20-MB hard disk drive) is $162; for a Mac IIcx (with an internal 40-MB hard disk drive and a color monitor), the price is $246. Volume discounts of up to 25 percent are also available, depending on the number of Apple products covered.

Most retailers said that the new policy will help sell Apple equipment. One dealer said, "I've always had to

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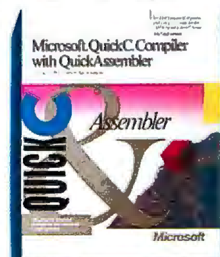

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At only 13.4 inches wide and 14.2 inches deep, microLaser may be the small kid on the block, but it packs plenty of punch. This printer takes full advantage of the advanced software that runs on your PC. That's because it uses the Adobe® PostScript printer language and is compatible with the HP LaserJet® Series II — allowing you to switch between them easily. With that kind of flexibility, the six-page-per-minute microLaser is ideal for word processing, spreadsheet and desktop publishing applications.

Because microLaser features the PostScript language, you can print fonts in a variety of type styles and sizes. Plus, you can print them tall-ways, long-ways, all kinds of ways. You can even print complex pages of integrated text and graphics.

Capabilities that grow as your needs grow.
One of the best things about microLaser is that you only buy what you need. So if you're not ready for PostScript language, you can buy the standard microLaser for less than $2,000 and add PostScript software and other powerful features later.

You can upgrade microLaser without tools or technicians by simply adding upgrade boards. These boards include up to four 1Mb increments of memory, serial and AppleTalk® interfaces and a PostScript interpreter. All you have to do to get additional fonts or emulations is plug optional microCartridges into two credit card-size slots.

Superior paper handling.
Part of what makes microLaser a truly personal desktop laser printer that takes up so little room is its paper drawer, which slides *inside.* Because microLaser holds 250 *sheets* standard (it holds 500 when you add an optional paper drawer), you spend less time refilling paper and more time creating superb-looking documents.

The printer also handles a variety of paper sizes and types — from letter, legal and executive to transparencies, labels and envelopes. For those times when you're facing a large mail merge task, just plug in an optional envelope feeder to easily alternate between letters and envelopes.

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Standard microLaser is HP LaserJet II-compatible, prints six pages per minute and comes with .5 Mb of RAM. microLaser PS has the same features as the standard microLaser, plus an Adobe PostScript interpreter with 35 typefaces and an extra 1 Mb of RAM.

Circle 312 on Reader Service Card

very carefully explain Apple's warranty terms to customers, but not until they have already decided on Apple equipment. If I do it sooner, they ask why it isn't longer than 90 days. But I must say that the 90-day warranty has always been a great reason to then sell AppleCare."

The warranty was just one item of good news for users. Apple cut suggested retail prices of the Mac SE and SE/30 by as much as 17 percent and similarly shaved prices of the LaserWriter IINT and IINTX. And as of March 1, the price of Apple's CD SC CD-ROM player is $899, 25 percent less than it used to be.

—Larry Loeb

Tools Will Give Windows a Role in Multimedia

If multimedia computing were a Hollywood movie, the Macintosh and the Amiga would be the stars, the De Niro and Streep. The IBM PC compatible would be the executive producer, running spreadsheets and taking care of unglamorous business chores.

But PC compatibles could grab a piece of the multimedia limelight this year, if developers come through with graphics, video, and audio tools for Microsoft Windows. Microsoft and other software vendors have now pledged to develop Windows-based tools for putting together multimedia presentations. These tools would be for recording, encoding, and editing audio; scanning, drawing, painting, and manipulating photos and graphics; capturing, editing, and digitizing motion video and animation; and editing and indexing text. Some of these packages are already working with the Mac, which suggests compatibility between Mac and Windows applications.

Microsoft has licensed MacroMind's multimedia playback software, Director, for use in a future version of Windows. Director 2.0 produces animation sequences for the Mac II in full color and with sound. The new Windows version (whose release date has not yet been announced) will be able to play back multimedia presentations prepared on the Macintosh. The same Macintosh files can be played through Windows, the companies said. (They recently demonstrated an IBM PC and Mac side by side playing Director 2.0 presentations.) MacroMind and Microsoft have agreed to explore additional cooperative efforts in related areas, including OS/2-based versions of animation run-time software.

"For multimedia to really take off, the industry needs a rich set of software tools from vendors across a wide range of disciplines," said Microsoft chairman Bill Gates.

Among the companies that are pledging to ship such tools for Windows-based applications by the end of this year are Asymetrix, Autodesk, Corel Systems, Electronic Arts, Farallon Computing, Zsoft, Meridian Data, and Micrografx.

—David Reed

Will This Be The Year of the Wireless LAN?

We've been hearing for years about "The Year of the LAN." But at the recent ComNet show in Washington, D.C., people were talking instead about "The Year of the Wireless LAN." For users who don't need the high data rates offered by digital land lines or who want to avoid the hassles of cabling, several companies are, or soon will be, offering systems for wireless communications. Each uses spread-spectrum technology, which employs high-frequency radio signals to link computers. This approach allows signals in a narrow frequency band to be spread and transmitted over a broad range of frequencies with lower energy content, thus minimizing noise and interference with other radio devices. The signal is then collapsed back to its original narrow frequency band at the receiving end of the transmission.

O'Neill Communications (Princeton, NJ) was one of the first to take this approach, with its LAWN (Local Area Wireless Network), a proprietary LAN that uses small transceivers to connect as many as 20 personal computers in a workgroup.

Ferranti Datacom (Sunnyvale, CA) plans to soon release the RM38, a $3450 radio modem designed for

continued

NANOBYTES

Claris (Santa Clara, CA) has acquired from Red Brick Systems a **query technology** that's supposed to make it easier for Macintosh users to access data from large corporate databases. The Executive Query Tool lets Mac users log onto relational databases using the standard Mac interface and download data without having to learn the SQL programming language. When a user on a client-server network makes a query, EQT generates the SQL code, which then queries the database. Claris plans to develop a new application based on EQT by the end of this year. EQT runs on top of standard server-access protocols like Apple's CL/1, OCI from Oracle, and DB-Lib from Sybase, which will allow for access to most corporate databases, Claris claims.

IBM's new **RISC System/6000** appears to be attracting significant **support from Unix software vendors**. Over 70 software companies exhibited products at IBM's San Francisco rollout of the new machines. While most of the demonstrated applications were for scientists and engineers, there were also database applications from Oracle, Ingres, and Informix, as well as financial and business management software. The programs shown were running under a prerelease version of AIX 3. Most used the X Window System and some of the preliminary graphics objects supplied in OSF/Motif. According to a list from IBM, about 200 companies say they'll be bringing their programs to the RS/6000.

The new CD-ROM presentation of Mozart's *The Magic Flute*, from **Warner New Media** (Burbank, CA), couples more than 7000 screens of information with 143 minutes of digital music. A HyperCard stack supplies extensive annotation, commentary, musical examples, extra narration, and excerpts from other recordings, as well as a full index. The three-disk set will sell for a suggested $66. You need a 1-MB Mac and Apple CD-ROM drive.

Pull Up A Chair And We'll Tell You Why

Ted: OK, we're putting together another ad for the magazines and I thought you should be the ones to write it.

Todd (laughing): Hey, Ted, I'm no writer.

Ray: Me neither. Don't you s'pose we could hire somebody to write our ads? (Laughter.)

Ted: No, because we've always been straight forward in our advertising. I've analyzed the market and I can't understand why anyone would buy a computer from anyplace except Gateway. Now I know you all agree with me, so I want you to tell the world what you can do for them. Just straight talk from a friend in the business. I'm recording this—

Troy: Is this legal?

Ted: —and I'm gonna give the tape to word processing for a transcription. And that's gonna be our ad.

Norm: This oughta be good! (Laughter.)

Ted: Todd, you're on. I'm looking for a computer system. Why should I buy from Gateway 2000?

Todd: Because Gateway has the best value. We lead the market in price, quality and service. It's that simple. You wanta get the best system for the best price from a company you can depend on? Then buy from Gateway 2000.

Troy: Yeah, shop around. But don't be fooled by stripped-down systems. Compare Gateway feature for feature and we blow the competition away.

Norm: And read the reviews. Our systems out-perform machines that cost twice as much.

Ted: Troy, you're on. You run the plant so you tell me what kind of quality I can expect?

Troy: Well we use a component that's not very common today—pride. Each machine that goes out the door is custom-built by one person. That person's pay is determined by how satisfied you are as a customer. We use only top-of-the-line components. You combine that with the midwest work ethic and you've got an unbeatable combination.

Ted: OK, Gateway's got great prices on quality systems. But we can't guarantee everyone that they'll never have a problem.

Ray: If we could, I'd be out of a job. (Laughter.)

Ted: Yeah, Ray. Tell me about your job. What happens if a customer does have a problem?

Ray: That's where we shine. Gateway's tech support is the best in the industry. We know what we're talkin' about, but most importantly, we care. We'll bend over backwards to take care of you. You won't hear us saying, "Sorry ma'am, that's a software problem." We don't care whose problem it is. If the machine is not working for you, we'll do everything in our power to get you up and running.

Ted: What if you can't fix a problem over the phone?

Ray: Then we can send a technician to almost anyplace in the nation.

Ted: Kathy—bet you thought I forgot you—what about customer service?

Kathy: Customers get very personal service here. When you call Gateway, you'll be assigned to one customer service representative who will follow your order from start to finish. Your personal rep will make a special effort to get to know you and make sure you're completely satisfied.

Norm: Hey, this sounds almost too good to be true.

Ted: Some people think that. But our customers don't—ask them. They know Gateway 2000 is the best value in the industry.

Norm: Do we have an ad yet?

Ted: Yeah, I think so. All I have to do is cut some prices on our systems. Then get ready for a really hot summer...

(Tape End Indicator.)

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Troy Miller, ***Plant Manager***

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Todd Osborn, ***Sales Manager***

Kathy Skidmore, ***Customer Service Manager***

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NANOBYTES

The 17-member Coordinating Committee for Multilateral Export Controls (COCOM) has agreed to **reduce restrictions on high-technology exports to the Eastern Bloc** countries undergoing political change—Czechoslovakia, Hungary, and Poland—but not to the Soviet Union. "In the American view, there's still a qualitative difference in the security situation between the Soviet Union and Eastern Europe," a senior administration official said.

Caere Corp. (Los Gatos, CA) claims that it has the **fastest optical page-reading system** on the market. The new Parallel Reader can process and recognize characters at a top speed of 700 characters per second, or 2500 words per minute, the company says. The $10,995 system's fast throughput is due mostly to its processing power and the way it handles pages. The box itself contains a 386SX CPU and four additional processor boards, each one holding a Motorola 68020 and 2 MB of RAM. Each 68020 board takes a page as it's scanned in and reads and processes the text. Other multiprocessor OCR systems assign different jobs to each processor and basically pass a page from one processor to the next, whereas Caere has all four boards work on different pages at the same time, said product support supervisor Dusty Perryman. The Parallel Reader comes with a 40-MB hard disk drive, a VGA display adapter, 1 MB of RAM, a 5¼-inch floppy disk drive, MS-DOS 4.1, and Windows 2.3; no keyboard, monitor, or mouse is included.

Tandy (Fort Worth, TX) has **slashed the price** of its low-end IBM-compatible 1000HX personal computer from $699 to $299. Introduced in 1987 as a home or school PC, the 1000HX comes with MS-DOS 2.11 and Tandy's DeskMate user interface in ROM. The computer supports an external 5¼-inch floppy disk drive (not included) and comes with Personal DeskMate 2.

situations in which the computer is literally moving while you use it (e.g., testing motor vehicles). The RM38 offers synchronous or asynchronous communications at up to 9600 bps. The 1-watt transceiver has a range of up to 10 miles, the company says.

Telesystems (Don Mills, Ontario, Canada) has taken a different approach than O'Neill: The Arlan 400 PC LAN uses transceivers that mount inside the computer (on an XT-bus board) and run a full version of Novell's NetWare. The data rate of the Arlan 400 is 230,000 bps—nearly 24 times the LAWN's 9600-bps speed—but the cards are also much more expensive ($1500 versus $495 per node). Telesystems president Wence Zenko says that his company is aiming for users who want to extend existing wired LANs between buildings. The radios have a range of 500 feet indoors and up to 6 miles outdoors across unobstructed space, Telesystems says.

Agilis (Mountain View, CA), maker of the eponymous "hand-held" workstation, is selling its radio technology by the slice. The company's new 21CSP module ($2495) plugs into the Agilis computer and lets it act as a mobile workstation linked to an Ethernet LAN, with a data transfer speed of 230,000 bps. Each radio has a range of 1 kilometer outdoors and 100 meters indoors, Agilis says. The main bus on the Agilis works at an Ethernet speed of 10 Mbps. The transceiver connects directly to the Ethernet bus and converts the data rate to 236,000 bps for wireless transmission.

Agilis plans to offer its technology for other communications protocols, a company official said. The company recently showed us a prototype with a LocalTalk port on a 3- by 5-inch board. As it so happens, the transceiver's data transfer rate of 236,000 bps coincides with the transmission speed of the LocalTalk protocol used on Macintosh-based AppleShare and TOPS networks.

—Nick Baran and Andy Reinhardt

Mac OS to Get Print-to-Video Capabilities

By the end of the year, the Mac OS will incorporate video output capability, including the ability to print a file to videotape. Apple Computer is working with Sony to enable the Mac to write to videotape on Sony video machines that have serial control ports, according to Tyler Peppel, manager of Media Integration at Apple. Some of these videotape machines (VHS and 8-mm) retail for as little as $300.

Apple wants to integrate sound and video manipulation in the Mac OS so that all Mac programs can take advantage of such multimedia capabilities, Peppel said at a recent conference on CD-ROM. Using a prototype of Mac System software, he was able to move a videotaped sequence to a single slide (created with the Power Point presentation program); when he clicked on a video display icon, the slide show ran with full animation and digital sound.

It would be as simple to write to videotape as to print to any other device, Peppel said. First you would select the videotape icon from the Chooser and then pick NTSC or PAL output and print.

—David Reed

ISDN Puzzle Pieces Slowly Falling into Place

Skeptics are still willing to take bets: Which will come first—ISDN or human colonies on Mars? But some observers of the communications industry now say that the Integrated Services Digital Network—which promises high-speed voice and data (including video) transmission over a regular phone line—is finally "a reality" due to several important developments in the last few months.

Most significant, they say, is that vendors and standardization groups have finally agreed on the Signal System 7 (SS7) standard for connecting islands of ISDN service to one another through conventional telephone switches. This will allow phone companies to connect the small pockets of ISDN service in cities such as Fresno and Chicago to one another, even though ISDN itself is not yet operating nationwide.

continued

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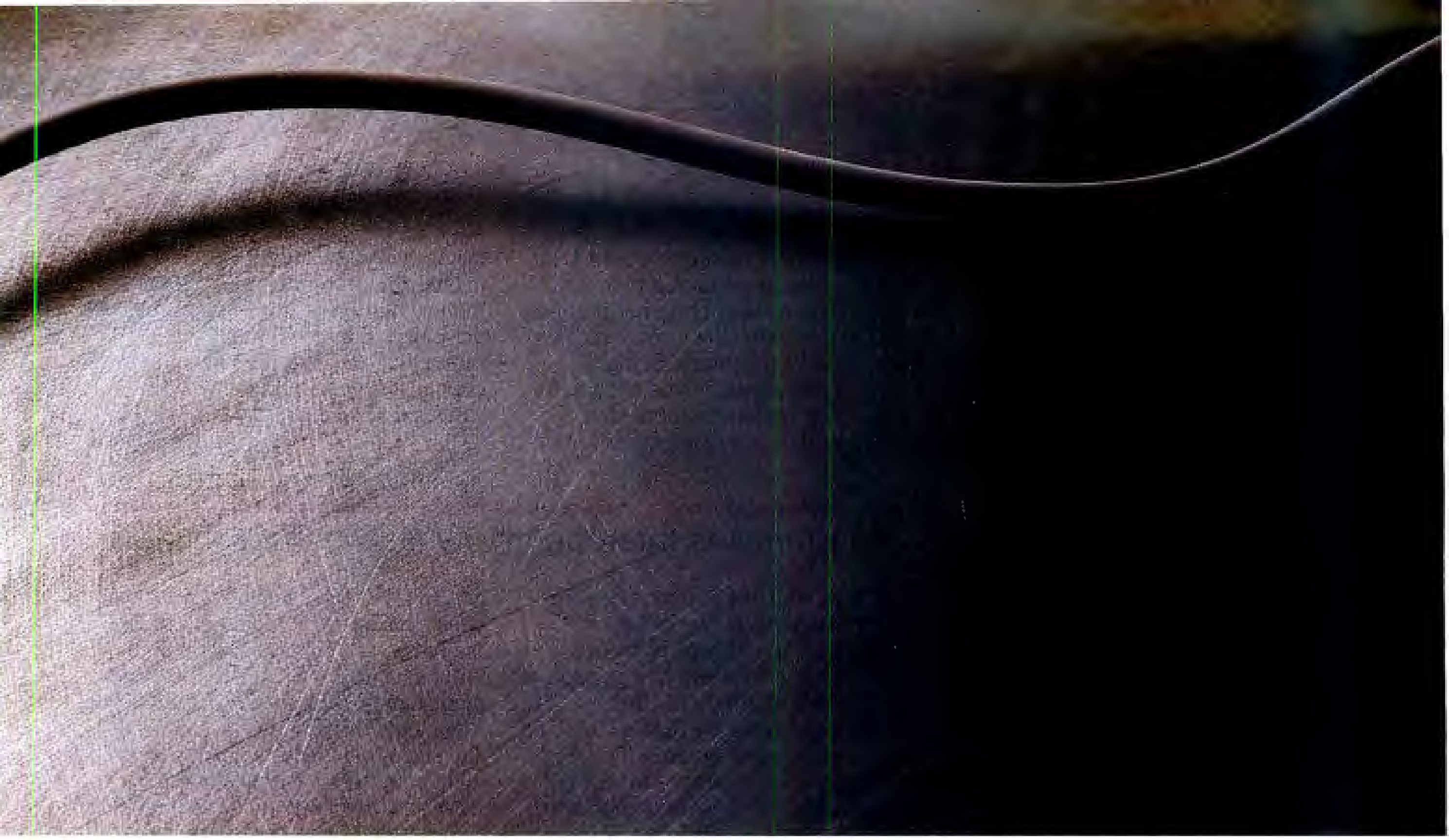

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Another major development is a final agreement on the so-called U-interface that governs the two-wire connections linking customer premises to local telephone lines. With these two pieces of the puzzle in place, ISDN is now standardized enough for large-scale implementation. One ISDN insider says that installation of large digital switches is proceeding faster than expected.

One thing holding back ISDN is the installation of fiber-optic cables all the way to the "local loop," or individual user site. Replacing existing copper wiring around the U.S. is expected to take another 5 to 10 years.

—Andy Reinhardt

IBM Promises Interoperability Between SAA, AIX

Although IBM has been heavily promoting its "seriousness" about Unix, manifested by its new RISC workstations and new version of AIX (IBM's rendition of Unix), there's a gap between IBM's Unix and its other operating systems. Those other operating systems—MVS, VM, OS/400, and OS/2—all comply with IBM's Systems Application Architecture. SAA is a set of guidelines for consistent interface and software development characteristics, designed to let SAA-based applications communicate and share data transparently.

The environments offered for the new RISC System/6000—AIX, OSF/Motif, AIX/Windows, and NextStep—do not conform to SAA.

IBM sees SAA as its main software architecture for its business customers, and AIX as the platform for its scientific and technical customers. In other words, IBM expects that banks, insurance companies, accounting firms, and financial institutions will use mainly PS/2s, AS/400s, and mainframes, running OS/2, OS/400, or MVS and VM. Engineers, financial and statistical analysts, and government contractors will use mainly IBM's new workstations running AIX.

But rather than have those two classes of users isolated from each other, IBM officials say that they hope to alleviate the incompatibility between AIX and SAA by providing "interoperability" capabilities. Those capabilities will include support for sharing files and databases, common programming languages, network management, E-mail exchange, and support for the X Window System and Presentation Manager on both SAA and AIX platforms.

—Nick Baran

Imagine Buying an i486 for 35 Cents

By the year 2000, manufacturing semiconductors will have become so inexpensive that chips as complex as the i486 will cost about 35 cents (currently about $800), and memory chips with 1-MB capacity will sell for a dollar, predicts one industry watcher. Andy Rappaport, president of the Technology Research Group (Boston), said at the IEEE Compcon Spring '90 conference that if historic and current trends continue, the cost of making semiconductors will be minimal, and consumers as well as designers will benefit. Many electronic goods will become dramatically more powerful, Rappaport said, to the point that the "16-MB, 15-MIPS microwave oven" is a serious proposition. The cost of the semiconductors in a workstation capable of 30-MIPS operation will drop below $100 by the year 2000, he predicted.

—Owen Linderholm

NANOBYTES

Texas Instruments (Dallas) **cut the price** of its TravelMate LT286 laptop computer. The Model 25, which comes with a VGA screen and a 20-MB hard disk drive, now costs $4599 instead of $4999. And the Model 45, which has a 40-MB hard disk drive, now costs $4999 instead of $5599.

If you buy seven of HP's top-line personal computers (386SX-, 386-, or i486-based Vectras), the company will throw in **a LaserJet III for free**. That's a $2395 value. Buy five, and HP throws in a LaserJet IIP. Buy three, and you get a free DeskJet Plus.

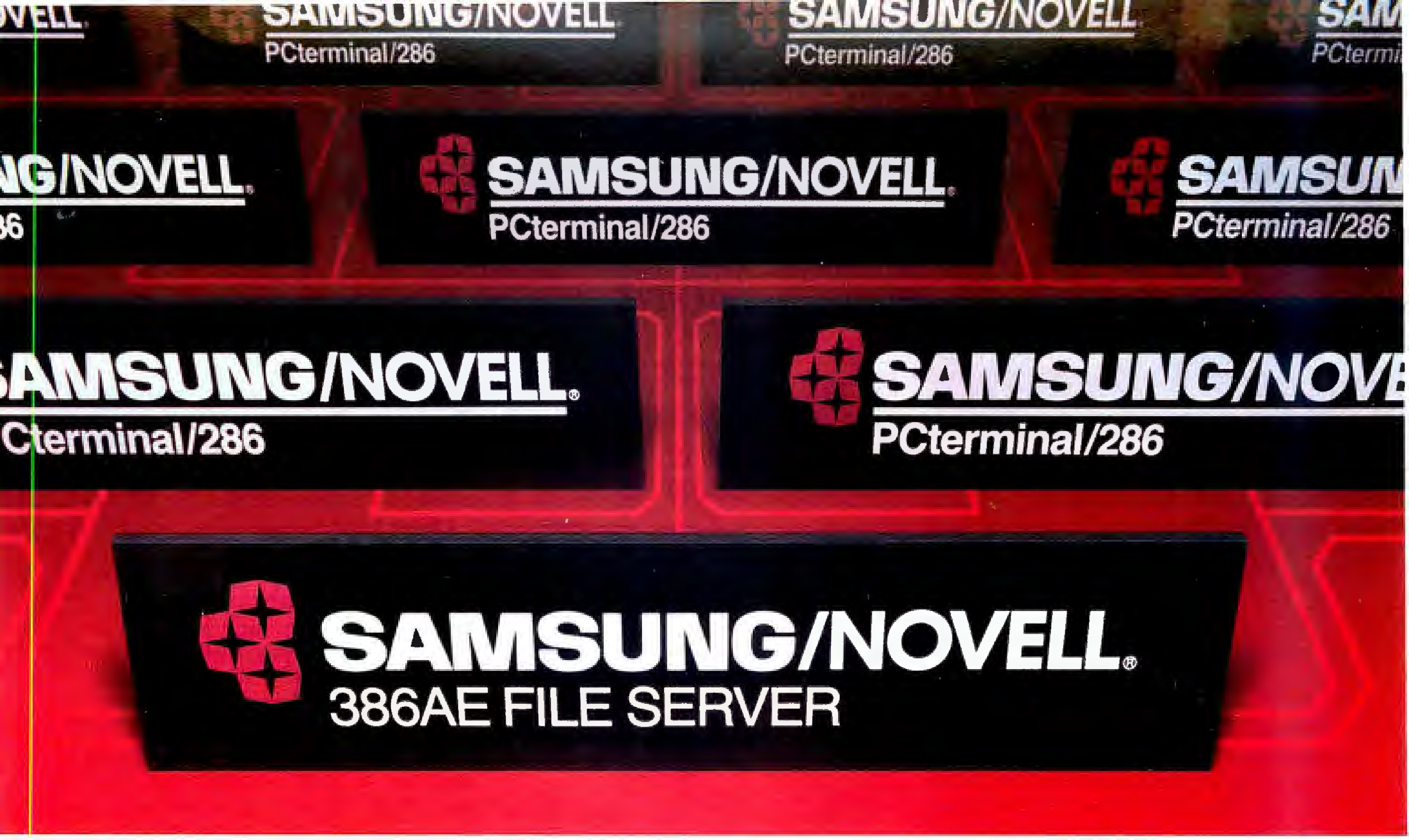
Irwin (Ann Arbor, MI) has **knocked $400 off the price** of its tape backup system for the Macintosh. The Model 5040, which is capable of storing 40 MB on a cartridge, is now $995. The Model 5080, which can back up 80 MB on a tape, is now $1295. Irwin recently started offering new tapes that will let both drives store an extra 20 MB per cartridge.

Advanced Micro Devices (Sunnyvale, CA) is **reducing the price** of the 16-MHz version of its 286 microprocessor by 30 percent. AMD says that demand for its 286 chips increased by 100 percent in the past year. The new price: $26 per chip in quantities of 1000, down from $37.

Cyrix (Richardson, TX) is now offering higher education a **discount on its FasMath coprocessor**, which is compatible with Intel's 80387. The new program lets a teacher buy two of the chips at half the normal price. The 16-MHz version normally sells for $570, the 20-MHz for $647, the 25-MHz for $814, and the 33-MHz for $994.

Astute observers noticed a bunch of ersatz reporters representing **"Computer Publicity News"** at IBM's RS/6000 rollout. They were, in fact, public relations employees from workstation maker Sun Microsystems.

PLUG US INTO YOUR NETWORK *and let us know what's going on. If you, your company, or your research group is working on a new technology or developing products that will significantly affect microcomputers and the way people work with them, we'd like to hear about it. Phone the BYTE news department at (603) 924-9281. Or send a fax to (603) 924-2550. Or write to us at One Phoenix Mill Lane, Peterborough, NH 03458. Or send E-mail to "microbytes" on BIX or to "BYTE" on MCI Mail. An electronic version of Microbytes, offering a wider variety of computer-related news on a daily basis, is available on BIX.*



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LETTERS

and Ask BYTE

The ASCII Controversy

Rip Collins' evaluation of ASCII (Stop Bit, January) is essentially correct. I never could comprehend the wisdom with which the punctuation and other symbols were arranged. The ASCII definitions with values greater than 127 seem tacked onto the end of the set as if by afterthought.

That's where my agreement ends. I don't understand how ASCII caused the divergence of compound delimiters in Ada, BASIC, and C. I agree that ASCII had something to do with the problem in not providing symbols such as "not equal to," forcing the framers of those languages to create their own. But I disagree that it forced everyone to produce different "not equal to" symbols. The choice seems arbitrary, depending on the framers' idea of what a comment or other symbol should intuitively look like.

Second, BASIC does not call text after a `REM` or an apostrophe "remarks" because comments are delimited by /* in C. BASIC was calling them remarks long before C existed. The issue is irrelevant to ASCII, anyway.

Third, programs do not "collapse under their own weight" on the basis of the order in which the language places the alphabet, digits, and other symbols. Well-written programs in those languages either use the order and layout of the character set and other system attributes to best advantage or find ways to circumvent the problems that those factors present.

Sure, ASCII order leaves something to be desired in some cases. Reordering the numerals and letters to facilitate character-to-hexadecimal conversion would be helpful in my line of work. However, pointing the finger at ASCII to such a degree seems unjustified.

Daniel M. Daly
Mishawaka, IN

Sorting the *interpretations* of unrelated terms would not be the phenomenal undertaking that the ASCII standard mandates were it not for the developers who promote "information interchange" as a sanctioned poetic license. Any Joe Blow who cares if "zany" precedes "aardvark" has never considered the computational poise that the ASCII standard provides in linking database, word processing, and spreadsheet functions with relative invisibility.

H. de Witt Robinson
Wilmington, DE

Apple Talks on AppleTalk

At Apple, we were pleased to read Mark L. Van Name and Bill Catchings' fine article entitled "AppleTalk Phase 2 and You" (January). Thanks.

Let me make one correction and provide clarification. The authors have equated an AppleTalk Phase 1 *zone* with a single network *segment*, and hence assert that zones are limited to 254 devices. This has never been the case. An AppleTalk zone is an arbitrary collection of network segments in an AppleTalk internetwork; although each segment is limited to 254 devices, a zone has no such limit. AppleTalk Phase 2 goes further. It allows any device on a given segment to choose the zone to which it wishes to belong. The network administrator can establish the list of zones from which the devices on a particular segment are allowed to make this decision.

WE WANT TO HEAR FROM YOU. *Please double-space your letter on one side of the page and include your name and address. We can print listings and tables along with a letter if they are short and legible. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

Because of space limitations, we reserve the right to edit letters. Generally, it takes four months from the time we receive a letter until we publish it.

On the subject of LocalTalk, it is clear that the authors have not examined the issue from the point of view of a customer's pocketbook. They say Apple has relegated LocalTalk to the low end. I suggest they avoid the potentially pejorative association of "low" and view the facts.

LocalTalk was conceived as and continues to be the lowest-cost LAN option today. We at Apple were not interested in engaging in "LAN locker room" contests ("my network goes further and faster"). Our interest was simply to allow the customer a penalty-free choice between LAN technologies at various price and performance points. LocalTalk has filled a real need.

As for a faster LocalTalk network, the question is whether it is worth creating yet another option; the customers' vote on FlashTalk will help answer that. By the way, it is not the "only option," as you style it. Don't forget good old Ethernet and now also Token Ring.

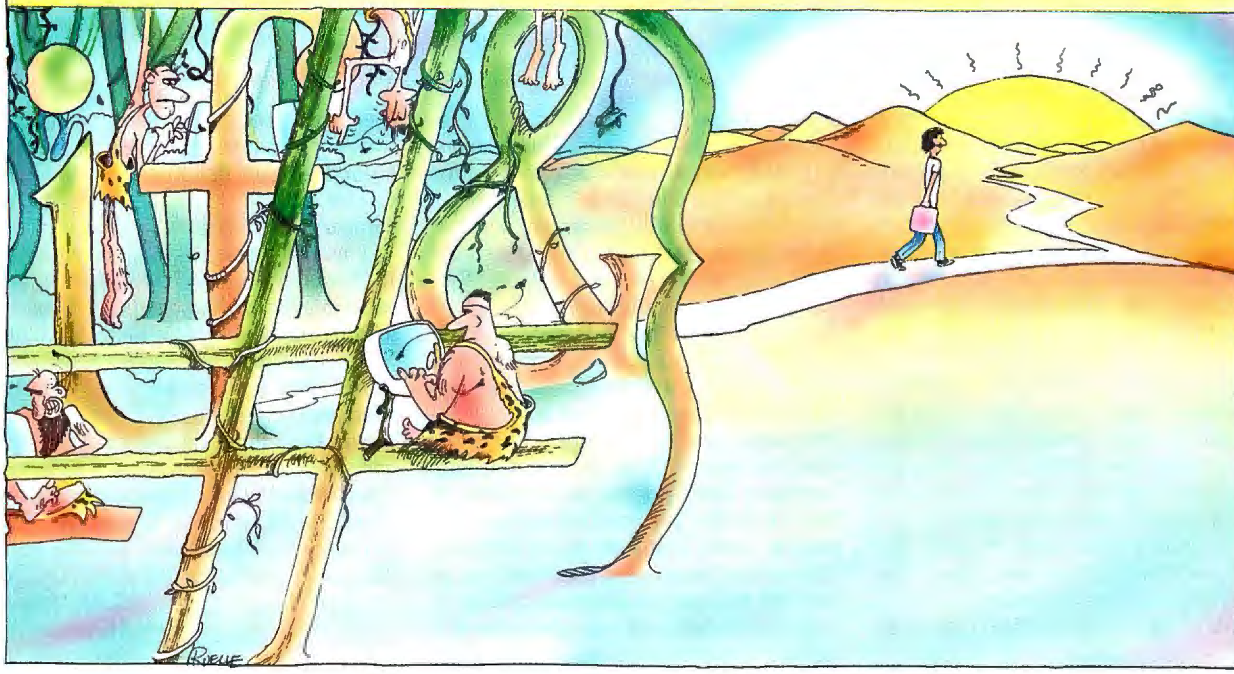
The authors mention that now, with the TokenTalk NB product, more than one protocol stack can be run simultaneously. This is not something new in the AppleTalk system. The same has been true of LocalTalk and EtherTalk/Ethernet, as users of Apple's MacTCP and many other stacks will attest.

Gursharan Sidhu
Technical Director
Network Systems Development
Apple Computer, Inc.
Cupertino, CA

Thank you for your correction about zones. We differ, however, on your second major point; we regularly consider networking issues "from the point of view of a customer's pocketbook." We stand by our statement that Apple has relegated LocalTalk to the low end, with all its good (low-cost) and bad (low-performance) implications. For only a few extra dollars per Mac, Apple could easily increase the LocalTalk performance of at least the newer Macs to match that of FlashTalk, but to date Apple has chosen not to do so. We admire Apple's low-hassle, built-in networking support, but we still think

continued

Great Moments in C-Programmer Evolution



Code-dweller emerges from the jungle

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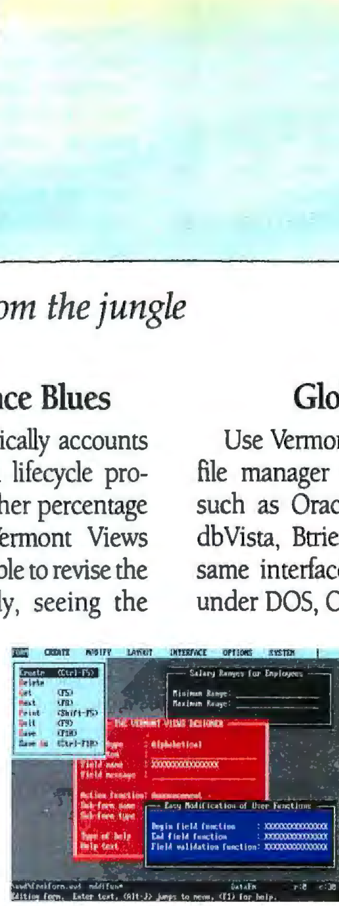

Screen generators for most C libraries require you to modify generated source code to create fully functional forms—after which you can no longer use the screen generator. Not so with the Vermont Views Designer. Designer forms and menus can incorporate any of the special capabilities of Vermont Views—such as nested menus, scroll bars, tickertape fields, scrollable form regions, choice lists, and memo fields—and still be revised interactively.

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—Randy Jones, Beta Tester

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that LocalTalk is slower than desirable.

You also quote our comment on FlashTalk as the "only option" out of context; it was, at the time we wrote that column, the only option that gave you higher performance over LocalTalk cabling. (DaynaTalk has since joined the fray.) Obviously, as the rest of our column dealt with them, we did not "forget good old Ethernet and now also Token Ring."

Finally, our statement that "More than one protocol stack can run on a single TokenTalk NB card simultaneously" does not imply that this ability is new to Apple networking; we were simply explaining how the TokenTalk NB card works.

We're glad to find Apple reading NetWorks, and we plan to cover more Mac networking issues in the future.

—Mark L. Van Name and Bill Catchings

DEC's Many Operating Systems

The assault from below has not forced Digital Equipment Corp. to abandon its "one architecture, one operating system" philosophy ("Computing with Light," January). DEC never had such a philosophy. It is conceivable that DEC management was sincere when it coined that slogan, but, if so, it never followed through. Even on the VAX, "one operating system" didn't last long. Ultrix is about as far from VMS as you can get.

Even within the DEC proprietary world, there was never a single architecture. The PDP-11 is still with us, and DEC sold a lot of them as Pro 350 and Pro 380 personal computers. The DECmate is a PDP-8, about as different from a VAX as is possible.

Seymour J. Metz
Annandale, VA

Uh-Oh, Call the Lawyers

Howard Eglowstein was absolutely correct in his response to Richard Levey's concerns about his hard disk drive write-protection modification (Ask BYTE, January). Not only is there no reason for concern over data errors or invalidating warranties, but hardware write-protection is the only "foolproof" way to protect a file on a PC hard disk.

I know that Eglowstein's modification works well, because I developed the same one four years ago and was issued a U.S. patent for it two years ago. Several hundred have been sold under the name Disk Defender, and customers have reported no problems. Great minds think alike, but if you want to give credit where credit is due, the patent office can document that I got there first.

Dennis Director
Evanston, IL

Mac Attacked

MacZealotry strikes again. I hope no one followed Don Crabb's advice by purchasing a Mac Plus with 1 megabyte of RAM and then tried to run applications under System 6 (Macinations, December 1989). He must have been kidding! System 6 itself barely runs in 1 MB.

He made another misleading statement: "This minimally acceptable OS/2 box will cost well over $3500." I can buy a 25-MHz 386 with 4 MB of RAM, a 65-MB hard disk drive, and color VGA video for under $2500 in any of several computer stores in the Seattle area. A Mac of similar performance and configuration would cost over twice as much. This is the beauty of the competition in the IBM PC-compatible marketplace.

Crabb seems confused about the difference between an operating system and a graphical user interface. I agree that OS/2's GUI, Presentation Manager, is not as refined in appearance as that of the Mac. However, OS/2 is considerably more refined than System 6.

Much of what Crabb calls refinement is merely user preference—he is used to the Mac way of doing things. I find some aspects of the Mac interface irritating; for example, all applications share one menu bar, inactive windows go blank, and you must hold down the mouse button while making a menu selection.

It is unfortunate that Crabb did not perform an unbiased comparison of the usefulness of OS/2, System 6, and their associated GUIs and applications, rather than making vague references about their level of "refinement." Such an approach would have been much more useful.

Waid Reynolds
Seattle, WA

Third-Party Apollo Vendor

In "Apollo Shrinks the Workstation Price Tag" (January), Ben Smith states that all options for the Apollo DN2500 are available only through Apollo. At Digital Micronics, our business and specialty is offering innovative solutions and options for upgrading Apollo workstations, including the DN2500. We offer memory boards, SCSI disk drives, tape drives, and high-resolution monitors.

Mark S. Bonney
Marketing Manager
Digital Micronics, Inc.
2131 Las Palmas Dr., Suite F
Carlsbad, CA 92009
(619) 931-8554

Helping Hands Update

We applaud Wayne Rash's column entitled "A Helping Hand" (January). However, the robotic arm that he mentioned was not designed by Prab; it was designed and is produced by the UMI Group Ltd., UMI-Microbot's parent company in the U.K.

The arm (which is designated by the RTX model number) is the most standard robotic system used in research by the leading medical/rehabilitation institutes. While the Prab Command is a sound generic approach, many other specific needs are being addressed by the medical research community, and there are many open areas needing work.

Interested readers can contact George Novelli, Managing Director, UMI Group Ltd., UMI House 9-15 St. James Rd., Surbiton, Surrey, KT6 4QN, U.K.

G. W. Rhodes
UMI-Microbot, Inc.
Sunnyvale, CA

All OS/2's Children

Mark J. Minasi's column on OS/2 multitasking (OS/2 Notebook, December 1989) uses the parent/child example to demonstrate the effects of delta and class on time slicing. This is fine as far as it goes, but the child programs fail to take advantage of one of the main features of OS/2's multitasking abilities—the use of shared code.

As he points out, the only difference between Child 1 and Child 2 is that they display 1 and 2, respectively, when reporting the number of iterations performed. So all that is required is a single Child program that passes its number as a parameter. Because OS/2 does not permit code segments to be written to, it can allow multiple processes to share the same in-memory copy of the .EXE file, each process having a separate copy of the data and stack segments.

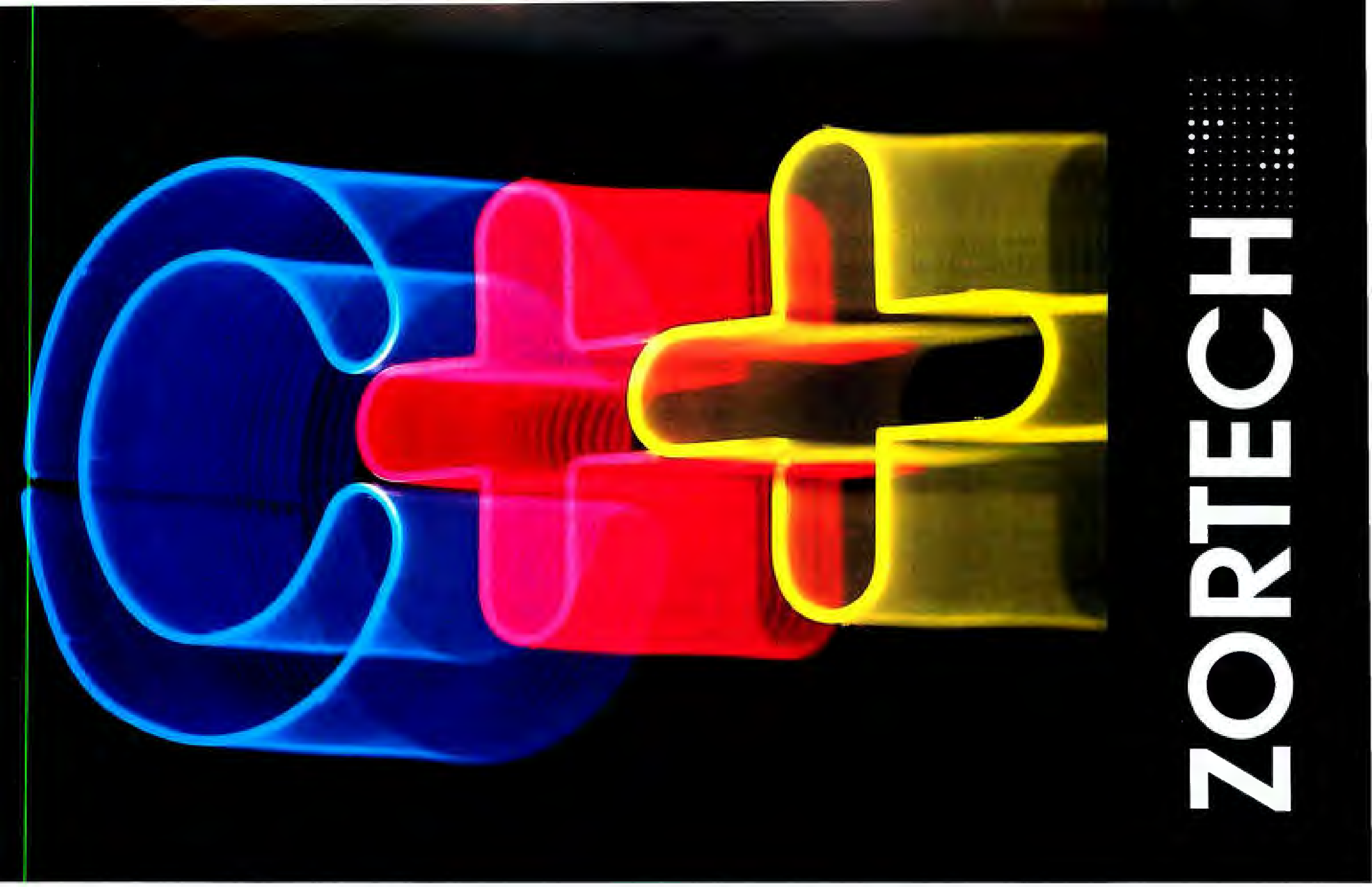
Bryan Ford
London, U.K.

The Primes of Our Lives

For a grizzled veteran of programming, it is amusing to see that prime number generation still enthuses and apparently puzzles younger programmers; one of whom, Milton Pope, reported that the Sieve of Eratosthenes runs twice as fast if you test only the odd numbers for primality (Letters, November 1989).

It is possible to increase the speed and reduce the memory requirements still further by a simple technique. This is based on the observations that the product of the first three primes is $2 \times 3 \times 5 = 30$, and that all other primes, when divided by 30, must produce one of the following eight remainders: 1, 7, 11, 19,

continued



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Scott Robert Ladd – Dr. Dobbs Journal – January 1990

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23, or 29. Therefore, you can represent 30 consecutive numbers in 1 byte, so that an array of 32K bytes can represent a table of all the primes in 960,000 consecutive numbers. If you want to go further than this limit, you can allocate a new array block for each 960,000 numbers that you want to check. This can go on until you run out of memory, patience, or both.

If you want to get fancy, you use blocks of $7 \times 11 \times 13 \times 17 = 17{,}017$ bytes. When you have tested the prime numbers of 7, 11, 13, and 17, you copy the first block of 17,017 bytes, and in the copy you turn on the bits in the first byte that indicate divisibility by these four primes. Now you can use this modified copy to initialize all subsequent blocks of 17,017 bytes instead of testing them for divisibility with 7, 11, 13, and 17.

Søren Brandt
Rabylille, Stege, Denmark

Another Voice Heard

I was dismayed to discover that the December Resource Guide for the Sound and Image Processing In Depth section did not list our VPC-1000. It is an IBM PC–compatible option board that recognizes continuous speech, is speaker-independent, and operates over standard telephone lines. The VPC-1000 package sells for $5500 and is also available from OEM suppliers such as DEC, Summa Four, Syntellect, Perception Technology, and Periphonics.

C. M. Brooks
Executive Vice President
Voice Processing Corp.
One Main St.
Cambridge, MA 02142
(617) 494-0100

Don't Forget Number Crunching

Fred Langa's editorial in the December 1989 BYTE overlooked a very important concept: number crunching. The 80387 or 80387SX requires two to three times fewer clock pulses for a typical math operation than the 80287 does. For example, `FMUL ST(1),ST(0)`, a multiply between two registers, takes 29 to 57 clock pulses on an 80387SX or 80387, and 90 to 145 clock pulses on an 80287.

If you have to do numerics processing, the 386SX/80387SX combination is far superior to the 286 or 80287.

Darrel L. Bartelheimer
Dayton, OH

Guidelines Needed for CASE

Your Product Focus entitled "Making a Case for CASE" (December 1989) was interesting, coming as it did after I had attended a brief methodology course at work. At my office, we have the KnowledgeWare IEW/WS set of tools, which I have found difficult to apply to my projects involving data transfer and processing across different platforms. Guidelines for determining which tools to apply to different types of problems are sorely needed.

Marc Walter
Loveland, OH

Big vs. Little

I enjoyed the review of the DECstation 3100 ("DEC's RISC Powerhouse," November 1989). I found the discussion about big- and little-endian machines interesting in a hardware review. I think this is primarily a software implementation issue. Network programs have the same problem that binary databases face. A native byte order needs to be defined, and the machines that don't conform to this native byte order need to flip bytes upon I/O. If the design takes this into account, moving to a different-endian machine merely requires recompiling the application. Addressing the issue at the hardware level reflects a lack of forethought regarding portability in designing software systems. If applications are intended to be portable, the byte order should not matter.

Marty Leisner
Rochester, NY

Enough, Already

I wonder if Pete Wilson ("The Wages of Sin," *IBM Special Edition*, Fall 1989) has any experience in the advertising and marketing fields. How many of us, I wonder, spend money every year on the latest and greatest version of a product simply because the manufacturer has convinced us that we don't know what we want and are not in control of our own needs? The demands that we place on hardware are more speed and compatibility with software that we already know, love, and have paid for.

Ric Naff
Dallas, TX

Who's Challenging Whom?

The November 1989 editorial ("What Slump?") states that the Motorola 68040 has not yet arrived to compete against the Intel i486. It seems to me that the i486 is now finally arriving to challenge the Motorola 68030, which has been in widespread use for over a year.

Let me refer you to BYTE's own benchmarks in the November 1987 issue ("MPW Compiler Lets Mac II's 68020 Shine"), comparing a Mac II with a 68020 to a Compaq Deskpro with a 386. Both ran at 16 MHz and had math coprocessors. In five tests, the 68020 was faster in three (for the Dhrystone test only, higher numbers mean faster performance):

	68020	386
Dhrystone	3278	748
Fibonacci	48.58	53.11
Savage	3.42	8.95
Sieve	4.73	5.98
Sort	7.17	5.58

[All times are in seconds except for the Dhrystone, which is in Dhrystones per second.]

Furthermore, versions of the 68030 running at 40 to 50 MHz are now available. Given that you can generally expect commensurate changes in each family of CPUs as the clock speed changes, it is clear to me that the 68030 today is where the i486 will be in two years.

Mel Jenkins
Key West, FL

World's First E-Mail System?

Would anyone care to dispute my claim of having written and implemented the first E-mail system? I wrote it in 1975 for a DEC PDP-11/45 running RSTS/E 6.0. It allowed a user to send mail to another user—either in real time, preempting his or her current screen, or to a "mailbox" for future delivery. Any reader wishing to dispute this claim can write me at the address below.

David L. Morris
11311 North Central Expy.,
Suite 300
Dallas, TX 75243

ASK BYTE

Spelling It Out

I became permanently disabled in 1980 due to viral encephalitis, which resulted in a right temporal lobectomy. Upon my release from the hospital, I was given a used Apple II Plus computer and an ImageWriter printer. I am writing an autobiography, which will describe my illness, surgery, two-month coma, and several years of intensive rehabilitation.

I have learned how to use only one main program—Bank Street Writer. I am searching for a spelling checker program. I have been told that my computer, being an older model, does not have enough memory to use a spelling checker. Is there anything I can do at this

continued

point? I would even consider trading my computer in for a newer model if that's possible.

Bill Hamilton
Bryan, TX

You don't say how much memory your computer has, so I'm going to assume that it's 64K bytes. If not, you can probably find 16K-byte upgrades for a reasonable price at any number of mail-order houses. But 64K bytes should be sufficient for what you're planning to do.

Sensible Speller IV from Sensible Software (335 East Big Beaver, Suite 207, Troy, MI 48083) is compatible with Bank Street Writer. Again, search for it from a mail-order house; a company like Programs Plus (75 Research Dr., Stratford, CT 06497, (203) 378-3662) should carry it. Be sure to ask for Sensible Speller IV—it will work on your Apple II Plus. Sensible Speller without the "IV" will not.

—R. G.

An AT in XT's Clothing

About a year ago, I purchased a Tandy 1000 TX. At that time, the salesperson gave me the impression that the TX was an AT-class machine. When the time came to upgrade the computer, I found out that it had an XT motherboard with a 286 chip for a processor. This really ticked me off, particularly because it was my fault for not reading the fine print.

My question is: Do I have an XT or an AT machine? I haven't been able to get a straight answer from anyone.

Another concern that I have is buying additional components for the computer. I would like to buy these options through mail-order companies in the U.S. (due to the high price of these components offered by Tandy here in Nova Scotia). However, people I talk to here give me opposing opinions as to whether my machine will accept printers, modems, and graphics cards manufactured by other companies. Do I have to buy components from Tandy?

James Erwin
Stellarton, Nova Scotia, Canada

You have an AT-class computer with an XT bus. The 1000 TX was Tandy's attempt to couple the power of a 286 with the economy of using 8-bit expansion cards. You should be able to use any 8-bit card that measures 10 inches or less in your computer and connect your 1000 TX to any standard printer or modem. Some advertisers in BYTE sell peripherals (e.g., hard disk drive cards) specifically for Tandy computers.

You cannot upgrade the graphics on the 1000 TX, since it uses a built-in CGA circuit on the motherboard that you can't bypass.—S. W.

Speaking the Language

I use Windows/386 extensively with my Compaq 386s. My monitor is the original Compaq VGA color monitor. One software package that I often use is Samna's Amí.

Here in Brazil we speak Portuguese, and the Portuguese language has some characters that are not found in English. I used to access such Portuguese-unique characters through the Alt keys on my Brazilian version of Word 3.0. (This version of Word has Alt keys adapted to special Portuguese characters.)

Enter Windows/386. Using Amí—or even Write (which comes with Windows/386)—not all the special characters are available. I understand that Windows/386 is a graphical environment. I suppose there must be a way to modify the font files for these characters so that I could print in Portuguese. Am I right? If so, how should I proceed?

Carlos Roberto Fortner
Sao Paulo, Brazil

Portuguese? Some of us here consider C a foreign language, so I had to go right to the source.

Samna has no immediate plans to release a Portuguese-language version of Amí (or Amí Professional) in the immediate future, but a spokesperson pointed out that any version of Amí can access the full ANSI Windows character set. The Alt key, used with the numeric keypad, will let you enter the numeric code of any character. A table in the back of your manual will show you the available characters. Samna was very helpful, and I'm sure that if you give the company a call at (404) 256-2272, someone will be happy to work with you.

It is possible to modify the Windows font. The font file itself is essentially a table of bit maps, one for each character. The format is documented in several books and the Windows' SDK (Software Development Kit) documentation. Unfortunately, because the printer drivers do not use the same font file, hacking the font file won't help you, either. What you need is a version of Windows with a full Portuguese character set. For that, I called Microsoft.

Strike three. The problem, apparently, is that Portuguese has two characters that are not normally available in the ANSI set. A Portuguese version would have the following two things: (1) support for these two characters and (2) Portuguese menu prompts.

Microsoft is not yet shipping a Portuguese version of Windows, but one is currently in development. There's no word on when it will be released. In your area, you might call someone at Microsoft Brazil in Sao Paulo (55-11-5304455) and see if the people there can help you track it down.—H. E.

The Vectra and VGA

In the March issue, Frederik Wessels wrote about a compatibility problem between a Hewlett-Packard Vectra computer and a VGA video board. I may be able to help him. In my job, I take care of about 70 Hewlett-Packard Vectras. I have found a couple of things that make a Vectra work better with VGA cards.

Run the setup program that came with your computer. Under the "set system configuration" option on the main menu is a way to indicate what type of video card you have installed. Select VGA.

If that doesn't work, then you might want to go back to the setup main menu and enter the word YADA. That's right. The elusive "HP Support Personnel" menu will greet you. If you see a selection called "Shadow RAM video BIOS," you may want to turn it off. Your VGA card may not like to have its ROM BIOS shadowed into RAM, so disabling the shadow option may work.

Anyway, if neither of these suggestions works, then the problem is probably a conflict between the video card and Hewlett-Packard's ROM BIOS.

Steve Riley
Computer Systems Engineer
Ashland Chemical
Dublin, OH

Thanks!—Lab Staff

FIXES

- There are two corrections to "The Mac State of Mind" by Daniel Rasmus (January). First, Apple has no plans to develop or distribute Pearl Lisp. Second, "Macintosh Allegro Common Lisp" is the correct name for Apple's Lisp product.
- The 800 number for Enpower Corp., published in What's New in March, is no longer correct. Further information regarding Enpower will be made available if it comes to our attention.
- In listing 2 of "Flirting with Assembly" by Hugh Kenner (April), the fifth line should read as follows:
`$74/43/ { JZ L2 (+43) }` ■

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Publisher's price: $39.95

C WITH ASSEMBLY LANGUAGE
Steven Holzer

Strengthen your C programs with assembly language. This example-filled guide shows you how to write powerful C programs that run as quickly as the C-assembly language interface, and actually incorporate assembly language instructions into your routines.

You learn how to write stand-alone assembly language modules, how to use inline assembly language and pass parameters, how to link external files and assembly language functions to C, and much more.
Publisher's price: $29.95

FRACTAL PROGRAMMING IN C
Roger Stevens

This extraordinary guide helps you reproduce — and create your own — complex fractals on a personal computer. You get an invaluable library of C routines for creating a myriad of fractals and images, as well as compelling ways to apply fractals to physical sciences.

Along with a user-friendly review of fractals, you'll get dazzling illustrations and easy-to-use routines for an extraordinary collection of fractals. You'll have images ranging from Lorenzo and other strange attractors to population and bifurcation diagrams, from the snowflake and other von Koch curves to Peono curves, and much more.
Publisher's price: $24.95

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WHAT'S NEW

HARDWARE • SYSTEMS

Ultra-Comp's 386

The Ultra-Max 386-33 is an inexpensive system from Ultra-Comp that comes with a 64K-byte cache, 4 MB of RAM, a 160-MB 28-ms ESDI hard disk drive, VGA graphics (including the monitor), both 3½-inch 1.44-MB and 5¼-inch 1.2-MB floppy disk drives, and DOS.

The Micronics motherboard has a Phoenix BIOS, an Intel 82385 caching controller, and a math coprocessor port. A 32-bit memory slot handles up to 8 MB (up to 16 MB with a daughterboard). There's also room for five 16-bit and two 8-bit cards.

The keyboard has 101 keys, and the 8-bit I/O board has one parallel and two serial ports. The VGA graphics is controlled by a 16-bit Genoa board with 512K bytes of RAM and displayed on a 14-inch Sony Super VGA monitor with a resolution of 1024 by 768 pixels.

Price: $4595; add $150 for tower configuration.

Contact: Ultra-Comp, 11988 Dorsett Rd., Maryland Heights, MO 63043, (800) 435-2266 or (314) 991-1988.

Inquiry 1120.

Tower or desktop, the Ultra-Max 386-33 is packed with features.

ALR Shrinks Its Tower

The FlexCache 25386DT Model 40 from ALR is a redesign of the company's 386/25 tower system. It includes 64K bytes of cache memory, 1 MB of RAM, a 5¼-inch 1.2-MB floppy disk drive, a 40-MB 28-ms hard disk drive, a 101-key keyboard, and a 200-W power supply.

There's also room to expand with three free half-height bays and one 8-bit and six 16-bit slots. The hard disk drive controller is located on the motherboard, and up to 16 MB of RAM resides within the 32-bit memory slot. The floppy disk drive controller and serial and parallel ports are on one 16-bit card, which takes up one of the slots.

The FlexCache Model 40 measures 21½ by 17 by 6 inches and weighs 60 pounds.

Price: $2695.

Contact: Advanced Logic Research, Inc., 9401 Jeronimo, Irvine, CA 92718, (714) 581-6770.

Inquiry 1123.

Grid Systems' 1450sx laptop weighs 8½ pounds without a battery.

Battery Not Included

Grid Systems' new 8½-pound backlit-VGA laptop doesn't come with a battery, but the optional nickel-cadmium battery pack attaches to the bottom of the system and looks like a base. The 2-hour battery weighs 3 pounds, and the 4-hour battery weighs 4 pounds.

The Grid 1450sx comes with a 3½-inch 1.44-MB floppy disk drive, a 2½-inch 20-MB hard disk drive, a 10-inch diagonal VGA monitor, an 82-key keyboard, 1 MB of RAM, and a Phoenix BIOS. Standard ports include two RS-232C serial, one Centronics parallel, and one connector for an external monitor. You can expand RAM to 5 MB, and a 2400-bps internal modem with MNP 5 data compression is available.

Price: $4995; 2-hour battery, $299; 4-hour battery, $399; modem, $595; cigarette-lighter adapter, $25.

Contact: Grid Systems Corp., 47211 Lakeview Blvd., P.O. Box 5003, Fremont, CA 94537, (800) 222-4743 or (415) 656-4700.

Inquiry 1121.

Casio Introduces Fourth B.O.S.S.

The SF-9000 Executive B.O.S.S. (Business Organizer Scheduling System), a new notebook computer from Casio, uses four types of expansion cards.

The SF-9000 comes with 64K bytes of RAM (expandable to 128K bytes with the ES-100 memory card); a 6-row by 32-column display; a separate business card library and telephone directory; a memo function; a side-by-side two-month calendar display, schedule, and daily alarms; and world-time functions.

The SF-9000, which has a QWERTY keyboard, measures ¾ by 3¼ by 6 inches and weighs 8 $\frac{7}{10}$ ounces. Three cards are optional: the ES-600 electronic dictionary, the ES-610 financial/legal spelling checker, and the ES-620 medical spelling checker.

Price: $299.95; ES-100, $129.95; ES-600, $129.95; ES-610, $79.95; ES-620, $99.95.

Contact: Casio, Inc., 570 Mt. Pleasant Ave., P.O. Box 7000, Dover, NJ 07801, (201) 361-5400.

Inquiry 1124.

A Rewritable Optical Drive for DOS, Mac, or OS/2

The LaserVault 650 is a rewritable optical subsystem that lets you store data generated from within DOS and the Mac OS. In July it will also support OS/2.

The drive is a 95-ms Sony SMO-S501. Tecmar includes a SCSI board (ISA or Micro Channel architecture) and Tecmar's custom software.

The key to LaserVault's multiple operating-system compatibility is the single-partition format, Tecmar says. You use it to partition sections for your DOS files, sections for your Mac files, and sections for your OS/2 files. You can make partitions almost any size. And a feature Tecmar calls "DOS compatibility" lets you mix DOS 2.x through DOS 4.x files. "DOS compatibility" also eliminates the 32-MB partition limit for MS-DOS versions earlier than 3.30.

Software features include a manager function for setup, partitioning, and diagnostics; a device driver for direct access; and a backup manager for archiving.

The setup program automatically formats and partitions new media and lets you set up your own partitioning requirements. Diagnostics perform drive and media testing. And the archiving portion of the software supports automated backup.

Price: $5495; interface kits, $200 to $600.
Contact: Tecmar, 6225 Cochran Rd., Solon, OH 44139, (216) 349-0600.
Inquiry 1125.

The LaserVault 650 is a rewritable optical drive with multiplatform SCSI drivers.

Low-Priced Color Monitor Ships with VGA Controller

The VisionMaster PMV14VC/plus is a 14-inch color VGA monitor for your PC or Mac that features a dot pitch of 0.28 mm and a maximum resolution of 1024 by 768 pixels.

The interlaced or noninterlaced monitor comes with a three-quarter-length VGA (640- by 480-pixel) card that has 512K bytes of RAM. Other features include a bandwidth of 45 MHz, a vertical scan frequency of 50 to 90 Hz, a tilt-and-swivel base, a nonglare screen coating, brightness and contrast controls, and a horizontal scan range from 31.5 to 35.5 kHz.

Price: $789.
Contact: Sirex, Inc., 132-14 11th Ave., College Point, NY 11356, (800) 722-0404 or (718) 746-7500.
Inquiry 1127.

Store Files on 700-MB DAT

MegaDat is an inexpensive 700-MB 4-mm digital audio tape storage system for PCs that features a 60-second maximum access time.

It supports both sequential and direct access, is front-loaded, and can be configured as an internal or external peripheral. You need NetWare 286, DOS 3.0, 1 MB of RAM, a hard disk drive, and a 16-bit slot.

Price: Internal, $2750; external $2950; one tape, $36.
Contact: GigaTrend, Inc., 2234 Rutherford Rd., P.O. Box 4298, Carlsbad, CA 92008, (619) 931-9122.
Inquiry 1129.

SPREAD THE WORD

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

Scan Documents with the Xerox Datacopy GS plus

Xerox offers its 8-bit flatbed scanner with software for your Mac, DOS, or OS/2 system and a package that includes desk accessory software for Windows-compatible desktop publishing with Presentation Manager, PageMaker, and Ventura Publisher.

The Datacopy GS plus has a SCSI port for your Mac and an 8-bit SCSI add-in card for ISA and Micro Channel–based systems. The scanner is adjustable for start-stop times, defining read areas, and contrast.

It will scan documents up to legal size with scanning densities of between 75 and 300 dpi in 1-dpi increments. Typical scanning speed is 21 seconds for a two-shade letter-size document. Output modes include two-level, 256-level dither, and 4- or 8-bit gray scale.

The Datacopy GS plus weighs 22 pounds and measures $21\frac{1}{2}$ by $13\frac{9}{10}$ by $4\frac{7}{10}$ inches. Options include the Automatic Document Feeder.

Price: $2195; document feeder, $595.
Contact: Xerox Imaging Systems, 535 Oakmead Pkwy., Sunnyvale, CA 94086, (800) 248-6550.
Inquiry 1128.

continued

Speed AutoCAD Redraws by Factor of 25

The Artist XJS is a new 34020-based graphics coprocessor board designed for high-end CAD applications. Coupled with an Artist GT software driver, which uses display-list processing, the XJS board performs AutoCAD redraws at speeds of up to 25 times faster than if you used the standard AutoCAD driver, according to the manufacturer.

The base controller has 1 MB of video RAM and offers 1280- by 1024-pixel resolution with 16 colors or 1024- by 768-pixel resolution with 256 colors. Add another megabyte of video RAM and you get 1280- by 1024-pixel resolution with 256 colors and 1600- by 1200-pixel resolution with 16 colors. A palette of 16.7 million colors is standard with all versions.

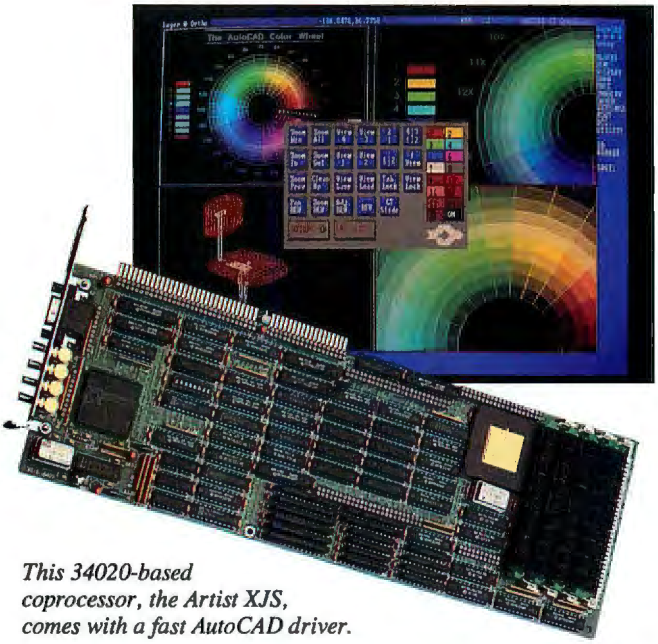
The base controller also has 1 MB of DRAM, which stores display lists. You can upgrade the DRAM with an optional 4 MB of user-installable single in-line memory modules.

You can use the XJS board in single-screen and dual-screen systems. You can use single-screen VGA pass-through using a multiscanning monitor.

Price: $3495; with 2-MB daughterboard, $4295; separate user-installable 2-MB daughterboard, $1000; VGA daughterboard, $795; VGA link, $249.

Contact: Artist Graphics, 2675 Patton Rd., St. Paul, MN 55113, (612) 631-7800.

Inquiry 1177.



This 34020-based coprocessor, the Artist XJS, comes with a fast AutoCAD driver.

IBM to Offer PS/2 Board and Software for Multimedia Work

IBM's new M-Motion Video Adapter/A is a Micro Channel card designed for multimedia. You use it to digitize and display video signals, and you can digitize sound and play it through a speaker.

The M-Motion Video Adapter/A can take National Television System Committee or phase alternate line input from video cameras, VCRs, videodisks, and TVs. You can manipulate motion or still images within windows, change the size of the windows, and lay text or graphics over the video images. You can use up to two standard stereo sources.

The software, the M-Control Program, provides tools for developing multimedia applications with the M-Motion Video Adapter. The package lets you control video and audio operations, such as changing the sharpness and color of an image on the screen or choosing the source of the input.

Price: $2250; M-Control Program, $150.

Contact: IBM, U.S. Marketing and Services, Westchester Ave., White Plains, NY 10604.

Inquiry 1134.

Add RAM in SIMMs to Your Deskpro 386s

Amkly Systems offers memory boards for your Compaq Deskpro that let you add 32-bit RAM modules for less than the competition.

The AMpac series boards all fit the Deskpro's 32-bit memory slot and let you upgrade your Deskpro's standard 2 MB with up to 13 MB of single in-line memory modules. The AMpac-SIMM-1000s and AMpac-SIMM-4000s feature 1 MB and 4 MB, respectively.

Price: AMpac-SIMM1000s, $695; AMpac-SIMM4000s, $1795.

Contact: Amkly Systems, Inc., 60 Technology Dr., Irvine, CA 92718, (714) 727-0788.

Inquiry 1133.

continued

RasterOps Board Puts Live Video on Mac Screen

With RasterOps' NuBus ColorBoard 364, you can inexpensively create full-motion video with your Mac. It captures video in 24-bit color from any National Television System Committee (NTSC) source—such as a TV, a VCR, or an S-Video recorder—and can display it in real time (30 frames per second) on any noninterlaced Macintosh screen.

Your Mac II can then display live, incoming video in a resizable window while running another software application. RasterOps claims that the ColorBoard 364 can run the live video simultaneously with any application without any performance degradation or interruption. MultiFinder is not required.

Accompanying software lets you select pixel depths (to adjust color), virtual screen size (from 640 by 480 pixels up to 4096 by 512 pixels), hardware pan and zoom, and other options. The frame-grabbing application "grabs" frames in real time (1/30 second). A series of HyperCard XCMDs (external links to other applications or peripherals) are included for developing multimedia applications.

RasterOps also plans a series of ColorBoard 364 add-on products for conversion to NTSC or to receive and tune broadcast signals.

Price: $1995.

Contact: RasterOps Corp., 2500 Walsh Ave., Santa Clara, CA 95051, (408) 562-4200.

Inquiry 1132.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Share Your LaserJet III

With the new ShareSpool cards from Extended Systems, you can connect up to four computers to one LaserJet. You install a card in the I/O slot in the printer.

The higher-performance 2094A connects through optionally available custom twisted-pair cables and Centronics parallel ports. The 2041C uses serial ports.

With the 2094A, PCs can be located up to 100 feet from the LaserJet Series III, and it provides 1 MB of RAM for spooling. Each 2094A accepts up to four simultaneous data signals at rates approaching 240,000 bps each.

The 2041C includes 256K bytes of RAM (a 1-MB version is also available). Data rates approach 19,200 bps.

Price: 2094A, $845; 25-foot cable, $70; 100-foot cable, $140; 2041C, $495; 1-MB 2041C, $690.
Contact: Extended Systems, 6062 Morris Hill Lane, Boise, ID 83704, (208) 322-7163.
Inquiry 1135.

ShareSpool cards connect your LaserJet to as many as four computers. They also provide RAM for spooling.

No More Bad RAM

Simcheck is a portable memory module tester for single in-line memory modules and single in-line packages.

It features a 16-bit 10-MHz V20 processor and an automated digital speed synthesizer for testing access time down to 20 ns. The two-line LCD displays module type, size, and speed. Simcheck then tests all data bits so you don't have to manually switch from bit to bit.

Auto loop test is a standard feature; Simcheck automatically generates test patterns. Simcheck also comes with programmable voltage sources for advanced testing techniques, including voltage bounce and voltage cycling. A chip-heat mode warms modules for temperature-dependent tests.

Innoventions says that Simcheck will identify defective chips within modules and open- and short-wiring problems and will provide repair information. Simcheck measures 5 by 7 by 1½ inches and weighs less than 2 pounds.

Price: $995.
Contact: Innoventions, Inc., 11000 Stancliff, Suite 150, Houston, TX 77099, (713) 879-6226.
Inquiry 1137.

Add Memory to Your IBM LaserPrinter

LP Memory is a memory module that lets you add 1, 2, or 3.5 MB of RAM to your IBM LaserPrinter 4019.

Pacific Data Products says that upgrading memory will let you take advantage of IBM's memory manager, which dynamically allocates RAM for soft fonts, bit maps, or a spooling buffer, depending on what type of print job you're performing.

Additional memory also lets you download fonts and forms, print at the maximum resolution of 300 dpi in desktop publishing applications, and perform higher-resolution printing in the plotter mode. You can also use LP Memory as a spooling buffer for the IBM printer-sharing option (for up to six PCs). The 4019 printer-sharing option is not buffered, relying on either the printer or processor memory for buffering activities.

Price: 1 MB, $395; 2 MB, $595; 3.5 MB, $895.
Contact: Pacific Data Products, 6404 Nancy Ridge Dr., San Diego, CA 92121, (619) 552-0880.
Inquiry 1136.

Control Stepper Motors from Your Parallel Port

A new kit and software called Indexer LPT from Ability Systems lets you control an included stepper motor through your computer's parallel port.

The starter kit includes a motor, a driver, a single-axis cable (for one motor), limit switches, and a manual that tells you how to use the Indexer LPT software. With the kit, you can control a motor axis with respect to position, home position, maximum and minimum velocity, acceleration, and automatic return to home.

LPT software, which loads as a device driver, can control up to six motors at once (through three printer ports). Included diagnostic software lets you troubleshoot motor problems.

Price: $600; software alone, $199.95.
Contact: Ability Systems Corp., 1422 Arnold Ave., Roslyn, PA 19001, (215) 657-4338.
Inquiry 1140.

Travel Overseas Without Worry About Foreign AC

The lapAdapt plug converter lets you use your laptop computer in many foreign countries without worrying that the AC will harm your machine or, more important, the data within, the manufacturer claims.

The grounded plug adapter converts 110-V to 240-V AC to work with your American-compatible laptop's AC power adapter and adds a grounding plug. You plug your AC adapter into lapAdapt's grounded connector.

The grounded connector plugs into the British adapter plug for the U.K. (about 2 inches square on each end with a 1-foot power cable in between) or into an included plug for other foreign outlets (also about 2 inches square).

Price: $49.95.
Contact: lapAdapt Electronics, 169 11th St., P.O. Box 611, Hoboken, NJ 07030, (201) 798-3030.
Inquiry 1138.

continued

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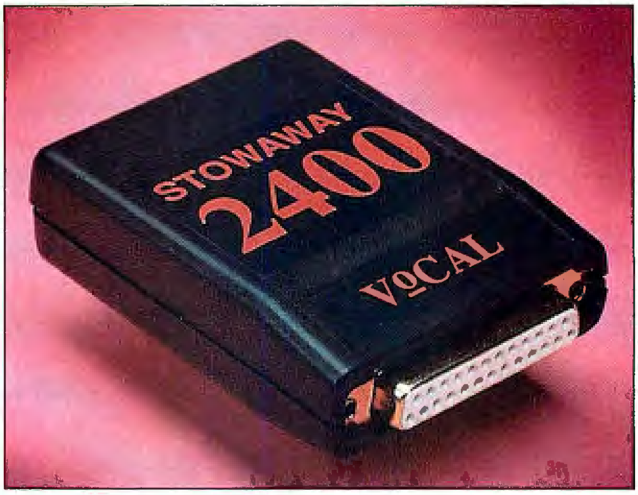
CONNECTIVITY



VoCal makes the Stowaway 2400 smaller by using telephone line power.

Pocket Modem Needs No Battery

The Stowaway 2400 is a pocket-size 2400-bps modem that uses telephone line power instead of a 9-V battery. Features include backward compatibility, auto-dial, auto-answer, and a 40-character command buffer.

All phone companies provide line power for tones and ringers at a guaranteed 20 milliamperes, and that's enough to power your Stowaway 2400 even if your telephone line is 20 miles from the nearest phone company generator.

The Stowaway measures 3 by ¾ by 2 inches and weighs 2⅕ ounces.

Price: $295.

Contact: VoCal Technologies, Ltd., 3032 Scott Blvd., Santa Clara, CA 95054, (408) 980-5181.

Inquiry 1141.

Low-Priced LAN Uses Parallel Ports

The PC-InterLink is a peripheral-sharing and file transfer network with a peer-to-peer network operating system, and hardware.

With the starter kit you can link two DOS-based personal computers. The hardware includes two parallel-port adapters, two 10-foot cables with RJ-11 connectors on the ends, and a four-port junction box. You can locate as many as four computers up to 100 feet from the junction box. The data transfer rate approaches 9600 bps, depending on your system's processor.

Price: Starter kit, $199.95; additional nodes, $49.95.

Contact: SoftWorx, 801 East Campbell Rd., Suite 355, Richardson, TX 75081, (214) 480-8278.

Inquiry 1150.

New Crosstalk Communications for NetWare LANs

New versions of R2LAN and Crosstalk XVI software now run on NetWare. R2LAN 2.0, a server-based remote-control program, now supports Novell's IPX/SPX transport protocols, as well as those of NetBIOS. Another new feature is the Guard Host Security System, which lets you control access to files on an individual basis. File transfer has also been enhanced, and hosts are now able to initiate calls to clients.

Version 3.71 of the network server version of Crosstalk XVI now has support for Novell's NetWare Asynchronous Services Interface, allowing you to communicate with a Novell LAN Asynchronous Communications Server.

Other features new to the network version include call logging, a command-line editor, support for files in other directories, and enhancements to Kermit and the program's scripting language.

Price: R2LAN, $795; Crosstalk XVI, $600.

Contact: Crosstalk Communications, 1000 Holcomb Woods Pkwy., Roswell, GA 30076, (404) 998-3998.

Inquiry 1145.

OS/2 Multitasking Communications Called MLink

MLink, a multiplatform data communications software package, has been redesigned from its DOS, Mac, and Unix roots to work with OS/2. It provides terminal emulation, error-free file transfer, data compression, and a built-in scripting language for automated operation.

It operates in OS/2's protected mode and can exploit such multitasking features as simultaneous communication from multiple ports, and interprocess communications. A development system version with a scripting compiler is also available.

A companion product, MLink Polling Manager, uses OS/2's multitasking as it works to automate file transfers with remote systems.

Price: MLink, $310; MLink Development System, $395; MLink Polling Manager, $695 to $3995.

Contact: Corporate Microsystems, Inc., Mt. Support Rd., P.O. Box 2059, Lebanon, NH 03766, (603) 448-5193.

Inquiry 1144.

continued

Save RAM with LANsmart 2.0

LANsmart 2.0 is a peer-to-peer network operating system that can run workstations and servers in as little as 10K and 64K bytes of RAM, respectively. It can also run concurrently with NetWare 2.15.

The RAM conservation is due to LANsmart's use of about 64K bytes of extended memory on workstations and about 70K bytes of extended memory in your server.

You can purchase LANsmart 2.0 in a starter kit that includes two ARCnet cards plus cabling (you must buy additional ARCnet cards separately). Ethernet and Token Ring kits are also available, as are cards.

If you want to run LANsmart on top of NetWare, you'll need a separate product called LANsmart NW, which you load on your NetWare 2.15 server. One possible application for running concurrent operating systems is using one tape backup system for the server and, through the peer-to-peer LANsmart, using another tape backup system for server-based tape backup of remote hard disk drives.

Price: ARCnet starter kit, $595; additional cards, $195; Ethernet or Token Ring starter kit, $1300; additional cards, $369; LANsmart NW, $595.

Contact: D-Link Systems, Inc., 5 Musick, Irvine, CA 92718, (714) 455-1688.

Inquiry 1143.

One step closer to a mainframe of your own.

Hard to believe? Take a look at the benchmarks.

The STEP 486*is*™ breezes past both an IBM 3083 mainframe and a CRAY-X-MP/48 supercomputer as if they were standing still.

The primary reason is Everex's proprietary Advanced Memory Management Architecture. We were the pioneers in bringing this write-back technology from the mainframe to the desktop.

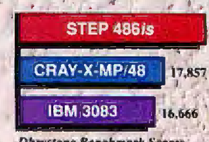
AMMA™ enhances the i486™ embedded cache—a combination we call "Two-Tier Caching." It makes the STEP 486*is* one of the fastest 486 PCs available today.

And AMMA is scalable from 64K to 256K. In small cache architectures, performance can suffer when main memory increases. AMMA cures this problem.

The upshot of it all? The STEP 486*is* will not only take you into the next generation of software, it'll run today's 286 and 386 software with scorching speed.

But users of STEP™ 386 machines can still keep up. The STEP 386/20 and 386/25 can easily be upgraded to a STEP 486*is* simply by replacing the CPU with an IN STEP™ 486 daughterboard.

Which means the next step closer to your own mainframe is not that big a step at all.



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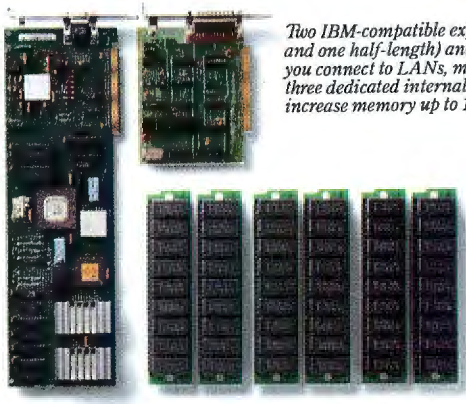


Two IBM-compatible expansion slots (one full-length and one half-length) and an internal modem slot let you connect to LANs, mainframes and more. Plus, three dedicated internal expansion slots let you increase memory up to 13MB.

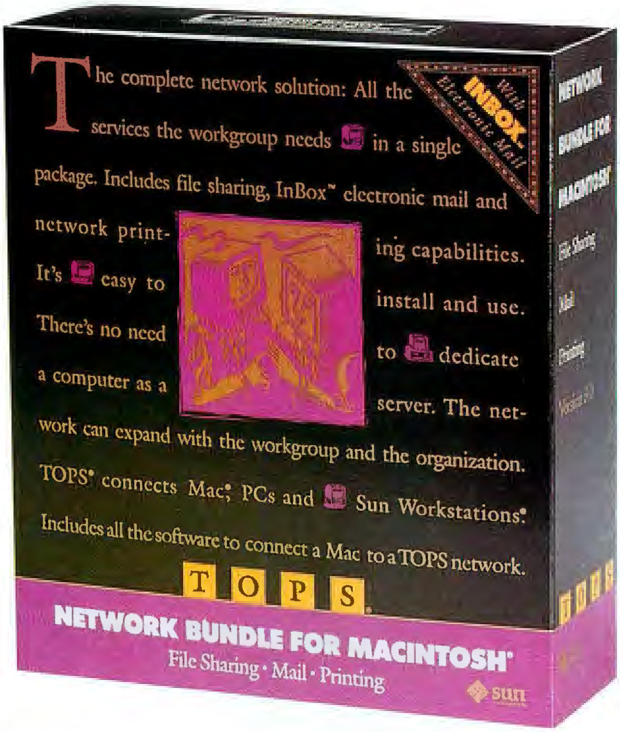
CONNECTIVITY

TOPS Network Bundles for DOS and Mac

The Network Bundle for DOS and the Network Bundle for Macintosh include new versions of the TOPS file-sharing system and the new InBox 3.0 E-mail system. The Network Bundles are designed to provide the three most common network services—file sharing, printer sharing, and E-mail.

TOPS Network Bundle for DOS has the new features of TOPS 3.0, including extended memory support. TOPS occupies between 65K and 230K bytes of conventional memory, depending on the configuration of the system. Also, you now can configure the file- and print-sharing systems to include only those features you actually use.

TOPS users now can print DOS applications directly to networked Apple LaserWriter printers. Also, because TOPS supports the Apple Filing Protocol (AFP) and the Hierarchical File System, a PC can operate as a file server for Macintoshes on your network.



File sharing and E-mail are now bundled by TOPS.

TOPS Network Bundle for Macintosh works with AFP-compatible multiuser applications such as 4th Dimension, FoxBase+, and FileMaker II. It now supports the AppleTalk limit of 254 zones and up to 254 servers per zone, and the new Apple LaserWriter drivers (6.0). A new version of MacLinkPlus/TOPS from DataViz is included, replacing the file translators found in previous versions of TOPS/Macintosh.

Price: Network Bundle for DOS, $249; Network Bundle for Macintosh, $299; DOS or Mac site upgrade, $125, or $185 for both.
Contact: TOPS, 950 Marina Village Pkwy., Alameda, CA 94501, (415) 769-9669.
Inquiry 1142.

NetWare Printing Made Easier

Two new versions of PS-Print, 3.0 and 3.1, are now available to help you print from any personal computer on your NetWare 2.1 to 2.15 LAN and NetWare 386 LAN, respectively.

PS-Print 3.0 gives you better flexibility in assigning print servers and is now compatible with NetWare-networked PCs that use noninterrupt-driven printer ports, Brightwork Development says. PS-Print 3.0 and 3.1 use about 8K bytes per printer on the print server.

Price: Site license for PS-Print 3.0 or 3.1, $395.
Contact: Brightwork Development, Inc., 766 Shrewsbury Ave., Jerral Center West, Tinton Falls, NJ 07724, (800) 552-9876 or (201) 530-0440.
Inquiry 1149.

continued

A Trio of Fax Modems

The 2400PF Fax/Modem from Micro Electronic Technologies is a low-priced pocket-size V.22bis (2400-bps) modem coupled with a send-only V.29 (9600-bps, Group 3) fax device. The unit measures 1 by 4½ by 2¾ inches, including the 9-V battery.

The backward-compatible (to 1200, 600, and 300 bps) data communications device doesn't include the "pass-through" port of its recently introduced 1½- by 5½- by 4-inch 2400XF sibling but does have software for timing faxes and for personal phone directories.

Price: 2400PF Fax/Modem, $279; 2400XF, $239.
Contact: Micro Electronic Technologies, Inc., 35 South St., Hopkinton, MA 01748, (508) 435-9057.
Inquiry 1146.

If you're on the road and need to receive faxes as well as send them, then The Complete Fax Portable might serve you well.

It's a V.29 (9600-bps, Group III) send-and-receive fax device. The Complete Fax Portable measures 1 by 5¾ by 3 inches and weighs 10 ounces, including the 9-V battery that is rated for 3 hours of continuous use.

An included TSR program resides in about 60K bytes of main memory and features the usual modem/fax features: timed faxing, a database of frequently faxed numbers, direct scanning, and broadcast.

Price: $499.
Contact: The Complete PC, 1983 Concourse Dr., San Jose, CA 95131, (800) 634-5558 or (408) 434-0145.
Inquiry 1147.

The FaxDat from Xecom is a V.22bis/V.29 fax modem with send and receive capabilities in an add-in card for your Compaq SLT/286, NEC ProSpeed 286, Toshiba T1600, or Zenith SupersPort 286.

When faxing, the card has fallback rates of 7200, 4800, and 2400 bps. If you use it for data communications, it includes MNP Level 5 error correction and data-compression technology and is backward-compatible with the V.22 and Bell standards. Each card is shipped with fax software.

Price: $625.
Contact: Xecom, Inc., 374 Turquoise St., Milpitas, CA 95035, (408) 945-6640.
Inquiry 1148.

Get the latest Word from SCO.

Microsoft Word 5.0 for UNIX Systems.

You've come to depend on SCO™ for the latest UNIX® System software solutions for PCs. Industry standards such as SCO™ XENIX® 386 and SCO UNIX System V/386 Release 3.2. World-famous applications such as SCO Professional,® the 1-2-3® workalike, and SCO™ FoxBASE+.™

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With Microsoft Word 5.0 for UNIX Systems, you can share a single copy of Word — on a single PC — with an entire work-group of 16, 32, or even more users on inexpensive terminals.

And your workgroup can share documents, style sheets, forms, macros, glossaries, and outlines — plus group review and editing features such as annotations and redlining — while sharing expensive printers and other resources as well.

Of course, Microsoft Word 5.0 for UNIX Systems still gives you Word's advanced productivity features. Data, text, and graphics integrated in a single document. Text flow around graphics. Side-by-side columns. A vast array of fonts and sizes. Links to spreadsheets and other programs. Line and box drawing. Spell checker and thesaurus. Speedkeys. And a whole lot more.

Microsoft Word 5.0 joins SCO's powerful team of multiuser business applications.

And since it's compatible with SCO Portfolio,™ Microsoft Word 5.0 for UNIX Systems supports the SCO Portfolio Clipboard, letting you copy and paste data to and from other popular applications such as SCO Professional and SCO FoxBASE+.

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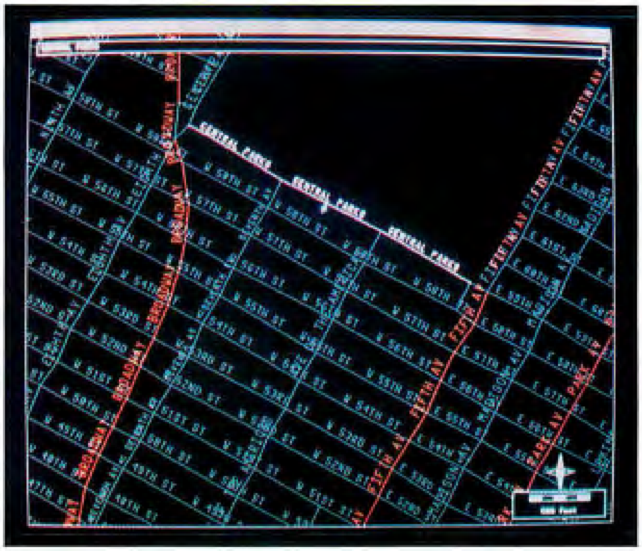
Circle 235 on Reader Service Card

Generate Mapping Applications with TerraView

TerraView is a library of cartographic functions that you can use to integrate and display user data in map form for demographics, real estate, and other applications that manipulate spatial information. According to TerraLogics, the library lets you treat maps and data as objects without concern for graphical screen operations or disparate map data formats.

TerraView can link symbols and text on a map to records in a database; applications can overlay, display, and operate on map data from the U.S. Geological Survey, Etak, Rand McNally, the U.S. Census Bureau, and other sources. TerraView functions, such as zoom, user-defined symbols, rotation, and scaling, are callable from many programming languages. Written in C, the library lets you write applications for DOS, Unix, the X Window System, Microsoft Windows, and VMS.
Price: $3495.
Contact: TerraLogics, 114 Daniel Webster Hwy. S, Suite 256, Nashua, NH 03060, (603) 889-1800.
Inquiry 1152.



An application created with TerraView responds to an inquiry about Central Park by highlighting downtown Manhattan.

Object-Oriented Pascal for the Mac

Symantec has released a new version of Think Pascal that supports Apple's MacApp library of classes for object-oriented programming in Pascal and includes Symantec's own Think Class Library, giving programmers a choice between a library that's comprehensive (MacApp) and one that's comprehensible (TCL).

A new class browser lets you examine and edit classes, while providing a way to navigate through complex object-oriented programs so that you can see how classes in a program are related. The browser shows a family tree for all the classes in a program so that you can see all the messages a class handles.

Think Pascal 3.0's linker supports segmentation directives that give you greater control over how programs are segmented. You can structure code in logical and functional units, and the linker strips out unused code down to the procedure level so that unused code portions don't add to the size of the final application. Symantec also improved the environment's resource editing capabilities, including resource tools licensed from Apple such as Rez, DeRez, and PostRez. Version 3.0 can now handle source files of up to 32,000 lines.

To run Think Pascal 3.0, you need a Mac Plus with 1 MB of RAM. You'll need 2 MB to run TCL and 4 MB to run MacApp.
Price: $249.
Contact: Symantec Corp., 10201 Torre Ave., Cupertino, CA 95014, (408) 253-9600.
Inquiry 1154.

A Simpler Look and Feel

A new version of Look & Feel, the designer utility that lets you prototype and simulate screens and turn them into C source code, is simplified and more portable than previous versions, Oakland Group says.

All the lower-level machine-dependent routines are isolated in the Oakland Windowing Library, so you can port the applications you build with Look & Feel 3.1 among different operating systems, such as DOS, OS/2, and Unix. Other improvements include fewer levels of indirection, smaller executables, and the ability to produce context-sensitive help. Look & Feel works with the company's C-scape Interface Management System, a programming library that helps you create data-entry, menu, help, and text screens, handling text and graphics together.
Price: $399 with C-scape; $149 without.
Contact: Oakland Group, Inc., 675 Massachusetts Ave., Cambridge, MA 02139, (800) 233-3733 or (617) 491-7311.
Inquiry 1156.

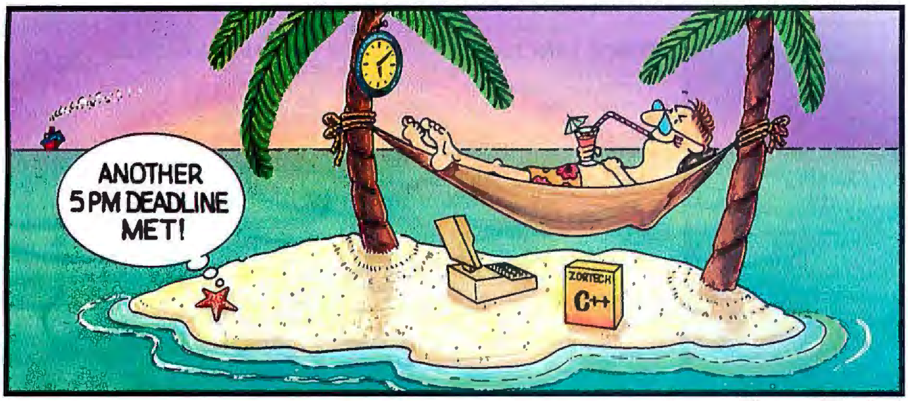
Identify Bottlenecks with Borland's Profiler

Borland says that the profiler recently added to its Turbo line is the first interactive profiler for PCs. With Turbo Profiler, you can highlight slow pieces of code and bottlenecks in programs, allowing you to rewrite slow portions or use different algorithms.

Turbo Profiler provides histograms, percentage values, and other statistics with which to measure the performance of selected parts of a program. You can examine code at the machine level, statement by statement, by groups of statements, by routines, or by defined areas. The profiler can map every time a selected piece of code is called, or it can take a statistical sampling. The menu-driven profiler can profile any program that has associated .MAP or CodeView tables.

Turbo Profiler 1.0, along with Turbo Assembler 2.0 and Turbo Debugger 2.0, constitute Borland's Turbo Debugger & Tools.
Price: Turbo Debugger & Tools, $149.95.
Contact: Borland International, 1800 Green Hills Rd., P.O. Box 660001, Scotts Valley, CA 95066, (800) 543-7543 or (408) 438-8400.
Inquiry 1153.

continued



Overtime...the C++ way!

Zortech... has brought the benefits of C++ to the masses since releasing the world's first native code C++ compiler for MS-DOS in June 1988. In November 1989, Zortech released the world's first C++ V2.0 MS-DOS and OS/2 native code compilers as well as the world's first MS-DOS source-level C++ debugger.

WHY C++?

C has been the language of choice for creating software to keep pace with advances in semiconductors and transmission systems. **C++ is today's choice.** C++, as a superset of C, offers all of C's advantages...and more. C++ is an object-oriented language which increases programmer productivity by helping to organize code and create reusable code. It's easier to conceptualize, implement and maintain an application using C++, giving the C++ programmer more time for other worthwhile projects and pursuits.

Zortech C++ Developer's Editon is the next generation MS-DOS C++ Compiler. One package includes the Zortech C++ Compiler, a C++ source-level debugger, a full set of popular classes, as well as complete source code to the standard library.

Zortech C++ Developer's Edition 2.0 features the latest AT&T V2.0 features such as multiple inheritance and type safe linkage, and it's now Microsoft Windows compatible.

WHY ZORTECH?

"Zortech is truly a fine compiler...If you've been waiting for a major player to offer a professional's C++ development system for OS/2 and Windows, as well as DOS, wait no longer...Zortech has it!"
- Richard Hale Shaw, *PC Magazine*, p. 38, March 13, 1990

"Zortech has done a commendable job with C++ 2.0, and I recommend it highly...The debugger is impressive...If you can afford it, get the developer's version...it's worth the money!"
- Bruce Eckel, *Micro Cornucopia*, pp. 8-17, March 1990

"The Zortech C++ Compiler has become an intimate part of the work I do...Zortech C++ is one of the best MS-DOS products I've had the luck to use. If you want to work with C++ 2.0 on an MS-DOS computer, I can highly recommend the Zortech 2.0 release."
- Scott Robert Ladd, *Dr. Dobbs Journal*, pp.64-73, January 1990

C++...The Video!

Zortech has commissioned a C++ video tutorial. The rules were: present C++ as simply as possible, make it teach C programmers C++ in the shortest possible time, and make it compiler/machine independent. It's now available...31 tutorials on six one-hour VHS tapes. Comprehensive workbook and tutorial disk are included.
PHENOMENAL TRAINING VALUE!

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C++ Compiler	199.95	**165**
C++ Debugger	149.95	**129**
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C++ Tools	149.95	**129**

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Corel Draw!	595	399
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HALO DPE	195	139
Lattice HighStyle	375	319
MKS SQPS	495	479
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Ventura Publisher	895	525
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Derive	200	179
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Mathematica 386	695	625
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LABTECH Acquire	195	179
LABTECH Notebook	995	779
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STATGRAPHICS	895	586
Tango PCB Series II	595	559
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386 MAX	75	66
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Norton Utilities	100	65
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Greenleaf DataMath Interface	75	69
Greenleaf DataWindows	395	309
Greenleaf DataWindows, OS/2	395	299
Greenleaf Functions	229	165
Greenleaf MakeForm	125	95
Greenleaf SuperFunctions	299	209
Greenleaf ViewComm	559	475
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MKS LEX:YACC	249	197
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MKS SQPS	495	479
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MKS Trilogy	119	105
MKS Vi	149	125
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Periscope 386 Flex Cable	400	359
Periscope Flex Cable Adaptor	350	319
Periscope I/OK	495	429
Periscope I/512K	595	505
Periscope II	175	125
Periscope II-x	145	99
Periscope III/10 MHZ	1395	1067
Periscope IV/16 MHZ	1995	1695
Periscope IV/20 MHZ	2295	1949
Periscope IV/25 MHZ	2595	2195
Periscope Plus Board 0K	300	269
Periscope Plus Board 512K	400	339
QUARTERDECK		
DESQview	130	115
DESQview/386	189	169
Manifest	60	53
QEMM-386	100	89
QRAM	80	72
RAIMA		
db_FILE/RETRIEVE	295	249
db_FILE/RETRIEVE Multi-User	595	569
db_FILE/RETRIEVE UNIX	595	479
WKS Library	195	169
SAGE SOFTWARE		
C Beautifier	50	42
Dan Bricklin's Demo II Program	199	159
PFinish	295	259
PFix86Plus	295	259
Plink86plus	495	395
PolyAWK	99	85
OS/2 Version	199	179
PolyBoost II	80	72
PolyDoc	199	169
PolyLibrarian	99	85
PolyLibrarian II	149	125
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Professional PVCS (Corporate)	495	419
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Watcom C8.0 Professional	495	419
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Programmer's Policies

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Unbeatable Prices
We'll match nationally advertised prices. (Subject to same terms and conditions.) Prices subject to change without notice.

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Disk seals cannot be broken unless manufacturer's policy states otherwise. Call for R.A. number.

Greenleaf CommLib 3.0

NEW! CommLib 3.0, the ultimate RS-232 library for C programmers. Interrupt driven file transfers in KERMIT, XMODEM, YMODEM, and ASCII are just a function call away. CommLib 3.0 includes support for RTS/CTS and XON/XOFF, baud rates up to 115.2Kb, and support for up to 35 ports on multiport boards. Modem control is easy with the more than 40 functions for Hayes compatible modems. Run different baud rates and protocols on several ports at the same time! Greenleaf's package includes on-line help, a five-hundred page manual, and free telephone support.

GREENLEAF Software®

List: $299 Ours: $209

Periscope... for REAL real-time Debugging

When you need to see what happened before your program crashed, and you need to see it in REAL real-time, the only way to do it is with a hardware-assisted debugger that offers you a hardware trace buffer as well as hardware breakpoints. Periscope offers the most powerful, yet cost-effective, line of hardware-assisted debuggers around. Next time your software-only debugger runs out of steam, check out Periscope® Model III (PCs and ATs running up to 10 MHz) and Periscope® Model IV (286s and 386s running up to 25 MHz). Call (800) 722-7006 or 404/875-8080 for technical assistance.

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db_FILE combines relational B-tree indexing and network model database technology assuring flexibility and optimum performance. Both access methods may be used independently or in combination for real power. db_FILE is written in C. Your db_FILE applications will be portable to most C language environments.

Special offer: Buy db_FILE now at our low special price and you will also receive complete C source code and db_RETRIEVE, the SQL-based Query and Report Writer.

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RAIMA™ CORPORATION

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WATCOM C8.0/386 is a 100% ANSI C optimizing compiler and run-time library for the Intel 80386 architecture generating applications for 32-bit protect mode. You can go beyond the 640K DOS limit when porting existing software or developing new applications. Importantly, library and source code compatibility with Microsoft C simplifies many porting projects. Significant features include: protected mode version of the compiler; VIDEO full-screen source-level debugger; Microsoft library- and source-compatibility; execution profiler; high-performance linker; graphics library.

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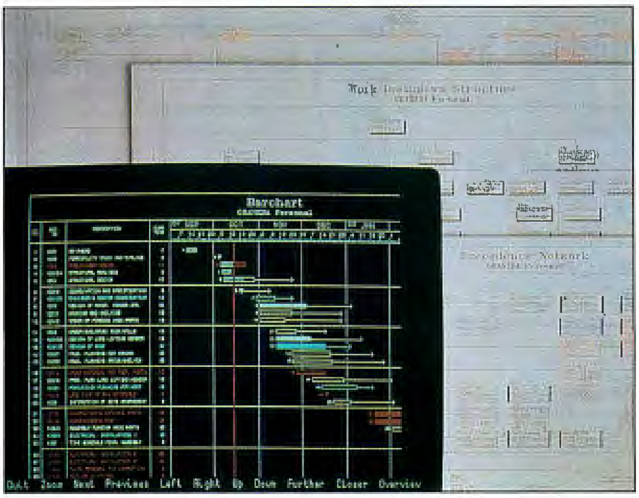
Graphics for Project Management Systems

Project management systems, while good for organizing schedules and tracking tasks, often provide only rudimentary graphical output at best. A new program called Graneda Personal uses a menu interface to work with project management systems such as Superproject Expert, Time Line, Artemis, Project Workbench, and Microsoft Project to create four types of drawings.

American Netronic says that a chart produced with Graneda Personal will have up to six times fewer crossovers than a drawing produced by a project management system.

The program runs on the IBM PC with 640K bytes of RAM and a hard disk drive.
Price: $995.
Contact: American Netronic, Inc., 110 Newport Center Dr., Newport Beach, CA 92660, (714) 760-8642.
Inquiry 1157.



The four types of drawings that Graneda can create include precedence network, arrow network, bar charts, and work breakdown structures.

Business Graphing on the Mac Without Typing Numbers

Tree Star's newest version of FlexiGraphs, the program that lets you create and edit business graphs without typing numbers into tables, includes a polynomial curve-fitting function. Once you draw a curve in a graph, FlexiGraphs 1.1 will generate a polynomial equation of that curve. The program also has new functions to smooth hand-drawn curves.

FlexiGraphs works in conjunction with Excel, WingZ, Cricket Graph, and DeltaGraph by taking a different view of presentation graphics. Unlike other packages that require you to enter and change the data to create and modify charts, FlexiGraphs lets you create a spreadsheet from a graph. By changing the graph (i.e., drawing directly on it with a mouse), you change the numbers "behind" the graph that go into the spreadsheet, letting you perform what-if and break-even analyses intuitively.

FlexiGraphs 1.1 runs on the Mac Plus.
Price: $179.
Contact: Tree Star, Inc., 1802 Hillside Rd., Santa Barbara, CA 93101, (805) 682-4096.
Inquiry 1162.

Integrated Business Management on the Mac

Colleague 2 integrates scheduling, pricing, billing, job traffic, income and expense reports, and other business management functions. You can customize its screens and fields in the database. The program has a built-in mail-merge function.

Other features include graphing for reports, general ledger, sales reports, accounts receivable, and a daily calendar.

The program includes a run-time version of 4th Dimension and requires a Mac Plus with at least 2 MB of RAM.
Price: $395.
Contact: Colleague Business Software, Inc., 10000 Research Blvd., Suite 210, Austin, TX 78759, (512) 345-9964.
Inquiry 1161.

DRI Eases Presentation Pain

The new version of Digital Research's Presentation Team offers text charting, drawing, and graphics capabilities. Version 2.0 gives you desktop publishing–type control over word charts and a preview window that lets you see—all on one screen—the changes that take place in your image as you select different attributes.

You can create and edit presentations with all visuals in one file so that you need not close one file and reopen another to view the next slide in a presentation.

The program supports GEM, CGM, PIC, EPS, and several other file formats. The program runs on the IBM PC with 640K bytes of RAM.
Price: $495.
Contact: Digital Research, Inc., P.O. Box DRI, Monterey, CA 93942, (408) 649-3896.
Inquiry 1158.

continued

New Spreadsheet Runs Under the X Window System

The eXclaim! program, which Quality Software says is the first spreadsheet to run under the X Window System, uses the OSF/Motif graphical user interface and takes advantage of X Window's mouse-driven windowed interface, not just the X terminal emulator. The Motif interface is carried throughout as eXclaim! uses its own three-dimensional pop-ups and icons. The new program has all the standard features of other spreadsheet programs like Lotus 1-2-3 and Microsoft Excel, including graphs and an alternate command interface bound to the Lotus-standard / (slash) key.

Fonts are adjustable, and Quality Software says that PostScript and LaserJet printers will produce near-WYSIWYG output when printer and screen fonts can be matched.

eXclaim! is for Unix System V 3.2 and 4.0 systems, Xenix, and OSF/1.
Price: $1000 to $10,000.
Contact: Quality Software Products, Inc., 5711 West Slauson Ave., Suite 240, Culver City, CA 90230, (213) 410-0303.
Inquiry 1159.

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The PC version includes interface cables for the IBM® PC, AT, PS/2 and compatibles. A utilities diskette with test and reset software, an Autodesk® Device Interface™ driver, Universal Mouse Emulator™ and a Microsoft® Windows driver. And an offer for a free tablet template (US and Canada only) worth over $245.

The Macintosh version has an Apple® Desktop Bus™ interface device to connect the tablet to the computer.

You'll also get the most software compatibility with over 250 PC programs and all Macintosh SE and II software written under the Apple Software Developers guidelines.

SummaSketch II tablets have a standard accuracy measurement of ±0.015 inches, selectable resolution of up to 1,016 lines per inch and high proximity so you can trace from documents up to ½" thick. Add in convenience features such as a power/proximity light, on-off switch, wedge shape design for easy use, lightweight construction for portability—and it's easy to see why SummaSketch is the industry standard and the obvious choice of today's computer professionals.

Best of all, you get all of these benefits at an affordable price. And that's why our new SummaSketch II is the easiest buying decision you have to make. Find out more about SummaSketch II today. For literature and the name of a local dealer call 1-800-888-2028, Ext. 304. For technical information call 203-881-5400.

PC MAGAZINE EDITORS' CHOICE
November 28, 1989
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For IBM/Compatible information circle 261, For Macintosh information circle 262, For Dealer inquiries circle 263 on Reader Service Card.

Finite Element Analysis on the Mac

LapCAD Engineering's new version of LapCADII, a finite element modeler that runs on the Mac, supports model sizes of up to 10,000 nodes. A PICT interface lets you run a blueprint through a scanner, read the resulting PICT file, reproduce the drawing, and mesh it into a finite element or solids model.

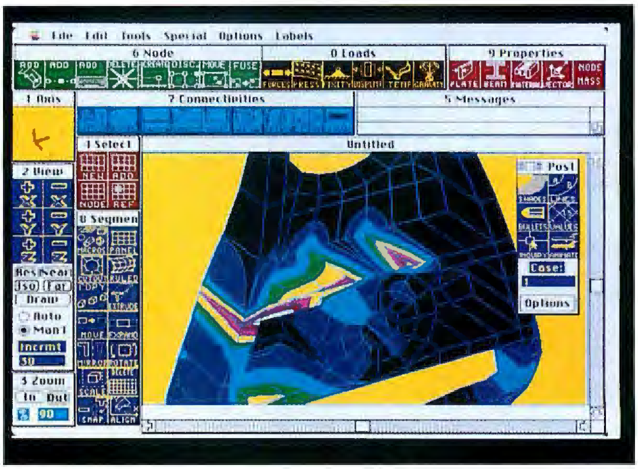
LapCADII 4.0 serves as a preprocessor and postprocessor for two finite-element-analysis programs, MSC/pal and MSC/pal 2, developed by MacNeal-Schwendler. Once the model is analyzed by the MSC programs, you use LapCADII to view the shapes and stresses.

LapCADII 4.0 supports wire-frame, hidden-line, shrunken-element, and shaded plots, and graphical modeling operations such as copy, rotate, snap, and contract.

Price: LapCADII 4.0, $495; MSC/pal, $1495; MSC/pal 2, $2495.

Contact: LapCAD Engineering, 1568 Diablo Point Court, Chula Vista, CA 92011, (619) 421-1236.

Inquiry 1163.



LapCADII, analyzing the stress contours of an automotive suspension part.

Real-Time Process Control

With Quick-Stat, a statistical control system, you can monitor manufacturing operations in real time, allowing you to eliminate waste and reduce downtime on an assembly line, Custom Technology says. The program is currently available for the IBM AT, and a Unix version with an X Window System display driver will be available by mid-June.

Quick-Stat can continuously acquire data from intelligent devices and immediately display data points against parameters such as an upper or lower control limit. In this way, the program can notify you when something on the assembly line is out of kilter.

As the program acquires the data from a programmable logic controller or any other measurement instrument, it can automatically calculate statistical functions. The program can simultaneously monitor up to 20 processes.

Quick-Stat supports devices from Alan Bradley, Gould-Modicon, Texas Instruments, other device manufacturers, and any device with an RS-232C serial port. It requires 640K bytes of RAM and a hard disk drive.

Price: Base configuration, $1995.

Contact: Custom Technology, 300 West Grand, Suite 605, Chicago, IL 60610, (312) 384-4104.

Inquiry 1164.

Emulate Pen Plotters with PrintAPlot

A new version of PrintAPlot, the utility that lets your printer emulate a conventional pen plotter, can print large drawings over multiple pages and lets you position an image anywhere on a page.

Other features of version 2.0 include rotation of drawings by 90, 180, or 270 degrees; the ability to scale drawings from 1 percent to 600 percent of original size; independent *x* and *y* positioning; and a generic HPGL setting that lets the printer emulate more plotters.

PrintAPlot 2.0 consumes 234K bytes of RAM.

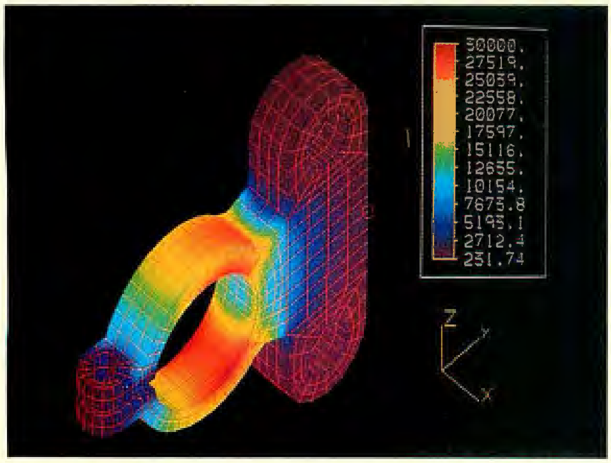
Price: $299.

Contact: Insight Development Corp., 2200 Powell St., Suite 500, Emeryville, CA 94608, (800) 825-4115 or (415) 652-4115.

Inquiry 1167.

continued

A Kinder, More Accurate, Nonlinear FEA



AccuPak, a new package for Algor's Design and Finite Element Analysis System for the IBM AT, combines a decoder and precision contouring with stress-to-nodes capability to make it easy for design engineers to perform accurate analyses. AccuPak's decoder uses a spreadsheet interface instead of providing you with lengthy text files. With the decoder, you can specify information about the model that you aren't able to specify in the modeling phase.

The stress-to-nodes technique extrapolates nonlinear stress values to element nodes and edges, where maximum stress is most likely to occur. Independent estimates of stress values at shared nodes are compared to indicate accuracy; from the comparison, the program assigns a confidence factor that you can plot to compare with stress plots.

Price: AccuPak, $895; base system with ViziCad Plus, $889.

Contact: Algor Interactive Systems, Inc., 260 Alpha Dr., Pittsburgh, PA 15238, (412) 967-2700.

Inquiry 1165.

SOFTWARE • OTHER

An Avalanche of CD-ROM Information

We've recently been buried by an avalanche of releases describing CD-ROM subscriptions and HyperCard directories of services. Here are a few of them.

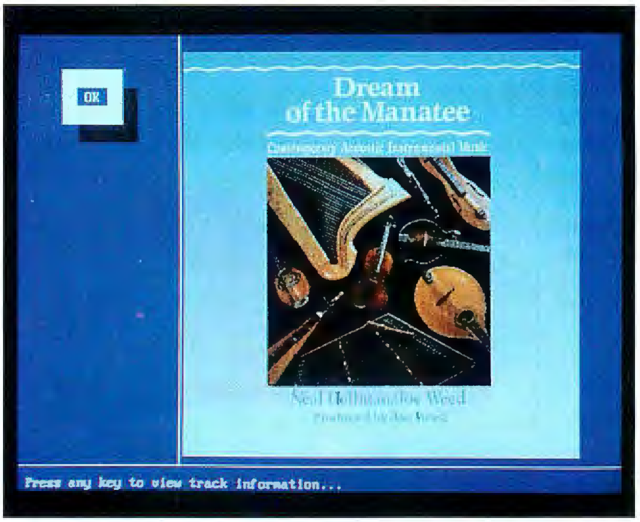
CD Guide, the magazine that covers the audio compact disk field, is now offering a quarterly CD-ROM subscription that provides over 40,000 listings, 4000 full reviews, sample audio tracks, and liner notes of CDs. Each update features new reviews, listings, and about 10 disks that include a sample track.

In addition to serving CD cognoscenti, the CD-ROM—also available for touch-screen monitors—can act as a point-of-purchase tool.

Filters let you search for a CD by several categories, including name, title, disk label number, and, if the disk is reviewed, sound and performance ratings. The program also lets you play any CD on your CD-ROM drive.

CD Guide Optical Edition conforms to the ISO 9660 standard and runs on an IBM PC.
Price: Single issue, $99; quarterly subscription, $259.
Contact: WGE Publishing, Inc., Forest Rd., Hancock, NH 03449, (800) 227-1053 or (603) 525-4201.
Inquiry 1168.

Shakespeare on Disc! includes the bard's 37 plays, five narrative poems, and 154 sonnets in both the Queen's English and American English versions. The CD-ROM requires an IBM XT with 640K bytes of RAM.
Price: $99.
Contact: CMC Research, Inc., 7150 Southwest Hampton, Suite C-120, Portland, OR 97223, (503) 639-3395.
Inquiry 1169.



With the CD Guide Optical Edition, you can examine liner notes or cover art while listening to the best cut from a featured disk.

MicroPatent is making 17 years' worth of abstracted information on U.S. patents available to IBM PC users who subscribe to its Automated Patent Searching (APS) system.

APS runs on the IBM XT or higher with 640K bytes of RAM, a hard disk drive, and a CD-ROM drive.
Price: Weekly subscription, $3150 per year; monthly, $950 per year; two-year back-file disks, $90 each; Toshiba XM 3201 CD-ROM drive, $895; Hitachi CDR 3600 drive, $799.
Contact: MicroPatent, 25 Science Park, New Haven, CT 06511, (800) 648-6787 or (203) 786-5500.
Inquiry 1170.

A HyperCard-based directory called the Macintosh Yellow Pages provides a listing of Macintosh software, hardware, accessories, books, CD-ROM titles, and magazines. The program has an indexing system that lets you search for a product using synonyms.

Each product listing includes a one-sentence description of the product. As in the Yellow Pages of your phone book, display ads purchased by companies further describe their products.

The Macintosh Yellow Pages will be updated on a regular basis. The program requires HyperCard 1.2 and a Mac Plus.
Price: $39.95.
Contact: Digital Media Publications, Inc., 362 Memorial Dr., Suite 121, Cambridge, MA 02139, (617) 225-7121.
Inquiry 1171.

The Specialty Series of databases from Aries Systems contains journal references selected from the National Library of Medicine's Medline database with abstracts drawn from more than 3000 biomedical journals. Initial offerings include clinical and research pathology, radiology, and primary clinical care.

Disks are available in High Sierra and ISO 9660 formats and run on the Mac Plus or higher (a Mac SE or higher is recommended).
Price: PathLine (pathology) and RadLine (radiology): $995 for a quarterly subscription, $595 for an annual subscription. Core Journals (clinical and primary medicine): $795 for a quarterly subscription.
Contact: Aries Systems Corp., One Dundee Park, Andover, MA 01810, (508) 475-7200.
Inquiry 1172.

Programmable DOS Shell for Power Users

Mi-Shell is a cross between a programmable Unix shell and a DOS shell such as Norton Commander, OpeNetwork says. The shell lets you browse through directories and execute commands on files or sets of files with a point-and-shoot or command-line interface.

The shell's programmable functions let you streamline your routines. You can assign arbitrary sequences of actions, written as a Mi-Shell script, to any keystrokes. Actions can depend on the environment, such as the file you are currently pointing to or its extension.

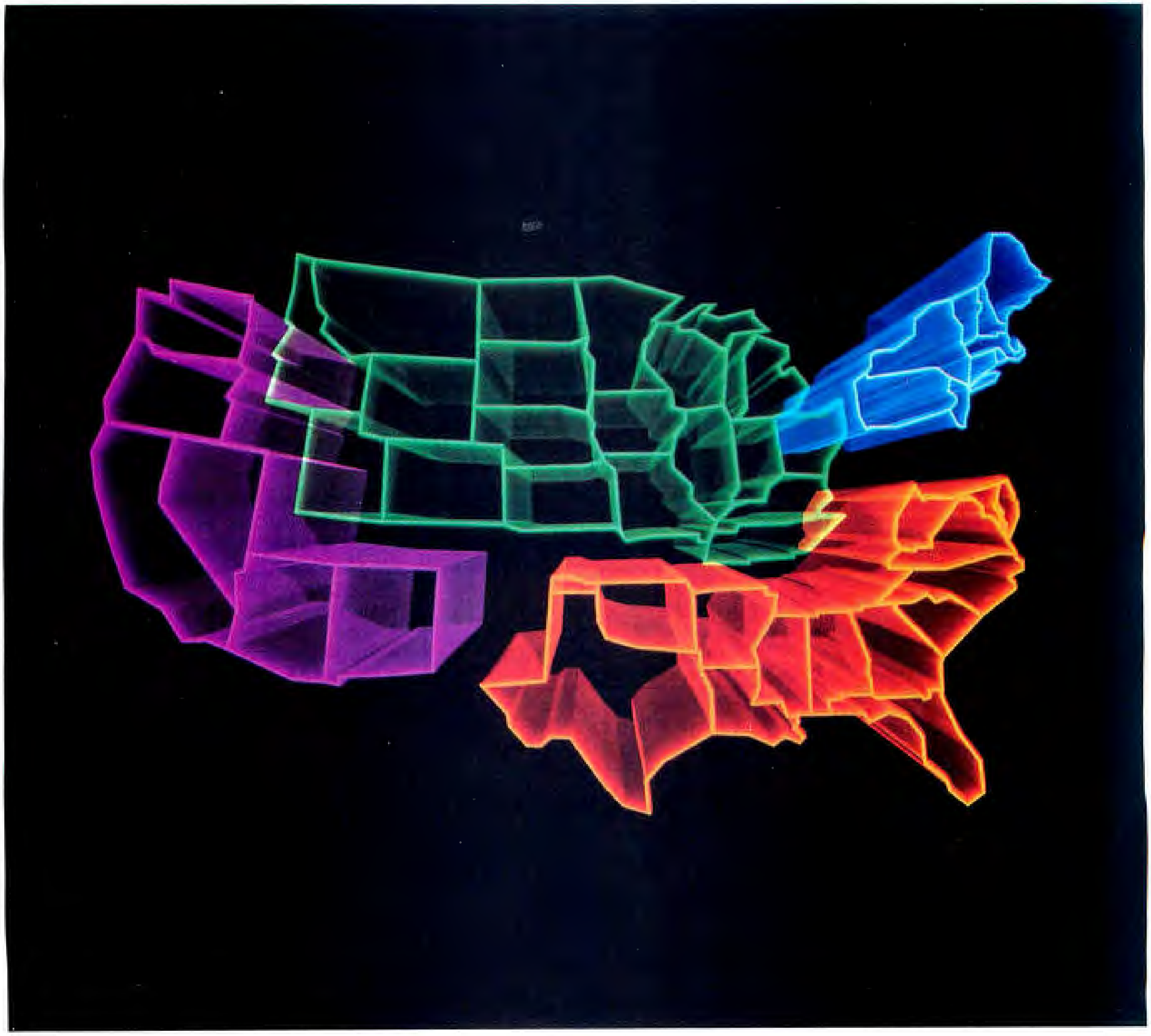
Mi-Shell lets you modify the size, appearance, and content of the display panels. You can display more or less information on each file and sort files in many ways, including by size, extension, and time stamp.

A built-in debugger is provided for the Mi-Shell script, which is a Forth-like language. Mi-Shell requires 130K bytes to initialize and needs 10K bytes of RAM when it executes an application.

Mi-Shell integrates with two other power tools from OpeNetwork: the Berkeley Utilities, which lets you execute Unix commands from your DOS environment, and Delta, an advanced file-comparison utility that is suited for programmers. You can use Mi-Shell instead of the command line to invoke these tools.
Price: $89; Berkeley Utilities, $125; Delta, $79.
Contact: OpeNetwork, 215 Berkeley Place, Brooklyn, NY 11217, (718) 638-2240.
Inquiry 1174.

REGIONAL

MIDWEST



PHOTOGRAPHIC IMAGE: ALEX PIETERSEN © 1989

A Snapshot Inside Apple from David Ramsey

In a presentation sponsored by North Shore Computers of Milwaukee, David Ramsey, a software engineer fired last year by Apple Computer for allegedly disclosing confidential information on CompuServe's MacPro forum, provided a glimpse of what it was like to work at the company and gave his opinions on several other topics, including System 7.0 and C++.

During both a private interview and his subsequent speech, Ramsey appeared to bear no ill will over his forced ouster from the Silicon Valley giant. "Do I hate Apple?" he began with a grin. "Let's look at what Apple has done for me. I was a relatively obscure programmer. Now I'm a famous media figure and martyr, and I'm making 50 percent more money. I love Apple."

In the private interview, he noted that "when I first started, Jean-Louis Gassée was up on the same floor as all the system software engineers, and we could just walk on over and talk to him... and show him something we're doing. And about a year and a half or two years ago, the executives all had a brand-new building built from the ground up, and they're enthroned in it. And, you know, I can walk into the lobby, but I can't get out of the lobby. I had to make an appointment to see him now. I thought that hurt a lot."

Ramsey also spoke on Apple's penchant for reorganization. As to whether Apple's constant reorganizing revealed any deep problems, he said, "They tend to have panic reactions which are overblown."

Ramsey also voiced his concerns for Apple's upcoming System 7.0. "I am very nervous about System 7.0 because they are trying to make this the last great hurrah of the classic Mac operating system. Consequently, they are throwing a number of features at it. . . . I don't think that they're feeling insecure about Windows or OS/2 or anything, but, if they were, it would explain a lot about System 7.0.

"System 7.0, as you know, is large, and it adds a completely new printing architecture that will break every printer driver in the world. It adds Apple's outline font system, which means that, in addition to dealing with bitmap fonts and PostScript fonts, you also now get to deal with outline fonts. Remember back when the Mac was... really simple and relaxed, and we laughed at the DOS people because they had all the font problems to deal with? Grab some noncomputer person and try to explain why what they saw on their screen and printed at their ImageWriter isn't what they got down at Kinko's Copy on their LaserWriter, that you've got three imaging models," he said.

"System 7.0 will have a lot of improvements. They will make it much, much easier for people to write third-party

continued

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print drivers. Although, of course, Apple has announced that, gee, we've had a little problem with this, it won't be in the initial release of System 7.0. There are some exciting parts about it. The new Finder looks pretty neat from what little I've seen and what Apple has talked about. I guess the basic thing is to say I'm cautiously optimistic, but I'm kind of nervous, and I'm not going to put it in my machine right away."

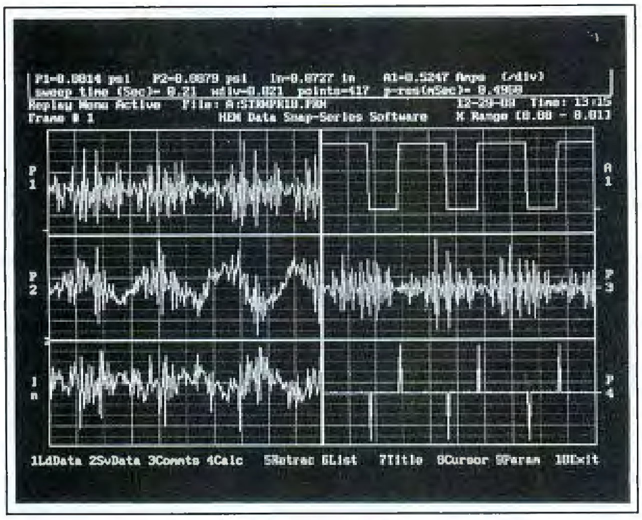
Concerning the current state of Mac technology, he said, "Apple hasn't done anything neat in a long time. I want to see Apple do some neat stuff. Their idea is the IIci."

While conceding that the IIci was a good machine, he remarked, "The [original] Mac hardware was boring, it was the software that was exciting. I think Apple's been living off of that too long." He answered hardware speculation by saying, "At the time I left Apple, there was no 68040 project going on that I personally knew about. I'm sure that's changed. I imagine Apple's working on it, but I don't know diddly about it." However, he ended dreams of an imminent 68020- or 68030-based Mac Portable by disclosing that such machines weren't in the immediate future due to "too much power drain."

He had praise for Apple's portable. "It's a nice machine. I rather like it. It's heavy and expensive, but I don't think you can compare it directly to a DOS portable." For example, his DOS portable is "very slow compared to the Mac. It's got no disk drives at all, no graphics, pretty much. You can't do that with a Mac. With a Mac, it's got to have a hard disk and lots of memory. It's got to have a razor-sharp, very-high-definition display."

Ramsey, now working for Aapps, a Silicon Valley start-up, also voiced his views on object-oriented programming. "Object-oriented programming is a big thing, it's a big bang, it's trendy, and it's neat. It really offers productivity benefits, but everybody's afraid that if they require so much to learn a new language, nobody will do it. So, it's a common thing today to graft these object-oriented constructs onto procedural languages. That's always kind of a hack, but it can be done neatly and elegantly. Apple hired the inventor of Pascal, Niklaus Wirth, to come in to help it with Pascal. And that gave us Object Pascal, which is pretty nice. It's clean, it's simple, there are only a very few extensions, but they're powerful."

Ramsey didn't have any kind words for C++, however. "C++ is taking a rather archaic language that was invented back in the early seventies, and they're throwing everything at it. It's extraordinarily complex, very steep learning curve, lots of ways to hang yourself. It's bad. It's not good." On the topic of preferred programming languages, he stated, "I'm pretty open. The only thing is that C++ . . . should be avoided at all costs."
—Reported by Jean Mickelson



Snap-Stream, showing six data acquisition windows.

Acquire and Store up to 500 Million Data Points

HEM Data's analog data acquisition package lets you continuously acquire and store up to 500 million data points at streaming rates of up to 1 MHz on a 386-based computer with extended memory. Called Snap-Stream, the program works with the company's core product, Snapshot Storage Scope. When used without Snap-Stream, the core program can store up to 32,000 data points without pausing.

At sampling rates of up to 3000 kHz, the programs let you plot up to 32 waveforms during streaming. You can have up to five display "pages" with any combination of one to 32 waveforms, and at any time during testing, you can look at a new display page. The program can acquire up to 80 waveforms simultaneously.

The program supports pre-test and post-test triggers, and you can zoom and pan through the data.

Price: Snap-Stream, $495; both programs, $890.
Contact: HEM Data Corp., 17336 Twelve Mile Rd., Southfield, MI 48076, (313) 559-5607.
Inquiry 1013.

Forecasting and Linear Programming for Business

With ForeProfit, you can analyze business data and forecast future trends using a variety of statistical techniques (e.g., regression modeling, linear programming, and time series analysis of historical data). With the program, you can build economic forecasting models, solve operational mix problems, and create graphs from data.

ForeProfit runs on the IBM PC with 512K bytes of RAM and a Hercules graphics card or better.

Price: $250.
Contact: Loon Valley Software, 420 Summit Ave., Suite 38, St. Paul, MN 55102, (612) 227-5552.
Inquiry 1017.

Save Mac Files Automatically

AutoSave II 1.1 is an INIT for the Mac that lets you save a file automatically at intervals of from 1 to 99 minutes. The program lets you exclude specific applications from being saved.

AutoSave II 1.1 runs on any Mac except for 128K- and 512K-byte Macs with unenhanced ROMs.

Price: $49.95; five-user package, $150; 10-user package, $250.
Contact: Magic Software, Inc., 2206 Franklin, Bellevue, NE 68005, (800) 342-6243 or (402) 291-0670.
Inquiry 1014.

Equal Access for DOS Users

As the use of multiplatform networks starts to increase in corporations, the need to access the same data from different platforms also increases. Micro Decisionware's version 3.3 of PC/SQL-link, an end-user access program, was designed with this need in mind. With PC/SQL-link 3.3, you no longer have to have OS/2 Extended Edition on your workstation to access the Extended Edition 1.2 Database Manager.

The program not only enables you to access the database over your network, but also lets you upload PC data. You can also access host-resident data stored in IBM's DB2 and SQL/DS, with the installation of PC/SQL-link host software.

PC/SQL-link runs on the IBM PC with DOS 3.3 or higher, 400K bytes of RAM, PC-SQL-link Requester, an OS/2 EE Router (which includes a DOS Database Requester), and a NetBIOS-compatible LAN.

Price: $300 to $500 per user.
Contact: Micro Decisionware, 2995 Wilderness Place, Boulder, CO 80301, (303) 443-2706.
Inquiry 1016.

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Autoplan is a car expense program for tracking the business use of your car. You can use it to keep track of maintenance statistics, tax rebates, insurance, licensing, vehicle costs, and loan information.

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Price: $49.
Contact: Black Cat Software, P.O. Box 4181, Station D, London, Ontario, Canada H5W 5H6, (519) 681-8072.
Inquiry 1015.

The Torah for the Mac

Davka Corp. has released a Bible research and study program that contains the complete Hebrew text and English translation of the *Chumash*, the Five Books of Moses. In addition to letting you hyperlink personal comments and illustrative graphics to English or Hebrew text, Torah Scholar lets you delve into the mystical world of hidden-code searches and *gematria*, a method of calculating numerical values of Hebrew words, the company says.

A less powerful version of the program, Torah Teacher, doesn't support interval searches or *gematria*.

Price: Torah Scholar, $295; Torah Teacher, $195.
Contact: Davka Corp., 845 North Michigan Ave., Suite 843, Chicago, IL 60611, (312) 944-4070.
Inquiry 1026.

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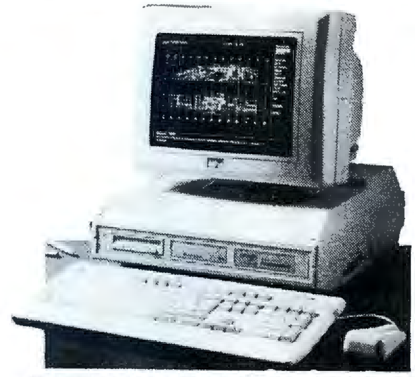

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Based on an 8-MHz NEC V20 CPU (compatible with the Intel 8088), the CF-150 offers many features within its 12- by 2½- by 10-inch chassis, including 640K bytes of RAM (expandable to 1.6 MB), a 720K-byte floppy disk drive, and a CGA-compatible, 640- by 200-pixel, non-backlit LCD screen. The removable battery is said to last up to 4 hours.

The CF-250 is a 12-MHz 286-based laptop with an 84-key keyboard and a backlit LCD screen with 640- by 400-pixel resolution. Standard equipment includes 1 MB of RAM (expandable to 2 MB) and a 20- or 40-MB hard disk drive.

Price: CF-150, $999; CF-250, $3999; CF-250 with 40-MB hard disk drive, $4399.
Contact: Panasonic Communications and Systems Co., Two Panasonic Way, Secaucus, NJ 07094, (800) 742-8086 or (201) 348-7000.
Inquiry 1001.

The CF-250 weighs 13 pounds, measures 12⅛ by 3½ by 13½ inches, and includes a removable battery.

Info Facility Added to System Utility

An Info facility that provides seven detailed reports has been added to MicroScope, a testing and diagnostics utility for the IBM PC. MicroScope 2.1 also includes a remote option for diagnostics via modem, Micro Tech Resources reports.

The seven reports include: a list of all equipment in the system; memory, I/O, interrupt, and DMA assignments; a map of how memory is used; a map of how the system uses I/O ports; an interrupt assignment table; a DMA assignment table; and information on the system environment.

The company added several new tests, including interactive processor, keyboard, and screen checks, and more detailed reports as to which memory chips failed.

MicroScope requires 128K bytes of RAM.

Price: $149.
Contact: Micro Tech Resources, Inc., 122 East Pittsburgh St., Greensburg, PA 15601, (800) 888-6818 or (412) 837-5200.
Inquiry 1002.

Phonetic Searching Added to filePro Plus 4.0

A new feature of filePro Plus 4.0, a relational DBMS from The Small Computer Co., lets you search for data phonetically, instead of having to make a request for data using perfectly spelled names and addresses.

The program uses a patented technology from Proximity Technologies that lets you search for a record by the "sound" of the name: The search capability differs from other so-called fuzzy search capabilities that require the use of a wild card. For example, if you search for a record by a customer's last name, Wang, the program can also provide information on Huang.

The browse feature in filePro Plus 4.0 lets you look up and update data that resides in another file without exiting the current file.

The product is available for DOS, OS/2, Xenix, AIX, Unix, and SunOS.

Price: $990 to $40,000.
Contact: The Small Computer Co., Inc., 41 Saw Mill River Rd., Hawthorne, NY 10532, (914) 769-3160.
Inquiry 1006.

Financial Calculator with 29 Routines

A new version of SolveIt!, Pine Grove Software's financial calculator, can handle adjustable rate and biweekly amortization. The program starts by asking you a series of questions, such as amount borrowed, term of a loan, and annual interest rate. You can carry the data you supply from one routine to the next to eliminate the rekeying of data, the company says.

Almost 30 routines are included with the program, including future value of a deposit, present value of a series, loan calculator, and required payment for a future sum. An accelerated payment routine shows how much faster you can pay off a loan when you pay additional money toward the principal above the regular payment. SolveIt! 3.1 has a purchasing power routine that calculates the future value and the effects of inflation, complete with Consumer Price Index information back to 1961.

You can run SolveIt! 3.1 in TSR or stand-alone mode. It requires 384K bytes of RAM.

Price: $49.95.
Contact: Pine Grove Software, 67-38 108th St., Suite D1, Forest Hills, NY 11375, (800) 242-9192 or (718) 575-9192.
Inquiry 1004.

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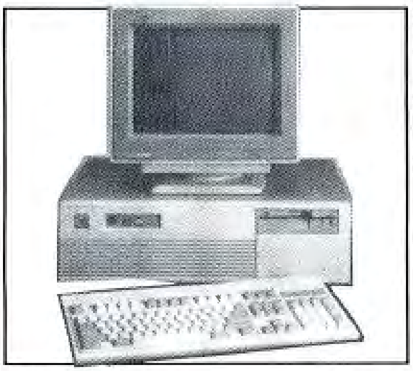

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With each Data/Fax modem for the Macintosh®, you'll get MAcKNOWLEDGE™ and our new Maxfax software. With many new features and enhancements, sending or receiving faxes with Maxfax couldn't get much easier. And if you have a Mac Portable try the new internal TravelModem™.

Model	Part #	Fax Speed (bps)	Modem Speed (bps)	Software	Cable	Send Fax	Receive Fax	Computer Compatibility	Price
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2400Minifax	PMD-7FAX	9600	2400	•	•	•		Any MS-DOS Compatible	$249
2400Maxfax	PMD-13MF	9600	2400	•		•	•	Internal PC/XT/AT Bus	$349
2400BFAX	PMD-13FAX	9600	2400	•		•		Internal PC/XT/AT Bus	$199
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2400T	PMD-17FAX	4800	2400	•		•		Internal Toshiba Laptop	$249
2400Maxfax	PMD-4MF	9600	2400	•	•	•	•	Macintosh® Plus or later	$449
2400Minifax	PMD-7MFAX	9600	2400	•	•	•		Macintosh Plus or later	$299
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A CD-ROM Dictionary for the Mac

The CD-ROM edition of *Webster's Ninth New Collegiate Dictionary* contains everything found in the paper version, including illustrations, plus the ability to play each entry word digitally as recorded by a professional announcer. For entries that show two or more ways to pronounce a word, the spoken pronunciation is the first one that is shown in the print edition.

The dictionary can run over TOPS or AppleShare networks, is MultiFinder-compatible, and runs on the Mac Plus, SE, SE/30, II, IIcx, and Portable.
Price: $199.95.
Contact: Highlighted Data, P.O. Box 17229, Washington, DC 20041, (703) 533-1939.
Inquiry 1009.

Forecast Sales Based on Historical Data

With Market Forecaster 3.0, manufacturers that use material requirement planning systems can create sales projections based on historical data. Market Forecaster can transfer sales data from outside systems to a built-in database and identify demand patterns for up and down trends, cyclical patterns, or unique patterns, its developer says. You can use the forecasts to help in production scheduling and sales management.

With the program, companies with extensive sales history data can identify and predict the demand for thousands of product combinations. As the system receives new data, it reestimates demand to predict future sales.

Market Forecaster runs on the IBM XT with 640K bytes of RAM and a hard disk drive.
Price: $6000.
Contact: Least Cost Formulations, Ltd., 824 Timberlake Dr., Virginia Beach, VA 23464, (804) 467-0954.
Inquiry 1007.

Document Proofer for Xenix, Networks

RightWriter, the proofreader that RightSoft says provides the equivalent of a light copy edit on your document, is now available in versions for Xenix 2.3 or higher and Novell and 3Com networks. The program uses parsing and an expert system with more than 4500 rules to analyze documents for errors in grammar, writing style, and punctuation. You can choose among five writing types, and you are able to turn off rules.

RightWriter requires 550K bytes of RAM on an IBM AT or higher and supports Unix versions of Microsoft Word 3.0, WordPerfect 4.2, Samna Word IV, and Samna Plus IV. It also supports ASCII. The network version lets you have your own configuration.
Price: Xenix version, $295; network version, $285 for five users.
Contact: RightSoft, Inc., 4545 Samuel St., Sarasota, FL 34233, (800) 992-0244 or (813) 923-0233.
Inquiry 1008.

Find Uninitialized Variables in dBASE

The latest version of dBFind, a synctax checker for dBASE III Plus, dBASE IV, Clipper, and FoxBase, finds uninitialized and unreferenced variables in your program. The program can also produce a system-wide cross-reference of variables and procedure names and individual source file cross-references, including how the variables are used in each reference.
Price: $99.
Contact: Software Development Factory, P.O. Box 1106, Hunt Valley, MD 21030, (301) 666-8129.
Inquiry 1012.

AlphaScan Monitor Now Compatible with 8514/A

AlphaScan, Sampo's 14-inch auto-synchronizing color monitor, is now compatible with IBM's 8514/A graphics standard, also making it compatible with graphics standards like MDA, CGA, EGA, MCGA, Super VGA, Mac SE/30, and Mac II, the company reports.

AlphaScan features a built-in tilt-and-swivel base, a selectable 110-/220-volt power supply, and TTL, VGA, and Mac II cables.
Price: $789.
Contact: Sampo Corp. of America, 5550 Peachtree Industrial Blvd., Norcross, GA 30071, (404) 449-6220.
Inquiry 1025.

Convert Programs Between Works, AppleWorks 3.0

A new version of Cross-Works, the IBM-to-Apple II file exchange utility, supports AppleWorks 3.0 and Microsoft Works. With Cross-Works 2.0, a word processing document transferred from IBM to Apple format (or vice versa) maintains underlining, margin centering, and other attributes. Transferred spreadsheets maintain formulas and data, without requiring any intermediate DIF files, SoftSpoken says.

As is true with the previous version, Cross-Works 2.0 can transfer programs among Lotus 1-2-3; WordPerfect; dBASE III, III Plus, and IV; and ASCII. Unlike the previous version, Cross-Works 2.0 lets you change default settings.

You can transfer files using the included cable or via a Hayes-compatible modem. A cable adapter lets you connect to a IIe Super Serial card for use with a printer without changing the jumper block.
Price: $99.95.
Contact: SoftSpoken, Inc., P.O. Box 18343, Raleigh, NC 27619, (919) 870-5694.
Inquiry 1011.

File Viewing Added to DOS Partner

EasySoft has released a new version of its DOS shell program, DOS Partner 1.1, that lets you view readable files one at a time or by directories in the file's native format. The program performs many DOS functions without requiring you to know DOS or DOS syntax, EasySoft reports.

The new version supports up to 26 local or network drives and runs over 3Com, Novell, and 10Net networks. It runs on the IBM PC with 300K bytes of RAM, which reduces to 6K bytes when running other applications. Applications supported in their native file formats include WordPerfect, WordStar, XyWrite, Volkswriter, Lotus 1-2-3, and Quattro.
Price: $99.
Contact: EasySoft, Inc., 1215 Hightower Trail, Suite B100, Atlanta, GA 30350, (404) 992-4140.
Inquiry 1010.

continued


F5 F6 F7 F8 Delete
F9 F10 F11 F12 Escape
Num Lock
Scroll Lock
End
Page Down
4 5 6 /
1 End
2
3 PgDn
0 Ins
. Del
+
microtype
! 1 @ 2 # 3 $ 4 % 5 ^ 6 & 7 * 8 (9) 0 — - + = Back Sp/Enter
Tab Q W E R T Y U I O P { [}] ~ ` Bk Sp
Ctrl A S D F G H J K L : ; " ' Enter
Shift Z X C V B N M < , > . ? / Shift
Caps Lock
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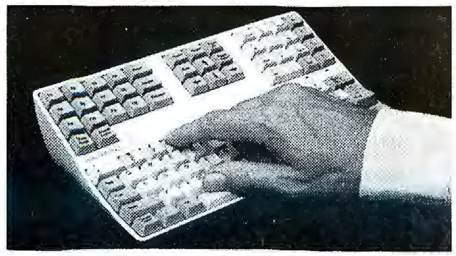
Alt
Ctrl
PrtSc * Sys Rq

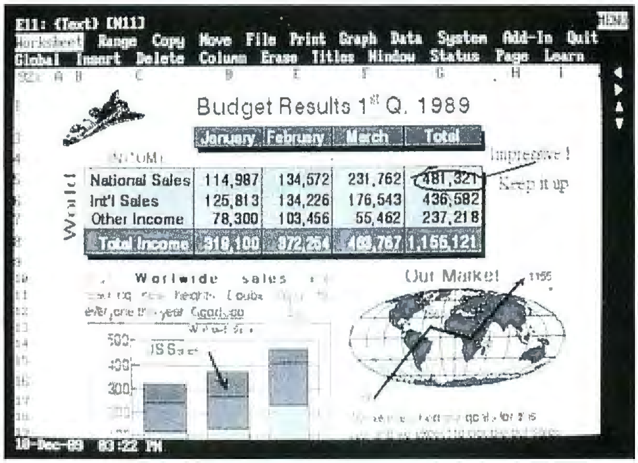


A Graphical User Interface for Lotus 1-2-3

With Impress 2 and Lotus 1-2-3, you can create a report with numbers, graphs, images, and text of up to 72 points in size, all on the same page, and all created within a spreadsheet, PC Publishing reports. Impress 2, through an agreement with Bitstream, takes advantage of scalable outline font technology and includes four fonts.

With Impress 2, you can type in text with word wrap and format it using justification. You can also change attributes at the character level. Other capabilities of Impress 2 include sideways printing, zooming, compression or enlargement of worksheets, and expanded columns and rows.

Impress 2 supports releases 2.0, 2.01, and 2.2 of Lotus 1-2-3. A version for release 3.0 will be available in June. Impress 2 consumes about 90K bytes of RAM.
Price: $149.
Contact: PC Publishing, Inc., 1801 Avenue of the Stars, Los Angeles, CA 90067, (213) 556-3630.
Inquiry 1018.



With Impress 2 and Lotus 1-2-3, you can position text vertically, annotate spreadsheets, and add text in sizes from 3 to 72 points to the worksheet.

Benefit Plan Administration

P&W Software's Benefit Plan Administration Module (BPAM) works with the company's universal benefit management program, PowerPlus, to handle health, life, and disability plans, plus 401(k) and vacation buy/sell arrangements. The program lets you define its layout to match the format of your other business programs, eliminating the need to reenter data from your payroll program, for example.

The program covers each benefit plan type under a cafeteria plan arrangement, as a regular post-tax benefit, or as a combination of both. The cafeteria plan qualifies for Section 125 pretax status, which lets a business pay for benefits with pretax dollars. BPAM's three-tiered rate table supports just about any credit or benefit cost rating in use today, the company reports.

BPAM supports flex-credit formula programs. You can manage any combination of fixed amount, percentage, or table-based credit allocations for all employees or groups of employees.

BPAM runs on the IBM AT with 640K bytes of RAM and a hard disk drive.

Other benefit administration modules include Flexible Spending Account Module ($2500); Discrimination Testing Module ($3000); Proposal and Enrollment Module ($2500); and Highly Compensated Employee Determination ($500). The ad hoc report writer goes for $200.
Price: $7500.
Contact: P&W Software, 5655 Lindero Canyon Rd., Suite 403, Westlake Village, CA 91362, (818) 707-7690.
Inquiry 1020.

Accounting for Windows

Accounting by Design has released a small-business, LAN-compatible accounting program, Bookkeeping by Design, that runs under the Microsoft Windows graphical user interface. The company says that the program is suitable for companies with one to 50 employees.

Modules provided include accounts payable, accounts receivable, invoicing, payroll, a general ledger system, and a report writer.

Bookkeeping by Design runs under Novell, LANtastic, 3Com, and other DOS 3.1-compatible networks on an IBM AT with 640K bytes of RAM, a hard disk drive, and a mouse.
Price: $695.
Contact: Accounting by Design, 2140 Shattuck Ave., Suite 501, Berkeley, CA 94704, (800) 548-9179 or (415) 845-4716.
Inquiry 1019.

A Clock for Your PC

The California Clock, a nondisrupting, continuously displaying digital alarm clock that can beep you when it reaches one of eight alarm reminder times, requires 8K bytes of RAM on your IBM PC.
Price: $19.
Contact: Abbot, Foster & Hauserman Co., 44 Montgomery St., Fifth Floor, San Francisco, CA 94104, (800) 562-0025 or (415) 955-2711.
Inquiry 1021.

Track Where Your Money Goes

As you might expect from a company called SimpleWare, DollarTracker doesn't have a lot of bells and whistles, but you can use the program to analyze financial data without much of a learning curve. The program uses three categories of information to organize your financial data: reference number, amount, and category.

Once you've entered the information, you can analyze where the money goes using searches like all checks written for more than $400 or all checks written for public utilities. SimpleWare says that DollarTracker offers easy data entry for expense tracking, budget control, and income tax reports.

The program runs on the Atari ST, Commodore 128, and MS-DOS machines. It uses about 8K bytes of RAM.
Price: $20.
Contact: SimpleWare Corp., 605 South Pacific Ave., San Pedro, CA 90731, (213) 832-1609.
Inquiry 1022.

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The mail brings some interesting things, including globes, teddy bears, and a pair of CD-ROM drives

It all started when I wanted to check out a new CD-ROM for the Macintosh. My Big Mac IIx is to the right of my desk. I have a small keyboard table for the Mac, and when really interesting software for it comes in, I generally pile it there.

You turn on the Mac by pushing a button on the keyboard. I did that and turned back to Big Cheetah. After a while, I noticed my Mac wasn't playing his start-up music, and when I looked around, he was displaying AASK, which is an initialization utility manager. AASK comes to the foreground if you hold down the space bar while the system is starting up. Sure enough, some of the software on the keyboard table was holding down the space bar and a couple of other keys.

I cleared the clutter off the table. Then I must have taken leave of my senses. Instead of reaching around to the far side of the Mac and pushing the "programmer's button"—hardware reset for the rest of us—I simply turned the Mac off.

I turned the Mac back on. It wouldn't boot. It did strange things, flashing stuff up and taking it down too fast for me to see, and eventually it just sat there with a picture of a floppy disk and a question mark. I used hardware reset. Same thing. Again, and again. I turned it off at the switch, waited a while, and turned it back on. Same thing. That Mac wasn't going to boot nohow.

I found a System floppy disk and booted with that. The Mac came up all right, but it erroneously reported that my write-protected System floppy disk was damaged and offered to initialize it. I quickly canceled that offer.

The Mac showed only two icons: the utility floppy disk and the big Priam 330-megabyte MacDisk. No sign of the 80-MB internal hard disk drive.

Don't panic, thought I. Try the program known as First Aid. That didn't work. First Aid thought there was an unnamed disk in addition to the floppy disk and the MacDisk, but it wouldn't do anything about it. Same thing. I put a System folder in the MacDisk and rebooted. The Mac told me my hard disk was damaged and offered to initialize it. I clicked cancel with a shudder.

By now I wasn't in a panic, but I was pretty upset. Who, I thought, who do I know who knows Macs, and I know well enough to call at 10:00 on a Sunday night? I certainly couldn't call BYTE's Tom Thompson; if it's 10:00 p.m. in Hollywood, it's 1:00 a.m. in Peterborough. Then I thought of Alex's friend Stefan Somogyi, who knows Macs better than anybody except maybe Tom. Stefan recently returned from a trip to Berlin, where he grew up, so it would be interesting to talk to him anyway.

Fortunately he was home, and I went through the symptoms. Stefan thought for a moment. "I never saw one do that before."

Now, I thought. Now it's definitely time to panic.

"Boot up with the floppy disk again," he told me. I did. No sign of the icon for the internal hard disk drive. "Have you got the First Aid program on that floppy disk?" he asked. I did. "Good. Pull the plug on the MacDisk, and boot up with the floppy disk."

I did that and launched First Aid. Then I clicked on the Drive button in the First Aid display; and lo!, it had found the 80-MB hard disk drive. I told Stefan.

"Great. Now before you tell First Aid to repair that disk, do a clover-S." I dutifully pressed the clover—I call it the splat—key and the S key. A new small window appeared on-screen. "Now tell First Aid to work on it."

It took a few minutes, but by gollies that did the trick. My 80-MB internal disk drive was back in action. Not only could the machine find it, but it could boot from it as well. The next thing to do was to plug in the MacDisk and reset while holding down the clover and option keys. That rebuilds the Desktop. With that done, all is well.

The moral of the story is that Mac software isn't as robust as DOS software. Apparently you should never turn off your Mac as a means of shutting it down: which leaves you in an interesting situation if you have a power failure and no uninterruptible power supply. I already have mine on a surge suppressor; now I'm going to connect it to the Clary UPS as well.

PC Librarian

If you have a properly installed and managed network, the Palindrome system that makes automatic archives to tape cartridges (see my April column) works wonders; but most of us don't have anything that fancy and have to be satisfied with something less: floppy disks for the most part, although in my judgment if your work is worth much, you'll invest in a WORM (write once, read many times) or a Bernoulli Box.

Either works pretty well. You use the DOS XCOPY command with a specified date, which copies everything accessed since then, and all's well. The WORM drive keeps everything sent to it, so that you can page back through and find previous versions of your work, which is a good thing: one corollary of Murphy's Law is that you will never need a previous version of your work until the day after you have erased the last copy.

You can do something of the sort with the Bernoulli Box by saving off various versions under different names or archiving Bernoulli disk cartridges. The

continued

Bernoulli disk cartridges don't hold as much as the WORM glass disks do (over 380 MB per side in the Maximum Storage WORM I'm using), so you have to do your own management and record keeping, which can get pretty tedious.

In addition to the backup problem, most of us need actual archiving: storing programs and files where you can get at them again, but out of the way so they don't clutter up your hard disk. That's where PC Librarian comes in.

PC Librarian will let you mark entire directories (with or without the subdirectories) and copy all those files into one large archive file, compressing them if you like. Another option is to encrypt them. PC Librarian builds a catalog of files you have archived; the catalog not only tells you where you put what, and when, but also lists the date, time, attributes, and file size for each file. You can print that catalog or view it on-screen.

Finally, it will optionally remove all archived files from your hard disk after it has copied and verified them.

The archive files so created can be in another directory on your hard disk; on a WORM drive; on a Bernoulli removable disk cartridge; on floppy disks; or on some distant medium accessed through a network. It does all this neatly and with little effort on your part. That's the good news.

The bad news is that it's slow when writing to floppy disks. Archiving 12 MB to 3½-inch 1.4-MB floppy disks (it needed 8 MB to store everything in compressed form) took something over an hour. However, archiving to a hard disk or WORM drive is much faster—about as fast as XCOPY provided that you're not compressing and encrypting.

There are some idiosyncrasies. For one, if you want to store on a WORM, you have to tell the system that's a "virtual drive"; unfortunately, the manual doesn't tell you that. It does insist that you use the Install program, which expands a number of the files. Clearly, they have archived much of the program itself in compressed form. I found that the best way to install the program was to copy the files, including the Install program, from the distribution floppy disk to a \PCLIB subdirectory on my hard disk and then run Install from there.

Once you've got it installed and have worked with it for a few minutes—I advise you to practice archiving files you don't care about until you get the hang of it—it becomes reasonably intuitive. The manual is complete and readable, but you don't have to read it except to search for features. There's a lot of good on-line instruction to handle most questions.

One good thing about PC Librarian is that the archive files and catalogs it makes are ordinary DOS files. That is, although you can't *read* the archive files (at least not in compressed form), you can copy the archive file along with its catalog and index files. In my case, when one archive got a bit large, I stored it and its associated files in a subdirectory named \PCLIB1 on a WORM drive and started a new one. I now have about four of them. To retrieve those files, I need only copy the archive and its associated index and data files back to the active area on my hard disk; PC Librarian does the rest.

The only real problem I've had with PC Librarian is having to run the Rebuild Catalog program a few times when I didn't think I should have to do that. In

continued

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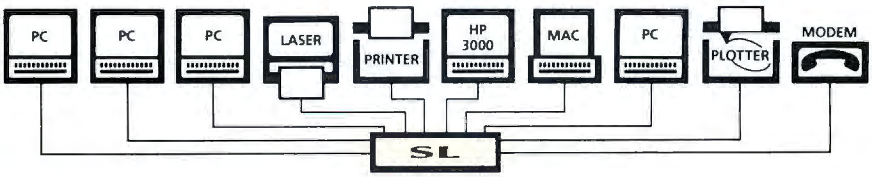

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every case, though, it worked fine, and no files were lost.

PC Librarian will tell you where your files are (by volume name if they're on floppy disks), when you did archiving sessions, and what you did during them. In fact, it generally does all the things you wish your librarian program would do. I like it enough to give it a User's Choice Award.

On that score, last month I ran out of space before I had finished with my awards; there really were a lot of good developments last year.

Northgate

Northgate Computer Systems burst on the scene in full force last year, with a full line of well-made and smooth-running computers, including fast 386s. They also make my favorite keyboard; and they distribute, at their cost, POURVOUS.COM, a tiny (20-byte) TSR program that makes the comma and period keys print commas and periods shifted or unshifted. (You do Alt-Shift to get the < > characters.)

The really outstanding feature about Northgate has been their technical support, which has become the standard that other mail-order computer companies must match. I have no problem giving Northgate two User's Choice Awards: for their keyboards, and for their technical-support group.

Real Science

It's not strictly a microcomputer topic, but in my judgment one of the most successful government agencies is the National Science Foundation, which supports fundamental science research and education. The National Supercomputing Centers supported by NSF have been spectacularly successful.

Designed to give American students a chance to familiarize themselves with supercomputers while in college, these centers quietly turn out new software and develop new ways to interface humans to computers—as well as to interface microcomputers to supercomputers.

The Chaos Manor Government Project of the Year Award goes to the NSF for its support of the National Supercomputing Centers, and I sure hope Congress not only pays attention, but doubles the budget. National support of the sciences receives a trivial amount for what we get for it. And now that Europe is reuniting, it's vital to give our students every advantage possible. If we're going to borrow money from our children, doesn't it make sense to invest some of it in their future?

OS/2

I don't recommend that users get OS/2 just yet. It has a lot of good features, but it also has the near-fatal flaw of requiring you to buy all new software. It's true that the OS/2 version of a program will likely be better than the DOS version (with some notable exceptions), but it's also true that for many of us, our DOS word processors and spreadsheets and CAD programs are good enough. Still, some applications actually need enormous blocks of memory and run smoother under OS/2 than under DOS with Phar Lap Software or Rational Systems extensions. Some people need OS/2.

If you're one of those, you have three choices: do without your DOS applications, run two machines, or use Polymod 2, available from The Software Lifeline. With Polymod 2 you'll still need two computers, but you can control one with

continued

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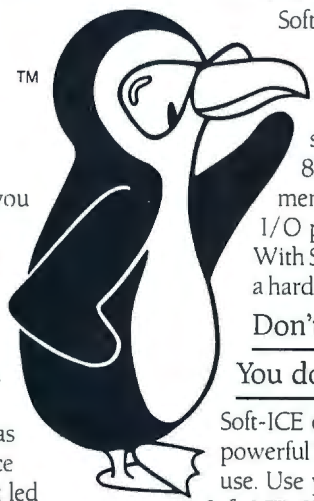

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the other; that is, you set up your DOS system as the master and then run OS/2 on a fast 386. You can then control the OS/2 machine with the DOS system, meaning that you can start processes in OS/2 and leave them running while you go about your normal DOS business. You can even run Polymod 2 in a DESQview window, which is a bit weird, but it works. I presume it would work with Windows as well, although I haven't tried that. What you must do is run a terminal-emulation program on your PC.

It's also possible to connect a number of terminals—up to eight—to the OS/2 system. I haven't done that, but it doesn't look as if it would be all that difficult. This makes your OS/2 machine a multiuser, multitasking workstation. If all terminals are actually PCs, you have at least one CPU per user, and I can think of circumstances in which you'd want to have multiple users on an OS/2 system; but I sure wouldn't load eight users on it at the same time.

Polymod 2 has password protection and what appear to be fairly good security procedures. All in all, it's a reasonable solution for a small business office consisting of three employees, each with a PC, and perhaps a couple of extra terminals used intermittently.

Now a warning: I am no OS/2 expert. I managed to get Polymod 2 set up so that I was controlling OS/2 on a 33-MHz 386 through Big Cheetah, my 25-MHz 386 running DOS 3.3. The Polymod 2 documents are good enough to accomplish that; and I had some help, in that I was sent a terminal board for my PC and a cable set. All the cabling information (it needs at least seven wires of an RS-232C cable wired exactly to a given specification) is in the manual. A breakout box helps a lot.

Once it was set up, I was able to do some OS/2 things, including running the Logitech Debugger, with the system. Everything seemed to work all right. I then took the system down, because I have no real need for it and an associate badly needed to borrow the OS/2 machine. I can't claim, then, to have given this a thorough test, nor am I really the right person to do that kind of test. However, it's my opinion that this may well be a relatively painless way to go from DOS to OS/2, since you can gradually move more and more applications to OS/2 while not yet abandoning DOS.

One final warning: Polymod 2 employs a copy-protection scheme that is a bit strange. Sometimes on start-up it asks you a question. There are little colored blocks at the bottom of each page of the manual, and each block has three alphanumeric characters printed in it; you must read the code off the appropriately colored block from the proper page or the system won't work. It's therefore guaranteed to drive color-blind users out of their minds. I don't have any trouble with the scheme, but I'm not color-blind.

Things My Postman Brings Me

First it was globes. Little ones on key chains. Slightly larger ones embedded in Lucite. One the size of an orange on a stand. Another the size of a grapefruit. They came in unmarked packages, with no return address, with banner print proclaiming THE WORLD IS COMING.

Eventually it did: the World Factbook 1989 Database on a CD-ROM. This is the unclassified database prepared annually by the CIA. It's available from Quanta Press, and it now works on both PCs and Macs. What they sent was the software for the Mac and the CD-ROM—indeed, the 3½-inch Mac disk was inside the CD-ROM case. This is the disk I was trying to look at when I had the Mac accident I mentioned earlier. Fortunately, the software for reading the CD-ROM on the PC is on the CD-ROM itself.

I've talked about this product before. It's a reasonable database, although not as complete as I would have thought. I presume the Mac version is identical.

Then came another large box. This one contained a teddy bear dressed in a camouflage uniform, complete with Green Beret, MacV patches, jump boots, and an extraction harness. A snappy-looking fellow, actually, with a marked resemblance to the colonel (now general) who invented the Green Berets.

There was also a military-style belt pouch containing a MacV SOG (Military Assistance Command, Vietnam, Special Operations Group) bandanna, a pencil, and a CD-ROM that claims it's a database about Vietnam.

I say claims because, while I can get a directory from the CD-ROM and install the software that's supposed to read it, whenever I try to access the thing, I get messages saying that the search has failed. That's on Big Cheetah. Trying it

continued

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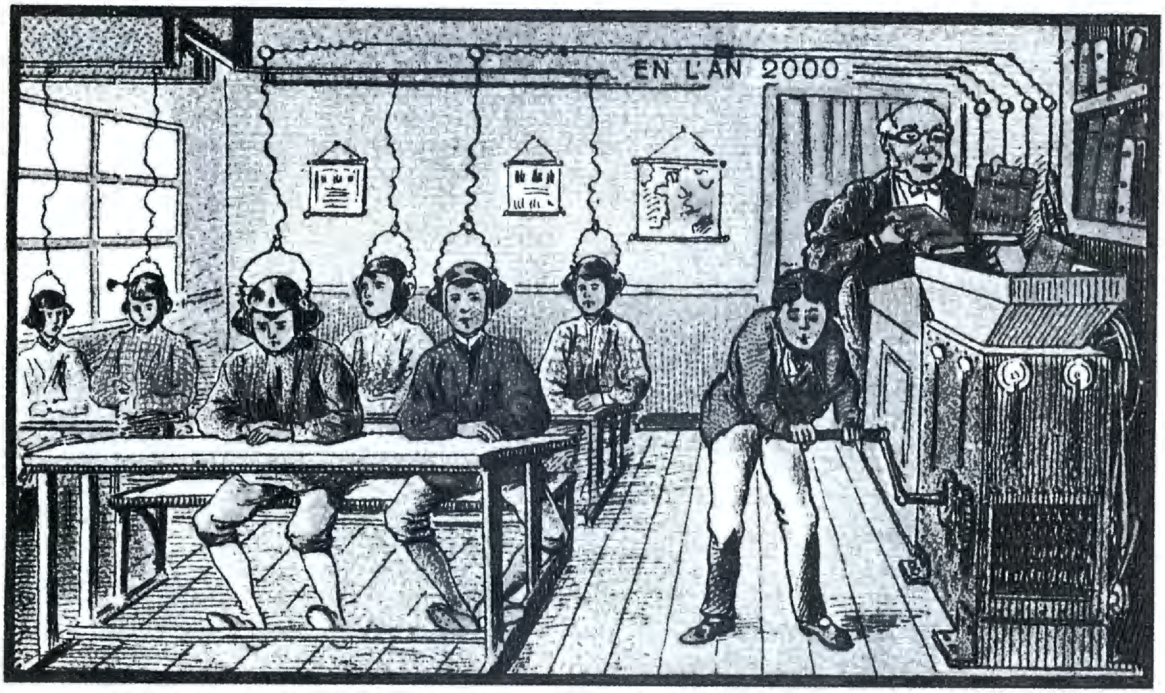

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on the Zenith Z-386/25 with a Tecmar VGA board gets me the message that the program doesn't support my graphics board.

Unfortunately, this isn't much of a surprise. For reasons I don't understand, no two publishers of CD-ROM software for PCompatibles use the same access programs, and about half of them don't work very well. I thought for a while I had done something wrong in the installation, but that wasn't so. I followed the instructions, and I do get into the database. It just won't read anything on either machine.

I really like the teddy bear, but I sure wish people would pay as much attention to making their software work as they do to calling attention to it.

Disk Utility Blues

Another recent arrival contained coffee mugs with CHAOS MANOR glazed onto them along with Golden Bow's Cupid logo. They're my favorite cups, duplicates of the ones Golden Bow sent last year. I'm glad to have got them, and I do use and recommend Golden Bow products, whether or not they send me coffee cups; but, alas, their disk utilities won't work with Roberta's Perstor hard disk drive controller (see my March column). Incidentally, that controller works quite well: fragmented files or not, it's a *lot* faster than her old controller was.

Actually, almost everyone's disk utilities are behind the times. As an example, I tried OPTune on the Premier 9000 (a 33-MHz 386). It won't work. The Premier has a disk cache on the motherboard, and if there's any way to turn it off, I haven't been able to find it. In addition, while OPTune (and Golden Bow's Vopt, for that matter) will repack the files on the disk, it won't do any other tune-up operation.

Neither will Gibson's SpinRite II: it too disqualifies itself when I try to run it on the Premier, even though the SpinRite package *says* it will work with DOS 4.01 and large disk drives. It sure won't with this one. It does partly run on the Z-386/25 (which runs a special Zenith version of MS-DOS 3.3 so that it can support a 150-MB drive), but even there it won't do its primary function. Neither will OPTune.

OPTune, SpinRite, and other such programs dynamically reformat your hard disk; that is, they pick the data off a sector, store it, reformat that sector, and put the data back down. SpinRite used to have the problem that it would try to guess if it found an ambiguous spot on your disk, which is all right, but it did it without even *telling* you, and that's not acceptable. The new version doesn't have that problem. If you have a standard machine, you can and should use one of these programs. I just wish they'd get versions I can use on really high-performance machinery.

Denon CD-ROM

For the last few years, I've used Amdek Laserdek CD-ROM drives with Big Cheetah. The drives are manufactured by Hitachi, and I've never had any trouble with them, barring that any CD-ROM drive eats memory. If you have a 386 and use a memory manager like Quarterdeck's QEMM-386, you can load the CD-ROM access software into that high memory area between 640K bytes and 1 MB before loading DESQview.

Then the CD-ROM drive is available in any DESQview window; as an alternative, you can load the .SYS portion into high memory and run the MSCDEX .EXE program inside a DESQview window. In the latter case, the CD-ROM is accessible only in that one window, but that's often good enough.

I prefer to have the WORM drive available in all windows, and its system and BIOS programs take up enough of that high memory area that there's no room for MSCDEX.EXE up there. If I run MSCDEX.EXE to low memory before loading DESQview, the CD-ROM drive is available to all windows, but the largest window I can make is 470K bytes or so, which is not enough.

Eventually, I hope, both Maximum Storage and the various CD-ROM drive vendors will come up with a way to let their access programs load most of themselves into expanded memory *above* 1 MB. Clearly this is the way things must go; there are far too many uses for that magic area between 640K bytes and 1 MB. For now, though, I have to make hard choices.

Anyway, Amdek wanted their drive back, and about then the Bureau of Electronic Publishing arranged for me to get a pair of Denon CD-ROM drives. Unlike the Laserdek drives, which are *almost* SCSI, the Denons are "real" SCSIs; they'll work just fine on the SCSI port on a Mac. Mine came with a PC SCSI board and software for both the PC and the Mac. I've used them with the PC and have also daisy chained them off the Mac's CD-ROM drive; they work fine with both machines.

Installing them in the Z-386/25 was a snap: just drop the board in and run the Install program. Some of the instructions were obviously written by people who speak English as a second (or more likely third) language, but they're clear enough. Once I had them set up in a daisy chain as drives D and E on the Z-386/25, I tested them with Microsoft Bookshelf, the Sherlock Holmes disk, Grolier's Encyclopedia, and several others. I had no

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Listing 1: *The Chaos Manor CONFIG.SYS and AUTOEXEC.BAT files.*

```
CONFIG.SYS
LASTDRIVE=Z
DEVICE=C:\QEMM\QEMM.SYS   RAM
FILES=24
BUFFERS=1
DEVICE=C:\QEMM\LOADHI.SYS /R:1 \BIN\ANSI.SYS
DEVICE=C:\QEMM\LOADHI.SYS  C:DENON\EXXTF210.SYS
     /D:DENON-CD/N:2/C:10


AUTOEXEC.BAT
PAUSE
VERIFY ON
BREAK=ON
C:\QEMM\LOADHI C:\BIN\POURVOUS.COM
C:\TECMAR\VGA PS/2
PATH=C:\QEMM\;C:\;C:\BIN;C:\NORTON;C:\DV;C:\QW;C:\MOUSE1;
REM  SET CAT=c:\PCLIB\
PROMPT $P $T$H$H$H $G
BE SA WHITE ON BLUE
C:\QEMM\LOADHI /R:2 BUFFERS 15
C:\QEMM\LOADHI /R:1 C:\MOUSE1\MOUSE
REM C:\MOUSE1\SETSPEED /P2 /FC:\MOUSE1\MOUSEPRO.FIL
CHKDSK
C:\QEMM\LOADHI C:DENON\MSCDEX /D:DENON-CD/M:20
REM SET CDPATH=C:\BKSHLF;D:\SOFTWARE;D:\BOOK
REM DV
```

problems. They're perhaps a bit faster than the Laserdek drives, but it's not a big difference.

They work fine together. I had real trouble daisy chaining Laserdek drives: sometimes they'd work, and sometimes they wouldn't, and I never learned why. The Denons gave no problems at all. Part of my test was to run them in a DESQview window, and that worked fine, too. The only problem I had was that Microsoft Bookshelf is memory-resident and you invoke it by pressing the Left-Shift-Alt keys, and Shift-Alt is understood by DESQview to mean that you're making a keyboard macro. I believe, though, that both Bookshelf and DESQview have ways to reconfigure the hot keys, so it should be simple enough to set them up so they don't conflict.

The Bureau of Electronic Publishing—a private company specializing in CD-ROMs and CD-ROM drives—is currently recommending Denon drives, and Microsoft offered me a Denon to replace the Laserdek. I haven't had these long, but they look good to me. Incidentally, like the Laserdek, the Denons have audio output, and they come with software to let you play compact disks through any stereo or boom box. Works fine, too.

Z-386/25 QEMM-386 Configuration

I have had a number of requests for the exact system I use with DESQview in my Z-386/25. What you see in listing 1 works well with the *new* QEMM.SYS from Quarterdeck. (Note: The DENON line in CONFIG.SYS is in two parts, but it is in fact one long line.)

This works with my current Tecmar VGA board; other boards may require you to exclude certain high memory areas.

QEMM-386 and Manifest

The new QEMM-386 memory manager from Quarterdeck is a delight. It's fast and darned near bulletproof. QEMM-386 will turn all (or as much as you want) your high extended memory—memory above 640K bytes and below 1 MB—into expanded memory usable by any EMS-capable program. It also comes with the LOADHI programs—both .SYS and .EXE—that will put drivers and such up there. Note in my CONFIG.SYS and AUTOEXEC.BAT files in listing 1 that I've packed just about everything into that high memory area.

Quarterdeck also has Manifest, the ultimate 386 system snooper program. Run Manifest, and you'll find out everything you ever wanted to know about your system, such as: Exactly where is the video RAM? Where does DOS put a thing like POURVOUS.COM? Which interrupts do what? And lots more. When I first got Manifest, I spent a couple of hours just poking around with it. It's fun.

QEMM-386 works with nearly everything. It's true that some versions of Microsoft Windows try not to work with QEMM-386, but you can get around that by renaming the program. Instead of QEMM.SYS, rename it to FRED.SYS, or any other .SYS you like, and change the CONFIG.SYS statement to match. QEMM-386 won't mind, and since all

continued

Microsoft is doing is testing for the name "QEMM," Windows/286 won't know what you've done. Windows/386 won't work with QEMM-386 at all, but that's no loss, as I've found Windows/386 to be unreliable.

If you have a 386, you really need QEMM-386 and Manifest, which get a User's Choice Award.

Bible Study

It was a remarkable coincidence. I'd just got the Biblesoft PC Study Bible working on the Z-386/25 when Father Wilcox came to see Roberta. Although it was an unexpected visit, it worked out well: he helped test the program.

The PC Study Bible consists of the Old and New Testaments. The following versions are available: the American Standard Version (ASV), the King James Version (KJV), and the New International Version (NIV). There's a complete concordance of each and a bunch of software to let you look for just about anything you like. You can ask for all instances of the word *poor* in the New Testament, or of *begat* in the Old, or whatever else strikes your fancy. Having got those, you can have the text from two different versions side by side on a split screen.

There's also a word processor with cut-and-paste capabilities and a smaller notepad that you can use anywhere in the program. This is one great aid to scholarly essays or sermons.

The whole thing works smoothly and quickly; on the Z-386/25, it's lightning fast, almost instantaneous. Naturally it's slower on an XT, but it will still get the job done.

The program isn't small. You need 2 MB of storage for the software and one Bible version; each additional version requires another 1.5 MB. You can also get an optional add-on, the Greek-Hebrew Dictionary, with Strong's translation and numbers and The Englishman's Greek-Hebrew Concordance. That adds another 2 MB.

The result is that you have all the tools of scholarship at your fingertips. Father Wilcox was impressed, so much so that I suspect we'll buy him a copy for his birthday.

The interface is surprisingly good, but there are a couple of glitches. For instance, if you tell it to change versions, it will do it almost instantly—but you have to remember those three-letter abbreviations (e.g., KJV) because the program will accept nothing else, and pressing the help key gets you the unhelpful message "That Version Not Available." Still, it's not all that hard to write these things in a notebook until you've memorized them.

All told, I have had a great deal of fun with this program, and I think anyone with an interest in the Bible, whether as revelation or as literature, would enjoy it. I've uploaded a demonstration version of BIBLE.ARC into my "tojerry/listings" topic on BIX.

AutoCAD

There aren't many well-known microcomputer applications written in Lisp, but Autodesk's AutoCAD is a major exception. AutoCAD is literally the standard that all other CAD programs are compared with. It's an extremely flexible program, with a great number of bells and whistles and nearly any feature you would want, including a programming language.

Of course, AutoCAD is more program than many of us need, and with all its features, it can be a bit formidable when you first try learning it. Fortunately, there's an alternative. AutoSketch is a cut-down version of AutoCAD. It has overlays, but not as many. It has the ability to store parts as objects, so you can bring them back wherever you want. It has dimensions, rotations, springing curves through a set of points, and most of the other things you'd expect.

Best of all, the drawings created with AutoSketch can be read into AutoCAD, if you ever want to go to the full-blown system. You can then get AutoShade, AutoSolid, and suchlike to make as complex a set of drawings as you'd ever want. I'm using AutoSketch to do the preliminaries on a new project. If it gets complex enough, I can change over to AutoCAD; by then, I'll be a lot more used to using CAD systems.

The Fax Dilemma

We have entered the Age of Fax. I think the only person I know who doesn't have a fax system is me, and I'm weakening. I've held out this long because, as Roberta points out, we already get more mail than we can handle; a fax system will generate even more paper. Also, I don't really want to get another telephone line to be tied up by a fax machine.

There's nothing to be done about the paper storm, but the telephone-line objection is a solved problem. The Voice/Data Switch from Rainier Technologies will do the job nicely.

The Voice/Data Switch is a black box about the size of an external modem. You bring your phone line into it and then connect one output to your phone and the

continued

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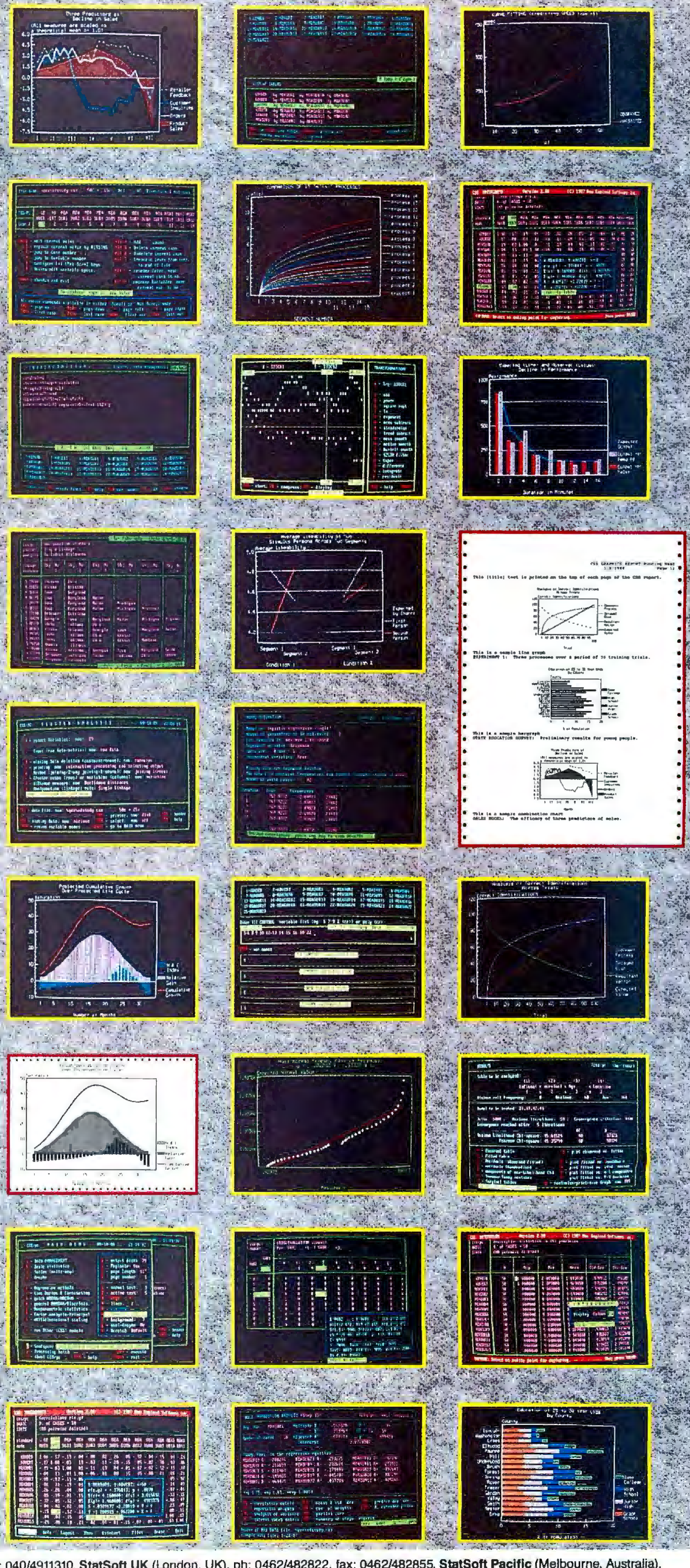

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DESQview 386 .... $219.95
Manifest $59.95
QEMM-386 .... $99.95
Quarterdeck Office Systems
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LAN version $199
United Software Security, Inc.
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Vienna, VA 22182
(800) 892-0007
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PC Study Bible $139.95
Biblesoft
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Inquiry 985.

Polymod 2 .... $1600
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POURVOUS.COM $5
Northgate Computer Systems, Inc.
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(800) 548-1993
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ProModem 2400 MFAX $299
Prometheus Products, Inc.
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(503) 624-0571
Inquiry 988.

SpinRite II $89
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Inquiry 990.

Voice/Data Switch TB201 ..... $299.95
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World Factbook 1989 Database CD-ROM $99
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Inquiry 993.

other to a modem or fax machine. You then record a message into the box. When someone calls, the box answers the phone and tells callers to dial 3 to talk to someone or wait for the tone if they want to send a fax (or modem message). That's it. The box switches from one to the other, thus allowing one phone line to serve for both data and voice.

The Voice/Data Switch will work fine with a private-branch-exchange or KSU internal phone system; just plug that in instead of a phone. You can even have another phone connected at the Rainier unit if you like.

This wouldn't be suitable for an office that gets a lot of fax traffic, of course, but for someone who doesn't get much, it will do the job nicely. Naturally, you can send a fax out with this system. While the fax part is in use, anyone who picks up the voice phone will hear a busy signal.

In my case, I'm connecting this to the new Prometheus ProModem 2400 MFAX fax/modem system for the Mac. I can then use the Mac scanner—either the Apple unit or the new Seikosha scanner—to get an image for transmission, and of course incoming stuff goes into a data file for printing on the LaserWriter. The Prometheus is both a fax and a standard 2400-bps modem, and it works fine. More on it another time.

Winding Down

As usual, I've hardly made a dent in the piles of stuff here. The game of the month is Action Stations (Conflict Analytics, 119-2 Norfolk Rd., Naval Air Station, Alameda, CA 94501). This is a first-class simulation of naval surface warfare as it might have been in, say, 1930, prior to the development of naval aircraft.

The book of the month is actually a pair by Rick Cook: *Wizard's Bane* and *The Wizardry Compiled*, from Baen Books. Imagine a typical Silicon Valley nerd transported into a world of magic—and the magic is subject to programming by a skilled hacker. Good fun.

Next month, a whole bunch of stuff, including reports on the American Association for the Advancement of Science meeting. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

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**Written by Neil Martin of the British Standards Institution (BSI) and printed in Personal Computer World June 1989, page 241.*

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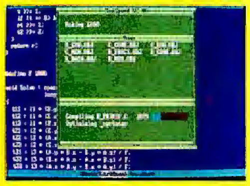

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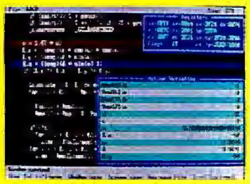

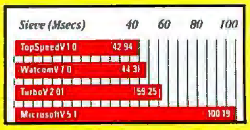

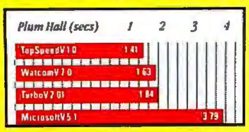

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Benchmarks measured by Mark Hamilton, November 24, 1989. Copyright © 1989, PC Business World and CW Communications Ltd.

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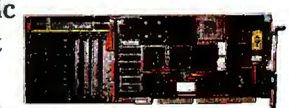

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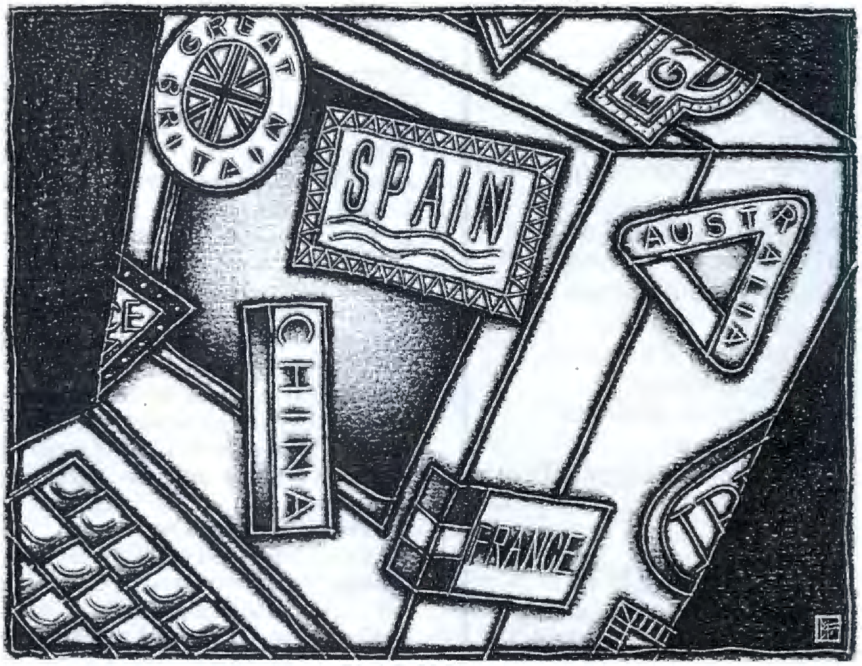
PROWLING THE NETWORKS

Getting on the Usenet network, and what to do when you've gotten there



Usenet, that anarchistic collection of computer sites that nobody seems able to explain adequately, is the network most information-starved Unix system owners aspire to connect to. Once your system is on Usenet, you can read and post news, gather the free software posted to `comp.sources` and `alt.sources`, keep your network maps up to date with `comp.mail.maps`, and exchange E-mail with people from around the world.

Getting on the Network

To get on Usenet, the age-old advice is, "Ask around." Unix users with network addresses are generally the best source of information about where to find a nearby mail or news feed (a site that agrees to supply you with a network connection). Computer science centers at local universities are often good places to start.

Many sites are set up for public-access mail and Usenet gateways, and these might help if you can't find any local feeds. There are also sites that allow dial-up connections to their Usenet-connected Unix systems—a useful idea for people with personal computers who don't want to run Unix just for Usenet purposes. A list of many of these systems (some of which request donations) is available by setting up a UUCP connection to the Telebit-equipped system `lgnp1` at (215) 348-9727, using a log-in name of nuucp and no password, and requesting the file `/usr/spool/uucppublic/nixpub` via UUCP. Note that no public BBS or regular dial-up log-in is available here. This is only for UUCP connections, courtesy of the donated time and equipment of Phil Eschallier.

A good node to hook up to might be UUNET (3110 Fairview Park Dr., Suite 570-B, Falls Church, VA 22042, (703) 876-5050, fax (703) 876-5059, or `info@uunet.uu.net`), a very large and specialized site with connections not only to Usenet, but also to the Internet and other major networks. UUNET is run by a nonprofit organization originally sponsored by the Usenix Association and exists solely as a communications link. It provides mail and news feeds, and it has over 600 megabytes of public domain software available for direct access or on tape. It also runs a commercial TCP/IP network service. Subscribers can get substantial discounts on certain modems and books, and a special rate for low-volume users was recently instituted. Dozens of Telebit modems, a high-speed T1 link and X.25 connections, and over 2.5 gigabytes of disk space make UUNET a unique system.

Getting the News

Getting the software needed to run a Usenet node seems like a classic dragon-and-egg problem, since it's distributed via Usenet. But once you have a simple UUCP connection to a Usenet site, they can just send you the source code, since the NetNews software itself is public domain. Xenix users have it a bit easier; they can get a precompiled version of the NetNews software directly from The Santa Cruz Operation.

Getting NetNews running is complex but not arduous; it's certainly more than can be covered in this limited space. I refer readers in search of more detail to Ben Smith's article "The Unix Connection" (May 1989 BYTE) and to the books *Managing UUCP and Usenet* by Tim O'Reilly and Grace Todino and *Using UUCP and Usenet* by Grace Todino, both published by O'Reilly and Associates, 632 Petaluma Ave., Sebastopol,

continued

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CA 95472, (800) 338-NUTS, (707) 829-0515, or `ora!nuts`. Once you've successfully exchanged news messages with your news feed, all you have to do is post your site data to the group `news.newsites`, with a copy to `rutgers!uucp-map`, and you're on the network.

So, what do you do once you are able to receive files from the network? The first thing you might do is ask your news feeds if they have the source code to a number of important communications-oriented programs, without which you will be working a lot harder than necessary (and if they don't have it, you can post a message in `comp.sources.wanted`).

Free and Useful

Written by Peter Honeyman and Steve Bellovin, `pathalias` computes relative mail paths from your computer to all others known on the network. It works by parsing the map data posted to the group `comp.mail.maps` and creates a database usable by other programs, including `uuhosts`, `smail`, and `elm`. The completed database contains not only what are considered to be the quickest paths, but also their relative cost. With over 18,000 entries in the database and all the possible permutations, you'll probably need at least 4 MB of memory to run it without excessive paging or swapping.

Created by John Quarterman, `uuhosts` is a large shell program that helps manage the information in the `comp.mail.maps` data files. It creates an index of all sites on the network and lets you look up all available data about a site on the fly. Once you've tried perusing the data with `grep`, you'll know why Quarterman wrote this program.

Many systems have antiquated mail delivery programs that can't properly handle network addresses and security concerns. The `smail` program solves these problems fairly well, although you might have to be creative when installing it on some systems. The program is configurable as issued, and, of course, you always have the source code to look at. The current released version is by Christopher Seiwald, as far as I can determine.

Originally written by Dave Taylor, `elm` (for Electronic Mailer) has generated so much interest that Hewlett-Packard (for whom it was written) has turned it over to a group called the Usenet Community Trust for further development. It's a screen-oriented mail program that you can use with AT&T Mail Forms as well as with regular Unix mail. It can use the `pathalias` database for outgoing mail and can reverse the path of incoming mail to help ensure that replies will get to the original sender. There are zillions of options that let you customize `elm`'s performance and even its screen appearance. The program can even file and answer mail for you automatically.

Another program that I have found very useful is `xcomm`, by Larry Gensch (lar3ry on BIX). It is a Unix-oriented telecommunications program, mainly oriented toward calling non-Unix systems. So that logging on can be done automatically, `xcomm` keeps a list of phone numbers and start-up scripts, which is similar to the way that UUCP works. It has `cu`-compatible `put` and `take` commands and lets you upload and download both binary and text files, using XMODEM and CIS protocols. You can start or end disk logs of interesting material while you are on-line. Its script language allows you to automate sessions. The program fills in the gaps left by standard Unix commands and lets you communicate with any system that supports the ASCII character set.

Other Networks

Usenet is certainly not the only Unix-oriented network, although it is the largest. Some other (but still by no means all) important networks include the Internet (which itself comprises ARPANET, CSNET, MILNET, and NSFNET), BITNET, CompuServe, FidoNet, and MCI Mail. Geographically oriented networks include ACSnet (Australia), EUnet (Europe), IUnet (Italy), JUNET (Japan), and UKnet (United Kingdom). While most of these are Unix-oriented, quite a few are not, but all can be reached via UUCP or TCP/IP connections from any Unix system. The trick is to have the appropriate mail software and to know how to reach the "gateway" machine to the target network while using the correct address.

That brings up another problem. Unix users using UUCP are accustomed to addresses like `gecko!lizard!serpent!reptile!dragon`, where you must specify an explicit path to ensure mail delivery. The preferred addressing method for the 1990s is called "domain addressing," which leaves the actual delivery mechanism out of the address. Thus, while my computer has been known for years as simply "infopro" under UUCP-Net conventions, you can now address it as `infopro.uucp`, signifying that it is the infopro machine in the UUCP domain. Notice that the "bangs" (! characters) are gone under this scheme. My new, improved, full domain address, therefore, is now `david@infopro.uucp`, in place of

continued

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the older infopro!david.

There are many other domains, each of which is a high-level gateway that knows how to route messages. For instance, you could have an address such as `foo@bar.klunker.com`, which would signify that the destination is a person with the log-in name foo on the computer called bar at a company named klunker (the suffix `.com` means it's a company or a commercial entity of some kind). Or you could send mail to `joe@finagle.smart-college.edu` (joe attends smart-college, an EDUcational institution, and has an account on a machine called finagle), or to `singh@curry.calcutta.in` (a person named singh at a computer called curry in Calcutta, India).

In each case, your software only has to know how to translate the domain (`.com`, `.edu`, or `.in`) into a machine destination. From that gateway machine, your message will be routed (internally to the domain) to the destination machine. In many cases, the information provided in the maps will go even further, allowing your computer to generate a path directly to `klunker.com`, `smart-college.edu`, or `calcutta.in`.

For more information on the wonderful and confusing world of network addressing and gateways (the above is only a small sample of the possible confusion), a recently released book by Donnalyn Frey and Rick Adams called *!%@:: A Directory of Electronic Mail Addressing and Networks* (O'Reilly and Associates, 1990) is a must. The book lists full details on over 100 different networks and has maps, contact, and gateway information, as well as many pages on all the addressing schemes. Rick Adams is the president and technical director of UUNET Communications Services and is in a good position to know the tricks for getting around the networks.

Over the next few months, I'll expand the discussion of public domain software past communications. I'll talk about the legendary Free Software Foundation and GNU Project, available archives and where to find them, and the work and benefits you can get from using "freely available" software. ■

David Fiedler is publisher of the Unix Video Quarterly *and the journal* Root, *as well as coauthor of the book* Unix System Administration. *He can be reached on BIX as "fiedler."*

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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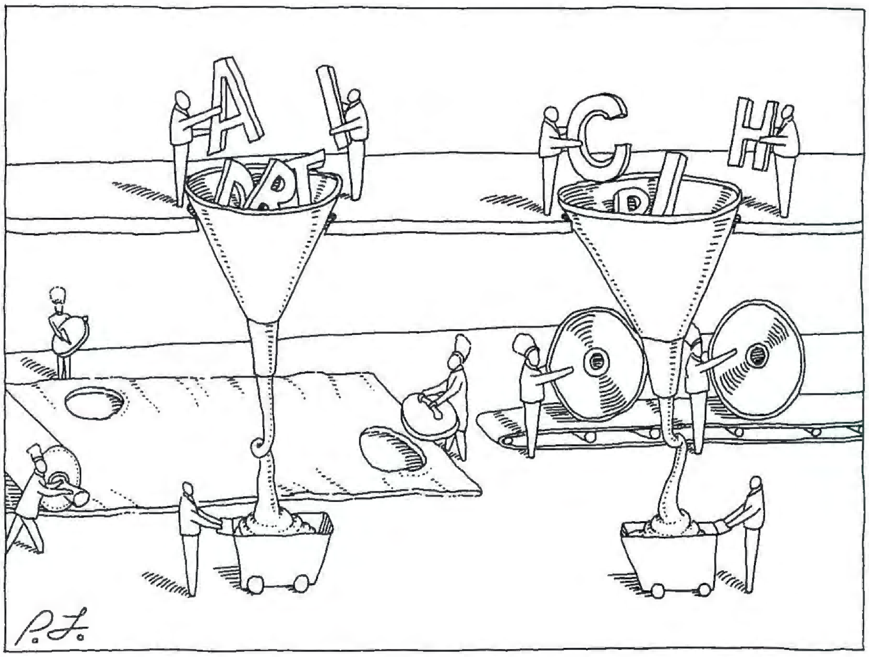
Do-It-Yourself CD-ROMs

If the information you need to access isn't on a CD-ROM, maybe you need to make your own



Last month I talked about how useful CD-ROMs are if you need rapid access to a vast quantity of information from commercially available sources. But what do you do if the data you need to access is your own proprietary information? You learn to "roll your own" CD-ROM.

A government agency had this kind of a problem. It simply had too many repair parts to keep track of. As a result, the agency's employees were frequently unable to find the correct replacement parts even though they were available somewhere in the warehouses and storerooms. Managers found that they were often buying parts at retail that were already in inventory because no one had been able to locate them.

Determining the cause of the problem was easy. The agency was responsible for keeping track of hundreds of thousands of parts, which it dutifully listed in catalogs that were printed on paper or stored on microfiche. There were so many entries in the catalogs that the employees couldn't be sure whether they were really finding the proper part or whether they were missing an item that was on a change sheet or a missing page.

The paper catalogs and parts listings were the biggest problem. A search of the piles of paper was doomed to failure. Even the handling and storage of the paper that was required for the catalogs was a problem. A solution was needed.

ROM to the Rescue

Although the agency had thousands of items to keep track of, the inventory was fairly stable. New items were added to the list slowly, and old items were removed only occasionally. What was needed was a compact, easy-to-use way to find the repair parts. A CD-ROM was an obvious choice.

Moving the parts catalogs to CD-ROM allowed the employees to look for a part by its stock number, its name, or by the name or stock number of the item it was installed in. The CD-ROM software allowed users to read descriptions of the item, see ordering instructions, and even see a drawing of the item if necessary. Suddenly, all that was required to serve as a catalog was a personal computer with a CD-ROM drive and a user with minimal training.

Doing It Yourself

While the government agency had the help of a consultant to convert the parts data for use with a CD-ROM, such conversions are rapidly becoming easy enough that some companies can do the work themselves. At the same time, the cost is dropping so fast and so drastically that publishing on a CD-ROM may become cheaper than publishing a catalog on paper. It all depends on the application.

This is not to say that the cost is insignificant. A company that has to convert records on paper to digital information will have a great deal of work to do. The information may have to be keyed in by hand, one record at a time, which can be expensive.

Of course, many businesses already have their information digitized. It may be in the form of an inventory, for example, which can easily be stripped of unnecessary fields and used as the information for the CD-ROM.

Once you've done this, the next important step is deciding what your users are going to do with the data. What kind of searches are you going to do? What will

continued

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ITEMS DISCUSSED

Prices are not included due to the individualized nature of the data conversion, data preparation, and premastering processes.

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the search criteria be? This information is critical in deciding how the data will be organized and indexed, and how useful the resultant CD-ROM will be.

Searches and Indexes

Deciding on the search criteria probably isn't as hard as it may seem at first glance. Essentially, the process consists of deciding what the users will be looking for and where they might find it. A parts listing, for example, might be set up so that you can search for the part number, the name, the revision or modification number, and the part number of the parent assembly. Other types of data require other search methods. You may even want to do a full text search in some cases.

The details of how you will approach this process depend to some extent on the abilities of the database software you plan to use. Some of the database packages designed for use with CD-ROMs let you search for two words in the vicinity of each other, some allow logical operators, and some only allow simple text searches.

Once you have decided what you want to look for and how you want to find it, you need to get your data into shape. It has to be in a format that the company that makes the CD-ROMs can use. Normally, if the data is in a flat ASCII file, a dBASE file, or a comma-delimited file, you needn't do anything. Your data is already in an acceptable format. Once you have chosen how you want to present your data, it's time to get it ready for the CD-ROM company.

The Four Steps

I spoke to Tom Vreeland, president of Network Technology in Springfield, Virginia. Network Technology provides the Lasertex software that many CD-ROM developers use to support searches. It also provides a complete CD-ROM development package, from preparing the data to providing the finished product.

According to Vreeland, there are four essential steps to producing a CD-ROM for distribution: preparing the data, premastering, mastering, and replication. Any company with the proper equipment can perform the first two steps and save the cost of paying an outside firm to do it. Mastering and replication involve the production of the actual disk, which requires specialized equipment. This must be done by a compact disk production company.

Once your company data is in electronic format (either it was already on disk or you had it keyed in), you must prepare it for premastering. This means that you have to take the information you developed about search criteria and indexing and put it into use.

Companies such as Network Technology, Crowninshield Software (Boston, MA), KnowledgeSet (Mountain View, CA), and Optical Publishing (Fort Collins, CO) provide database software and development tools that allow companies

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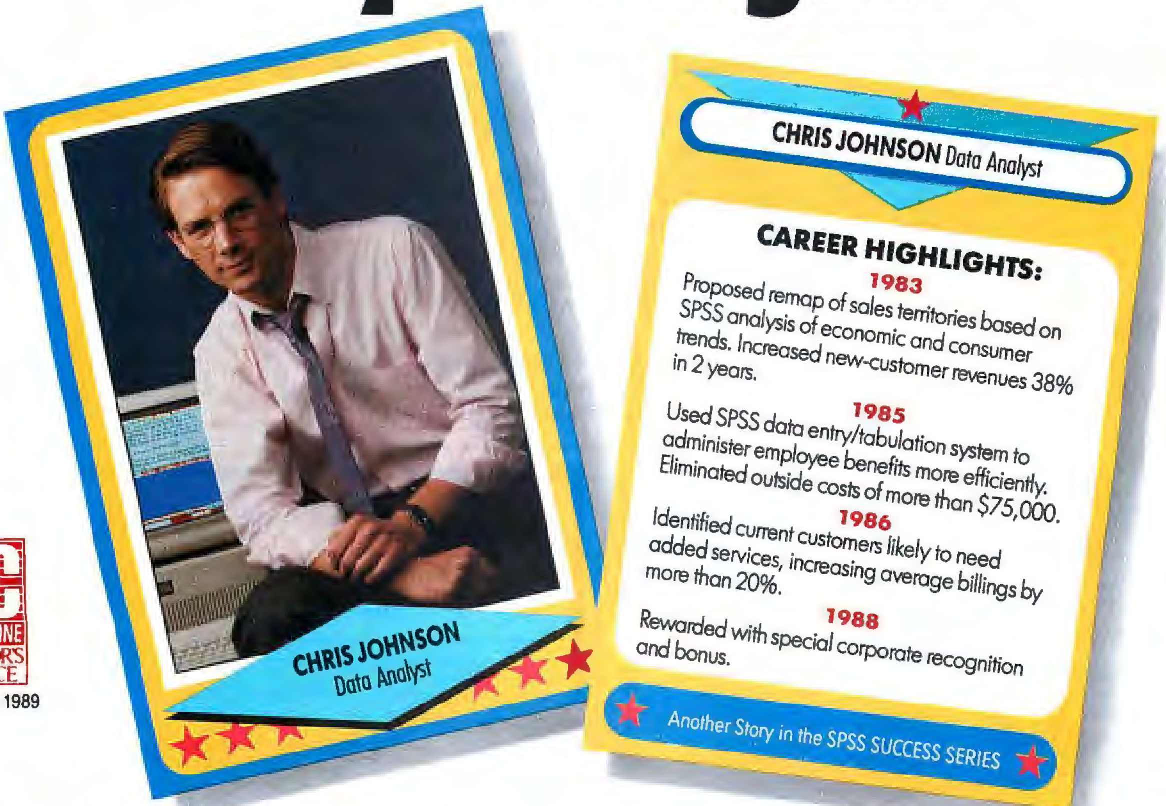

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to develop their own CD-ROM search routines using packaged software. These packages provide an easy-to-use interface with menus and windows, and they usually support the display of graphics images on computers equipped to display them.

Once the data-preparation step, which includes testing of the search software, is complete, the next step is premastering. This process involves adding the indexes and the error-correction information that will be needed to support CD-ROM use and transferring the information to either a nine-track tape or a WORM (write once, read many times) disk.

Most software will support CD-ROM development on an IBM AT-compatible computer. A few packages will let you use a minicomputer or a mainframe, which will speed up the process. In either case, the transfer medium must hold all the data, the indexes, and the error-correction information, which can amount to as much as 800 megabytes for one CD-ROM. This is why you need tape or a WORM disk.

Once you have delivered the tape to the CD-ROM production company, the process is out of your hands. The company will create the master used for manufacturing the disk itself and then injection-mold the distribution copies. You will receive a shipment of the finished product, ready for sending out to your customers.

The Costs

Depending on how much of the work you can do yourself, and on what shape your data is already in, CD-ROM production can be relatively inexpensive. According to Vreeland, the entire process, including production of the finished disks, can cost less than $10,000. The exact costs are difficult to determine, because they depend on the amount of data, the work to be done, and the royalties on the database software.

Network Technology charges $13 per disk—a price that covers disk production and the royalties. Other suppliers have other ways of charging, so exact comparisons are difficult unless you have detailed information on your specific circumstances.

One often-overlooked cost is the addition of a CD-ROM drive to the computers that you'll use to access the CD-ROM you are developing. In the past, these drives were expensive, but the price has been dropping. Vreeland pointed out that CD-ROM suppliers, including his company, are trying to find ways to increase sales of the CD-ROM drives so that more people can use the CDs they produce.

Because of much lower prices, it's much easier to convince your customers to buy a CD-ROM drive to use your catalog. After all, they don't want to be inundated by catalogs any more than you do. And they do want to be able to find products and inventory easily using a minimum of staff time. CD-ROMs can make that happen. ■

Wayne Rash Jr. is a contributing editor for BYTE and a member of the professional staff of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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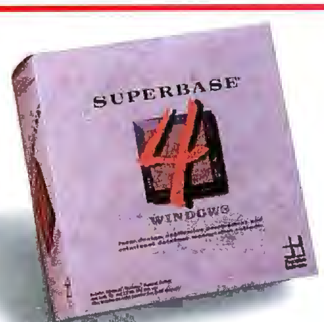

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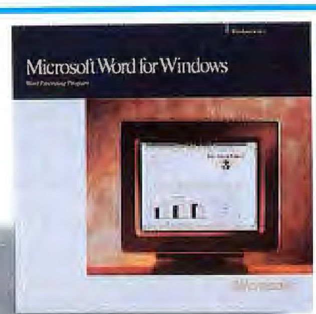

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5408 □Hyperpad 1.0 . . . . 85.
Broderbund ... CP
1434 □New Print Shop *(NCP)* . . . . 39.
1433 ▣Memory Mate 3.01 *(NCP)* . . . . . . 45.
ButtonWare ... NCP
6419 ▣PC-File 5.0. . . . . 75.
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6004 ▣Omnipage 386 2.1 . . . . 599.
Central Point ... NCP
5039 ▣PC Tools Deluxe 6.0. . . . . 89.
5038 □Copy II PC 5.0. . . . . 27.

Chipsoft ... NCP
1663 🄱TurboTax for 1989 Taxes 7.0. . . . $45.
🄱Individual States. . . . . .each 34.
Chronos Software ... NCP
4387 ▣Who•What•When 1.09 . . . . 119.
Concentric Data Systems ... NCP
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Corel Systems ... NCP
5506 □Corel Draw 1.1. . . . . 329.
Crosstalk Communications ... NCP
2908 □Crosstalk XVI 3.7 . . . . 119.
5611 □Crosstalk for Windows 1.0 . . . . . 129.
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1748 ▣DacEasy Accounting 4.0 . . . . 89.
Data Storm ... NCP
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Delrina Technology ... NCP
4325 ▣PerFORM 2.0. . . . . 169.
Delta Technology ... NCP
5829 ▣Direct Access 5.0. . . . . 52.
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5876 ▣db Publisher Report Maker 2.0 . 185.
Dow Jones ... NCP
5494 🄱News/Retrieval Membership Pkg. 24.
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2762 □Mace Utilities 1990. . . . . 89.
3950 ▣Fastback Plus 2.1 . . . . 109.
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2233 🄱Foxbase Plus 2.1 . . . . 199.
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2901 □Word 5.0 .... 209.
6195 ▣Word for Windows .... 329.
2856 ▣Excel 2.1 *(req. 80286/80386)* ... call
6133 ▣Excel for OS/2 1.0 .... 339.
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Quarterdeck ... NCP
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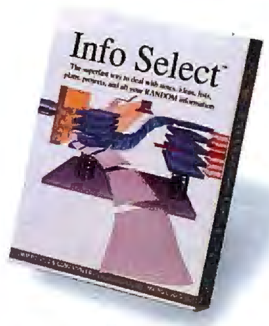

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6289 ▣Draw Partner 1.0 *(for Harvard Graph.)* 59.
Symantec ... NCP
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6572 ▣WealthBuilder 1.1 .... 145.
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Revolution Software ... NCP
4480 ▣VGA Dimmer 2.01 *(screen saver)* . 19.
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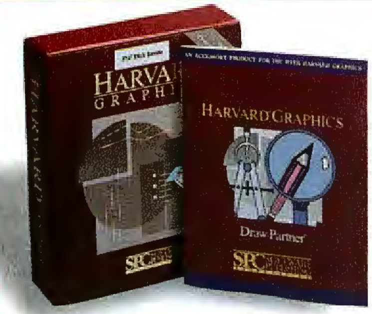

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5000	☐*Upgrade to Version 6.0*	89.
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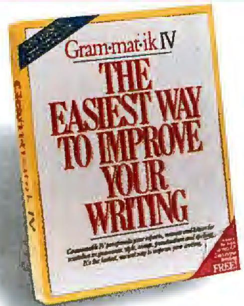

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5804	▣Deluxe Paint II *(Enhanced)*	89.
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5106	▣Space Quest III	39.
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5993	▣Welltris	22.
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3438	▣1st Math *(ages 5 to 8)*	22.
3439	☐2nd Math *(ages 7 to 16)*	27.
	Sublogic ... NCP	
6190	☐Air Transport Pilot	33.
	True BASIC, Inc. ... NCP	
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Manufacturer's standard limited warranty period for items shown is listed after each company name. Some products in their line may have different warranty periods.

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6811	360SX *(stand-by power source)*	255.
	AST Research ... 2 years	
1299	SixPakPlus 384k *C/S/P*	187.
6795	SixPak 286 512k	209.
4107	RAMpage Plus 286 512k	419.
4105	RAMpage Plus Micro Channel 512k	419.
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5788	HL-8Ps PostScript Laser Printer	2949.
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1604	2-Position switch box	25.
	Cuesta ... 1 year	
1608	Datasaver 400 Watt *(power backup)*	429.
	Curtis ... lifetime	
1694	Emerald SP-2	36.
1707	Ruby SPF-2 *(6 outlets)*	55.
1708	Ruby-Plus SPF-2 Plus	65.
	Diconix ... 1 year	
5655	150 Plus Printer *(Parallel)*	359.
	Epson ... 1 year	
	We are an authorized Epson Service Center.	
1906	FX-850 *(80 col., 264 cps, 9 pin)*	call
1904	FX-1050 *(136 col., 264 cps, 9 pin)*	call
5183	LQ-510 *(80 col., 180 cps, 24 pin)*	call
1930	LQ-850 *(80 col., 264 cps, 24 pin)*	call
6765	LQ-1010 *(136 col., 180 cps, 24 pin)*	call
1917	LQ-1050 *(136 col., 264 cps, 24 pin)*	call
4116	LQ-2550 *(136 col., 333 cps, 24 pin)*	call
5184	LX-810 *(80 col., 180 cps, 9 pin)*	call
1052	Printer-to-IBM cable *(6 feet)*	15.
	5th Generation ... 1 year	
3952	Logical Connection 512k	call
	Hayes ... 2 years	
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2308	Smartmodem 2400B *(w/Smartcom II)*	279.
5991	9600 Baud V series modem	759.
	Hercules ... 2 years	
2318	Graphics Card Plus	189.
	Hewlett-Packard ... 1 year	
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6582	Laserjet IIP *(w/toner)*	1039.
6581	Deskjet Plus *(w/ink cartridge)*	719.

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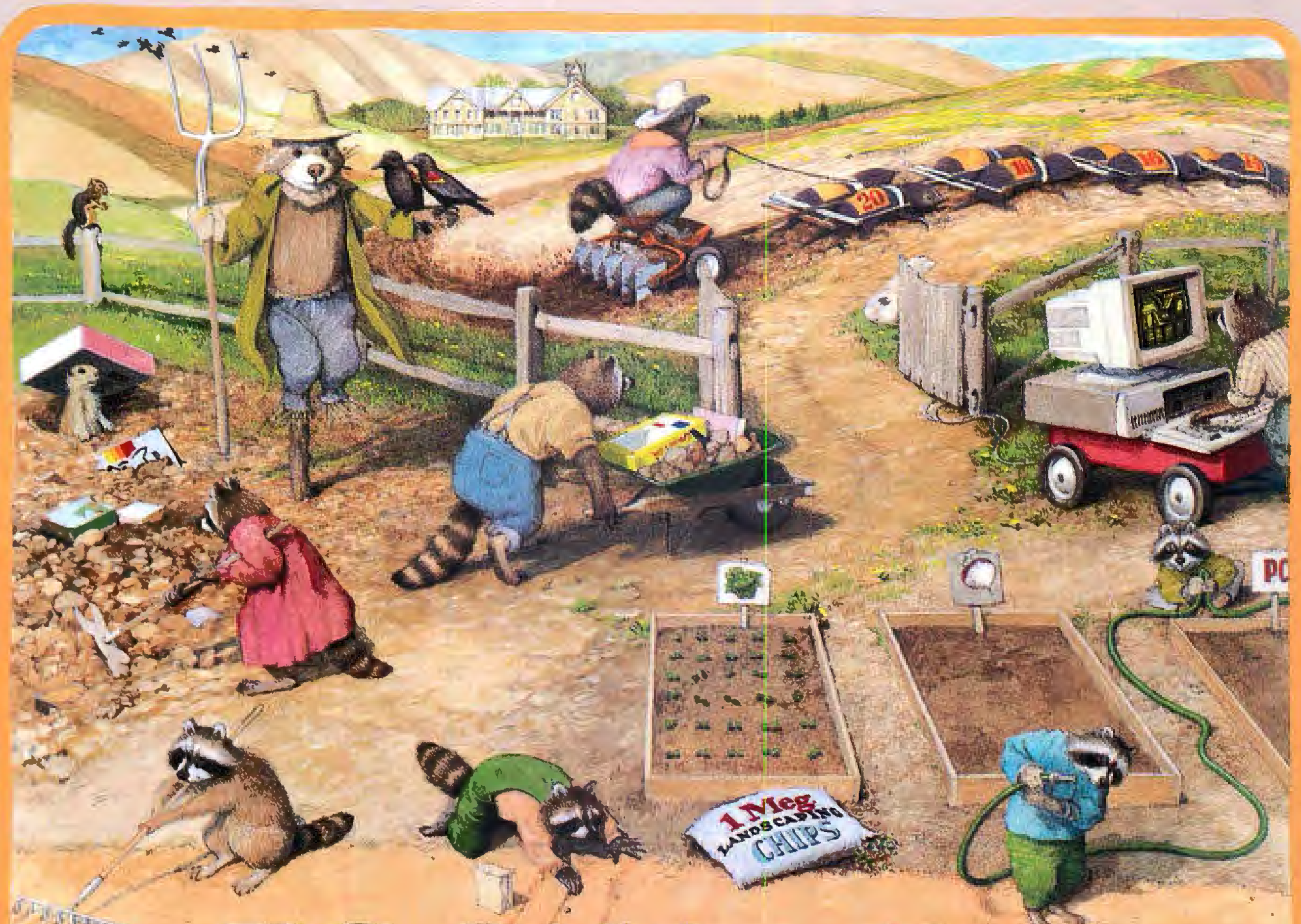

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Silicon salad days.
(Or, how we mind our Peas & Cukes.)

Way up north in the fertile crescent of Marlow, NH (pop. 562), we know how to dig down deep. Which is pretty difficult (even for our celebrated 20 mole team) since the bedrock's just inches below the surface and the growing season's shorter than the day is long. But, with the winds of change blowing non-stop through the micro fields, you can't just scatter your seed any which way. You have to put down roots! We ought to know—we were the first company to sell peripherals and software exclusively for IBM personal computers. So when customers call us for product specs, prices, or technical assistance, they're dealing with a company that has its paws (and peas) planted firmly in the ground.

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Grow your own in a PC Connection Mint Garden. Offer not available outside the Continental U.S. or to accounts on net terms. One per customer.

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to make your PC go.

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5113 44 Meg Cartridge Tripak *(5 1/4")* . . . 249.
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5502 83-152M Ext. Tape Drive. . . . . 759.
5500 83-152M Int. Tape Drive . . . . 629.
6153 DC2120 Cartridge *(5 pack)* . . . . 135.
5190 DC2000 Pre-formatted Cartridges ea. 35.

Pacific Rim ... 1 year
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3106 Hardcard 40 Meg *(28 ms)*. . . . . . . 599.
6425 Hardcard II 40 Meg *(19 ms)* . . . . . 599.
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2287 40 Meg Int. HD for PC ST251-1 *(w/controller and cables, 28 ms)* . . 419.

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4670 1.44 Meg Drive for XT *(3 1/2")*. . . . . . 99.
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5511 Right Angle Printer cable *(6 feet)* . . . 15.
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3297 3 1/2" DS/DD 720k Diskettes *(Qty. 10)* . . 14.
3298 3 1/2" DS/HD 1.44Mb Diskettes *(Qty. 10)* 29.
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6712 QD 600A Tape Cartridge . . . . 27.
6715 QD 6150 Tape Cartridge . . . . 27.

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6556 256k DRAMs *(100 nanosecond)*. . . call
3248 256k DRAMs *(120 nanosecond)*. . . call
4366 1 Meg x 9 SIMMs *(100 nanosecond)* call
5510 1 Meg x 9 SIMMs *(80 nanosecond)* call
5746 1 Meg Chips *(80 nanosecond)* . . . . call

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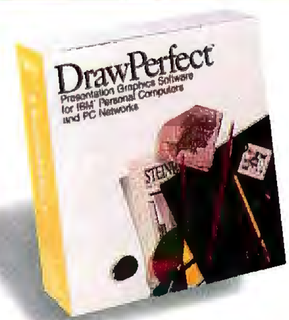

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2346 Inboard 386/PC w/1 Meg *(w/free Ami)* 579.
4266 Above Board Plus 512k......... 419.
4267 Above Board Plus I/O 512k...... 449.
5336 Above Board Plus 8 2 Meg...... 599.
5342 Above Board Plus 8 I/O 2 Meg ... 629.
4272 Above Board 2 Plus 512k .... 469.
5396 Above Board MC 32 0k .... 359.
4275 Connection CoProcessor *(w/Fax-it)*. 529.
4857 Visual Edge .... 449.
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2369 80287-10 *(for PS/2 Models 50 & 60)* 229.
4750 80387SX *(for 80386SX CPU's)*.... 309.
2371 80387 *(for 16 MHz 80386 CPU's)*.. 349.
2372 80387-20 *(for 20 MHz 80386 CPU's)* 399.

Kensington Microware ... 1 year
2587 Master Piece Plus Remote .... 89.
2582 Master Piece Plus............. 109.
5697 Expert Mouse *(Trackball for PS/2)* . 115.

Key tronic ... 3 years
4518 101 Plus Keyboard .... 99.

Kraft ... 5 years
5801 New Game Adapter *(2 game ports)*. 27.
5800 3 button Thunder Joystick........ 29.
5802 Trackball..................... 69.

Logitech ... limited lifetime
5464 Series 2 Mouse *(C9 for PS/2's)* .... 69.
5151 HiREZ Mouse *(C9)* .... 85.
6029 Trackman *(Trackball)* *serial* 85. *bus* 89.
4297 ScanMan Plus *(hand scanner)* ... 185.
6786 ScanMan w/Catchword 1.0...... 315.

Micron Technology ... 2 years
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6669 Intensify 2 Meg Expansion for HP LaserJet II *(upgradeable to 4 Meg)*. 329.
6013 Beyond Mem. Brd. for Model 50 *(512k)* 359.

Microsoft ... lifetime
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2898 Mouse with Windows 286 2.1 .... 139.

MicroSpeed ... 1 year
6007 PC-TRAC Trackball *serial* $75. *bus* $85.
6010 FastTRAP 3D Trackball *serial* 99. *bus* 109.

Mouse Systems ... lifetime
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5997 Trackball *(1 yr. wrnty.) serial* 75. *bus* 85.
4306 PC Mouse II w/PC Paint+ .... 89.

NEC ... 2 years
4799 Multisync 2A *(VGA Monitor)* ..... 499.
5085 Multisync 3D Monitor .... 689.
6208 Multisync 4D Monitor.......... 1199.

Orchid Technologies ... 4 years
4690 ProDesigner VGA *(800 x 600)* .... 249.

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3100 1200 Baud External Modem *(mini)* . 77.
3103 2400 Baud Internal Modem ..... 135.
3102 2400 Baud External Modem..... 179.
5286 2400 Baud Int. MNP Modem *(Lev. 5)* 175.
5285 2400 Baud Ext. MNP Modem *(Lev. 5)* 209.
4542 2400 Baud Internal Modem for PS/2. 229.

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4561 Safe 250W *(standby power bkup)* 199.
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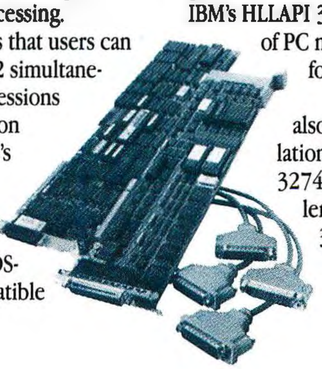

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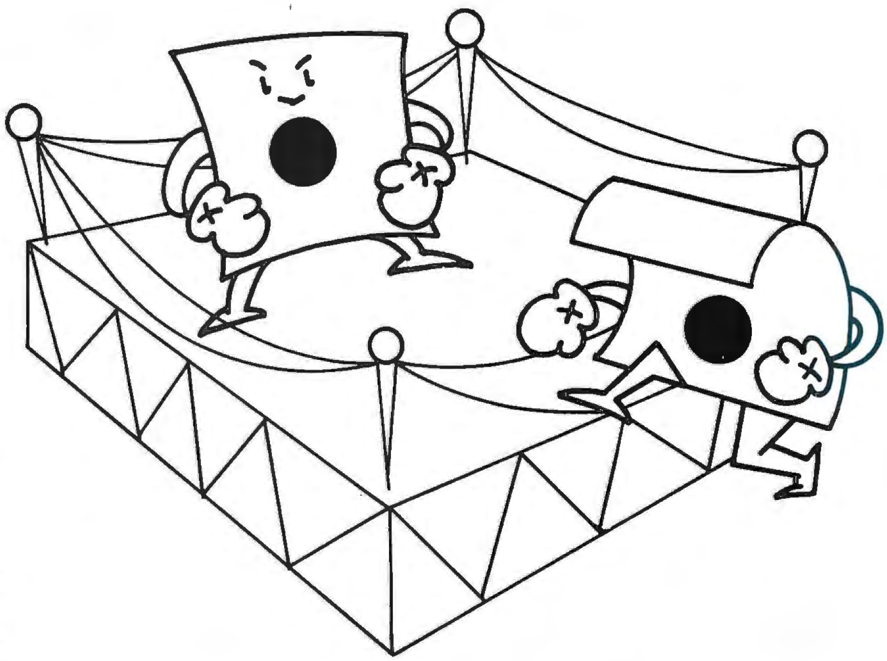
MICROSOFT'S NETWORK HEAVYWEIGHT

LAN Manager finally has the right stuff to challenge Novell's NetWare



Novell's NetWare presently holds the LAN title. Microsoft's LAN Manager has aspired to the championship for some time, but its current version, 1.0, has never been a serious contender. LAN Manager 2.0, however, just may have what it takes to make a serious bid.

Microsoft needed to release a radically improved version of LAN Manager, because version 1.0 was scarcely more than a basic LAN operating system. Sure, it let you share files and printers. It even had the major underlying functions that such applications as the SQL Server required.

What it lacked were the many features that would turn it into something that you could trust with large applications and their data. In an all-too-rare moment of vendor honesty, Microsoft even criticized its own product in a "report card" that the firm distributed in its Fall 1989 seminar entitled "Back to School with LAN Manager." While that report card gave LAN Manager 1.0 A's and B's for basic LAN services, the product didn't get above a C+ in such significant areas as administration, security, and fault tolerance.

With all these deficiencies, you might at least expect to get a small system. No such luck; LAN Manager 1.0 was a memory hog that consumed about 150K bytes on each client machine.

LAN Manager 1.0 had another problem that the report card didn't mention: The main commercially available versions, 3Com's 3+Open and IBM's LAN Server, were just too different. Even the perennial partners Microsoft and IBM bickered over whether such technical goodies as named pipes would be in their respective versions.

Meanwhile, Novell was happily selling its NetWare line. That line wasn't perfectly compatible (see "NetWare's Missing Links," February BYTE), but it was a lot closer than the LAN Manager versions.

Novell even went a step further and shipped NetWare 386, which can take advantage of the power of the 386 processor. LAN Manager 1.0, on the other hand, shared a basic trait with its underlying operating system, OS/2: Both were aimed at the 286 and made no special use of the 386.

LAN Manager 1.0 was also stuck with the slow OS/2 file system, which paid in speed for its DOS compatibility. Perhaps even more damaging is the fact that OS/2 still has not taken off the way that Microsoft hoped it would.

New Strengths

Now along comes LAN Manager 2.0. It isn't perfect, but it addresses all the problems of version 1.0. We like it enough that we plan to install and test the beta version on our lab's biggest server, the dual-processor Compaq Systempro.

Version 2.0's improvements start with those areas that earned bad grades in version 1.0. Its security options, for example, now include such important functions as password aging and the ability to restrict when and where LAN users can log in.

The new version's fault-tolerant features are now competitive with those of SFT NetWare. It can work with uninterruptible power supplies. It includes such data redundancy options as disk and controller mirroring, in which one disk/controller pair can be a constantly up-to-date copy of another.

LAN Manager 2.0 also makes it easier

continued

ILLUSTRATION: DEBORAH BLACKWELL © 1990

to manage large LANs, chiefly by offering domains. A domain is a group of servers that share a single database of user accounts. LAN Manager stores that account database on a single server, the domain controller. All log-in requests go through the domain controller; after logging in, users can work with any server they like. There are also now five levels of operator privileges.

Smaller and Faster

While it was adding all these new features, Microsoft didn't forget the product's core. LAN Manager 2.0's client code has slimmed down to under 100K bytes. If you have EMS 4.0 expanded memory, you can even get the client portion down to 60K bytes.

LAN Manager 2.0 is faster than the previous version, too, although here the big gains are in the server code. One of the most significant improvements is LAN Manager's ability to use OS/2 1.2's new High Performance File System. The HPFS, with its B-tree sorted directories, is faster than the DOS file allocation table file system of earlier OS/2 versions. The HPFS also does a better job than the FAT system of keeping files contiguous, so that such disk improvement techniques as sector prefetching and caching yield better results.

Microsoft has also made a special 386 server version of 2.0 that should yield further performance gains. This 386 version actually makes some changes to OS/2 1.2, which still doesn't do anything special to use a 386.

The main change has to do with where in the processor hierarchy of the 386 (or i486) LAN Manager 2.0 runs. The 286, 386, and i486 offer four levels, or rings, of processes. The most privileged level, ring 0, is where the guts of OS/2, its kernel, run. LAN Manager normally runs in the least privileged level, ring 3, along with all the other OS/2 application programs. This design forces LAN Manager to run under the normal OS/2 security controls and doesn't require any changes to the OS/2 kernel—LAN Manager is just another application.

This design is also potentially slow. For one thing, communication between processes in different rings is, in processor terms, fairly expensive. Also, every time LAN Manager needs any file service, it has to go through OS/2.

LAN Manager 2.0 changes all that when it runs on 386 or 486 servers. Its most critical file access code goes into a subsystem in ring 0. This subsystem includes a special 386 version of HPFS, the core of the Server Message Block protocol, and the LAN adapter device drivers. These components bypass OS/2 entirely and manage their own interactions and handle all LAN Manager 2.0 file access requests. (All other requests go to the normal LAN Manager code, which is still in ring 3.) Microsoft further increased the speed of these components by rewriting them to take advantage of 386 instructions.

Even that's not the whole story, because you can move the entire new 386 portion of LAN Manager 2.0 onto a second processor in a dual-processor server. That processor will handle nothing but the well-greased file requests. The primary processor will run the rest of the world: OS/2, the ring 3 part of LAN Manager, and any LAN applications on your server.

This processor arrangement is called

continued

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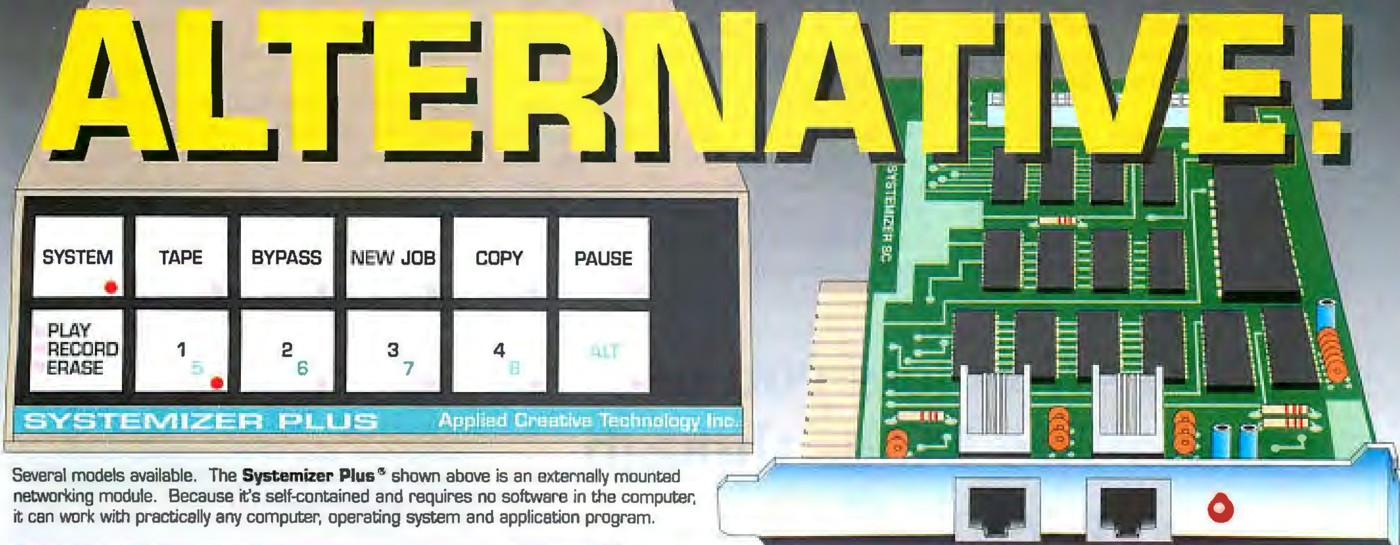

Several models available. The **Systemizer Plus**® shown above is an externally mounted networking module. Because it's self-contained and requires no software in the computer, it can work with practically any computer, operating system and application program.

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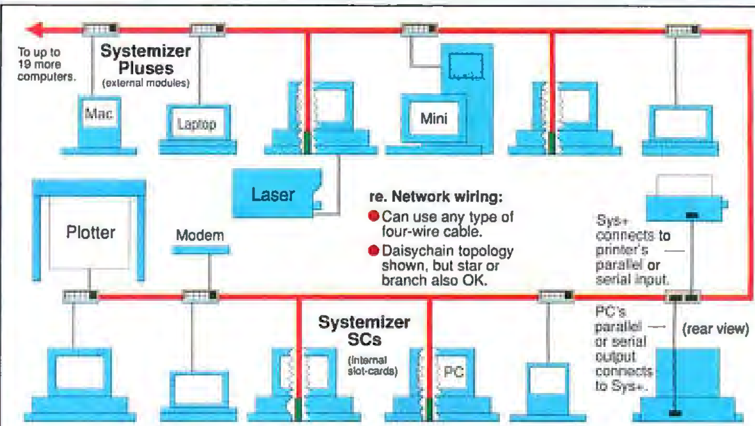

Example Systemizer network consisting of 11 micros *and* a minicomputer, sharing 3 printers and a modem via a mixture of Systemizer Pluses and Systemizer SCs. Note: though not shown here, some of the computers could also be connected to a traditional LAN or WAN.

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asymmetric because the two processors are definitely not equal. Not surprisingly, many vendors, including Compaq, have recently announced asymmetric, dual-processor 386/486 servers.

A Salute to Consistency

Even with these technical improvements, LAN Manager 2.0 still has a potential multiple-version problem. While its biggest commercial versions remain IBM's LAN Server 1.2 and 3Com's 3+Open 2.0, such vendors as Compaq, Torus, Tapestry, and Ungermann-Bass will also join the LAN Manager 2.0 field.

Unlike the case with their version 1.0 products, the vendors of version 2.0 seem to be trying to stick to a single core. We've talked to a lot of them, and it really does sound like they all plan to stay close to the Microsoft base—when both IBM and 3Com say that they want the LAN Manager core to be consistent, we have to take note.

But that is not to say that these different vendors will offer identical products—far from it. They'll just make their marks by supplying different products and services built around the 2.0 core. 3Com will add such features as mail, internetworking, and support for the Apple File Protocol. We expect IBM to leverage its integration with its databases and mainframes by offering such services as Unified Profile Management, in which the database and the file servers will share user IDs and passwords.

The different versions also will not have completely compatible cores. IBM's LAN Server 1.2 will still have some differences in its application programming interfaces, although we believe that the vendor does plan to make good on its commitment to bring LAN Server and LAN Manager together.

The Byte Budget

All of us who use LAN Manager 2.0 will also pay something for its many new features: memory. The vendors claim minimum requirements of 4 to 6 megabytes; we suspect that 8 MB will be the norm.

We also have to wonder when we'll finally see shrink-wrapped versions of version 2.0. IBM and Compaq claim that they will ship the product in the first quarter of this year, so it should have arrived before this column sees print. We pressed IBM on this point, and the vendor held firm to its March 30 ship date. 3Com will follow in the third quarter of this year; it needs the additional time because of all the extra features that its version will include. Those dates seem believable, if a little optimistic, as we write this column. Microsoft has the software in beta testing, and OEMs have beta versions in their hands.

A Call to Arms

If LAN Manager 2.0 does everything that its press releases say it will, it will have taken a giant step forward. We don't expect it to be the end of NetWare by any means, but LAN Manager 2.0 is impressive. It will be interesting to watch its effect on the LAN marketplace and on NetWare. We'll keep you posted. ■

Bill Catchings and Mark L. Van Name are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "wbc3" and "mvanname," respectively.

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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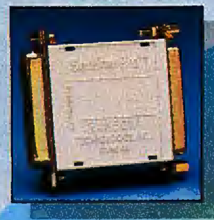

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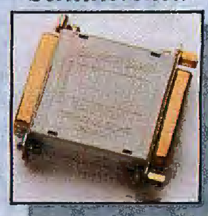

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THE FRUITS OF CONNECTIVITY

It's not enough to connect computers; they must also share information

Connectivity. Apple sometimes chants this word like a mantra. It's as if connectivity were the be-all and end-all of computing. With the multiplatform shops of the nineties, connectivity can often make the difference between everyone working together or in isolation.

However, this often overlooks the reason for these interconnections. The fact that the Macintosh now uses LocalTalk, EtherTalk, and TokenTalk misses the real point. Those environments are just the nuts and bolts that tie dissimilar computers together. The real reason for connecting computers is simple: sharing information.

Apple has done a decent job of creating—or encouraging others to create—all those different networking technologies for the Mac. However, Apple should go further. Where is its vision of the new computing made possible by these connections? Where is Apple's white paper on how connectivity makes all kinds of new uses for technology possible?

Telling us that the Mac now works fully in all the major microcomputer, minicomputer, and mainframe networking environments isn't adequate. Apple should also be telling us how these interconnections, combined with the Mac's own ease-of-use benefits, will make new things possible.

Instead, Apple's Knowledge Navigator picture of the future is vague, almost fanciful. Come on, now: What kind of information sharing should all these hookups allow? Do you see a world dominated by new categories of groupware applications (à la Lotus Notes)? Do you see transparent computing across platforms and vendors (e.g., IBM's OfficeVision)? Do you see transparent information interchange? Please call a timeout from the quarterly earnings reports and reorganizations.

Of course, get your current house in order. Get your product line sorted out. Drop your prices across the board so that new Mac users don't keep asking me, "Why is a Mac SE so much more expensive than a 286 DOS machine, Don?" Then tell us what lies in the future. And tell us how you'll take us there. That vision made the Mac popular, successful, and different. Don't blow it now.

Third-Party Visions

If Apple isn't sure about what to tell us, it should look for inspiration among third-party vendors. It can start with its own subsidiary, Claris. The people at Claris have a real vision of the future that's not based on Knowledge Navigator or the various ways that multimedia will enhance our lives. Claris's future is based on a careful consideration of where the Mac technology is now and what can be done to extract the most out of it in the future.

If you aren't familiar with Claris, you should be, even if you don't care one bit about the Mac. Claris has figured out that its products have to talk with each other, transparently.

Big deal, you say? Well, it certainly can be: Try to make dBASE Mac talk with FullWrite Professional. Or try to make Excel talk to Word. Sure, you can exchange parts of files, and even have those parts auto-update. But transparently? No. I'm not singling out these applications as bad; it's just that people sometimes try to use one application's data (that Excel spreadsheet) in another one (adding the spreadsheet figures to a

continued

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quarterly business report in Word).

Claris has publicly (the only place it counts for its customers) committed to making its applications talk together seamlessly. Its XTND file format is part of that commitment. Its devotion to Apple's Inter-Application Communication (IAC) is another. And its product development strategy is the third.

The bottom line is that Claris is well aware that connectivity really means transparent data exchange and update among applications, Macs, and, eventually, different workstations running other operating systems. Claris envisions you sitting in front of your computer and working with the information rather than worrying about the tool. That's a real computing future that makes for a real computing strategy. I hope Apple listens.

Foresight at Farallon

Claris isn't the only third party Apple should be listening to. Farallon Computing, manufacturer of PhoneNet, is another. I recently spent a day at Farallon's new digs in Emeryville, California. The first thing that struck me was the company's knowledge about computing in general and the Mac specifically. Farallon knows its own products (inside and out), its competitors' products, what is happening in the computer market, and where the company is going.

Although Farallon makes many dollars on its easy-to-buy-and-use AppleTalk cabling systems, it doesn't think in terms of being a networking company. Like Claris, Farallon sees the big picture: the reason for technology, and what it should be doing for us.

As I reported in March, Farallon's new product, MediaTracks, is hot stuff. It's exactly what I mean when I say that the company has a handle on the big picture. MediaTracks is not the be-all and end-all of multimedia applications. It's not MacroMind Director or Studio/8. It allows you to edit Mac video (i.e., Mac screens you've recorded with ScreenRecorder), annotate it, add sound and voice-overs, and use it. It accomplishes this task simply and straightforwardly, the way a computer application ought to.

Farallon knows that the future of computing revolves around this kind of almost embarrassing simplicity that works across computers, computers that can be across the country. It knows that Mac technology should be driving this realization and leading the way to real communications connectivity (which goes far beyond Apple's connectivity mantra). But don't take my word for it. Watch Farallon closely over the next year.

I just hope that Apple watches, too.

Tip of the Month

If you own a Mac Portable, be careful with the Sleep command that's executed from the Finder's Special menu or from the Battery desk accessory. It can cause some problems with files that are left open when it's executed. Sleep effectively turns off all the Portable's subsystems, except the static RAM, keeping your current application and its attached file ready for immediate use. Just press any key, and the Portable resumes where it left off, without rebooting.

All of that's fine—in theory, anyway. But I've recently discovered some problems caused by Sleep. I was working with my Mac Portable in Cupertino last week, and I had two applications (and their attached documents) open under

continued

MultiFinder. I saved the documents to the hard disk and decided to get some sleep (the human kind). I was planning to get up at seven and finish my work, so I used Sleep to keep things just a keystroke away.

Awaking at seven, I pressed a key and the Portable came back to life, putting me back into MultiFinder with my two applications (VersaTerm-Pro and Nisus), just where I had left them. Except. . .I switched to the Nisus file. It was, to use a popular expression, toast. The screen was filled with garbage—no text. The application was OK, but the file was definitely not. I closed the file and reopened it with Nisus. Same problem. The saved version from disk was also history. Fortunately, the disk backup was OK.

After some hours of experimentation with Sleep and other Nisus test files, I duplicated the problem repeatedly. It comes down to a problem with Nisus's auto-save feature (which can be set to different timings) conflicting with Sleep. Nisus probably thinks the machine is in an active state during Sleep (which it isn't) and tries to auto-save the file, which is impossible since the hard disk is powered off.

I tested Sleep in other contexts. After doing a few experiments with MacWrite II, Excel, FileMaker II, VersaTerm-Pro, WingZ, and StuffIt, I found that Sleep can definitely trash files when these applications are left open under MultiFinder and the command is executed. I even managed to trash the VersaTerm-Pro application itself, with an alarming ease.

I reported these problems informally to friends at Apple and found they've had problems, too, with their own Portables. My advice: Don't use Sleep to save a system context where you have multiple applications open under MultiFinder. Save your files and close the applications before invoking Sleep. Better yet, just invoke the Finder's Shut Down command, which accomplishes the same thing and turns off the Portable. For now, when I go to shut down my brain in the wee hours, I'll shut down my Portable, too. Sleep apparently is not as good. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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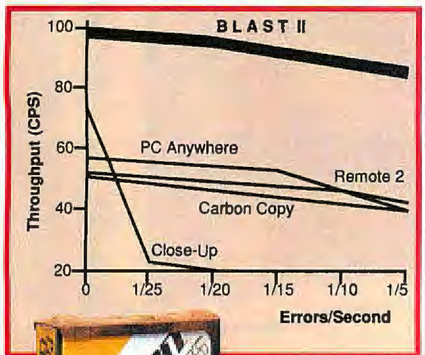

Remote control speed tests run using the DOS "TYPE" command for an 18K "C" source file at 1200 bps between IBM-XTs.

BLAST's new remote control module gives you complete control of a remote PC, including its programs, data, disks, screens and keyboards.

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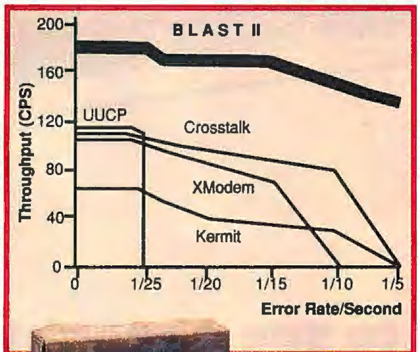

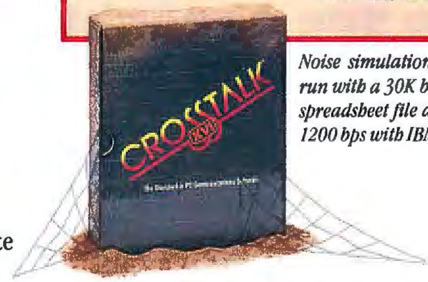

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DATA GENERAL	RDOS; AOS; AOS/VS
WANG	VS
PRIME	PRIMOS
HP	3000/MPE; 1000/RTE
HARRIS	VOS
TANDEM	LXN
UNISYS	BTOS, CTOS, UNIX
UNIX	AT&T; Altos; NCR; Sun
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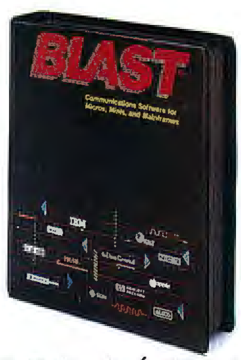

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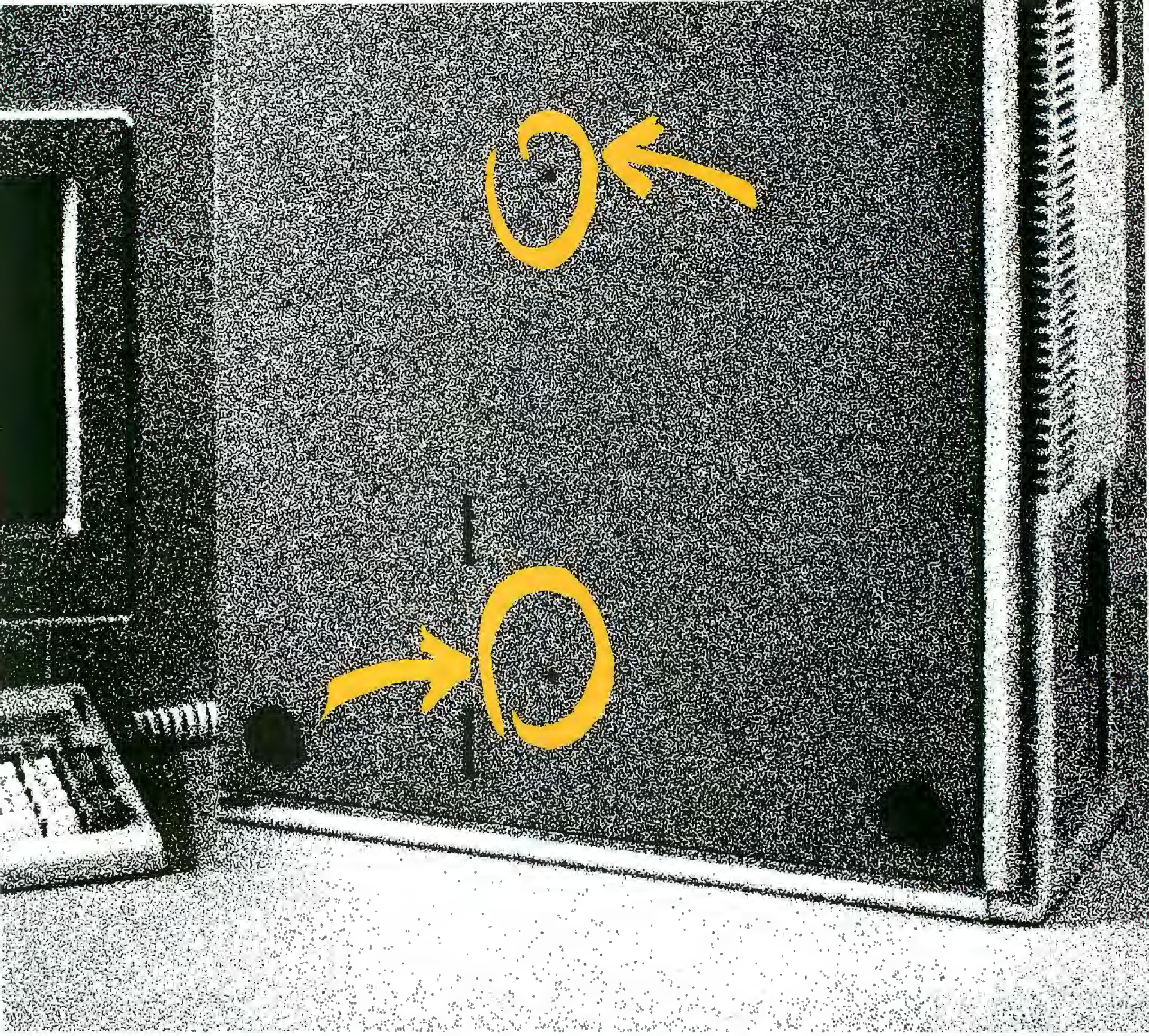

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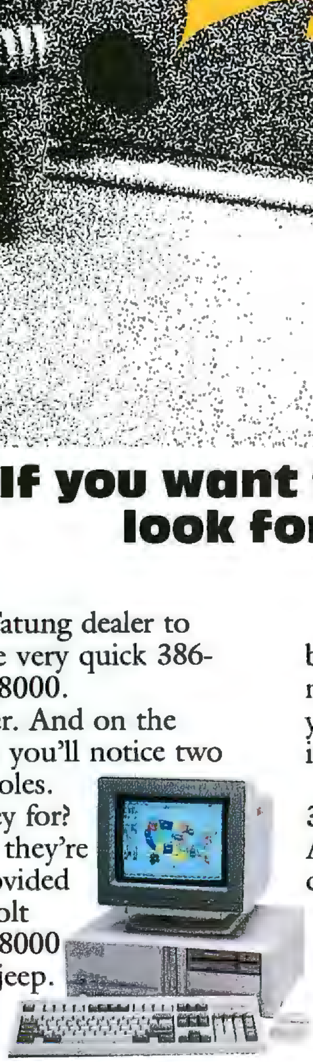

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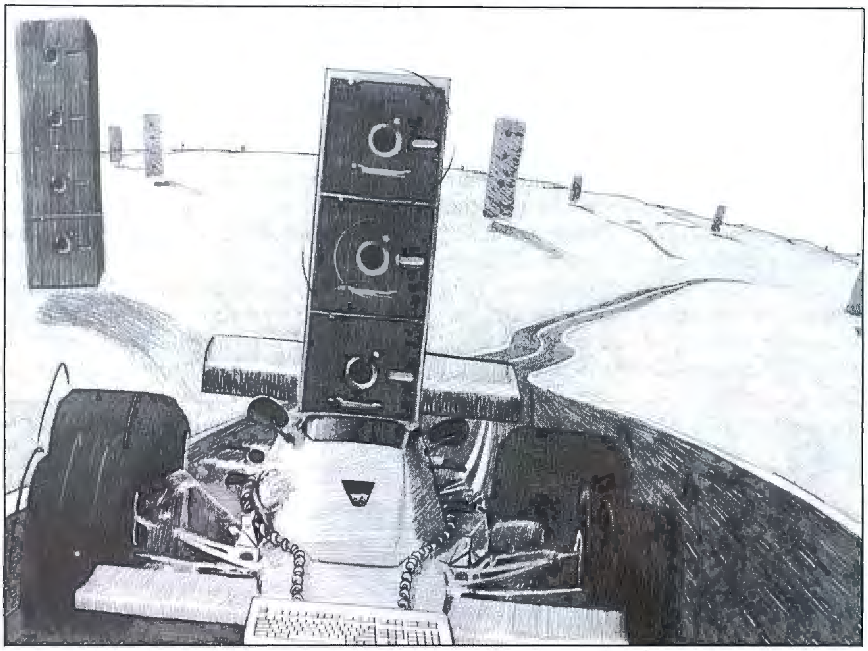
Circle 268 on Reader Service Card

DIGGING INTO HPFS

Putting the new HPFS under the magnifying glass



I have now had a few months to play with the High Performance File System. As I've mentioned before, it's a bit faster than the old file-allocation-table (FAT) system, on balance, and is also chock-full of new features. Microsoft has been pretty close to the vest about the innards of HPFS, mainly because it doesn't want to give anything away that would make the patent process more difficult. Since Microsoft hasn't released some details yet, I got out my Norton Utilities and did a little spelunking. To make my examples simpler, I am assuming that all files are contained in the root directory of the disk.

HPFS Disk Organization

Under the FAT system, the disk had the following:

- a DOS boot sector with disk ID information and a pointer to the FAT
- a FAT that indicates where your files exist, with data areas allocated in terms of multiple-sector minimum units called *clusters*
- a root directory to tell you what files you have
- a large data area for the files themselves

Under HPFS, a disk is divided up quite differently (see figure 1). It now has the following:

- A boot area with disk ID information (16 sectors).
- The Superblock (right after the boot area), which contains 32-bit pointers to major system areas, including the root directory, a map of free space on the disk, and a list of bad areas on the disk, as well as other system information (e.g., the last time that CHKDSK/F was run on the disk).
- The Spareblock (right after the Superblock), which contains other system information (I will not use any of its information here).
- Data bands. The 8 megabytes following the Spareblock is data band 1. Minimum disk space allocated to a file is no longer the cluster, but rather the smaller (less wasteful) sector. Disks are divided into these 8-MB data bands regardless of disk size.
- Free-space bit maps. Immediately following data band 1, four sectors (2K bytes) with a bit map describe the free space in data band 1. For each sector in data band 1, there is a bit. If the bit is equal to 1, the sector is occupied; if it's 0, the sector is free. Right after the free-space bit map for data band 1 is the one for data band 2. Data bands 2 and 3 sit next to each other, allowing a single file to be as large as 16 MB in contiguous length. Thereafter, pairs of free-space bit maps are wedged between pairs of data bands. Figure 1 shows a disk layout for a 32-MB hard disk drive.

How HPFS Finds Files

Under FAT, a pointer from the directory to the FAT leads in turn to other FAT pointers, which together describe which clusters make up the file. Under HPFS, it's a mite more complex, but the net effect is faster file access. To find a fairly contiguous file in the root directory, HPFS executes the following algorithm.

First, look in the Superblock at byte offset 12 for a 4-byte value that points to something called an *fnode* (pronounced "eff node") for the root directory. That 4-byte value is a sector offset. Thus, if the value is, for example, 700, the item being looked for is in the 701st sector on

continued

ILLUSTRATION: JEFFREY BARSON © 1990

the partition (701st because counting starts from 0). All "pointers" in HPFS are 4-byte sector offsets.

Next, use the Superblock pointer to find the fnode of the root directory. Fnodes are sectors that contain basic information about a file or directory. For example, a 100-sector file would actually take up 101 sectors on the disk: 100 sectors for its data and a sector for its fnode. Fnodes can take several forms, depending on how large a file is and how many extended attributes it has, but basically fnodes tell you where a file is and describe its EAs. The 72nd byte in the fnode of the root directory contains a 4-byte pointer to the root directory's sectors. In my case, the sectors ended up near the end of data band 1.

Use that 72nd byte in the root directory's fnode to access the root directory. The root directory gets allocated four sectors, as do all directories. Within the sectors, directory entries are variable-length, as the filenames can be as large as 255 characters. I'll explain what I've decoded of the directory in a minute, but it appears that each directory entry consists of 31 bytes and a filename. The directory then ends with a dummy record. Four of those 31 bytes point to an fnode for the file that you're looking for. (The file gets an fnode, just as the root directory did.)

After this, use the fnode pointer in the directory to find the fnode for the file in question. The fnode for a file describes the space that the file uses in one of two ways. The much more common way describes a file's location through the use of *sector runs*, which are 8-byte structures consisting of a 4-byte run length and a starting sector offset. For example, say the file occupies sectors 100 to 106 and 200 to 201. This file has two sector runs: a seven-sector run that starts in sector 100, and a two-sector run that starts in sector 200.

There's room for eight sector runs, so any file that's fairly contiguous (i.e., eight fragments or less) will fit nicely into this scheme. Figure 2 contains a partial fnode illustrating the eight sector runs for this file.

For the pathologically fragmented files, HPFS also allows an fnode to point to up to 12 *allocation sectors*, each of which can contain 40 sector runs of its own. This is probably about as much as anyone could want, although HPFS can have the allocation sectors contain not sector runs but more pointers to allocation sectors, and so on.

I found that the eight length/starting sector pairs started at byte offset 40 in the fnodes that I examined.

Finally, use the sector runs to find the file itself.

HPFS Directories

What about directories? It is known that a directory entry will contain an fnode pointer, a filename, size, and several dates (i.e., date created, date last read, and date last modified). It appears that a directory entry looks like 31 bytes and a filename. Here's what I've pieced together. First, the directory sector contains 56 bytes of some kind of preamble.

continued

Figure 1: *Paired data bands can store 16 megabytes of contiguous sectors.*

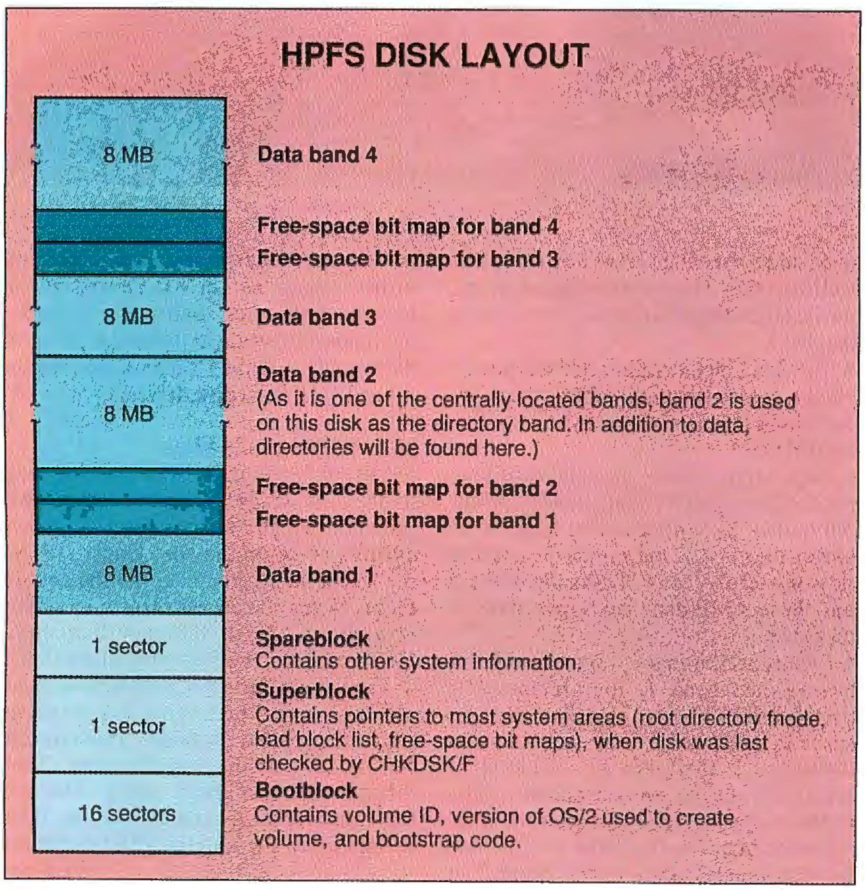
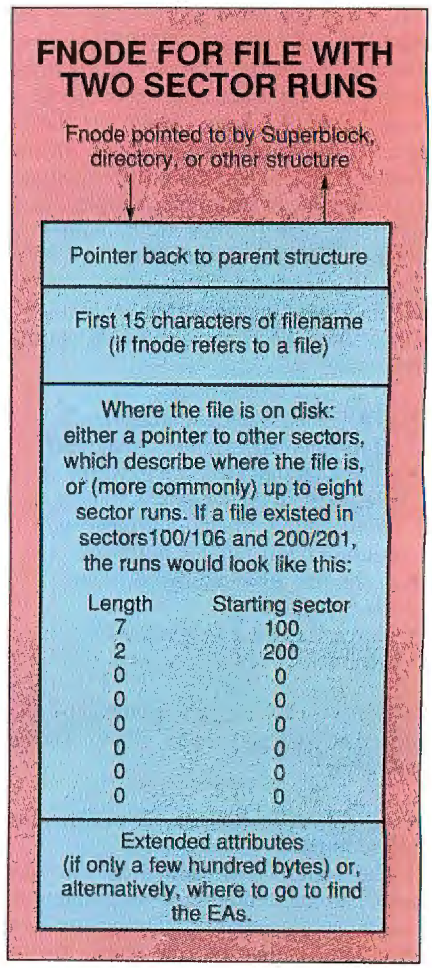


Figure 2: *Fnodes can point to eight sector runs directly, and many more indirectly. For all but the most pathologically fragmented files, the direct scheme should do.*



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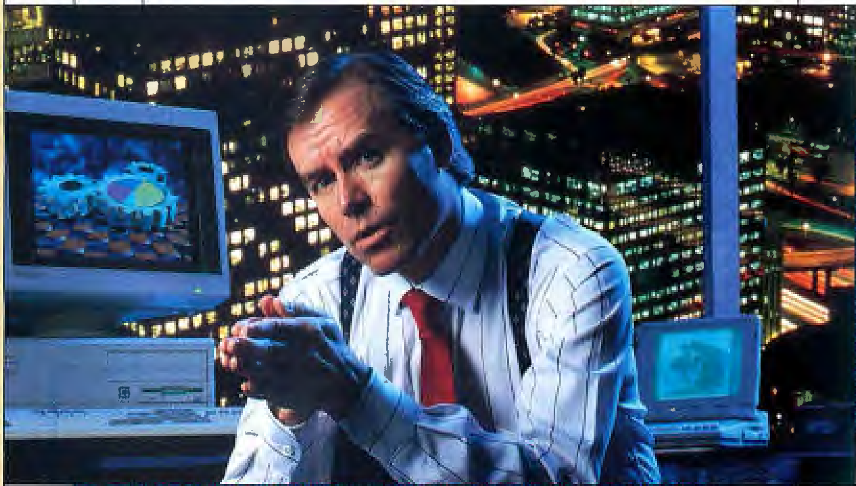

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Circle 300 on Reader Service Card

LAYOUT OF A DIRECTORY ENTRY

The 31 bytes preceding each filename.

Offset	Size	Description
0	4	Unknown
4	4	Pointer to file's fnode
8	4	Date of last modification
12	4	Size in bytes
16	4	Date last read
20	4	Date created
24	6	Unknown
30	1	Length of filename
31	1-255	Filename

Then come 31 bytes preceding each filename, laid out as shown in the table.

The directory is again finished with a dummy record that is all zeros except for length (1) and filename (hexadecimal FF). The new dates—date last read and date last modified—have the potential to be extremely useful.

But dates under HPFS are different than under DOS. DOS gurus know that directory dates and times are expressed so that the first 2 bytes are the time and the last 2 bytes are the date. Under HPFS, it's just a single 4-byte entry that represents seconds since 1-1-1970. Why the new format? It simplifies greatly the task of doing date arithmetic. If all dates are merely "seconds since January 1, 1970," you can calculate differences between dates by subtraction.

A Welcome Improvement

Everything in HPFS seems to have been conceived in multiple levels to provide maximum speed *and* flexibility. For example, consider the EAs. They will be useful because they let you attach up to 64K bytes of information to a file—information *about* the file. One person at Microsoft told me that he has a program that computes file checksums, which are then stored as an EA for the file. He then has a program that runs in the background computing file checksums and comparing them to the values in the EAs—OS/2 antivirus protection!

EAs sound good, but where are they stored? Microsoft seems to have reasoned thus: In most cases, there will be no more than a few hundred bytes' worth of EAs, although there may be more in a few cases. HPFS was therefore designed to store the EAs right in the fnode if they don't take much space, or (if they do need a lot of space) to move them out to a separate sector. The result: Getting to EAs in most cases is instantaneous, because HPFS is already examining a file's fnode. But for those who need it, larger EAs can be had, at a minor cost in speed.

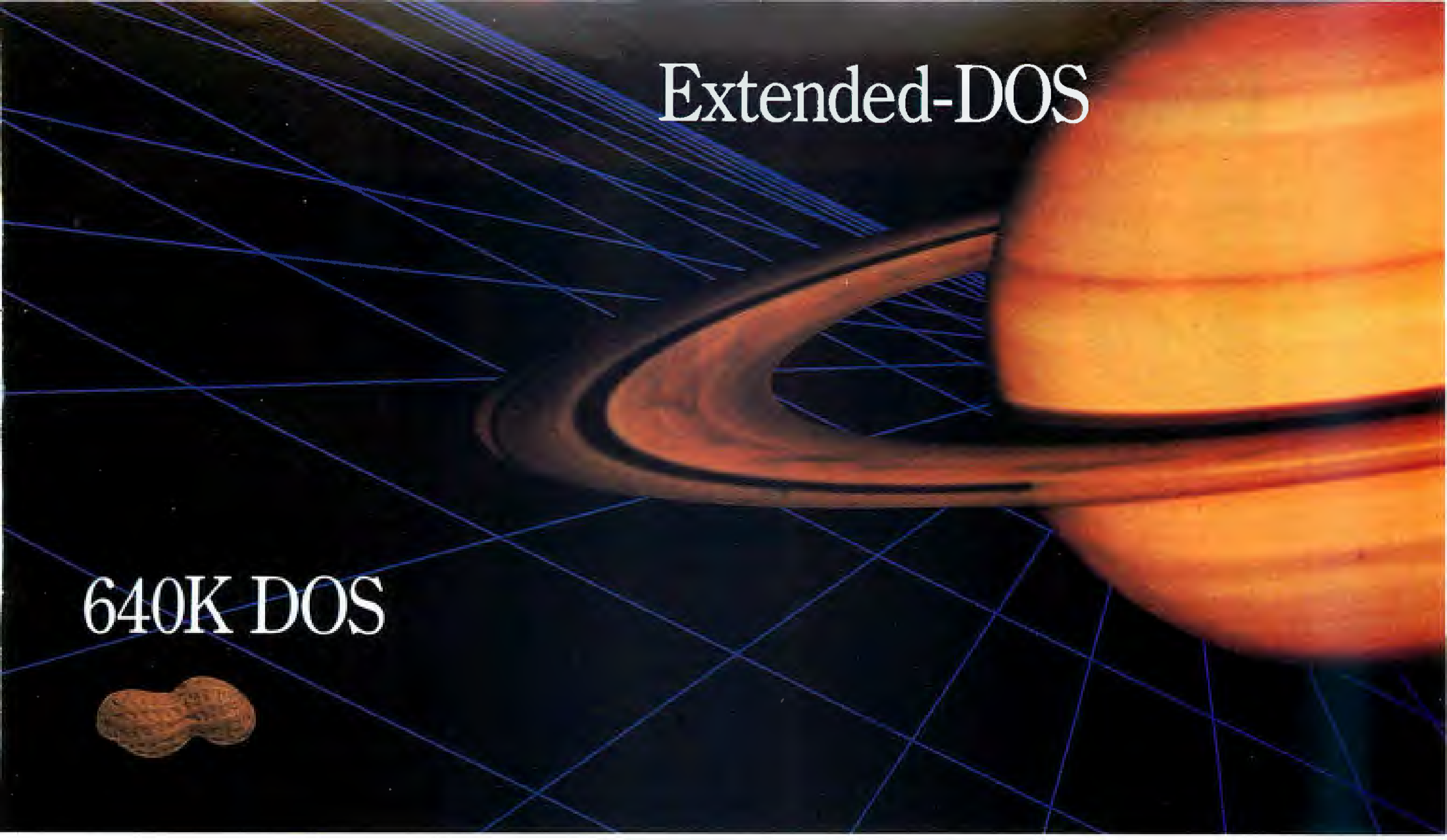
Microsoft has designed a new system with the future in mind. The space constraints of FAT systems are gone. The indirection offered by the fnodes makes adjusting file location or size much simpler, and the fnodes contain some redundant items that FAT systems lack, which makes data recovery a bit easier. Extra dates in the directory will make backups and file maintenance simpler. All in all, HPFS is a nice improvement. ■

ACKNOWLEDGMENT

Thanks to the Microsoft folks who let me in on the new date format and confirmed what I had figured out about the HPFS structure.

Mark J. Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.



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Circle 199 on Reader Service Card

BYTE editors' hands-on views of new and developing products

What the ScanMan Can Scan

As hand-held scanners become more popular, manufacturers are scrambling to enhance their features. Logitech, one of the many firms selling hand-held scanners, is no exception, and it has completely redesigned its ScanMan Macintosh scanner with the most common uses of these hand-held scanners in mind.

Most users of hand-held scanners are interested in easily and rapidly scanning smaller pictures or graphics of some sort and columns of text, rather than full pages, which are better handled by the more traditional flatbed and page-feeding scanners. Typically, the scanned results will be used in desktop publishing applications for newsletters and brochures, with output going to a 300-dot-per-inch laser printer. Two other common uses are scanning columns of text and numbers for use with optical-character-recognition packages and scanning images for use in software, particularly HyperCard.

The **ScanMan Model 32** scans up to 32 levels of gray, as well as black and white, allowing more accurate photographic reproduction. True gray-scale scanners store the gray information as gray levels rather than as patterns of black-and-white dots. This lets them represent the shades accurately when images are resized and edited.

I tried a beta version of the scanner. The hardware had been finished, but some bug fixes were still being made to the software. All the major functions of the program worked, however. Setting the scanner up involved plugging it into the chain of SCSI devices using its control box and then installing some system software. The system software can be run as a desk accessory or as a stand-alone program. The scanner has a new case, which lets scans be much straighter and lets you see more of what is being scanned.

Unlike most hand-held scanners, which rely on a roller near the scanner head to help the scanner move across the paper and measure the speed at which it is being moved, the ScanMan uses a combination of the roller and two extra wheels on the lower part of the device. These help keep you from twisting the scanner sideways while scanning, resulting in a straighter and more accurate scan. This proved to be very smooth to roll and had a reasonable resistance to being moved sideways. Another nice innovation is a scanning speed LED on the case. This lit up to let me know when I was scanning too fast and losing image data.

The ScanMan now has a new scanning head with greater accuracy. It is a true 400-dpi scanner and includes software to let it scan up to 32 levels of gray. This is achieved by having the scanner use an area six dots square to measure for gray levels. This technique reduces the accuracy of the scanner to 66 dpi when using 32 gray levels. However, laser printers can also print only gray scales by using shading patterns of black-and-white dots. The result is that a gray-scale scan made using the Logitech scanner will print out perfectly on a laser printer. However, it will not look any better if output goes to a typesetting machine like a Linotron. Certainly it was possible to get very good output from scanned images printed on a laser printer and even on an ImageWriter, although care was needed here in the exact choice of resolution and halftoning method.

The scanning software provided with ScanMan now lets you scan horizontally or vertically by simply clicking on an icon. Resolution can be varied from 100 dpi up to 400 dpi by setting a switch. Brightness and line art or gray-scale select switches are also included. These settings are recognized automatically by the scanner, so you don't have to choose them from software as well.

The software has a basic but full set of image-editing tools. Most important is the ablity to save copies of images in a wide range of formats.

File formats supported include 1- or 8-bit TIFF, PICT or PICT2, and MacPaint. You can also select different resolutions depending on whether output is to go to the screen, an ImageWriter, or a laser printer. The software lets you perform halftoning in several ways, since different techniques work better for different purposes.

The ScanMan is a carefully thought-out extension to previous hand-held scanners. Its ease of use and functionality have both been considerably enhanced, and I highly recommend it when typeset quality is not required.

—***Owen Linderholm***

THE FACTS

ScanMan Model 32
$499

Requirements:
Mac Plus, SE, II, or Portable. A hard disk drive is recommended.

Logitech, Inc.
6505 Kaiser Dr.
Fremont, CA 94555
(415) 795-8500
Inquiry 995.

NCR's 386SX: Quick, Quiet, and Secure

As good an example as any of the quality of German engineering, NCR's new small-footprint **20-MHz 386SX** offers speed, comfort, and security.

The motherboard includes 2 megabytes of RAM (expandable to 32 MB), an onboard Super VGA controller, two serial ports, and a parallel printer port. Some "special" features are a 16K-byte memory cache using "two-way anticipated caching" methods and an ISA bus-write buffer. The back of the motherboard has an additional 37-pin connector for an external hard disk drive or streaming tape drive. The keyboard jack is the small IBM PS/2 variety. The case and chassis wrap all the components in steel and lock them with a solid tubular key lock for hardware security, low noise, and RF shielding. The system is powered by a 175-watt auto-sensing power supply that doesn't require any configuration for voltage or frequency. A nearly silent fan cools the power supply, as well as the rest of the system.

The hard and floppy disk drives are mounted on a separate internal subsystem that is easy to remove and install. They do not require additional controller boards since they have their own controller hardware. This means that all five ISA bus slots are available for peripheral boards, even when the system is configured with three drives.

NCR shares the lead in the commercial and banking transaction market, and it has very few competitors. This machine is a good example of why: Although it is a general-purpose SX, it has features that make it especially attractive for the large office. It is as quiet as a laptop. But more important, it has security as its central theme. A secure system with secure software makes it difficult for unauthorized users to access the system. This computer has an embedded security system with a master password and three user-level passwords. If the security feature is used, the system will not boot without a password. Only the master password can reconfigure the system with the setup menu. Applications software can access calls to the security system to evaluate what level of security the user possesses.

You might be able to get around all this by installing your own routines by means of the floppy disk drive. But a secure system would not have a floppy disk drive. This configuration is the reason for the floppy disk drive connector at the back of the machine. You can plug an external drive into this to do system maintenance, backups (onto the streaming tape), or system builds. This port, as well as any of the communications ports, can be disabled from the system setup menu.

We evaluated the machine with both MS-DOS and SCO Xenix/386. The MS-DOS CPU benchmarks showed that this machine runs nearly 75 percent faster than most 16-MHz 386SXs and as fast as most 20-MHz 386 machines. Even using the 32-bit benchmarks of Xenix, the new NCR 20-MHz 386SX showed between 70 percent and 90 percent of the performance of a full 32-bit system with a 20-MHz 386 processor and zero-wait-state memory. Very impressive.

—Ben Smith and Roger Adams

THE FACTS

20-MHz 386SX

Standard:
All systems come with two serial ports, one parallel port, 2 MB of 80-nanosecond RAM, and a VGA monitor.

Options:
Base system with one floppy disk drive, $3795; with one floppy disk drive and a 44-MB hard disk drive, $4680; with one floppy disk drive and a 100-MB hard disk drive, $5490; extra memory, $750 for 2 MB.

NCR Corp.
P.O. Box 2989
Norcross, GA 30091
(800) 544-3333
Inquiry 996.

A Tuned-Up dBASE IV

Ashton-Tate has tuned up dBASE IV and made it a little easier to use in its new incarnation as **dBASE IV 1.1.** It now requires only 450K bytes of RAM (instead of 512K bytes), a disk-caching program is included in the new version, and some performance-tuning options are available to speed up operations.

Version 1.1 has its own disk-cache code for single-user operation. The cache is installed automatically into all available extended or expanded memory when you load the program. A command-line option lets you

continued

limit the amount of memory used, but this is hardly needed since the cache is unloaded automatically when the program is closed, freeing the memory. The cache does speed things up. For example, sorting a database of 1419 10-field, 173-byte records on a single field took 14 seconds not using the cache and 7 seconds using it. Sorting a larger database, 3230 records with the same specifications on a single field, took 29 seconds without the cache and 19 seconds with it.

The performance-tuning options are BAK, TMP, and DBHEAP. Since they're DOS environment variables, they must be set from DOS before loading dBASE. BAK and TMP specify paths to backup and temporary files. The DBHEAP allows the juggling of RAM allocation between dot prompts and overlay swapping. You can optimize the execution of dBASE programs by tweeking this memory allocation to fit the program you're using.

Ashton-Tate has removed many of the version 1.0 restrictions on recursive user-defined functions (UDFs) and all the ON commands. A new command, DBTRAP, was added to protect you from shooting yourself in the foot. When DBTRAP is on, the system takes steps such as saving parts of the existing environment, prohibiting certain recursions, and blocking UDFs from using certain commands (e.g., CLOSE, PACK, and MODIFY STRUCTURE).

Be aware that dBASE IV isn't something you install and immediately begin using to write complex reports drawing on multiple data tables. But if you've used earlier incarnations of dBASE, you should feel right at home, although you'll have to read the manual to take advantage of many of the functions and features. The familiar dot-command structure is there for dBASE programmers. For novices and casual users, there is the Command Center, a point-and-shoot facility for performing most functions. If you're totally new to dBASE, for a program as large and complex as this, it's quite easy to use. You'll face somewhat of a learning curve, but it's gentle and easily managed. And the choice of using query by example or Structured Query Language to generate reports is a real plus.

—George Bond

THE FACTS

dBASE IV 1.1
$795; developers' edition, $1295

Requirements:
IBM PC or compatible with a hard disk drive, 640K bytes of RAM (450K bytes available at the DOS prompt), and 3.25 MB bytes of free disk space.

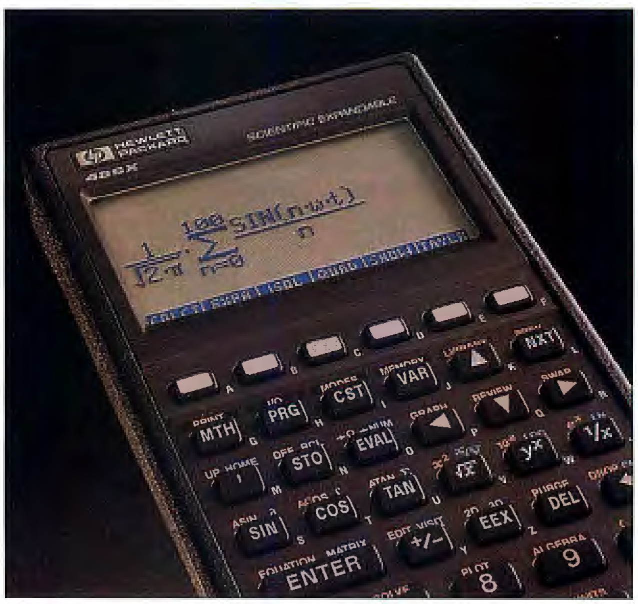
Ashton-Tate
20101 Hamilton Ave.
Torrance, CA 90509
(213) 329-8000
Inquiry 997.

HP's New Calculator Is Virtually a Hand-Held PC

Hewlett-Packard's HP 41 calculator has just reached the end of its 10-year life cycle and is being replaced by the **HP 48SX**. The original HP 41 was basically a calculator for scientists and engineers, and it included serial I/O, a full programming language, and memory expandability.

The 48SX is more than just a calculator. The base model comes with 32K bytes of RAM and 256K bytes of ROM. It has an RS-232C serial port and two slots for RAM or ROM cards, letting you expand memory up to 288K bytes or use add-on programs like equation libraries for specific applications. An optional HP Solve Equation Library card is available, which includes over 300 equations for engineering and scientific problems ranging from columns and beams to fluid flow or magnetism.

HP is offering an optional serial interface kit with software, which links the



calculator to either Macintosh or DOS systems. In fact, the kit lets you control the calculator from the host computer, allowing you to use the calculator as an equation-solving peripheral. The calculator also has a two-way infrared interface for use with HP's infrared printer or for exchanging programs or data with another 48SX.

The 48SX fits in the palm of your hand and weighs only 9 ounces. Unlike the 28S, the 48SX does not have the folding-notebook-style design, which was unpopular with HP customers.

In addition, the 8-row by 22-column display is greatly improved over the display of the 28S. The new calculator uses a supertwist LCD design, allowing better contrast and readability. The HP 48SX has impressive graphics and calculus functions, finding roots, intersec-

continued

THE FACTS

HP 48SX
$350

Options:
Serial interface kits (PC or Macintosh), $99.95; HP Solve Equation Library card, $99.95; 32K-byte RAM card, $79.95; 128K-byte RAM card, $250; infrared printer, $135.

Hewlett-Packard Co.
1000 Northeast Circle Blvd.
Corvallis, OR 97330
(503) 757-2000
Inquiry 998.

tions, derivatives, slopes, and so on.

The 48SX has several new features that engineers and scientists will find very useful. Unlike previous scientific calculators from Hewlett-Packard, the 48SX lets you actually enter an equation the way you would with paper and pencil. Previously, you could only store variable values in the calculator and then execute the equation by translating it into keystrokes. With the 48SX, you can type in the actual equation, supply the variable values, and hit the Solve key.

Another feature that I found impressive is the automatic-unit management capability of the 48SX. The calculator can automatically convert units into the resultant units that you specify. For example, you can enter meters and seconds and tell the 48SX to solve the equation in miles per hour. Or you could enter newtons, meters, and hours, and have the calculator solve the equation in watts.

The 48SX calculator also comes with a new high-level programming language. It is not compatible with the language used in the HP 41, but an emulator is provided so that HP 41 programs will run on the 48SX.

Overall, I found the Hewlett-Packard 48SX to be an impressive calculator for serious engineering and science applications.

—Nick Baran

A Mac Monitor That's Sure to Turn a Few Heads

Pivot is a Macintosh full-page monitor that offers both portrait (vertical) and landscape (horizontal) orientations. What's unique about it is that you can twist the Pivot display a full 90 degrees, going from full-page portrait to a full-page landscape mode, and the image on your screen will rotate as well.

THE FACTS	
Pivot $1690 *Requirements:* Mac SE/30 or Mac II family.	Radius, Inc. 1710 Fortune Dr. San Jose, CA 95131 (408) 434-1010 **Inquiry 999.**

If you need a full-page display but also need both width and length for different applications, Pivot might be just the ticket.

Pivot works with all existing Mac software, Radius claims. Its 15-inch diagonal screen size offers a portrait resolution of 640 by 864 pixels and a landscape resolution of 864 by 640 pixels. I found the display clear, crisp, and impressive, as I would expect from a full-page monitor. The Pivot weighs slightly more than Radius's standard full-page display, but its dimensions are almost identical.

Pivot displays two or four shades of gray and is upgradable to 16 shades. It works with either a Mac SE/30 or any member of the Mac II family. Pivot works as a standard full-page display (portrait only) with either a Mac Plus or SE.

Designing Pivot's unique rotating display created many headaches for Radius's engineering staff. First, they had to develop a high-speed pixel rotation engine for the interface card. This they did, creating one that rotates pixels 90 degrees at a rate of over 51 MHz.

Indeed, I found Pivot very fast in redrawing a Microsoft Excel spreadsheet. For example, when I tilted the display from portrait to landscape, the screen would go blank for about a second and then the spreadsheet would reappear, including the cells that had been left out of the portrait display. The speed of the display redraw was the same—regardless of whether I was going from portrait to landscape, or vice versa. Also, I found the display easy to rotate with just a finger.

Pivot includes a "position-sensing device" that sends an interrupt to the computer whenever you change the display's position. The monitor's system software then reprograms the bit-map orientation, reorganizing the Mac Desktop to match either portrait or landscape mode. Also interesting is that Pivot scans in the same direction in both modes: from left to right, top to bottom in portrait; and from left to right, bottom to top in landscape.

Pivot's internal circuitry is positioned to allow proper cooling in either landscape or portrait mode. Similarly, the monitor's magnetic shield is designed to work in either.

The Pivot's list price is $1690 (which includes the Mac SE/30 or NuBus interface board), making it actually only $200 more than Radius's standard full-page display monitor. Sure, full-page displays aren't cheap, but it's nice to see Radius offering the unique Pivot at a competitive price. And while not every full-page monitor user needs the extra functionality of landscape mode, those who do might swivel their heads to take a closer look at Pivot. ■

—Jeffrey Bertolucci

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Commodore Sets Course for Multimedia

■ Bob Ryan

Imagine the ideal multimedia platform. It would have impressive graphics and sound, be easy to use, and work transparently with sophisticated video equipment. Throw in a low-overhead multitasking operating system, and you'd have all the pieces you need to run sophisticated multimedia applications. You'd also have an Amiga from Commodore.

Realizing this, Commodore has finally defined a focus for the Amiga line and staked its claim to the emerging multimedia market. The centerpiece of the company's strategy is a new, 68030-based computer, the Amiga 3000.

The Amiga 3000 (see photo 1) has many impressive features, the best of which may be its price. With the 16-MHz model selling for $3495 and the 25-MHz version fetching a mere $3995, the new system costs nearly $3000 less than a comparably equipped Mac IIci. This aggressive pricing, combined with the new look and capabilities of the machine, makes the Amiga 3000 a formidable entry into the multimedia marketplace.

Bits and Pieces

The Amiga 3000's two models are the 3000/16, a 68030/68881-based machine running at 16 MHz, and the 3000/25, a 68030/68882 machine that runs at 25 MHz. Except for clocks and coprocessors, the models are identical.

The Amiga 3000 is the first Amiga with a native 32-bit architecture. With the exception of the graphics system, which uses a 16-bit bus and a National Television System Committee (NTSC)-compatible 7.14-MHz clock, all the internal pathways in the Amiga 3000 are 32 bits wide and use the processor's clock. Commodore has also managed to make the external I/O bus capable of 32-bit transfers without losing compatibility with 16-bit peripheral cards. The I/O bus—called Zorro 3—multiplexes the address and data lines for I/O cards capable of 32-bit transfers, while treating 16-bit Zorro 2 cards normally.

> The Amiga 3000 boasts enhanced custom chips, a fast 32-bit processor, and a stunning new look to its Workbench interface

Goodbye, Flicker

The heart of the Amiga 3000 is an enhanced version of the custom chip set that defines the Amiga line. The enhanced Denise chip can output up to 1280 horizontal pixels in four colors, and it sports a new 640- by 480-pixel-resolution productivity mode. (Unlike other high-resolution modes on the Amiga, the productivity mode is not interlaced, and it is limited to four colors.) Being programmable, Denise lets you mix different horizontal and vertical resolutions and provides the overscanning necessary for video applications. The new Agnus chip doubles the amount of accessible chip RAM to 2 megabytes. (In Amiga parlance, *chip RAM* is memory accessible by both the CPU and the custom chips. It is used primarily to hold graphics and sound data that gets massaged by the custom chips. Memory available to the CPU exclusively—and used primarily to hold executable code and nondisplay data—is called *fast RAM*.) The only chip not upgraded is Paula, which provides the Amiga's four-voice sound.

New to the graphics system is a deinterlacing/scan doubling capability, which takes interlaced high-resolution screens and outputs them without flicker to a 31.5-kHz VGA monitor. It also eliminates the black scan lines between rows of pixels on both low- and high-resolution displays. As a result, the Amiga 3000 produces a rock-steady high-resolution display. Unlike earlier Amigas, which by default ran the Workbench interface in medium resolution (640 by 200 pixels), the Amiga 3000 can effectively use high resolution (640 by 400 pixels) without additional hardware.

Although the new capabilities of the graphics system are significant, they don't address the larger question of how to upgrade Amiga graphics to 8- and 24-bit color while maintaining compatibility with current graphics software. (The tight coupling of the graphics system and the Amiga CPU, which gives the machine its superior graphics performance, ironically also makes it more difficult to upgrade the graphics capabilities.) Palette limitations on the Amiga 3000 are the same as for earlier Amigas: 32 colors in low resolution and 16 in high resolution, of a possible 4096. Techniques such as extra half-bright, dynamic high-resolution, and hold-and-modify let you increase the number of colors on screen (up to 4096 in the case of HAM), but they either force you to swap palettes on the fly—a serious drain on system bandwidth—or don't let you define each pixel independently. (The latter drawback is actually an advantage when you use HAM mode for video work; because it can take up to three pixels to change from one color to another, HAM mode is naturally antialiasing.)

Despite these alternative graphics modes, the lack of native 8- and 24-bit color on the Amiga is a concern. Such capabilities will be necessary for next-generation video and multimedia applications and are already available for many of the Macintosh, MS-DOS, and Unix machines. The Amiga must provide for

continued

Photo 1: The Amiga 3000 features 2 MB of memory, an 880K-byte floppy disk drive, and a 50-MB SCSI hard disk drive.

PHOTOGRAPHY: PAUL AVIS © 1990

8- and 24-bit color to remain competitive. Amiga Product Manager Keith Masavage wouldn't comment on Commodore's plans in this area other than to say that "both short-term and long-term solutions are in the works."

Motherboard Tour

The Amiga 3000 motherboard reflects a high degree of integration (see photo 2). In addition to the enhanced Agnus and Denise chips, the motherboard contains eight other proprietary chips fabricated by Commodore. These include a bus controller, a RAM controller, and a DMA controller. The DMA controller works in conjunction with a SCSI controller chip to provide 32-bit DMA for SCSI I/O devices such as hard disk drives. The Amiga 3000 uses 512K bytes of ROM to hold the multitasking executive, system libraries, and disk operating system. Commodore also plans to upgrade the Amiga 500's and the Amiga 2000's ROMs to 512K bytes.

The RAM controller—dubbed Ramsey—manages access to fast RAM on the motherboard. The Amiga 3000 comes with 2 MB of RAM—1 MB of chip RAM and 1 MB of fast RAM. It also comes with sockets that can hold up to 4 MB of fast RAM using 4 by 256K-bit paged or static-column zig-zag in-line packages, or 16 MB using 4 by 1-megabit ZIPs.

The Amiga 3000 doesn't use a large external cache to speed memory access by the 68030. It does, however, handle both burst-mode and page-mode access to fast RAM. A standard memory access to fast RAM involves two wait states, while burst mode can result effectively in zero-wait-state performance. Under ideal circumstances, the page mode can reach transfer rates of over 33 MB per second. The Ramsey chip determines which mode is appropriate for any particular memory access.

The megabyte of chip RAM in the system comes in the familiar DIP packaging, and the motherboard contains sockets for another megabyte. The megabyte of fast RAM on the motherboard also comes in socketed DIP chips. When you upgrade your fast RAM using ZIP packs, you move the original fast RAM to the empty chip RAM sockets to give you the maximum 2 MB of chip RAM.

The Amiga 3000 comes with a standard Amiga 3½-inch 880K-byte floppy disk drive and an internal 3½-inch 50-MB 17-ms SCSI hard disk drive. It also lets you mount internally another 3½-inch disk drive—floppy or hard.

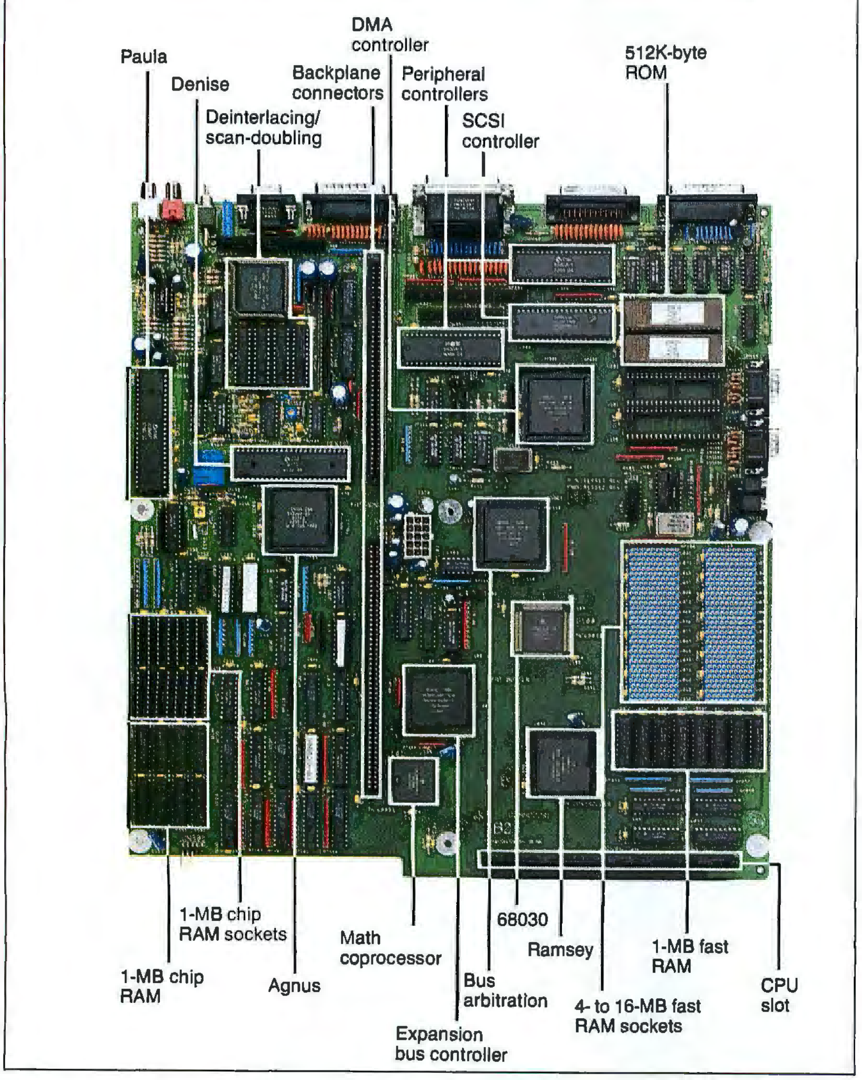

Photo 2: *The Amiga 3000/25 motherboard integrates many functions into discrete chips. The expansion backplane connects to the two 100-pin sockets at left-center. Expansion boards thus lay parallel to the motherboard. Note the 200-pin CPU slot at right-front. (Food for thought: The 68040 comes in a 179-pin package.)*

Expanding Your System

The expansion backplane on the Amiga 3000 attaches to two sockets on the motherboard. The backplane lets expansion hardware automatically configure itself during start-up and supplies DMA access to the motherboard. The backplane supplies four Zorro 3 expansion slots. In addition, the backplane has two AT-compatible slots in line with two of the Zorro slots, and a video slot in line with a third. You use the AT slots in conjunction with the BridgeBoard cards from Commodore, which provide the Amiga with XT and AT compatibility. The video slot gives expansion cards direct access to the Amiga video-output signals. It is useful for devices such as video-effects generators and genlocks.

The Amiga 3000 also supplies several standard I/O ports. The keyboard and two mouse ports are located on the right side of the machine. On the back are a parallel port, a serial port, a floppy disk drive port, a SCSI port, two audio ports, a 15.75-kHz RGB video port, and a 31.5-kHz VGA video port. The RGB port is identical to those on earlier Amigas, ensuring compatibility with earlier monitors and other video equipment. Its signal doesn't run through the deinterlace/scan doubling hardware. The VGA port, which *is* connected to the new display hardware, drives any standard VGA monitor. You can disable this hardware—or adjust its output—using two controls

continued

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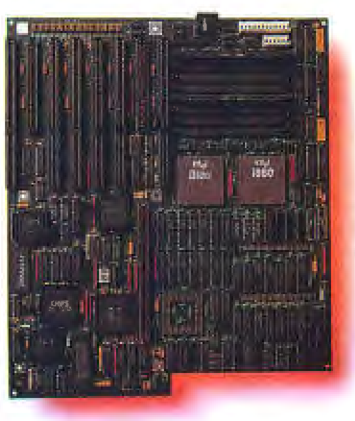

A PC Revolution. In the PC environment, the 4860 is a 486-based MotherBoard which runs over 2 times faster than 386 computers. It's fully compatible with DOS, IBM's OS/2, Novell Netware and UNIX. What's more, Hauppauge's 4860 supports up to 64 MBytes of memory *without* a RAM expansion board!

RISC-Y Business. Thanks to the 4860's symmetrical architecture, both the i486 and the i860 processors can access the full range of memory, I/O system, and the 64-bit expansion bus. The result? Unprecedented dual processor performance.

You'll find that the i860 processor is ideal in graphics applications, performing up to 25 million floating-point operations per second. That's more than 10 times faster than the i486 processor alone! There's even an optional 64-bit frame buffer card for ultra high-performance workstation graphics.

For UNIX Workstations, Too. The 4860 board makes a great foundation for high-performance RISC workstations that run advanced UNIX applications. Many workstation vendors are choosing the i860 processor as a standardized vehicle for CAD and simulation systems, and the 4860 is perfectly compatible with these applications.

Technical Features: ▪ 4 Megabytes of high speed RAM expandable to 64 MBytes shared between i486 and i860 processors ▪ Socket for optional 128K static RAM cache module for the i486 ▪ Full size PC/AT form factor ▪ Eight EISA I/O slots ▪ 64-bit expansion slot ▪ 1 parallel, 2 serial ports.

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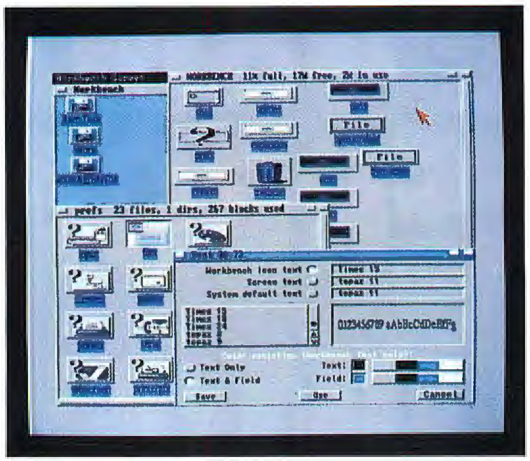

Photo 3: *The Amiga OS 2.0 sports an all-new Workbench interface. Built on new versions of the Amiga shared libraries, Workbench 2.0 provides easy access to multiple programs. A hardware blitter enhances its operation by providing the system with a rapid way to move rectangular blocks of memory, such as those that define a window.*

on the back of the machine.

The most significant expansion connector in the Amiga 3000 is a 200-pin CPU slot. Although it's incompatible with the 86-pin CPU slot on the Amiga 2000, it serves the same function. It permits you to upgrade the 3000 with a next-generation processor—in this case, the 68040 and its descendants. You could also use it to hold a large external memory cache for the on-board 68030.

Cleaning Up Workbench

In the past, many people dismissed the Amiga as an unprofessional machine because of the look of its Workbench interface. When all you saw was a four-color, 640- by 200-pixel screen with visible scan lines between each row of pixels, it was easy to forget the sophisticated hardware and software that lay beneath it.

The Amiga 3000 uses version 2.0 of the Amiga operating system. With this version, Commodore has reworked both the look and the functionality of the Workbench interface by upgrading or rewriting most of the underlying system software. The result is a new interface (see photo 3) that can hold its own against any GUI on the market. It provides consistent and easy access to the multitasking ability of the Amiga.

Among the improvements in Workbench are enhanced Preferences tools for setting your system configuration, new Workbench menus, alternate window views, Adobe fonts, bit-map font scaling, horizontal and vertical scrolling of the Workbench screen, a new front-to-back gadget, a new window-selection procedure, the ability to view files that lack .info files, the ability to execute AmigaDOS commands without using the AmigaDOS shell, the ability to start an application by "dropping" a data file into it, and many new and improved utilities. In addition, Commodore has integrated ARexx into the operating system. ARexx is a macro language that lets you share data between two or more Amiga programs equipped with ARexx message ports. (Such ports have lately become de rigueur on Amiga applications.) ARexx allows you to create "meta-applications" using stand-alone Amiga programs.

Amiga OS 2.0 also has a lot of new goodies for programmers. First, Commodore is at last including standard file and font requesters with the Amiga. In addition, it is supplying a gadget toolkit. This lets you integrate custom gadgets into the Intuition windowing system. It also provides an object-oriented interface to gadget programming. Finally, 2.0 provides a "hotlink" service that notifies your program about events of interest to it. This is particularly useful when you change a Preference setting that your program must be aware of.

Commodore designed 2.0 to be compatible with software written for earlier versions of the operating system. According to Commodore, programs that abide by the rules will run under 2.0. However, Commodore knows that everyone didn't follow all the rules, and the company is working with developers to fix software that may break under 2.0.

Currently, the Amiga has a good-size software base, although it is skewed toward graphics and video applications, as opposed to mainstream business programs. Because the Amiga 500 and 2000 can be upgraded with the enhanced chip set and run OS 2.0, programs written for the 3000 will also run on most of the Amiga installed base of nearly 1.5 million machines.

A New Beginning?

The Amiga 3000 is an impressive machine, and Commodore is supplying it with strong support. In addition to the 3000, Commodore is preparing well over a dozen new hardware and software products designed to position the machine in a few key markets. The first of these is business, where Commodore hopes the Amiga's multimedia capabilities will provide the kind of entrée that desktop publishing gave to the Macintosh. Central to the company's business push is AmigaVision, an icon-based authoring system that lets anyone create interactive multimedia applications.

Also, Commodore is finally acknowledging the importance of networking by providing software and hardware solutions, either directly or through third parties. For the short term, this means Ethernet and third-party X Window System server software (X/11 from Gfx-Base). By in the middle of this year, it will mean TCP/IP-NFS and NetWare client software. Beyond that, Commodore has plans to support ARCnet and FlashTalk hardware and assorted network operating systems. The company also hopes that, by increasing its penetration into businesses through networking and multimedia, it will attract more mainstream developers to the system.

Commodore is also actively pursuing the higher-education and government markets, in large part by providing Unix in addition to the new networking products. It is actively porting Unix System V.4 to the Amiga. Even with the additional cost of the operating system, the Amiga 3000 will make an inexpensive, yet powerful, Unix workstation. Finally, Commodore hopes to maintain a large share of the home/personal productivity market, primarily through sales of the Amiga 500 and low-end versions of the Amiga 2000.

With a primary focus in multimedia and secondary pushes in education, government, and productivity, Commodore has at last outlined a strategy that takes advantage of the Amiga's strengths. With the Amiga 3000, it has produced the most capable multimedia platform you can get in a single box. If the machine were the only criterion, I'd already call Commodore's strategy a success. ■

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

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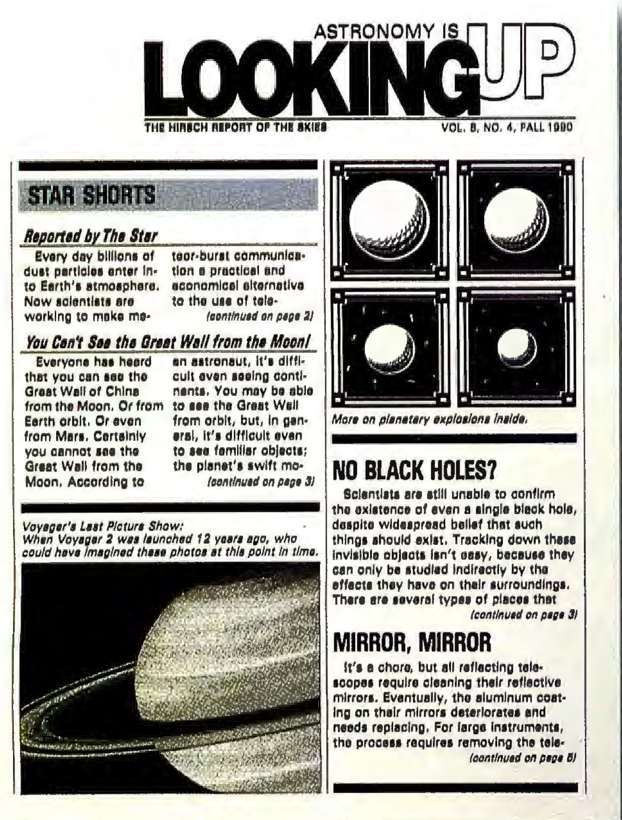


ASTRONOMY IS LOOKING UP

THE HIRSCH REPORT OF THE SKIES VOL. 8, NO. 4, FALL 1990

STAR SHORTS

Reported by The Star

Every day billions of dust particles enter into Earth's atmosphere. Now scientists are working to make meteor-burst communication a practical and economical alternative to the use of tele-
(continued on page 2)

You Can't See the Great Wall from the Moon!

Everyone has heard that you can see the Great Wall of China from the Moon. Or from Earth orbit. Or even from Mars. Certainly you cannot see the Great Wall from the Moon. According to an astronaut, it's difficult even seeing continents. You may be able to see the Great Wall from orbit, but, in general, it's difficult even to see familiar objects; the planet's swift mo-
(continued on page 3)

Voyager's Last Picture Show:
When Voyager 2 was launched 12 years ago, who could have imagined these photos at this point in time.

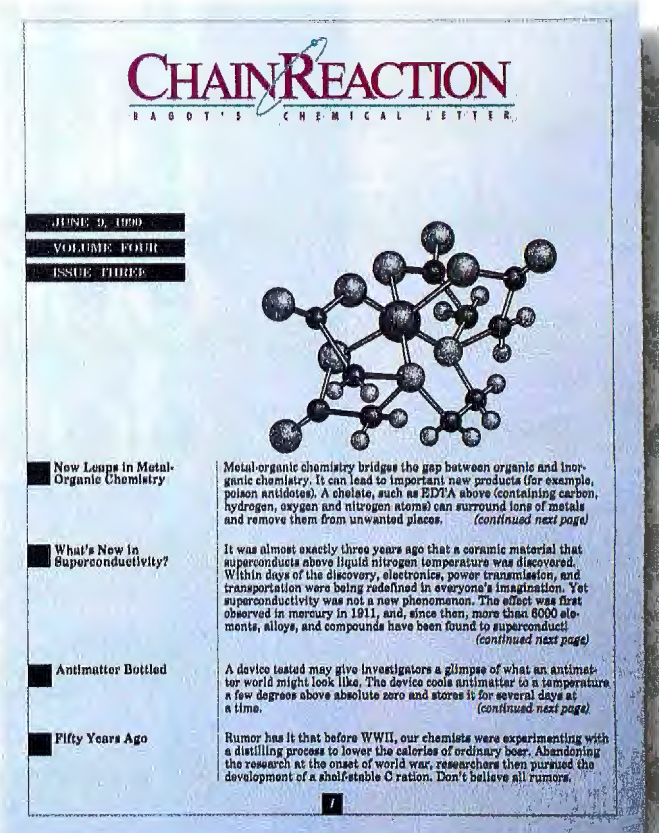
More on planetary explosions inside.

NO BLACK HOLES?

Scientists are still unable to confirm the existence of even a single black hole, despite widespread belief that such things should exist. Tracking down these invisible objects isn't easy, because they can only be studied indirectly by the effects they have on their surroundings. There are several types of places that
(continued on page 3)

MIRROR, MIRROR

It's a chore, but all reflecting telescopes require cleaning their reflective mirrors. Eventually, the aluminum coating on their mirrors deteriorates and needs replacing. For large instruments, the process requires removing the tele-
(continued on page 5)



CHAIN REACTION

BAGOT'S CHEMICAL LETTER

JUNE 9, 1990
VOLUME FOUR
ISSUE THREE

New Leaps in Metal-Organic Chemistry

Metal-organic chemistry bridges the gap between organic and inorganic chemistry. It can lead to important new products (for example, poison antidotes). A chelate, such as EDTA above (containing carbon, hydrogen, oxygen and nitrogen atoms) can surround ions of metals and remove them from unwanted places. *(continued next page)*

What's New in Superconductivity?

It was almost exactly three years ago that a ceramic material that superconducts above liquid nitrogen temperature was discovered. Within days of the discovery, electronics, power transmission, and transportation were being redefined in everyone's imagination. Yet superconductivity was not a new phenomenon. The effect was first observed in mercury in 1911, and, since then, more than 6000 elements, alloys, and compounds have been found to superconduct!
(continued next page)

Antimatter Bottled

A device tested may give investigators a glimpse of what an antimatter world might look like. The device cools antimatter to a temperature a few degrees above absolute zero and stores it for several days at a time. *(continued next page)*

Fifty Years Ago

Rumor has it that before WWII, our chemists were experimenting with a distilling process to lower the calories of ordinary beer. Abandoning the research at the onset of world war, researchers then pursued the development of a shelf-stable C ration. Don't believe all rumors.

1

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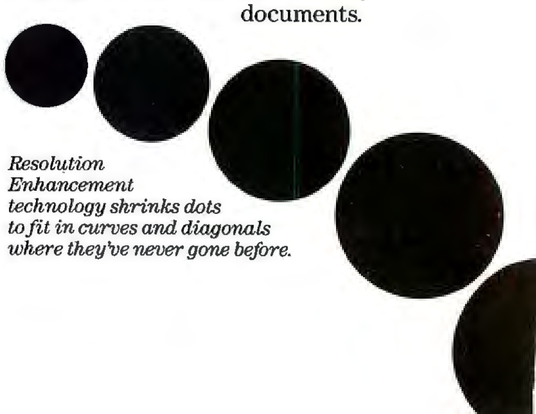
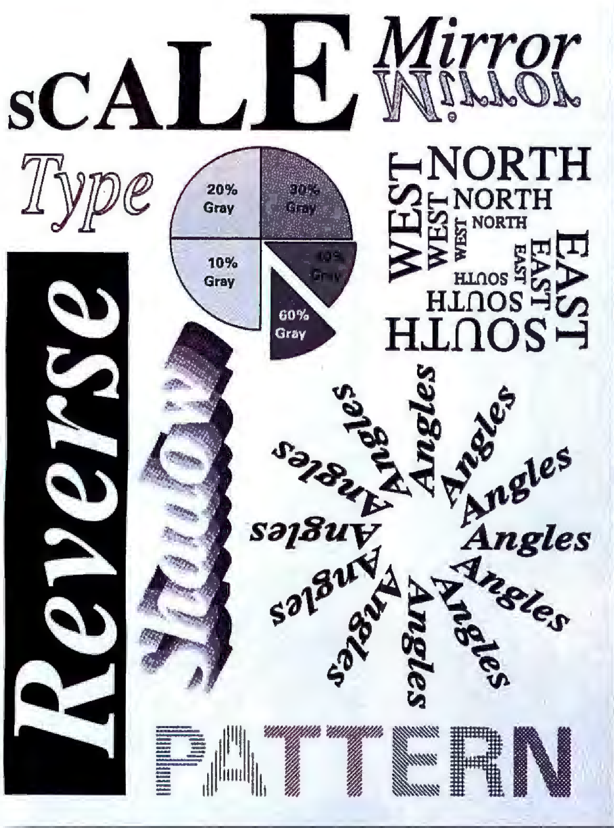
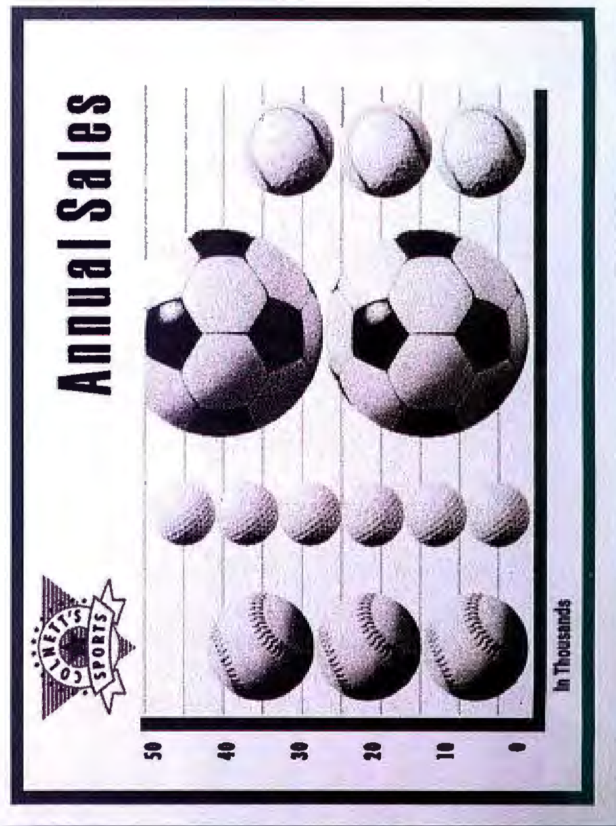


Resolution Enhancement technology shrinks dots to fit in curves and diagonals where they've never gone before.

whole new ball game.





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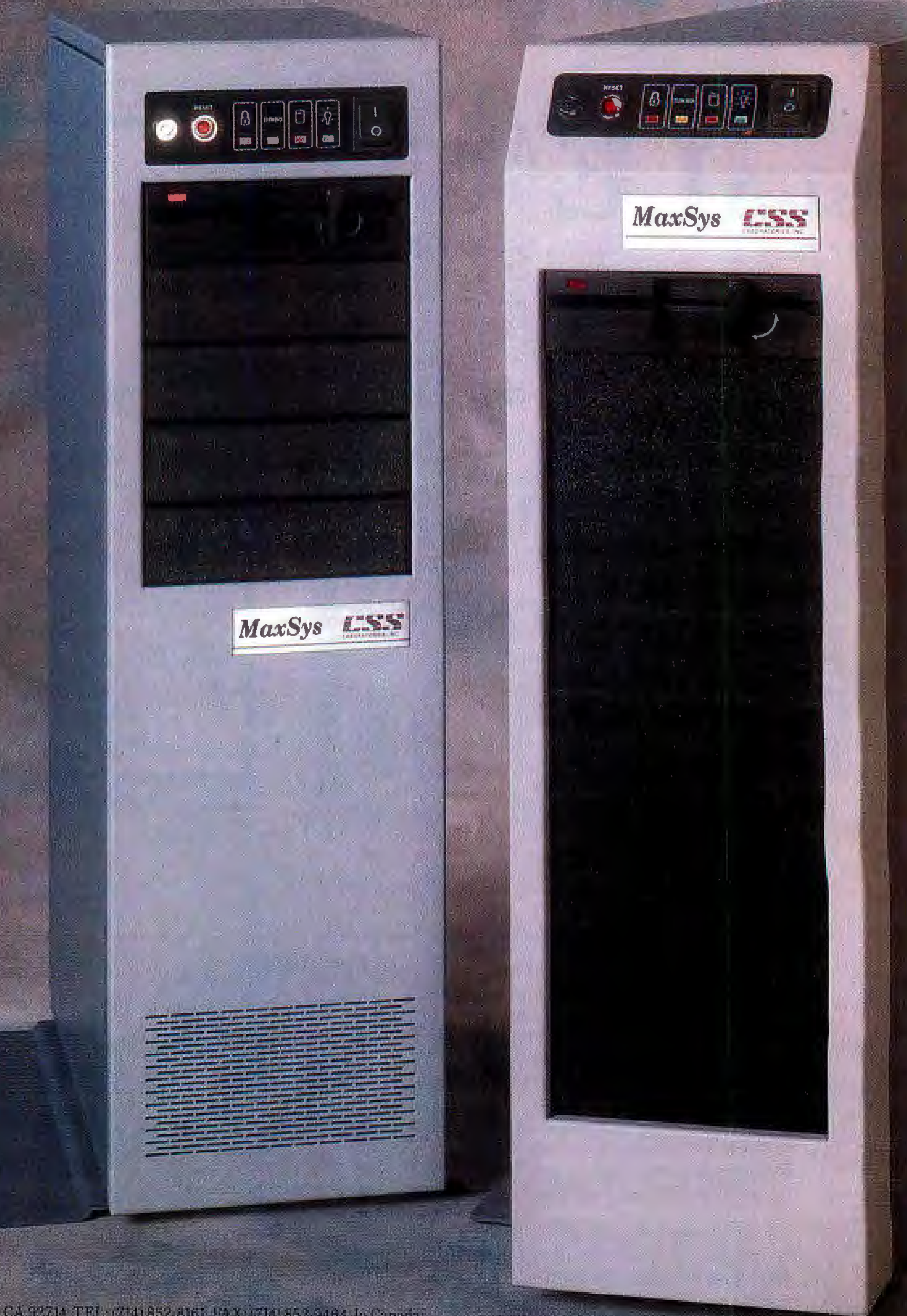

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Circle 68 on Reader Service Card (DEALERS: 69)

Two new 33-MHz 486 PCs set speed records, but that's not the whole story

The Fast Keep Getting Faster

■ Michael Nadeau

If speed was all ALR's and AST Research's 33-MHz i486-based PCs had to offer, I wouldn't be writing this article. They are fast—real fast. But both machines represent changes in marketing and design that could affect all Intel-based PCs.

You can buy the ALR (Advanced Logic Research) PowerVEISA 486/33, nicely configured, for a price comparable to or less than that of some 386 systems—you even get the fast Extended Industry Standard Architecture (EISA) bus. AST hasn't set a price for its Premium 486/33 yet, but its estimated list price is under $10,000. If that's too high, you can buy either box in 386 form and, with a quick board swap, later upgrade it to a full-blown 33-MHz 486 system. Clearly, the pricing of these and other 486 systems will force 386 system prices downward, and the systems' designs indicate that the ability to upgrade an existing PC is becoming an important factor to many customers.

First, the Hardware

From the outside, both the ALR PowerVEISA 486/33 and the AST Premium 486/33 look just like other high-end offerings from those companies (see photo 1). The PowerVEISA is a tower design that uses the EISA 32-bit bus. The Premium comes in desktop form with Industry Standard Architecture 16-bit slots. EISA tower and desktop configurations are available, but AST would not give a price for either. To upgrade the Premium from ISA to EISA requires a motherboard swap ($1250 for the 486/25 version). The ALR and AST systems should be available by the time you read this.

The PowerVEISA (for versatile expandable integrated scalable architecture) offers 33-MHz 386 and 25- and 33-MHz i486 CPU options. Prices range from $5795 to $8495 for the base Model 80 configuration (with 5 megabytes of RAM; 64K bytes of RAM cache; a 1.2-

continued

Photo 1: *The AST Premium 486/33 (left) is a desktop design with an ISA bus, while the ALR PowerVEISA 486/33 sports a tower design with an EISA bus. AST offers EISA versions in both desktop and tower form.*

PHOTOGRAPHY: PAUL AVIS © 1990

MB floppy disk drive; an 80-MB hard disk drive and integrated device electronics [IDE] controller; five drive bays; serial, parallel, and mouse ports; and a 200-watt power supply). The 25- and 33-MHz i486 upgrade modules cost $1995 and $3195, respectively; the company will buy back the 25-MHz i486 module for $1200 when you upgrade to the 33-MHz version.

The CPU module is about half the size of AST's (see photo 2). It is home to the CPU, the FPU socket, and associated components. The cache memory card uses ALR's FlexCache architecture, which consists of 64K bytes of 25-nanosecond static RAM (SRAM).

Nine expansion slots are available, including one 8-bit and two 16-bit ISA slots, three 32-bit EISA slots, and three proprietary slots that hold the CPU, expansion memory, and RAM cache cards.

The motherboard holds up to 17 MB of 80-ns 1-MB or 4-MB single-in-line-memory-module RAM (the 32-bit memory card can hold another 32 MB of RAM). It is also home to the integrated serial, parallel, mouse, and disk I/O functions. The unit we received from ALR was a standard Model 80 with an ALR VGA monitor and graphics card.

> *You won't notice a difference in performance unless your applications are the most power-hungry.*

Next!

The Premium has five 16-bit ISA slots, one 8-bit ISA slot, and three proprietary CUPID (Completely Universal Processor and I/O Design) slots, which also make use of three of the 16-bit slots. The CUPID slots hold the CPU card (called the Fastboard) and 32-bit memory (16 MB for each slot). CPU options range from a 16-MHz 386SX to the 33-MHz i486. AST expects the standard configuration for the Premium to be at least 4 MB of RAM, a 5¼-inch 1.2-MB floppy disk drive, MS-DOS 3.3, an embedded hard disk drive controller, one parallel and two serial ports, and five drive bays. The system we received from AST contained 8 MB of RAM, an 80-MB hard disk drive and a Western Digital hard disk drive controller, and an AST VGA monitor and graphics card.

AST used a different upgrade approach from ALR; the Fastboard holds all hardware dependent on the speed of the CPU, up to 4 MB of 80-ns SRAM, and a slot for an Intel or Weitek 4167 math coprocessor. The system board, identical for all CUPID models, contains the AST BIOS, expansion slots, application-specific ICs, and I/O components.

Prices for the upgrade boards were not available at press time, but they will depend on what machine you are upgrading. For instance, you will pay more for the Fastboard 486/33 for a 386SX system than for a 25-MHz 486 system, even though the boards are the same. AST's literature says that you must return your old CPU board, for no rebate, when upgrading, but an AST spokesperson said that trading your old board was up to the customer.

Both systems looked like the prototypes they are; wire jumpers populated both the upgrade modules and system boards. Both ran flawlessly, though, which is more than I can say for the first 25-MHz 486 systems BYTE encountered. Intel's experience with that chip has obviously given it a running start with the 33-MHz version.

Performance Plus

On our CPU and FPU benchmark tests, both machines blew away everything else

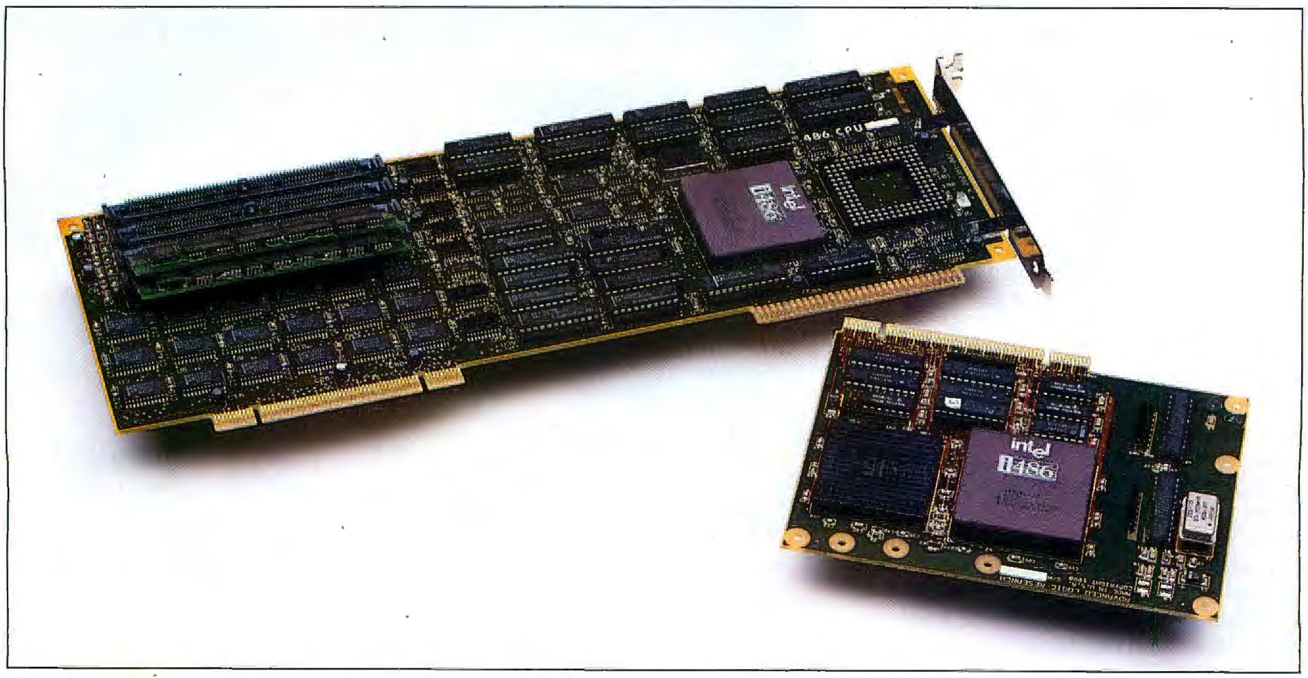

Photo 2: *ALR's CPU upgrade module is much smaller than the AST Fastboard card, and it uses only the separate proprietary slot on the ALR motherboard. AST's card uses one of the standard 16-bit slots, as well as a proprietary 32-bit slot. Both designs make for simple upgrades.*

BYTE BENCHMARK INDEXES

ALR's FlexCache architecture seems to be the difference in the CPU index scores. Nonetheless, both machines are screamers, especially on the FPU side. Both machines are prototypes, and these numbers should be considered preliminary.

	CPU	FPU	Disk I/O	Video
ALR PowerVEISA 486/33	9.69	37.03	3.48	4.02
AST Premium 486/33	8.21	37.10	*	3.40
Cheetah Gold 33 (25-MHz i486)	6.52	21.49	9.49	5.57
Compaq Deskpro 386/33	6.09	15.50	2.90	4.53

*Did not complete one test in our disk I/O benchmarks, for reasons we could not determine.

Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT = 1. For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

BYTE has seen. The ALR PowerVEISA 486/33 easily bested the AST Premium 486/33 on the CPU index: 9.69 versus 8.21 (see the table). I attribute the wide gap in the CPU ratings to ALR's external 64K-byte read- and write-back cache. The most significant differences were in the string move tests, which benefit from a good cache. The Premium 486/33 depends on the 8K-byte cache built into the i486.

Both machines blasted previous FPU marks by about 10 index points: 37.03 for the PowerVEISA 486/33 and 37.10 for the Premium 486/33. This should make a strong argument for 33-MHz i486s in math-intensive applications, such as CAD or serious financial work.

The PowerVEISA 486/33 appears to have the edge in price and performance. Both machines are prototypes, however, and prices and benchmark numbers can change. All prices given here are retail list; dealers will usually offer significant discounts.

For the Power-Hungry Only?

In truth, you won't notice a difference in performance between these machines, or even between these machines and fast 386 systems, unless your applications are among the most power-hungry. But even everyday applications are demanding more and more processing power.

Graphical user interfaces require a great deal of computing overhead and encourage software developers to add sophisticated features. A word processor today is passé unless it can generate graphics, perform desktop publishing functions, and seamlessly work with a variety of output devices and other software. Throw a network, voice mail, and image processing into the picture—all running under a GUI—and it's easy to see a future where even the low person on the PC totem pole is going to require much more computing muscle than is common today.

The handwriting is on the wall, but lesser systems still do the job and will continue to do so for the immediate future. In many cases, it's easier to justify purchasing a 386 system that can make use of a more powerful CPU than a machine that's stuck with one configuration. When the applications begin to burst out at the seams of the hardware, the upgrade will be relatively painless in terms of both cash spent and time lost due to setting up.

These systems are inexpensive only in the sense that you get a lot of processing power for the money. Neither the ALR PowerVEISA 486/33 nor the AST Premium 486/33 will be sales leaders, but they provide the power for those who need it now and, in lower-end configurations, a convenient way for others to upgrade as their circumstances and needs dictate. ■

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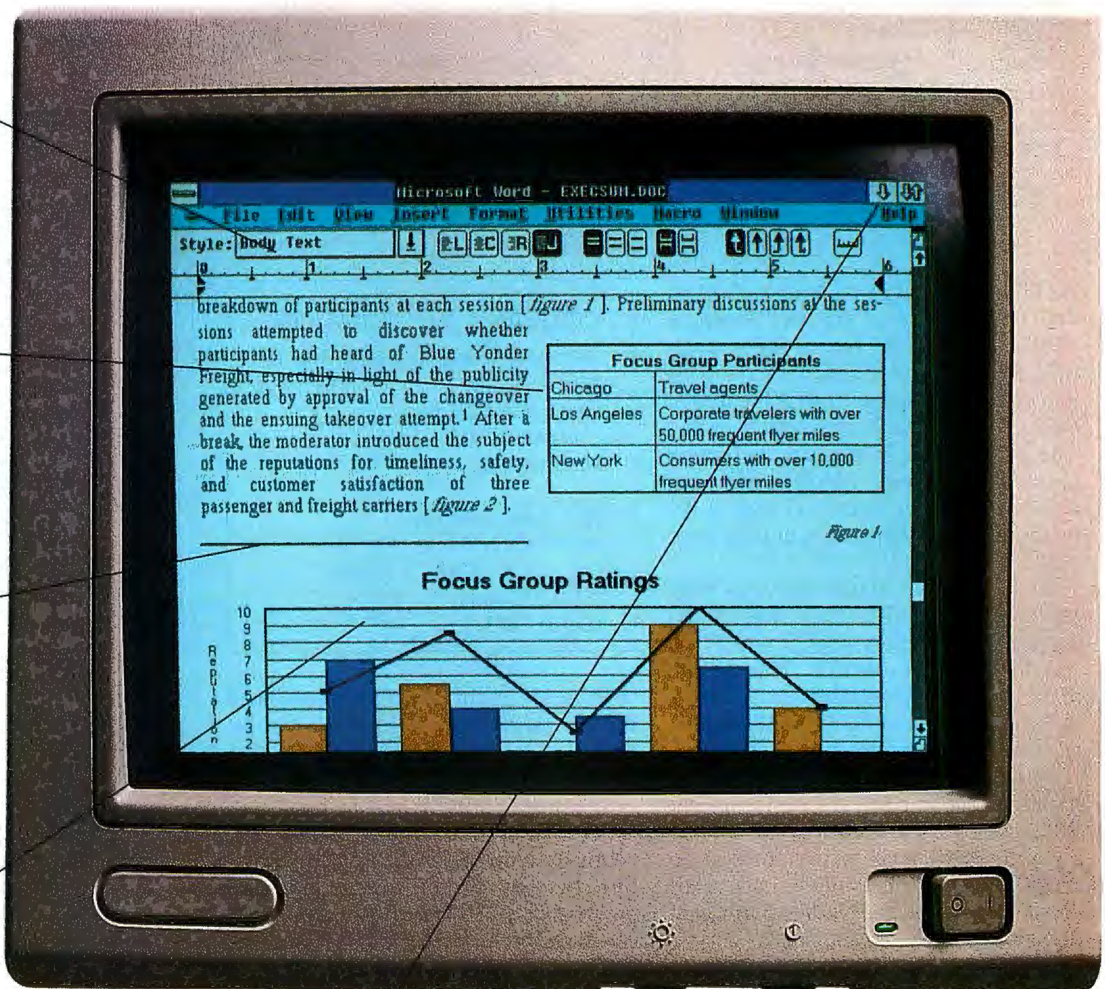
We've taken someth documents. The



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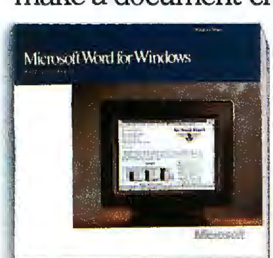

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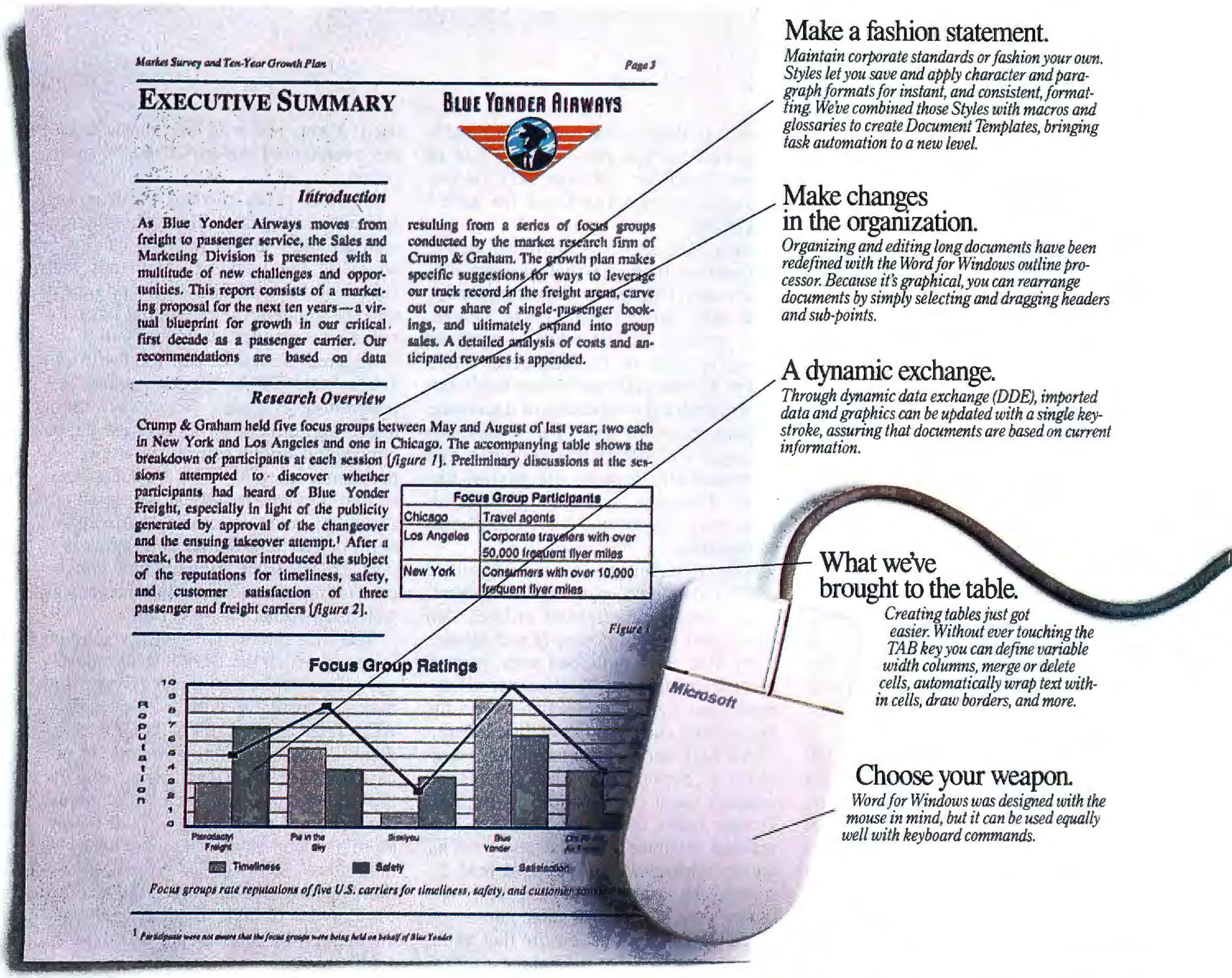
Market Survey and Ten-Year Growth Plan *Page 3*

EXECUTIVE SUMMARY

BLUE YONDER AIRWAYS

Introduction

As Blue Yonder Airways moves from freight to passenger service, the Sales and Marketing Division is presented with a multitude of new challenges and opportunities. This report consists of a marketing proposal for the next ten years—a virtual blueprint for growth in our critical, first decade as a passenger carrier. Our recommendations are based on data resulting from a series of focus groups conducted by the market research firm of Crump & Graham. The growth plan makes specific suggestions for ways to leverage our track record in the freight arena, carve out our share of single-passenger bookings, and ultimately expand into group sales. A detailed analysis of costs and anticipated revenues is appended.

Research Overview

Crump & Graham held five focus groups between May and August of last year; two each in New York and Los Angeles and one in Chicago. The accompanying table shows the breakdown of participants at each session [*figure 1*]. Preliminary discussions at the sessions attempted to discover whether participants had heard of Blue Yonder Freight, especially in light of the publicity generated by approval of the changeover and the ensuing takeover attempt.[1] After a break, the moderator introduced the subject of the reputations for timeliness, safety, and customer satisfaction of three passenger and freight carriers [*figure 2*].

Focus Group Participants	
Chicago	Travel agents
Los Angeles	Corporate travelers with over 50,000 frequent flyer miles
New York	Consumers with over 10,000 frequent flyer miles

Figure 1

Focus groups rate reputations of five U.S. carriers for timeliness, safety, and customer satis...

[1] *Participants were not aware that the focus groups were being held on behalf of Blue Yonder*

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Multiuser Databases:

SQL servers are not all created equal

Rich Finkelstein

According to conventional wisdom, all Structured Query Language (SQL) database servers are the same and have become "commodities," but nothing could be further from the truth. Each DBMS has distinct characteristics that make it either appropriate or inappropriate for a particular application. To further complicate matters, it seems that vendors place a high priority on adding features to their DBMS checklist—even though many of the features may offer little or no direct benefit. You should therefore look for the DBMS that best matches your requirements.

In spite of all the confusion, SQL servers have a lot to offer. Basically, a SQL server is a database engine that performs relational mathematics on sets of data. Unlike the case with a plain-vanilla relational DBMS, you don't have to tell a SQL server *how* to find the data you want; instead, you just ask for the data. The only catch is that you have to ask for the data using the server's SQL.

All the servers reviewed here support ANSI Level 1 SQL. Most support ANSI Level 2 and try to stay close to IBM's System Application Architecture (SAA) SQL. Some of the DBMS vendors have added useful extensions to their SQL, such as string, mathematical, and statistical functions, along with special data types, such as multigigabyte binary fields. Each SQL implementation differs considerably in this area, so you'll want to check for specific functions that are critical to your applications. Two SQL servers in this review, Ingres and InterBase (see the text box "A New Kid in Town: InterBase" on page 142), let you define your own functions for added flexibility.

Each SQL server is equipped with a transaction manager that ensures that tables and indexes are synchronized—even after program or system failure. The problem is that when a program abruptly ends or the computer shuts down, a particular transaction might not have completed its updates, or data in the buffers might be lost. The transaction manager will detect this condition and automatically remove all partial updates. Therefore, tables and indexes reflect only committed (i.e., completed) transactions.

The SQL servers must also guard against data loss after a disk failure. They have backup/restore utilities that create and restore copies of a database. They also come equipped with forward recovery procedures that recover all updates that were completed between the last backup and the point of disk failure.

All SQL servers support *entity integrity* (i.e., each record in the table must be unique) via a combination of the SQL Unique Index facility and the Not Null column attribute. Another type of integrity, *referential integrity*, is best described by example. If you have two tables—say, a customer table and an invoice table—you must ensure that an invoice is not added to the database unless the customer exists in the customer file. Otherwise, the tables become out of sync, and thus the referential integrity will be lost. You also want similar integrity when you update and delete customer records.

Some SQL servers have no referential integrity. It is up to the user or programmer to handle the problem, with either program code or a series of interactive SQL commands. This will inevitably lead to unsynchronized tables. In some cases, depending on the application tool used, it may not even be possible to enforce referential integrity from the application.

A much better method for handling referential integrity is by storing the referential rules in the DBMS "catalog," which is the body of commands and functions for that DBMS. Every time a table is updated, the referential integrity rules are automatically executed, or "triggered" (not to be confused with Oracle's SQL*Forms triggers, which are program-level code). This way, users and programmers no longer have to be concerned about referential integrity problems. Integrity rules are centralized so that they are consistent across all applications and are easier to maintain. Servers like SQL Server and Ingres support DBMS-level triggers that can be used to implement referential integrity as well as any other business rule.

The best referential integrity solution is one in which the DBMS vendor develops all the referential integrity logic and makes it available with the SQL CREATE TABLE or ALTER TABLE commands. Database administrators do not have to create any trigger logic, since the DBMS engine automatically maintains the referential integrity. As a result, there's much less of a chance of errors or omissions. IBM's OS/2 Extended Edition Database Manager (see the text box "A Preview of OS/2 Extended Edition" on page 146) implements this type of solution.

All the SQL servers except Progress have application programming interfaces (APIs) that support various languages such as C, COBOL, and Pascal. Progress implements its own 4GL language.

All the SQL servers reviewed here strive for high performance, especially if their makers sell their DBMSes in on-line transaction processing (OLTP) environments. Every server supports B-tree indexes for fast direct and sequential retrievals. They each also include query

continued

The SQL

THE SQL FEATURES

The major features that set the SQL servers apart (● = yes; ○ = no).

SQL server	Price	Operating systems	4GL	Languages	Locking level	Query optimization	Index storage options	Data storage options	Referential integrity
XDB	$2590	DOS	Forms	C, COBOL, Pascal	Row	Cost-based	B-tree	None	Partial with DDL
SQLBase	$2495	DOS, OS/2	SQLWindows	C, COBOL	Page	Cost-based	B-tree	Hashed	None
SQL Server	$2495	OS/2, Unix, VAX/VMS	ABT Workbench	C	Page	Cost-based	B-tree, clustered	None	Triggers
Oracle	$2499	OS/2, Unix, VAX/VMS	SQL*Forms, SQL*Report	C, COBOL, FORTRAN	Row	Syntax-based	B-tree	Clustered tables	None
Ingres	$2490	Unix, VAX/VMS	ABF, QBF, RBF	C, COBOL, FORTRAN	Page	Cost-based	B-tree, ISAM	Hashed, sequential	Triggers
Informix	$1600-$10,000	Unix, VAX/VMS	Informix-4GL	C, COBOL	Row or page	Cost-based	B-tree, clustered	None	None
NetWare SQL	$795	NetWare VAP, NetWare 386, NLM	None	C, COBOL, Pascal	Row	Syntax-based	B-tree	None	None
Progress	$4500	DOS[2], Unix, VAX/VMS	Progress-4GL	None	Row	Cost-based	B-tree	None	Partial with file triggers

[1]No error checking or logic. [2]Single-user version only.

optimizers that automatically select indexes when data is accessed or updated.

The servers all include automatic page or record locking that maximizes concurrency when many users are accessing the same date. Table-level locking would be the worst situation, since it would let only one user at a time access a table. Page-level locking locks several records at a time and promotes a higher level of concurrency. Record-level locking is the finest level of granularity for more concurrency.

All the servers also have automatic deadlock detection. Deadlocks occur when two or more transactions are waiting for records that are being held by other transactions. Since none of the transactions can continue processing, the SQL server must abort at least one transaction and send a message to the program to requeue the transaction.

These are the basic and necessary features of database servers. But each vendor has enhanced its server far beyond these basics.

XDB

XDB is one of two SQL servers that can run under MS-DOS (an OS/2 version is also in the works). It will run on any NetBIOS LAN and requires only 640K bytes of memory. You can use a special 16-megabyte version to run in extended memory. Depending on your application, XDB should be able to handle up to 15 users with this additional memory.

XDB is highly compatible with IBM's mainframe DB2 DBMS. Most of the SQL DBMSes try to duplicate DB2's SQL syntax. XDB also duplicates DB2's messages and return/error codes. In addition, XDB displays data in the same way that DB2 would, and it maintains DB2's SQL restrictions.

XDB follows DB2's version 1.2 syntax closely. It includes the same data types, among them VARCHAR (variable characters) and LONG VARCHAR (long variable characters). XDB's LONG VARCHAR is currently limited to 1500 bytes, while DB2's can handle up to 3200 bytes. XDB also implements the CREATE SYNONYM statement, NOT NULL WITH DEFAULT, and CREATE VIEW WITH CHECK OPTION.

Release 2.3 of XDB copies DB2's operators and functions. These include CURRENT TIMESTAMP, CURRENT TIME, CURRENT DATE, and CURRENT USER system variables. XDB uses DB2's || concatenation operator and supports several date and time formats, including those of the International Standards Organization, IBM USA, IBM European Standard, and Japanese Industrial Standard Christian.

These additions give XDB several levels of compatibility. XDB supports ANSI SQL Level 2, IBM's SAA, IBM's DB2 SQL, and its own XDB extensions. No other SQL DBMS can make this claim. XDB uses a compatibility flag to enforce a particular standard; if you want all users and programmers to use the DB2 standard and no other extensions or deviations, you can turn on the DB2 compatibility flag to permit only DB2 commands, functions, and data types.

These features make XDB the perfect platform for developing DB2 applications. Many large organizations use the Micro Focus or Realia COBOL compilers together with the Customer Information Control System option, which you can purchase in a package with XDB, to develop applications that will ultimately run under DB2.

You do not need NetWare to operate XDB on a LAN. Many people choose simpler network operating systems such as LANtastic, which supports printer and file sharing.

Stored procedures	BLOBs	User-defined functions	DB2 gateway	Optimized distributed query	Two-phase commit
○	○	○	○	○	○
Partial[1]	○	○	●	○	○
●	●	○	●	○	Partial
●	○	○	●	○	○
●	●	●	●	●	Partial
○	●	○	○	●	○
○	○	○	○	○	○
○	○	○	○	○	○

XDB on a server is exactly the same package as XDB on a single-user DOS PC. It is simple to install, and it has an interface that reflects its PC heritage. Many of the other servers have migrated from Unix or VAX systems and have user interfaces that are more appropriate for those environments than for PCs. They also carry excess baggage because they were developed for larger systems long before PCs were introduced.

In addition to its simplicity, XDB has many other attractive features. It has partial referential integrity in its SQL data definition language (DDL), and the company says that an upcoming version will extend its capabilities so that it will more closely emulate IBM's DB2. Currently, XDB supports PRIMARY KEY definition and INSERT referential integrity.

XDB implements row-level locking, which increases concurrency. XDB supports both of DB2's isolation levels: Cursor Stability and Repeatable Read. CS releases the row-level lock on the record after the program is finished processing it. RR maintains the locks until the transaction is completed, and it guarantees that the record will not be updated by other transactions until the transaction has ended.

XDB's weak spot is its application development tools. Its forms development system is showing its age and needs more functionality. You can use it to develop medium-size applications, but for more complex work, you will need to use the COBOL or C language interfaces. However, the company says that it is working on major enhancements to address many of these weaknesses.

SQLBase

The other DOS-based DBMS is SQLBase, one of three product lines from Gupta Technologies. The company also markets a windows application development tool called SQLWindows, and a mainframe cooperative processing link called SQLNetwork.

SQLBase was the first SQL database server for the PC. Initially it ran under DOS, but now it also runs under OS/2. (Gupta says that it will also have a Sun Unix version this year.) SQLBase will run on any NetBIOS network and also as a stand-alone DBMS under DOS.

SQLBase installation and administration procedures were designed with the PC user in mind. Its backup and recovery procedures exemplify this goal. You need only one command—BACKUP SNAPSHOT—to make an on-line backup of the database and its associated audit logs. You can use the RESTORE SNAPSHOT command to recover from disk failures. SQLBase automatically applies the correct backup and audit files without further user intervention.

Experienced administrators can use the BACKUP DATABASE/LOGS and RESTORE DATABASE/LOGS for finer control over backups and restores. After the databases and logs have been restored to the disk, the administrator has the option of recovering data to a specific point in time, to the point of disk failure, or to the time the on-line backup ended. The ROLLFORWARD TO END/TIME/BACKUP command supports these options.

SQLBase supports both B-tree indexes and hashed indexes (i.e., tables). B-tree indexes offer the best all-around performance, but if you need fast direct retrievals, then hashed tables can't be beat. Hashed tables let you access records directly without any indexes. A special randomizing algorithm inserts and retrieves records with only one I/O operation.

Since hashed table algorithms do not require any index retrievals, they eliminate at least one, and sometimes two or three, I/O operations for each record access. This can dramatically improve performance. You can also build B-tree indexes on any field in the record.

SQLBase's algorithm is especially good on tables with infrequent updates and serially numbered keys. You can define other types of tables to be hashed, but you must verify that the randomizer is doing a good job of randomizing the records. If the randomizing algorithm is not appropriate for the record's key, records will randomize to the same database page. Then when the page is filled, SQLBase chains that page to another page at the end of the database. This creates long synonym chains, and it's a poor use of space. Instead of saving I/O operations, the system ends up doing more.

SQLBase provides excellent support for mixing decision-support systems on the same server as OLTP applications. SQLBase's read consistency guarantees that a user who wants to only read a record will never be blocked by a transaction updating the same record. The update transactions will never interfere with queries and reports. Read consistency adds extra overhead, which hurts overall performance. The database administrator has the option of turning read consistency on or off.

SQLBase lets you use one command to store and execute a series of SQL commands. Gupta Technologies calls this facility "chained-SQL." Chained-SQL minimizes the interaction between the database server and the application program running on a PC workstation. Theoretically, chained-SQL can boost SQLBase's performance 40 percent or more; unfortunately, chained-SQL has limited practical usefulness.

continued

Chained-SQL does not let developers check for errors, nor does it allow any branch or control logic. Almost all applications require these capabilities, so it's unlikely that you will be able to take advantage of chained-SQL. Chained-SQL should be contrasted with SQL Server's and Ingres's stored procedures, which are fully functional and provide real performance advantages.

SQLBase supports COBOL and C language APIs. SQLBase's API permits backward fetches, which is important in PC applications.

SQLWindows is an excellent programmer's tool for developing sophisticated windows-based applications. SQLWindows has a long learning curve, but it's worth the effort if you need to build windows applications. With some refinement, SQLWindows can become the tool of choice for SQL database developers. Together with SQLNetwork, it can access DB2 databases. Gupta Technologies has announced that it is developing links to other DBMSes, including OS/2 Extended Edition Data Manager, Oracle, and SQL Server.

SQL Server

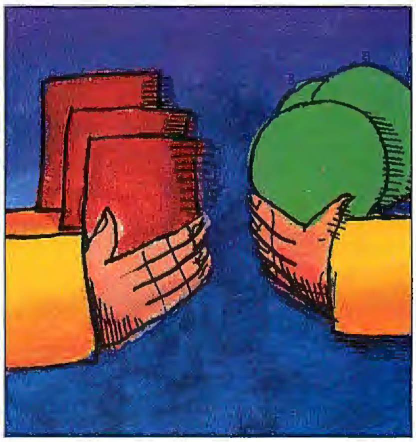
The Microsoft/Sybase SQL Server has long set the standard for client/server technology. SQL Server runs under various Unix systems, OS/2, and VAX/VMS. The OS/2 version of SQL Server requires named pipe network support, so you must install a version of LAN Manager (e.g., 3Com 3+Open, the Ungermann-Bass version, IBM LAN Server), or Novell's NetWare Requester for OS/2.

SQL Server has limited distributed update support (i.e., the ability to update several remote and local databases within a single transaction). It comes with function calls for coordinating updates across multiple databases, but it is the programmer's responsibility to issue the correct function calls. It is much better if the DBMS does all the work. SQL Server also supports remote procedure calls that allow transactions to execute procedures on other SQL Servers.

SQL Server supports referential integrity and other business rules with triggers. Triggers are small SQL programs, written in SQL Server's Transact-SQL language, that are stored in the DBMS catalog. Each trigger is associated with a particular table and a SQL update function (e.g., update, delete, and insert). They are automatically executed whenever a transaction updates the table. You can write triggers to enforce any database validation rule, including referential integrity.

Since they are stored in the catalog and automatically executed, triggers promote consistent integrity constraints across all transactions. The triggers are easy to maintain because they are stored in only one place—the DBMS catalog. Rules are enforced for any application that accesses the database, such as spreadsheet programs.

SQL Server also stores rules in its catalog. Rules apply to columns, and you use them to specify user-defined data



types and range checks.

SQL Server implements a multithreaded, single-server architecture. This type of architecture is also used by SQLBase. Multithreaded servers perform most of their work and scheduling without interacting with the operating system. Instead of creating user processes, multithreaded servers create a thread for each new user. Threads are more efficient than processes, and they use less memory and CPU resources. In contrast, Oracle and XDB use a process/user architecture.

Its multithreaded architecture enables SQL Server to efficiently service a large number of users. It can service 40 users simultaneously on a 10-MB 33-MHz Compaq with only minor degradation in performance. However, SQL Server's single-server architecture does not allow it to take advantage of multiple processors. However, Sybase says it is working on a "virtual server" architecture that will create multiple servers on a single machine.

SQL Server was the first DBMS to implement stored procedures, which are similar to triggers. They are small Transact-SQL programs that are stored in the DBMS catalog. Any applications (e.g., databases and spreadsheets) can call a stored procedure. Instead of executing one SQL command at a time, stored procedures execute several commands simultaneously—without any further interaction with the application.

This saves a considerable amount of network overhead and can boost performance by 40 percent or more. Since Transact-SQL is a full language, developers can write complete procedures with branch-and-control logic, assignment operators, and error-checking capabilities. Oracle's OTEX and SQLBase's chained-SQL do not have these features.

Clustered indexes is a little-known but highly valuable performance feature that greatly increases sequential processing performance. Clustered indexes maintain table data in a physical keyed sequence that enables sequential processing without the use of indexes.

Most other DBMSes must use indexes to sequentially retrieve a range of records or a whole table. This means that the transaction must perform at least one index I/O operation and one data I/O operation for each record. Often the DBMS must perform more. Suppose a transaction must retrieve 1000 records. It must then perform 2000 or more I/O operations.

Clustering reduces the number of I/O operations by eliminating the index I/O operations and clustering data in the same database page. If the database record size is 100 bytes and the database page size is 2000 bytes, then you can sequentially cluster 20 records to a page. This means that the transaction needs only 50 I/O operations (1000/20) to read all 1000 records. That's 40 times less I/O operations than required with simple B-trees. In my experience, this feature makes the critical difference in the success and failure of an OLTP application.

SQL Server has other useful features. Version 4.0, which is available on Unix platforms, supports 2-gigabyte binary fields that can store a lot of text or large images. It also has disk mirroring and fault-tolerance features. Sybase has also defined an Open Server specification that allows developers to build gateways between Sybase and other DBMSes such as DB2.

SQL Server has some weaknesses as well. It does not support the standard IBM SAA application "cursor" programming interface. A cursor stores the results of a SQL query and allows a program to move forward through the data one record at a time. Sometimes, as in the case of SQLBase, a programmer can move backward within a cursor. Without a cursor, it's harder to program transactions that must browse through data.

continued

A New Kid in Town: InterBase

Most PC users have never heard of Interbase Software, but that may change. Ashton-Tate recently bought a 51 percent equity interest in the company and plans to use Interbase Software technology in its next-generation SQL database server. Although for now the program InterBase does not run on a PC, there's little doubt that Ashton-Tate will exploit its advanced distributed database capabilities and its ability to handle what Interbase Software calls Online Complex Processing.

In the view of Interbase Software, OLCP environments are substantially different from on-line transaction processing. Typically, OLTP transactions tend to look alike and involve small chunks of high volume. OLCP environments are complex and unpredictable, involving database requests of arbitrary size. Examples of OLCP applications include manufacturing resource planning; real-time process control; medical, publishing, and financial trading; and CAD/CAM applications.

InterBase has many unique features that are oriented toward OLCP. Among those are a new type of trigger called an event trigger, which automatically executes a procedure whenever a particular event occurs. The event trigger is managed by the DBMS, not by the application. InterBase also supports data integrity triggers similar to those of Sybase and Ingres.

InterBase features BLOB (for binary large object) data types of unlimited size. Developers can write BLOB filters that standardize BLOB access and that hide BLOB characteristics from the program. Once a filter is written for a particular BLOB, you don't have to be concerned about how to handle it.

InterBase supports a peer-to-peer network architecture. In a peer-to-peer architecture, there is no central server, and InterBase allows any or all workstations to act as database servers. InterBase's distributed database capabilities include a two-phase commit that allows transactions to update multiple databases at multiple sites. Ingres and Sybase also support two-phase commits, but InterBase's is automatic and under DBMS control. Ingres and Sybase's implementations require programmer coordination.

OLCP transactions have long durations and lock large amounts of data. InterBase implements a special multiversioning locking technique that allows transactions to retrieve and hold records for long periods of time without blocking other transactions. This technique also works well for distributed OLCP transactions, but it's not clear how well it supports concurrent OLTP transactions. The same locking and storage mechanisms that make it appropriate for OLCP applications may make it inappropriate for OLTP.

Currently, InterBase runs on VAX/VMS, Apollo, and SunOS workstations. Ashton-Tate will very likely introduce a 386 version for OS/2 in the near future—possibly by the end of the year.

SQL Server does not have any application development toolkit under OS/2. Sybase says that it is porting its APT-Workbench toolkit to Presentation Manager, but that version will not be available until later this year. Until other products become available, developers must use SQL Server's C language API.

Oracle

Oracle Corp., the leading provider of Unix DBMSes, recently released its OS/2 database server. An Oracle database is portable to many different platforms as long as you maintain the same version of Oracle across all platforms.

Oracle claims that Oracle for OS/2 runs on a number of different networks, including Novell's IPX/SPX, NetBIOS, and TCP/IP. SQL*Connect allows users to connect to remote Oracle databases. Oracle's distributed database technology enables users to query local and remote Oracle databases within a single query. However, Oracle does not optimize distributed queries or support distributed updates. Oracle also has gateways to non-Oracle DBMSes such as DB2, but in practice these gateways have had stability and performance problems.

Oracle uses a process-per-user architecture. Each user connection demands its own server process. The up side of this architecture is that, within limits, it can use multiple processors. The downside is that it consumes memory resources and incurs extra CPU overhead. This can be a problem in single-processor 386 computers.

Oracle 6.0, the version that runs under OS/2, corrects many of the deficiencies of prior versions. Oracle 5.1, the most widely used version, locks full tables after an update. Oracle 6.0 now implements row-level locking using a time-stamping mechanism. Oracle supports a multiversioning mode that is similar to SQLBase's read consistency. This, together with its row-level locking, makes it especially suitable for mixed reporting and transaction environments.

However, Oracle still has a query and reporting weakness, and that is syntax-based optimization. This means that a SQL command behaves differently depending on the order of the table names in the SQL WHERE clause. This is a poor and antiquated solution. Instead of using a cost-based algorithm to determine the best way to join tables, Oracle puts the burden on users.

Skilled programmers may be able to find the right syntax, but if table sizes change, then you must modify the program. What's more, under certain circumstances, such as when you are using a third-party front-end product, the generated syntax may be completely out of programmer control.

Although Oracle claims that its current version 6.0 performs much better than version 5.1, the claim is based on Oracle's OTEX feature. OTEX is similar to SQLBase's chained-SQL, and it can give Oracle a big performance boost. But OTEX has little practical value—it has no support for branch-and-control logic or any other programming logic. Like chained SQL, OTEX can only return the error code of the last SQL command executed.

SQL*Forms is Oracle's application development tool set. SQL*Forms has limitations that the company will address in version 3.0. This product is supposed to contain procedural capabilities in the form of Oracle's PL/SQL language, which the company is also working on.

Ingres

Ingres competes very closely with Oracle. It runs on a number of Unix and VAX

continued

platforms. The manufacturer says that a version for OS/2 will be available by July. Other versions support the Sun386i and several networks, including Sun NFS, TCP/IP, and VAX DECnet.

Developers can access remote Ingres databases via Ingres/Net. You can use Ingres/Start for distributed updates and queries. Ingres optimizes distributed queries, but its distributed update capability, like SQL Server's, must be managed by the programmer. Ingres can access remote DBMSes, such as DB2, with its General Communications Architecture. In the past, Ingres's gateways have not been found to be reliable, but GCA appears to overcome these problems. GCA is the first gateway architecture that is based on the ANSI Remote Data Access standard.

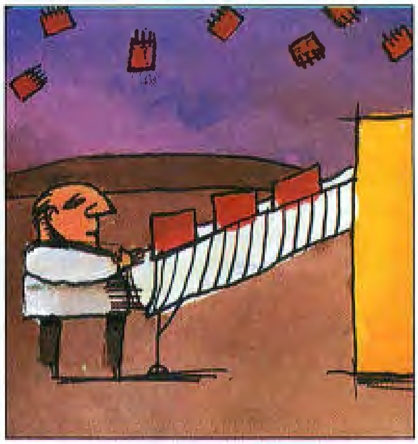
Ingres is the only DBMS that supports a multithreaded, multiserver architecture. This overcomes the one-processor limitation of the multithreaded, single-server architectures. Administrators can start up multiple servers on a computer. These servers would be able to use multiple processors with no limitations. The advantage is that administrators would be able to direct transactions to specific servers, giving higher priority to critical transactions.

Ingres has many special features that make it technically superior to its competitors. For example, most other SQL DBMSes, with the exception of Oracle, use cost-based algorithms to optimize SQL queries. To determine the best index paths, they store row counts in their SQL catalog. Ingres stores not only counts but also histograms. Histograms more thoroughly describe data, since they capture its skewed nature.

Ingres also does a better job of interpreting SQL commands. There are many ways to express the same question within the SQL language. In most DBMSes, performance can be negatively affected by a nonoptimal formulation. For instance, some DBMSes perform better on joins, while others prefer subqueries. Ingres uses a "query-flattening" algorithm that ensures that all possible SQL constructs perform equally well.

Ingres supports hashed table structures as well as B-trees. As with SQL-Base, this gives the database administrator added physical storage flexibility. Ingres's Intelligent DBMS has recently been released on VAX and other high-end Unix platforms. The Knowledge Management Extensions (KME) includes stored procedures and triggers similar to those of SQL Server. Ingres's triggers and stored procedures are created using Ingres's OSL language. Unlike SQL Server, Ingres allows multiple triggers per update operation per table. Procedures are therefore easier to write and maintain.

The KME contains a Resource Control System that establishes limits on resource consumption. With this facility, administrators can limit the number of rows returned by a query. This prevents runaway queries. Another facility, the Access Control System, allows database



administrators to control authority at the group level instead of the user level.

Skilled programmers can use the Object Management Extensions (OME) to define their own functions, operators, and data types. An example of a user-defined data type would be a geographical location. Instead of trying to describe geographic points and distances between points by using standard data types, skilled programmers can develop their own data type called POSITION. They can also create a user function called DISTANCE, which calculates the distance between POSITIONs. Users can then use these data types and functions directly in their SQL commands.

Ingres comes with a complete development tool set called Application-by-Forms. The company also offers an end-user query tool called Simplify.

The Santa Cruz Operation will package Ingres into its new 386-based Unix 5.2 operating system called Open Desktop. Under normal circumstances, Open Desktop with Ingres would be considered a good alternative to an OS/2 database server. Unfortunately, there seems to be very little awareness of the product. However, that could change.

Informix

Informix is very popular for small- and medium-size Unix-based applications. It is easier to administer than other Unix DBMSes, it requires fewer hardware resources, and it offers excellent performance. Informix has great portability (supporting more than 250 platforms), as well as a good set of development tools that are oriented toward the professional programmer.

There are two versions of Informix. Informix-SE, Informix Software's original DBMS, runs on top of its C-ISAM file manager. This version runs under DOS, Unix, and DEC VMS. It does not have the performance characteristics of Informix-Online and is mainly used for applications with low transaction processing requirements. Access into Informix-SE is through a C-ISAM call interface or via SQL. Applications written with the SQL interface are compatible with the Informix-Online DBMS.

Informix-Online (formerly called Informix-Turbo) is Informix Software's entry into the OLTP marketplace. It does not run on as many platforms as Informix-SE, and it has not been ported to VAX/VMS or DOS, although an OS/2 port is in the works.

Informix-Star is Informix's distributed database system. Under Informix-Star, client workstations can access one or more remote Informix-Online databases. The distributed system uses Informix-Net to connect clients with the database servers.

Informix-Net, which is the Informix network product, supports both TCP/IP and DECnet networks. Applications can read multiple databases but can update only one database at a time. A cost-based optimizer decides the best way to do a multitable join.

Informix uses a multiprocess shared-memory architecture. Each user requires his or her own process that can share memory with other processes. This is similar to Oracle's architecture. The advantage to this architecture is that it will make use of a multiprocessor computer. The disadvantage is that it requires more operating-system resources (i.e., memory and CPU) than the multithreaded architectures of Ingres and Sybase.

Informix has a flexible locking manager. Most DBMSes support only one type of locking—table, page, or record. Informix supports all three. Database administrators use the ALTER TABLE command to choose the locking level. Large tables can be assigned page-level locking, while smaller tables can have record-level locks. Locking levels can be changed dynamically from within a program.

Like SQL Server, Informix supports

continued

A Preview of OS/2 Extended Edition

IBM's OS/2 Extended Edition has two components: the Communications Manager (CM) and the Data Manager (DM). Version 1.1 of DM could be used only as a single-user SQL DBMS, since there was no way to access it on a network. Version 1.2 of OS/2 EE will come with a new facility called Remote Data Services (RDS), which will allow applications running on OS/2 or DOS workstations to access the DM database server.

RDS will route SQL calls to the database server using IBM's Advanced-Program-to-Program Communications (APPC) protocol. This protocol is supported by OS/2's CM. Applications using the DOS requester will access the server using NetBIOS.

Neither OS/2 nor DOS RDS requires a network operating system. But if you need remote printing or file sharing, you will need IBM's LAN Server NOS. LAN Server supports over 90 percent of LAN Manager's calls and is the only NOS that IBM certifies for OS/2 EE.

IBM also added referential integrity support to the SQL data definition language that closely follows DB2's implementation. The company has also completed its SQL implementation by adding the UNION operator.

OS/2 EE supports Cursor Stability as well as Repeatability Read isolation levels. It has a new isolation level called Uncommitted Read, which allows read-only transactions to bypass any update locks.

DM's Query Manager is vastly improved and makes good use of Presentation Manager's graphical interface. Developers and end users can create forms and reports using QM. You can develop more-sophisticated applications using the IBM language interfaces.

QM comes with COBOL/2, Pascal/2, and FORTRAN/2 language interfaces. It has an interface to a new procedures language that is based on IBM's mainframe REXX interpreter language. The procedures language can call and pass variables back and forth between QM's forms and reports. This is a fast way to build applications. A business graphics interface has also been added to QM that allows users to install a graphics package designed to work with the graphical interface.

DM includes an operational status tool that displays a snapshot of server activity, including database names, alias names, the time and date of the last backup, and how many applications are currently connected to a specific database.

DM's major weakness is that it has no utilities to recover from disk failures. This means that you have to re-enter all transactions that were entered between the time of the last backup and the disk failure. Only the SQL database server is missing this function. IBM says that it recognizes this as a problem and adds that it is working on a solution.

IBM also says that it is working on direct links between OS/2 EE and DB2 using CM's APPC protocol. Already, IBM has announced OS/2 Customer Information Control System CICS (CICS is IBM's mainframe teleprocessing monitor), which supports an APPC connection between a PC CICS program and a mainframe CICS program. IBM has announced plans for complete distributed database capabilities among all its database servers, but that's probably several years off.

clustered indexes, 2-gigabyte BLOB (for binary large objects) fields for long text and large images, and disk mirroring. It also has a database performance monitoring tool called DB-Monitor.

Simple applications can be developed using the PERFORM form-design system and the ACE report writer. More-complex applications will need Informix-4GL. Informix-4GL is halfway between a procedural and a nonprocedural language. Most systems can be developed entirely within Informix-4GL, but C and COBOL language interfaces are available. Informix-4GL/RDS is an interpretive version of Informix-4GL, which allows programmers to develop applications interactively and then execute them without compilation.

Informix Software has had some past failings in the area of user support. For example, users tend to complain about the company's slow response to fixing bugs and poor telephone support. Lately, however, the company has put extra effort into upgrading its support, and it appears that progress is being made in this area.

NetWare SQL

NetWare SQL has its origins in Softcraft's popular Btrieve file manager. Many corporations and value-added resellers (VARs) use Btrieve's indexed file manager together with procedural programming languages such as C, Pascal, and COBOL to build complex applications. A few years ago, Novell bought Softcraft and made it a division of the company. Btrieve has evolved into NetWare SQL and is now packaged with Novell's NetWare.

The latest version of NetWare SQL is a step up from Btrieve but is missing important implementation features, which causes it to lag behind its competitors. It still has several major shortcomings, such as the lack of a 4GL, stored procedures, hashed tables, clustered indexes, a good buffering algorithm, and good optimization.

NetWare SQL is the only SQL DBMS that runs as a Novell value-added process, which means that it does not require a separate server. Other SQL DBMSes need their own server, since they run under DOS or OS/2. Novell says that NetWare SQL 386 will be written as a NetWare 386 Network Loadable Module (NLM). NetWare SQL has limited distributed capabilities. It can read records from a remote NetWare SQL server one record at a time using remote procedure calls.

The only major SQL feature that NetWare SQL is missing is support for null values. Forward recovery from disk failures is also missing, although this problem is supposed to be corrected in NetWare 386, which is due out sometime in the middle of the year.

NetWare SQL's transaction management system is not nearly as sophisticated as that of its competitors. It automatically locks tables unless programmers explicitly request record-level locks. Programmer-controlled locking adds to programming time and is susceptible to errors. In this day and age, that is simply unacceptable.

The soon-to-be-released NetWare SQL 386 will have some improved performance features—for example, a limited stored procedure capability and

continued

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Inquiry 1079.

improved optimization. As an NLM, it should be able to take advantage of NetWare 386's considerably improved performance.

Initial reports on NetWare 386 are good, but it still has to be proven as a reliable platform for running mission-critical applications. There is some concern about NetWare 386's inability to protect programs from other NLMs. A runaway NLM can bring down a database server, which would be unacceptable for most application situations.

NetWare SQL 386 will also include an embedded SQL precompiler for C. This follows the ANSI and IBM proposed standards. The precompiler translates SQL commands into low-level call functions.

On one hand, I don't have anything against NetWare SQL, but on the other hand, it is difficult to find strong reasons to recommend it. The best reason to use NetWare SQL is its ability to run as an NLM. In the near future, NLM versions of XDB and SQLBase will be available, and that would eliminate NetWare SQL's one real advantage.

Progress

Progress is a favorite of VARs and small organizations. It has complete DBMS capabilities and an adequate 4GL. Progress's chief competitor is Informix, which runs on most of the same platforms as Progress. Like Informix, Progress is portable across dozens of Unix and VAX platforms. A single-user DOS version is also available. Progress operates over NetBIOS, TCP/IP, DECnet, and Novell SPX/IPX networks.

Progress was one of the last true relational DBMSes to support SQL. Release 5.0 supports almost all of ANSI Level 2 SQL and most of IBM's SAA SQL. Progress does not have any procedural language interfaces, but it has embedded SQL support in its own 4GL. You can also use Progress interactively. Progress's embedded SQL uses a standard cursor mechanism that retrieves and manipulates data one record at a time. The technique is similar to the way other SQL servers embed SQL in C, COBOL, and Pascal.

Release 5 also implements a multithreaded, multiserver architecture that is similar to that of Ingres. It attempts to maximize the use of multiple processors while minimizing CPU and memory overhead. Progress has automatic record locking. Developers are given many methods of fine-tuning locking control

by defining the scope of a transaction. To do this, developers use the DO TRANSACTION and REPEAT TRANSACTION statements. Progress has a database monitor for managing multiuser performance, and a full set of data administration utilities.

Progress has a data dictionary that stores field- and file-level validation rules. This is similar to SQL Server and Ingres's rules and triggers. In Progress's version, administrators use Progress's 4GL to define the rules. Unlike SQL Server and Ingres, which support file-level triggers for updates and deletes, Progress supports validations only on deletes—not on updates or inserts.

The heart of Progress is its 4GL. If you like the 4GL, you will like Progress. Since there is no other language interface, you must build all applications completely within the 4GL paradigm. I found it awkward and at times more difficult than procedural languages. Nonetheless, many developers swear by it, and if you can live within the constraints of a 4GL, you'll find you can be productive with Progress.

Perspectives on SQL

As you can see, each of the SQL servers offers unique characteristics that may make it ideal for a given application (see the features table on page 138). To put everything in a proper perspective, consider the following.

XDB is a good choice if you want a SQL server that is relatively inexpensive, runs on any NetBIOS network, and

continued

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requires minimal data administration. It also makes sense if you're looking for a development platform for DB2 applications.

SQLBase does not have the portability of some of its competitors, such as Oracle, but it is easy to manage and has a good set of supporting tools. SQLBase will appeal to a wide range of developers and users who need a high-performance SQL database server with low resource requirements.

SQL Server is full of features, and it's an excellent choice for mission-critical OLTP applications. It is more costly in terms of resources and administration overhead than SQLBase and XDB, but for large networks and critical applications it can't be beat. Many corporations have even begun moving DB2 applications down to SQL Server.

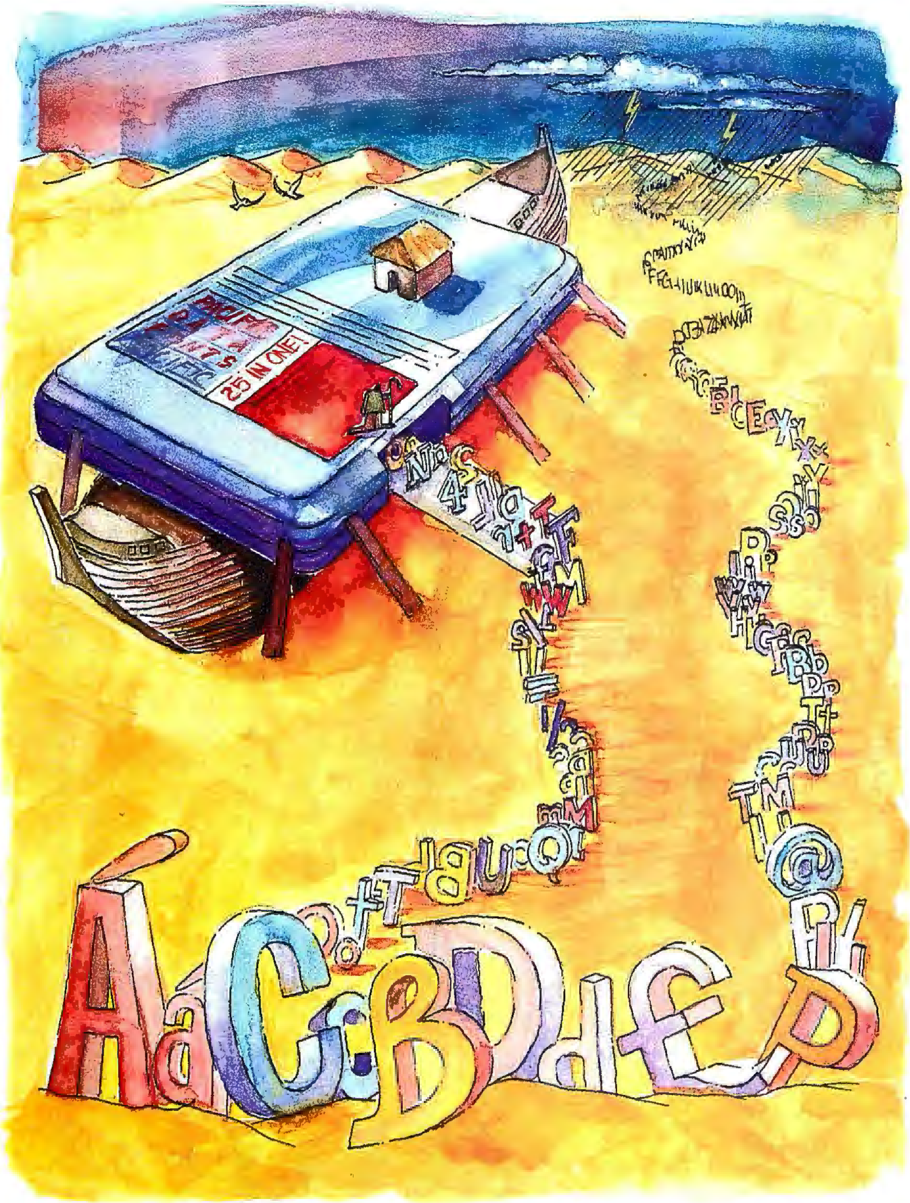
Oracle's strengths are its portability and large base of application support. Technologically, it lags behind its competitors, and it is a complex relational DBMS that is difficult to administer. It badly needs stored procedures and triggers. It should also implement either clustered indexes or hashed tables. The development tools also need upgrades.

Ingres's OME and KME extensions have established its technological leadership, which is a direction that other vendors should also consider.

Informix is a perfect fit for smaller Unix systems. Informix's chief rival on Unix 386 platforms is the Ingres Open Desktop system. Ingres appears to have the edge in tools and administration facilities, while Informix has excellent VAR pricing and a large developer base. Both DBMSes are good picks, and customers will benefit from the competition.

Progress release 5 with SQL can now claim ANSI SQL compliance and has a rich 4GL to back it up. Unix developers enjoy Progress's aggressive pricing strategy that encourages VARs with low runtime costs. Prices are dependent on the type of platform and operating system but are very competitive with Informix's. This is especially true if you consider that the total Progress package is sold at one price, while Informix's Informix-4GL and Informix-RDS are priced separately. Progress provides a good alternative to Informix and Open Desktop—provided that you like its 4GL. ■

Rich Finkelstein, president of Performance Computing, Inc., in Chicago, is a leading consultant on relational and SQL-based database technology. You can reach him on BIX c/o "editors."



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World's Fastest Lunchbox

Dolch's P.A.C. 486-25 claims the portable performance title, but only for those with very deep pockets

Mark L. Van Name and Bill Catchings

It was inevitable: 486 portables could not be far behind the first 486 desktop systems. The Dolch-P.A.C. (Portable Add-in Computer) 486-25 is the first—and, as we write this in late January, the only—486 portable.

The P.A.C. 486-25 is not a machine for the casual user. Its base system includes a 25-MHz i486 CPU, a socket for a Weitek WTL4167 floating-point coprocessor, 2 megabytes of memory, a 100-MB hard disk drive, a 5¼-inch 1.2-MB or 3½-inch 1.44-MB floppy disk drive, an electroluminescent CGA display, and three open AT-style expansion slots. Our evaluation unit came with the 3½-inch floppy disk drive, an additional 2 MB of memory ($780), a carrying case ($95), MS-DOS 3.3 ($150), and a VGA gas-plasma display instead of the standard EL screen ($595).

The P.A.C. 486-25 is also not for the poor user. The base system runs a hefty $12,995; our review unit would set you back $14,615. Dolch's 25-MHz P.A.C. 386-25 lunchbox portable in a comparable configuration costs $3100 less; you pay a huge premium for the i486.

Top Performance

Of course, you get something for all that extra money: performance. The P.A.C. 486-25 is by far the fastest portable computer that BYTE has ever tested. In the BYTE benchmarks, its overall application index of 26.3 is about 47 percent higher than that of the nearest competitor, the Toshiba T5200/100.

The i486 provides virtually all of that performance edge. The P.A.C. 486-25 beat the T5200/100 on BYTE's CPU index by about 57 percent. The i486's internal FPU increases the overall computing lead even farther; the system was more than three times faster on BYTE's FPU tests than the T5200/100, the Compaq Portable 386, or even Dolch's own P.A.C. 386-25.

The P.A.C. 486-25's video and disk subsystems, however, hold it back. The video system was slower than those of all three of the above-mentioned portables—a full 33 percent slower than that of the T5200/100. Several factors contributed to this poor showing. First, the unit's Paradise VGA Plus adapter was an 8-bit card with only 256K bytes of memory. You can't replace the Paradise card with a faster one because Dolch modified the Paradise card to drive the gas-plasma display. The display actually connects to the card via the special display adapter on top of the card, not via the normal monitor connector. (There's also a special DC-to-DC converter that converts power from the unit's 200-watt supply into the power that the display requires.)

The disk subsystem's performance, while better than the display's, is also nothing to crow about. It turned in a BYTE disk I/O index that was 9 percent above the T5200/100's, but a full 16 percent below that of the P.A.C. 386-25. One reason for this mediocrity may be the overhead of translating the physical

continued

Dolch-P.A.C. 486-25

Company
Dolch Computer Systems
2029 O'Toole Ave.
San Jose, CA 95131
(800) 538-7506
(408) 435-1881

Components
Processor: 25-MHz Intel i486; socket for 25-MHz Weitek WTL4167 floating-point coprocessor
Memory: 2 MB of 80-ns DRAM in four 1-MB SIMMs on motherboard and 2 MB of RAM on 32-bit memory card (expandable to 16 MB); 128K bytes of BIOS ROM
Mass storage: 3½-inch 1.44-MB Toshiba floppy disk drive; 100-MB 23-ms IDE Conner Peripherals hard disk drive
Display: 11-inch gas-plasma VGA
Keyboard: 86-key AT layout with 12 function keys
I/O interfaces: One 9-pin and one 25-pin serial port; one 25-pin parallel port; five AT-style expansion slots (three open); one proprietary 32-bit memory card slot

Size
16 × 9½ × 7⅘ inches; 20 pounds

Price
Base system: $12,995
As reviewed: $14,615

Inquiry 861.

characteristics of the Conner Peripherals 100-MB IDE (integrated device electronics) hard disk drive into a configuration that the BIOS can handle. The overhead slows the drive, which offers a 23-millisecond average access time and a 1-to-1 interleave.

Despite this slow disk subsystem and display, the P.A.C. 486-25 is an amazing performer that made us want 486s on our desks.

Compatibility

The P.A.C. 486-25 fared wonderfully on our compatibility tests. Its standard AT-style expansion slots worked with all our test cards, including a Western Digital Ethernet controller. The system also had no trouble with a Microsoft Serial Mouse or the Xircom Pocket Ethernet Adapter.

On the software side, the unit flawlessly ran all our almost two dozen test programs, including several—Borland's Paradox 386 version 2.03, Foresight Resources' Drafix CAD Ultra 3.03C, Microsoft's Windows/386, Quarterdeck Office Systems' QEMM-386 1.10, and Wolfram Research's Mathematica 1.2—that use 32-bit instructions and memory beyond 640K bytes.

Opening the Lunchbox

Despite its sterling PC compatibility and great performance, the P.A.C. 486-25 is stodgy-looking. Its almost 20-pound case is a dull gray rectangular box the color of an old Sears toolbox.

Inside, the P.A.C. 486-25 resembles a standard AT clone turned on its side. The vertically mounted Advanced Integration Research (AIR) motherboard runs along the front of the case, just behind the display. It measures 13 by 9 inches, the same size as the motherboard in many 386SX desktop systems, and sports over 75 chips—a lot, considering there's no memory or VGA support on it. There is only one application-specific IC, a Chips & Technologies integrated peripheral controller that manages the AT bus. The ROM BIOS is from Phoenix Technologies; the system by default copies both the ROM BIOS and the video BIOS to 32-bit memory for faster access.

The i486 in our evaluation unit was a B6 step chip, so it still had a few bugs in its FPU section. A Dolch spokesperson said that Intel plans to swap final i486s for B6 chips when the final chips are in full production; at that time, Dolch will in turn give early P.A.C. 486-25 buyers final i486s. The user can perform the swap (the CPU is socketed) or return the unit to Dolch at his or her expense.

The system's memory is on a separate AIR card in a proprietary 32-bit expansion slot. That card can hold up to 16 MB of memory in 16 1-MB single in-line memory modules. Our evaluation unit had 4 MB of 80-ns DRAM. The i486 contains a built-in 8K-byte cache and a cache controller that manages the system's memory and lets the CPU run without wait states about 85 percent of the time.

The P.A.C. 486-25 has five AT-style expansion slots: four 16-bit and one 8-bit. In our evaluation unit and in most P.A.C. 486-25 configurations, three of those slots are empty, providing a lot of expansion space for a portable. The other two slots hold the video and I/O cards. With a 5¼-inch floppy disk drive, one of the empty slots is limited to three-quarter length, but our unit's 3½-inch drive left all three slots clear to their full lengths. You reach the connectors on installed cards easily by removing a panel on the left side of the machine. To keep all the expansion cards and the i486 cool,

continued

Dolch-P.A.C. 486-25

APPLICATION-LEVEL PERFORMANCE

Dolch-P.A.C 486-25 **26.3***

WORD PROCESSING

XyWrite III+ 3.52	**Medium/Large**
Load (large)	:11
Word count	:01/:06
Search/replace	:03/:10
End of document	:01/:07
Block move	:07/:07
Spelling check	:03/:18
Microsoft Word 4.0	
Forward delete	:10
Aldus PageMaker 1.0a	
Load document	:07
Change/bold	:12
Align right	:09
Cut 10 pages	:08
Place graphic	:02
Print to file	1:06
Index:	**5.18**

SPREADSHEET

Lotus 1-2-3 2.01	
Block copy	:01
Recalc	:01
Load Monte Carlo	:05
Recalc Monte Carlo	:02
Load rlarge3	:01
Recalc rlarge3	:01
Recalc Goal-seek	:01
Microsoft Excel 2.0	
Fill right	:03
Undo fill	:54
Recalc	:01
Load rlarge3	:10
Recalc rlarge3	:01
Index:	**5.35**

DATABASE

dBASE III+ 1.1	
Copy	:55
Index	:04
List	:52
Append	1:39
Delete	:02
Pack	1:17
Count	:03
Sort	:51
Index:	**2.68**

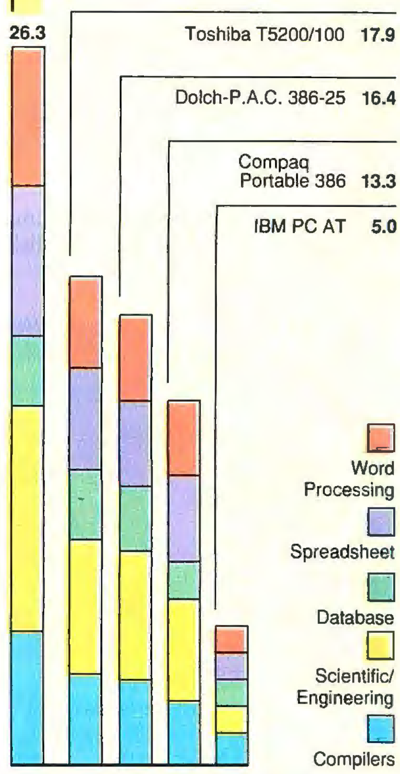
SCIENTIFIC/ENGINEERING

AutoCAD 2.52	
Load SoftWest	1:12
Regen SoftWest	:16
Load StPauls	:05
Regen StPauls	:02
Hide/redraw	3:41
STATA 1.5	
Graphics	:10
ANOVA	:06
MathCAD 2.0	
IFS 800 pts.	:05
FFT/IFFT 1024 pts.	:05
Index:	**8.15**

COMPILERS

Microsoft C 5.0	
XLisp compile	2:12
Turbo Pascal 4.0	
Pascal S compile	:02
Index:	**4.94**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT=1.



*Cumulative application index. Graphs are based on indexes at left and show relative performance.

LOW-LEVEL PERFORMANCE[1]

Dolch-P.A.C. 486-25

CPU

Matrix	1.74
String Move	
Byte-wide	20.78
Word-wide:	
Odd-bnd.	17.04
Even-bnd.	12.31
Doubleword-wide:	
Odd-bnd.	13.55
Even-bnd.	8.07
Sieve	7.63
Sort	5.78
Index:	**6.20**

FLOATING POINT[2]

Math	1.64
Error	
Sine(x)	0.66
Error	
e^x	0.66
Error	
Index:	**28.20**

DISK I/O

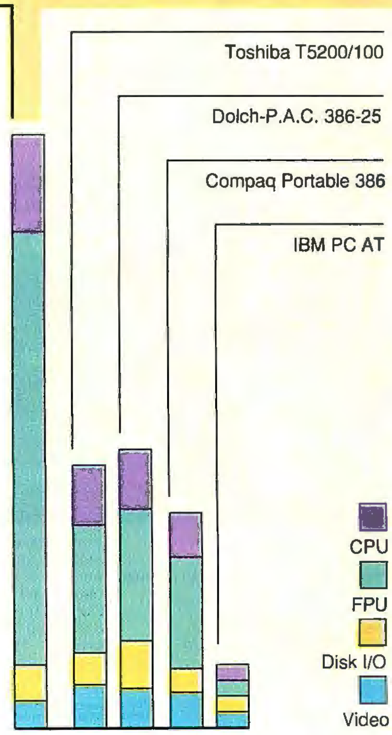
Hard Seek[3]	
Outer track	3.26
Inner track	3.35
Half platter	6.70
Full platter	10.09
Average	5.85
DOS Seek	
1-sector	12.52
32-sector	22.06
File I/O[4]	
Seek	0.06
Read	0.48
Write	0.83
1-megabyte	
Write	3.39
Read	1.77
Index:	**2.48**

VIDEO

Text	
Mode 0	5.38
Mode 1	5.42
Mode 2	5.24
Mode 3	5.26
Mode 7	N/A
Graphics	
CGA:	
Mode 4	2.33
Mode 5	2.33
Mode 6	2.42
EGA:	
Mode 13	4.06
Mode 14	4.34
Mode 15	N/A
Mode 16	4.37
VGA:	
Mode 18	4.61
Mode 19	2.55
Hercules	N/A
Index:	**1.81**

CONVENTIONAL BENCHMARKS

LINPACK	6420
Livermore Loops[5] (MFLOPS)	0.68
Dhrystone (MS C 5.0) (Dhry./sec.)	13192



N/A = Not applicable.
[1] All times are in seconds. Figures were generated using the 8088/8086 and 386 versions (1.1) of Small-C.
[2] The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.
[3] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).
[4] Read and write times for File I/O are in seconds per 64K bytes.
[5] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

the P.A.C. 486-25 has two fans, one in the unit's upper right corner and one in the power supply.

Our only complaint about the P.A.C. 486-25's expansion abilities is that our evaluation unit's case was too snug. It bowed the cards slightly, so that getting them in and out was tricky.

Storage

Just below the upper fan is a drive assembly that contains the Conner hard disk drive and a slim-line Toshiba floppy disk drive. A Chicony Electronics CH-101 I/O adapter controls the two drives. That card also provides two serial ports and one parallel port. If a 100-MB hard disk drive isn't big enough for you, Dolch also offers a 200-MB drive for $1995.

The BYTE Lab had some hard disk drive troubles: The first drive it received was bad, and the second produced intermittent read errors. We did not, however, experience those errors; the drive ran without any problems throughout our tests. A Dolch spokesperson attributed the trouble with the first drive to damage during shipping.

The rest of the system is pretty much the same as other Dolch portables. The 86-key detachable keyboard clips onto the front of the unit. It follows the original AT keyboard layout, with two exceptions: There are 12 function keys, not 10, and those keys are in a row across the top of the keyboard rather than in a cluster on the left side. The keyboard had a mechanical click that was a little tinny for our tastes.

The only standard software was a set of two disks of Paradise VGA utilities and the built-in Phoenix setup program. Dolch sells MS-DOS, but you have to install it yourself.

The documentation is among the worst that we've seen. The manual was obviously assembled from different pages of other Dolch manuals—some pages were numbered sequentially, some by chapter—and it contained many small inaccuracies. A separate motherboard manual was somewhat helpful, but Dolch should put more time into its documentation. A Dolch spokesperson said that the company was in the process of preparing new manuals.

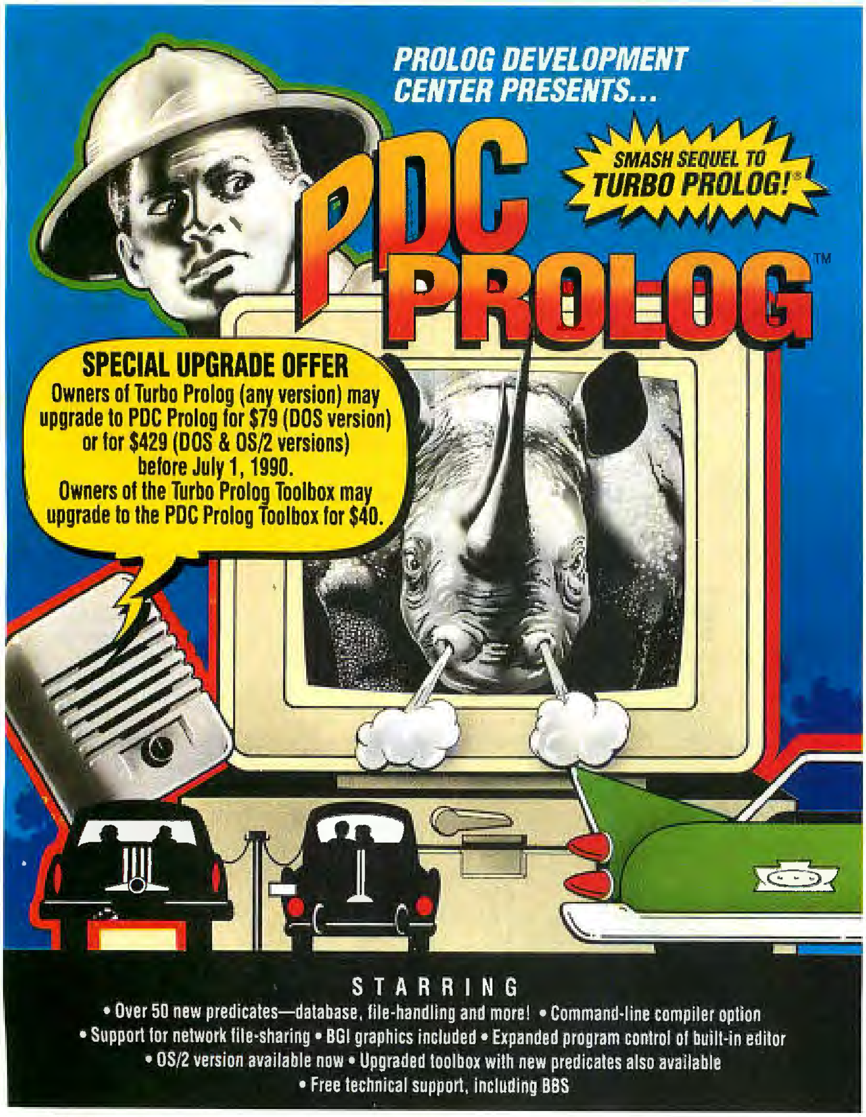
The Good and the Bad

On the support side, there's good news and bad news. The good news is a toll-free number for technical support and staff who know the system inside and out. The bad news is a standard one-year parts-and-labor warranty, under which you pay to ship the unit to Dolch for repair.

That warranty, like Dolch's software policies, was fine once, but not today. Vendors such as Dell, Austin, Gateway 2000, and PC Brand install DOS on the hard disk for you and provide a year of on-site service standard, even with their $2000 to $3000 clones. It's a shame that a company that's selling a system for $13,000 (or more) can't offer the same niceties.

The bottom line for the P.A.C. 486-25 is simple: It provides the best portable performance available, but at a very high price. If you need all that speed badly enough, and if you can afford the price, go for it. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.



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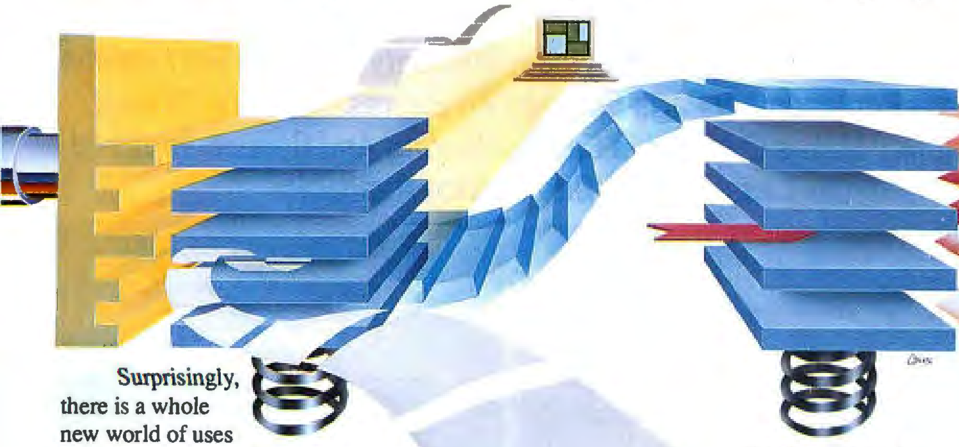

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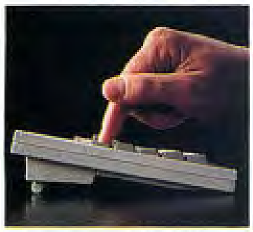

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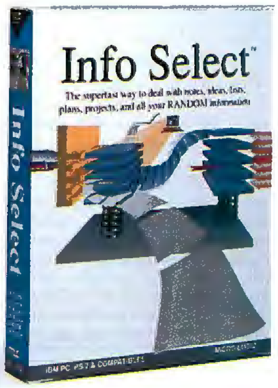

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BASIC OPERATION: You will see several windows of different sizes side-by-side on your screen. Info Select windows can hold: notes, plans, lists, facts, letters, contacts, and much more. You can: open a new window, type into it, and shape it; edit an existing window; resize, remove, or print a window; browse through windows with the arrow keys; search for a group of windows related by a word or phrase; hot-key between INFO SELECT and a wordprocessor or spreadsheet; and much more. **EASY POWERFUL FEATURES:** five ways to see overviews; hypertext; fast sort; line drawing; date tickler; dialer; searching by text or date ranges; add columns of numbers; 3-D wordprocessing; support of some commands of popular wordprocessors; can store data in EMS; template or free-form windows; import and export files, screens, and databases; move, join, and duplicate windows; efficient on portables; stand-alone or memory-resident; pull-across menus; and much more. Data is structured in multiple stacks of intelligent text windows; uses a unique easy powerful system of parallel text processing and progressive resolution searching without keywords. Version available with LAN file locking and sharing. **SPECIFICATIONS:** infobases up to 10 megabytes; text searches up to 700kb/sec; up to 32,000 characters per window; up to 64,000 windows per infobase; takes just 7K in swap mode; for the IBM PC/XT/AT/PS2 and true compatibles; not copy protected. **MAIL ORDERS:** Send name, address, phone number, and payment by check, Visa, or MC to address shown. Please include $3.50 shipping ($10 outside continental USA). 30 day money back guarantee. **TORNADO OWNERS:** INFO SELECT includes everything in Tornado and much more. Call today for our special limited time trade-up offer. **EUROPEAN CUSTOMERS:** Contact Atlantex U.S.A. (203) 655-6980. **TRADEMARKS:** Trademark (owner): Tornado and Info Select (Micro Logic), Agenda (Lotus Development), Sidekick (Borland International), Grandview (Symantec), IBM PC, XT, AT, PS/2 (IBM).

Four 386SXes to Go, Hold the AC

These 386SX laptops provide 386 power without the cord

David Claiborne

It's no longer sufficient for a laptop to be small and lightweight and operate on batteries for several hours. As laptops have become more sophisticated, so have their users, who increasingly expect support for VGA displays and the processing power to accommodate power-hungry 386-based desktop applications. The problem is that, traditionally, these features have been mutually exclusive. To attain small size and weight and also achieve long battery life, processing speed and crisp displays have often been compromised.

The introduction of a new class of battery-powered 386SX laptop computers has changed all that. These computers take advantage of the 386SX CPU's lower power requirements to provide 386 processing power without being tethered to an AC power cord. The newest 386SX laptops all feature VGA graphics with a good aspect ratio, a minimum of 1 megabyte of memory, and a 20- or 40-MB hard disk drive in a 15-pound clamshell package that runs for 1½ to 3 hours on a single battery charge.

I recently tested four of these machines: the Dell 316LT, Tandon LT/386, Toshiba T3100SX, and Zenith SupersPort SX. The BYTE Lab benchmarks revealed some performance differences, but all these machines performed well, and all were significantly faster than comparable 286 laptops. They were also compatible with a variety of application programs, including Microsoft Word

Clockwise from top: The Tandon LT/386, Toshiba T3100SX, Zenith SupersPort SX, and Dell 316LT.

5.0, Lotus 1-2-3 release 3.0, and Borland's Paradox 386. There were, however, some definite performance differences and cost/performance trade-offs.

Dell 316LT

The 316LT is Dell Computer's first laptop, and it's impressive. The base system includes 1 MB of RAM, a 3½-inch 1.44-MB floppy disk drive, and a 20-MB 27-millisecond hard disk drive for $3499. The 40-MB 25-ms hard disk drive in my review machine boosted the price by $300. Both hard disk drives are Conner Peripherals devices with an integrated device electronics (IDE) controller.

The 316LT sports attractive styling—something that's often absent in other machines. You'll find the on/off switch, reset button, and AC power jack on the left side of the unit, just under the keyboard. The battery pack slides in from the left side, just to the rear of the switches, and the floppy disk drive sits opposite the battery pack.

continued

	Dell 316LT	Tandon LT/386	Toshiba T3100SX
Company	Dell Computer Corp. 9505 Arboretum Blvd. Austin, TX 78759 (512) 338-4400	Tandon Computer Corp. 609 Science Dr. Moorpark, CA 93021 (805) 529-8227	Toshiba America Information Systems, Inc. Computer Systems Division 9740 Irvine Blvd. Irvine, CA 92718 (714) 583-3000
Components	**Processor:** 16-MHz 386SX **Memory:** 1 MB of RAM, expandable to 8 MB **Mass storage:** Internal 3½-inch 1.44-MB floppy disk drive; 40-MB 25-ms hard disk drive **Display:** 6- by 8-inch, 640- by 480-pixel VGA backlit LCD **Keyboard:** 83-key modified IBM Enhanced layout **I/O interfaces:** Serial, parallel, external analog VGA monitor, and keyboard ports; 8-bit half-card slot **Battery life (observed):** 1½ hours **Recharge time:** 2 hours	**Processor:** 16-MHz 386SX **Memory:** 1 MB of RAM, expandable to 5 MB **Mass storage:** Internal 3½-inch 1.44-MB floppy disk drive; 40-MB 25-ms hard disk drive **Display:** 6½- by 8½-inch, 640- by 480-pixel VGA backlit LCD **Keyboard:** 82-key modified IBM Enhanced layout **I/O interfaces:** Serial, parallel, and external analog VGA monitor, floppy disk drive, keyboard, and numeric keypad ports **Battery life (observed):** 3 hours **Recharge time:** 14 hours	**Processor:** 16-MHz 386SX **Memory:** 1 MB of RAM, expandable to 13 MB **Mass storage:** Internal 3½-inch 1.44-MB floppy disk drive; 40-MB 25-ms hard disk drive **Display:** 6- by 8-inch, 640- by 480-pixel VGA gas-plasma **Keyboard:** 86-key modified IBM Enhanced layout **I/O interfaces:** Serial (two), parallel, external analog VGA monitor, and numeric keypad ports; modem slot; proprietary expansion slot **Battery life (observed):** 3 hours (two batteries) **Recharge time (hours):** 3 hours (1½ hours per battery)
Size	3⅗ × 12⁷⁄₁₀ × 14³⁄₁₀ inches; 15⅕ pounds	3⅗ × 12⅗ by 13½ inches; 14⅗ pounds	3¹⁄₁₀ × 12⅕ × 14⅕ inches; 14⁹⁄₁₀ pounds
Price	Base system: $3499 As reviewed: $3799	$4429	$5999
	Inquiry 867.	**Inquiry 868.**	**Inquiry 869.**

The external connections are at the rear, hidden behind a plastic panel that slides away to reveal connectors for a parallel port, a serial port, an analog VGA monitor, and an external keyboard. Also present are a half-length 8-bit expansion card slot and two external connectors for unannounced options.

The 83-key keyboard offers an arrangement that's similar to the IBM Enhanced layout, except that the Control and Alt keys only appear on the left side of the keyboard. Laptop users should experience no problems switching between the 316LT and their desktop computer.

The display is a backlit LCD that uses black characters on a white screen and measures 6 by 8 inches. A Chips & Technologies video BIOS provides full VGA capability.

Getting inside the 316LT is a simple matter of removing nine screws on the bottom of the case. The interior reveals three unique features. One is the half-length expansion card slot. Another is a set of eight single in-line memory module sockets that you can fill with 1-MB SIMMs for a total of 8 MB of memory. The third feature of note is the nickel-cadmium battery, which is the smallest and lightest used by the machines reviewed: It weighs just 1⅔ pounds and measures 6 by 3⅕ by 1⅕ inches. (The Toshiba battery is actually lighter at 1½ pounds, but you need two of them.) It had a relatively short operating period of 90 minutes or less during testing. Most people will want a second battery. An internal backup battery powers the computer for up to 2 minutes, so you can swap in a freshly charged main battery without losing data.

You access Dell's ROM-based power management system by pressing the Ctrl/Alt/Insert keys. Options include shutting down the display and the hard disk drive during periods of extended inactivity, and disabling devices that you are not using, such as the serial and parallel ports, or a math coprocessor, if installed. Changes don't take effect until you reboot the computer.

The 316LT's bundled software consists of a tutorial and a few utilities—DOS isn't included. The utilities disk contains an extensive diagnostic program, an EMS 4.0–compatible expanded memory manager, and four utilities that adjust the display.

Since you can't take a Dell machine to a dealer (the company sells exclusively through mail order), Dell takes extra pains to make sure its documentation will help its customers install upgrades and fix problems. The company provides complete and explicit instructions for taking the 316LT apart, adding memory SIMMs, adding an expansion board, and even swapping out the hard disk drive. But the manual is in a three-ring, slipcased binder that's almost as large as the computer itself. Given that the 316LT is a portable computer, the manual should be portable, too.

Tandon LT/386

The Tandon LT/386 is the least attractive of the four units evaluated. The $4429 base machine includes 1 MB of RAM, a 3½-inch 1.44-MB floppy disk drive, and a 40-MB hard disk drive.

The unit's on/off switch is a standard rocker switch. Three external connectors (serial, parallel, and floppy disk drive port) are mounted on an exposed strip that's subject to damage during transit.

The 82-key keyboard layout is easy to use. It has Control and Alt keys on both sides of the keyboard and an Fn key at the lower left corner that invokes the Home,

Zenith SupersPort SX

Zenith Data Systems
1000 Milwaukee Ave.
Glenview, IL 60025
(800) 553-0331

Processor: 16-MHz 386SX
Memory: 1 MB of RAM, expandable to 8 MB
Mass storage: Internal 3½-inch 1.44-MB floppy disk drive; 40-MB 25-ms hard disk drive
Display: 6- by 8-inch, 640- by 480-pixel VGA fluorescent backlit LCD
Keyboard: 79-key modified IBM Enhanced layout
I/O interfaces: Serial, parallel, external analog VGA monitor, expansion chassis, and disk drive ports; modem slot
Battery life (observed): 3 hours
Recharge time: 3 hours

3⅗ × 12⅕ × 15⅗ inches;
16⁷⁄₁₀ pounds (with battery)

$5999

Inquiry 870.

PageDown, PageUp, and End functions. The 12 standard function keys are only half as high as the other keys, but I didn't find this to be a problem.

The Tandon display is the largest of the four, measuring 6½ by 8½ inches. The display, however, was one of the unit's weakest points. The hinge mechanism that lets you set the display to the optimum angle for the ambient light didn't work. Tandon says that this is not a problem with currently shipping machines. The screen is noticeably slower than the other LCDs; when I rapidly moved a mouse in Microsoft Word 5.0, the arrow indicator disappeared from the screen. But one nice feature of the display is the ability to toggle between black on white, white on black, and an external monitor.

Although Tandon, Dell, and Zenith all use the Conner Peripherals 40-MB hard disk drive, only Tandon optimized its BIOS to work with it. The resulting improvement in the drive's transfer rate didn't show up on BYTE's low-level disk benchmarks. But the LT/386 achieved impressive scores in disk-intensive application tests such as the dBASE III tests. In fact, the enhanced performance of the hard disk drive gave the Tandon the highest application index of the group.

Unlike Dell, Tandon doesn't want the user to open its computer. A proprietary slot is accessible by simply removing an external panel and sliding in a card. Tandon is developing a modem card and a card to link an expansion chassis to the LT/386. Neither was available at press time.

The Tandon system board accepts an 80387SX math coprocessor and an additional 4 MB of memory on two special memory cards. The instructions for adding a math coprocessor or extra memory are simple: "Contact your Tandon dealer for assistance." Despite this lack of direction, it is easy to open the unit and locate the empty socket for the coprocessor. But there's no mention of how to install the memory cards. Tandon says that it will include instructions in future revisions of the user's manual.

The Tandon battery is another weak link and demonstrates less engineering development than other laptop batteries. The nickel-cadmium battery floats loosely inside its storage cavity and rattles around when you move the computer. Tandon rates battery life at 3 hours, assuming no accessories and a 10 percent disk duty cycle. To conserve power, you can set the display and disk drive to turn off after a user-selectable time-out period ranging from a few seconds to 15 minutes. As with the Dell 316LT, the power management functions are in ROM. You access them by pressing Ctrl/Alt/Esc. The machine reboots itself upon exiting the setup program.

Like the other units, the LT/386 uses an external AC transformer, about the size of a small brick, to provide AC power and to recharge the battery. But where the other units recharge the battery pack in 2 to 3 hours, the LT/386 takes up to 14 hours. The time is even longer if you're using the computer during the recharge period.

The LT/386 comes with Tandon's version of MS-DOS 3.3. The standard software includes the Microsoft expanded-memory device driver for 386-equipped computers. There are no diagnostics or tutorial programs.

Documentation consists of a thin, wire-bound manual that covers both the LT/386 and the LT/286, and a DOS manual. The manual provides information on setting up the computer, a short overview of the DOS command structure, and a cursory guide to installing options.

Toshiba T3100SX

Toshiba's 386SX laptop breaks ground in several areas, maintaining Toshiba's position as a major innovator in the laptop field. The machine's biggest achievement is the low-power gas-plasma display that makes the technology feasible in a battery-operated laptop. Even with the low-power design, Toshiba had to make concessions elsewhere in the machine to obtain sufficient power for the display, but the screen is very sharp.

The basic configuration includes a 3½-inch 1.44-MB floppy disk drive, a 40-MB hard disk drive, and 1 MB of RAM. But the T3100SX can accept up to 13 MB of internal memory. The unit also includes dual nickel-cadmium batteries that power the machine for up to 3 hours and let you swap out a depleted battery with the power on.

The on/off switch is located on the right side, just behind the floppy disk drive. Located on the left side are openings for an optional internal modem, an optional numeric keypad, and a reset button. In the rear of the machine, the remaining external ports are tucked behind the carrying handle. These include two serial ports, a parallel port, and an RGB port for an external VGA monitor. The parallel port accommodates a printer or an external floppy disk drive. Toshiba also includes a proprietary 16-bit expansion slot.

The 86-key IBM Enhanced-style keyboard is well laid out. The Fn key toggles the computer speed, displays the battery monitor window, and invokes the numeric keypad overlay.

The gas-plasma screen is impressive. It measures 6 by 8 inches. This provides an ideal 4-to-3 aspect ratio for VGA. It's sharp enough and fast enough to use as your desktop display. The internal circuitry maps the VGA color palettes into 16 intensity levels. Using VHCAD, a Toshiba utility program, you can assign VGA colors to specific gray levels. The VHCAD program includes 10 preset combinations that have the gray scales already optimized for most applications. The screen is the slowest of the displays tested, but what it lacks in speed, it more than makes up for in clarity.

Toshiba compromised hard disk drive performance to get the power for the plasma display. The T3100SX uses a specially built hard disk drive with a slower than normal rotation speed to save power. The slower rotation speed doesn't slow the average access speed—the drive still performs at around 25 ms. But it does slow the transfer rate in BYTE's benchmark tests. In the 1-MB write/read tests, the hard disk drive is substantially slower than those of the other units.

continued

Tandon LT/386, Zenith SupersPort SX, Dell 316LT, Toshiba T3100SX

APPLICATION-LEVEL PERFORMANCE

WORD PROCESSING	Tandon	Zenith	Dell	Toshiba
XyWrite III+ 3.52	Med./Large	Med./Large	Med./Large	Med/Large
Load (large)	:10	:13	:14	:19
Word count	:04/:28	:04/:27	:04/:27	:04/:28
Search/replace	:07/:26	:07/:26	:07/:27	:07/:28
End of document	:02/:15	:02/:15	:02/:15	:02/:18
Block move	:16/:16	:14/:13	:14/:14	:11/:10
Spelling check	:11/1:24	:11/1:23	:11/1:24	:12/1:28
Microsoft Word 4.0				
Forward delete	:20	:19	:19	:19
Aldus PageMaker 1.0a				
Load document	:09	:09	:09	:13
Change/bold	:32	:33	:27	:37
Align right	:24	:24	:26	:28
Cut 10 pages	:23	:20	:30	:31
Place graphic	:06	:04	:05	:06
Print to file	2:02	2:14	2:16	2:43
Index:	**2.10**	**2.17**	**2.09**	**1.94**

SPREADSHEET	Tandon	Zenith	Dell	Toshiba
Lotus 1-2-3 2.01				
Block copy	:05	:05	:04	:05
Recalc	:02	:02	:02	:02
Load Monte Carlo	:18	:18	:18	:27
Recalc Monte Carlo	:09	:09	:09	:09
Load rlarge3	:05	:04	:05	:06
Recalc rlarge3	:02	:01	:02	:02
Recalc Goal-seek	:05	:05	:05	:05
Microsoft Excel 2.0				
Fill right	:07	:06	:06	:07
Undo fill	2:51	2:08	2:06	2:41
Recalc	:01	:02	:02	:01
Load rlarge3	:31	:25	:29	:35
Recalc rlarge3	:02	:02	:02	:02
Index:	**1.96**	**2.14**	**1.97**	**1.91**

DATABASE	Tandon	Zenith	Dell	Toshiba
dBASE III+ 1.1				
Copy	:36	:55	1:03	1:17
Index	:06	:06	:06	:29
List	1:33	1:11	1:09	1:34
Append	1:23	2:03	2:05	2:38
Delete	:02	:03	:04	:05
Pack	:55	1:35	1:36	2:09
Count	:04	:05	:05	:26
Sort	:33	:57	:58	1:52
Index:	**2.72**	**2.05**	**1.94**	**1.02**

SCIENTIFIC/ ENGINEERING	Tandon	Zenith	Dell	Toshiba
AutoCAD 2.52				
Load SoftWest	2:36	2:49	2:42	2:58
Regen SoftWest	2:24	2:39	2:31	2:53
Load StPauls	:46	:46	:46	:51
Regen StPauls	:41	:41	:42	:44
Hide/redraw	35:21	36:56	36:31	37:15
STATA 1.5				
Graphics	1:16	1:11	1:11	1:11
ANOVA	:49	:45	:46	:47
MathCAD 2.0				
IFS 800 pts.	1:27	1:27	1:30	1:35
FFT/IFFT 1024 pts.	1:45	1:44	1:48	1:53
Index:	**0.84**	**0.83**	**0.83**	**0.78**

COMPILERS	Tandon	Zenith	Dell	Toshiba
Microsoft C 5.0				
XLisp compile	4:38	4:43	5:03	5:41
Turbo Pascal 4.0				
Pascal S compile	:05	:05	:05	:07
Index:	**2.17**	**2.13**	**2.13**	**1.62**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT=1.

LOW-LEVEL PERFORMANCE[1]

CPU	Tandon	Zenith	Dell	Toshiba
Matrix	6.66	6.61	7.01	7.58
String Move				
Byte-wide	51.46	50.79	52.49	39.82
Word-wide:				
Odd-bnd.	42.73	42.13	46.23	44.71
Even-bnd.	25.76	25.40	26.27	19.94
Doubleword-wide:				
Odd-bnd.	27.79	27.44	29.77	29.93
Even-bnd.	19.44	17.24	21.37	19.88
Sieve	33.32	32.79	37.13	44.61
Sort	31.86	31.43	31.58	35.85
Index:	**1.90**	**1.93**	**1.82**	**1.88**

FLOATING POINT[2]	Tandon	Zenith	Dell	Toshiba
Math	N/A	N/A	N/A	N/A
Error				
Sine(*x*)	N/A	N/A	N/A	N/A
Error				
e^x	N/A	N/A	N/A	N/A
Error				
Index:	**N/A**	**N/A**	**N/A**	**N/A**

DISK I/O	Tandon	Zenith	Dell	Toshiba
Hard Seek[3]				
Outer track	3.34	3.32	3.37	5.08
Inner track	8.36	3.37	3.39	5.11
Half platter	8.42	8.39	8.02	10.29
Full platter	11.79	10.02	10.98	10.29
Average	7.98	6.28	6.44	7.69
DOS Seek				
1-sector	14.97	12.71	12.81	12.26
32-sector	37.66	23.70	24.76	36.96
File I/O[4]				
Seek	0.18	0.07	0.10	0.05
Read	0.55	0.56	0.56	1.44
Write	0.84	1.00	0.92	1.36
1-megabyte				
Write	3.19	3.59	3.29	5.20
Read	3.06	3.06	3.08	7.06
Index:	**1.76**	**2.12**	**2.05**	**1.50**

VIDEO	Tandon	Zenith	Dell	Toshiba
Text				
Mode 0	5.95	5.11	5.09	5.64
Mode 1	5.93	5.11	5.06	5.64
Mode 2	6.59	5.24	5.27	5.59
Mode 3	6.57	5.25	5.27	5.58
Mode 7	N/A	N/A	N/A	N/A
Graphics				
CGA:				
Mode 4	2.49	2.44	2.60	2.67
Mode 5	2.53	2.41	2.60	2.68
Mode 6	2.80	2.71	2.86	2.86
EGA:				
Mode 13	4.56	3.86	4.06	4.74
Mode 14	5.22	4.50	4.67	5.17
Mode 15	N/A	N/A	N/A	N/A
Mode 16	5.22	4.46	4.67	5.17
VGA:				
Mode 18	5.44	4.69	4.89	5.40
Mode 19	2.76	2.91	2.86	2.91
Hercules	N/A	N/A	N/A	N/A
Index:	**1.56**	**1.81**	**1.77**	**1.63**

CONVENTIONAL BENCHMARKS	Tandon	Zenith	Dell	Toshiba
LINPACK	2942.79	2901.44	2991.52	3123.28
Livermore Loops[5]				
(MFLOPS)	0.0069	0.0069	0.0072	0.0068
Dhrystone (MS C 5.0)				
(Dhry./sec.)	3475	3840	3501	3410

N/A = Not applicable.

[1] All times are in seconds. Figures were generated using the 8088/8086 and 386 versions (1.1) of Small-C.

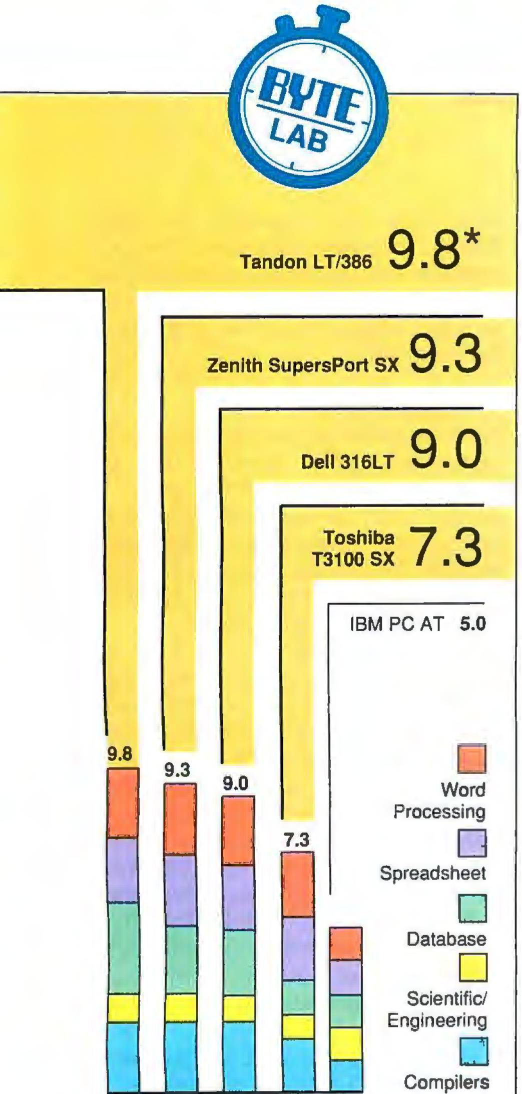
[2] The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

[3] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

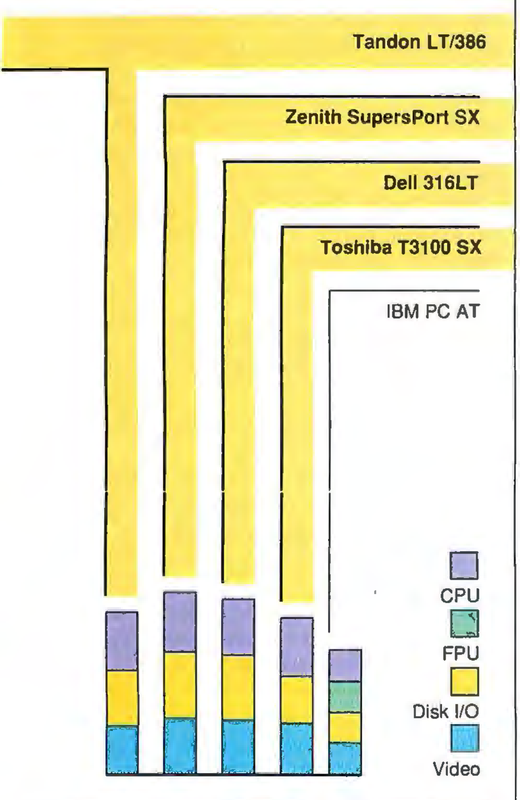
[4] Read and write times for File I/O are in seconds per 64K bytes.

[5] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.



*Cumulative application index. Graphs are based on indexes at left and show relative performance.



Toshiba's laptop experience is most evident in its power management system. First there are the dual battery packs. When one battery is depleted, the unit automatically switches to the second battery. Built-in charging circuitry indicates when a battery is being charged or is fully charged. The usual device power time-out and deactivation controls are activated from a ROM-based setup program that implements changes without requiring a system reboot. The auto-resume feature lets you turn off the computer while running an application and then resume at the same point when you turn the machine on again. Each battery is good for about 90 minutes, yielding a total of 3 hours of running time. Recharge time is about 3 hours for both batteries, assuming that the machine is turned off.

Toshiba includes an extensive amount of software with the T3100SX. Microsoft DOS 4.01 is standard, as are Quarterdeck's QEMM, an expanded-memory manager for the 386SX, and PC-Kwik Power Pak, which includes a disk cache, a print spooler, a RAM disk, and screen and keyboard accelerators. Also included is an on-line hypertext manual that covers both MS-DOS 4.01 and the T3100SX itself.

Written documentation includes a detailed manual that makes use of screen images, color photographs, and line drawings; two DOS manuals; and two small operation guides.

While Dell and Tandon were still planning accessories at press time, Toshiba supplies a wide range of options for the T3100SX, including an external battery charger ($399) that holds up to three battery packs, an external keypad ($99), an expansion chassis with five IBM PC-compatible slots ($999), and an Ethernet card ($699).

Zenith SupersPort SX

Zenith, a longtime player in the laptop field, has also developed a steady stream of innovative laptops. The SupersPort SX carries on the tradition. The unit borrows a great deal from its predecessors, but it improves performance substantially with the 386SX processor. The base configuration and price are the same as the Toshiba's.

The SupersPort SX uses the standard Zenith battery pack that attaches to the rear of the unit. This gives the SupersPort the ability to operate without its battery. If you're going to be near a power source, you can leave the battery pack at home, shedding 5 pounds and 3

continued

inches of depth from the machine's dimensions. When connected to the AC adapter/charger, the battery recharges in 3 hours. Extra batteries are $289 each.

The on/off switch, external keyboard socket, and floppy disk drive are located on the right side of the unit. The left side has an opening for a 1200-bps ($299) or 2400-bps ($499) internal modem. A sliding plastic panel at the rear of the unit protects a serial port, a parallel port, an analog VGA monitor port, an expansion chassis connector (a three-slot expansion box is $499), and an external floppy disk drive interface. Only the serial and parallel ports are accessible when the battery pack is attached.

The 79-key keyboard is the weakest part of the SupersPort SX. The key arrangement makes the transition from laptop to desktop difficult. The most serious offenders are the Escape key, located below the F1 key rather than in the top left corner, the backslash key, located to the right of the Enter key, and the Insert and Delete keys, located in the top right corner. To use F11 and F12, you must press Fn/F1 and Fn/F2, respectively. The SupersPort's display is a fluorescent backlit, VGA-compatible LCD with 640- by 480-pixel resolution and a 6- by 8-inch screen.

The SupersPort's display is noticeably faster than the Tandon's, but it isn't as clear as the Dell's. Like Tandon, Zenith doesn't want users opening up its machine. The company provides access to the math coprocessor, ROM BIOS, backup battery, and modem via a series of hatches and access panels on the bottom of the computer. Installing additional memory, however, requires removing the cover. Here Zenith provides no instructions, except to refer you to an "approved service center."

The unit's 5-pound battery provides up to 3 hours of operation, provided you use power judiciously. Power management on the SupersPort lets you shut down various system components when they aren't needed. The setup program is part of a ROM-resident monitor program, invoked by pressing Ctrl/Alt/Insert. The setup program features three screens, each containing a different configuration for battery operation, AC operation, and AC operation with an expansion chassis. The setup program can disable the modem, change the computer operating speed, and set time-out periods for the display and hard disk drive. The system reboots whenever changes are made.

Zenith includes MS-DOS 3.3. The ROM-resident monitor program contains both setup and diagnostics functions. The documentation is sparse. Two DOS manuals are complete, but the documentation supplied on the SupersPort itself provides details on only the externals of the computer.

The Right Choice

All four machines present price/performance trade-offs. Choosing the right machine depends on your needs. In terms of cost, the computers are grouped much more tightly than the list prices indicate. Dealer discounts usually shave 20 percent to 30 percent or more off the Zenith, Toshiba, and Tandon units.

Performance-wise, no machine has the best of everything. The Dell 316LT offers the easy memory expansion and a crisp paper-white LCD, but its performance was middle-of-the-road, and its battery life should be longer. The Tandon LT/386 took top honors on the application index, due in large part to the close integration of its hard disk drive, but its overall construction leaves much to be desired. Also, both Dell and Tandon are planning, but didn't yet have, internal modems available. Toshiba and Zenith have modems available for their laptops.

If detailed graphics are a requirement, the Toshiba T3100SX eliminates the competition with its gas-plasma display. The graphics come at the cost of a slower disk drive, as well as the slower video performance that gave the system the lowest application index of the four machines. But the T3100SX has many innovations, particularly in the area of power management, to recommend it as the top choice.

The Zenith SupersPort SX achieved the highest marks in terms of raw CPU, disk I/O, and video performance. The SupersPort suffers, however, from a nontraditional keyboard arrangement, and, at 16⁷⁄₁₀ pounds with the battery attached, it's almost 2 pounds heavier than the Toshiba.

The Toshiba T3100SX is my choice. The display is delightful to work with. If you're going to use CAD applications, desktop publishing, or anything else that requires a crisp display, the Toshiba is the top pick. If top screen quality is not a hard requirement, I'd choose the Dell 316LT. It has several unique design features, and it provides above-average performance at below-average price. ■

David Claiborne is a computer consultant and freelance writer based in Highland, Maryland. He can be reached on BIX c/o "editors."

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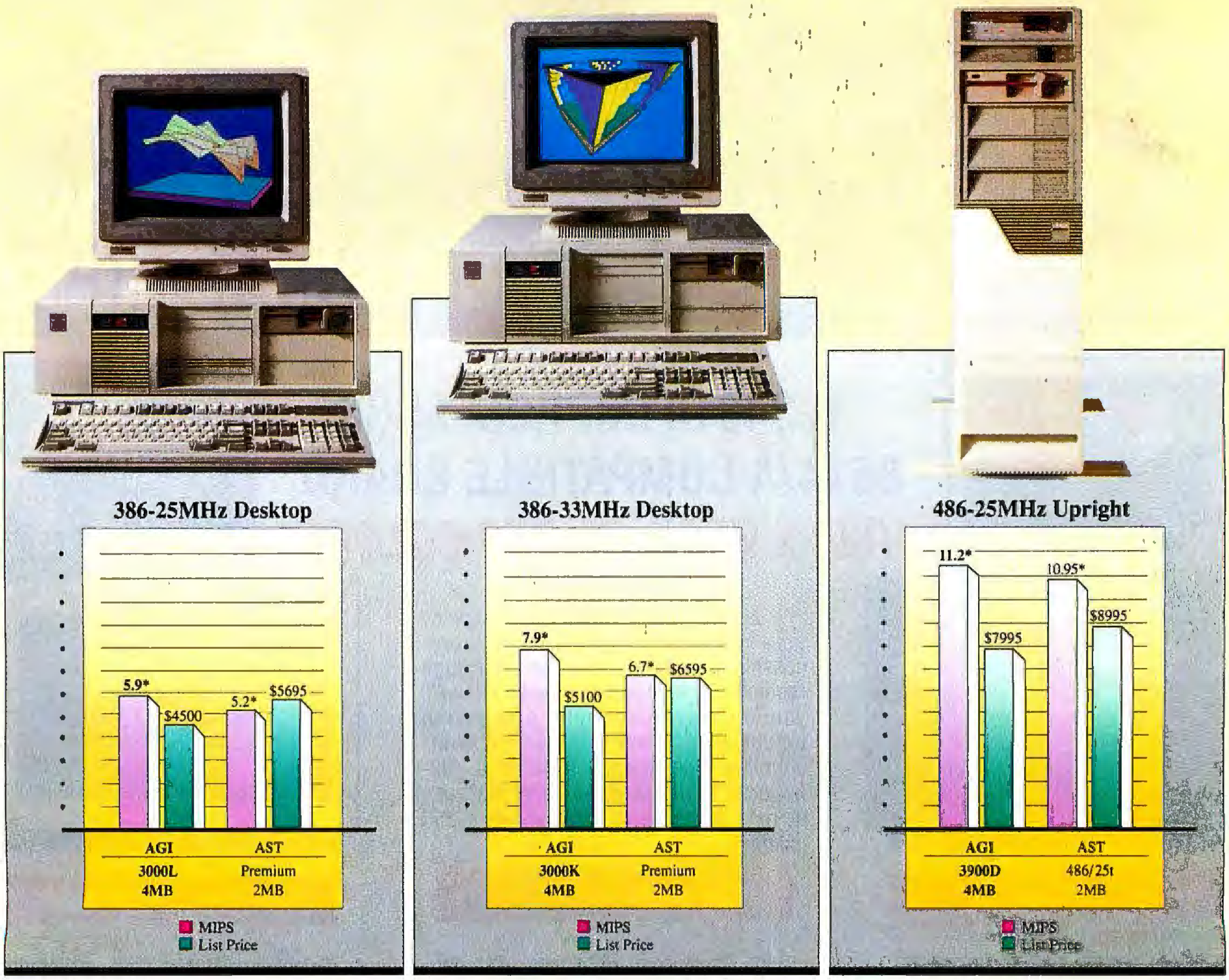

Sources: * Power Meter MIPs Version 1.5, The Database Group, Inc.

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Tom Yager

At $18,995, the Opus 8140-PM tower gives software developers and workstation users a bargain in high-end performance.

Power. The lust for it is pervasive not only on Capitol Hill, but on the desks of users and developers as well. Ever since the introduction of the first PC, the word heard most often from computer users has been *more*.

The truly power-hungry have a friend in Opus Systems, which has introduced the Personal Mainframes. These machines consist of a Motorola 88000 RISC coprocessor card sitting in the expansion slot of a 16-bit IBM AT clone. PMs (eight models were available at the time of this writing) integrate easily into the PC world, with the most unusual construction I've ever seen in Unix machines.

What really surprised me is that these are relatively inexpensive machines—the portable version is base priced at $13,995. [Editor's note: *This low-cost portable system, the 8110-PM, was evaluated in a January Short Take and was later obtained for benchmarking. The benchmark table on page 171 lists the test results for a 20-MHz system with 8 megabytes of memory.*] They turned in BYTE benchmark figures significantly higher than those of systems costing much more, delivering what appears to be the best performance for the money.

Unix Veteran

Opus has been in the Unix business for quite a while and has always emphasized both performance and ease of integration. As for the latter, Opus may have the market cornered. Everything that it sells starts with an Industry Standard Architecture-bus coprocessor card. These cards offer incredible capabilities to those who have a spare 16-bit slot in their system. CPU, memory, and FPU are all on the card, and the host processor (286, 386, or i486) remains on the motherboard where it belongs, unaware of the coprocessor until it's told of it.

My review system, the 8140-PM, arrived with a 25-MHz 88000 CPU, instruction and data caches, and 16 MB of 32-bit memory. A 20-MHz 386 acted as the I/O server. A 330-MB ESDI hard disk drive and controller, a 150-MB cartridge tape drive, and an Artist TI12 graphics coprocessor card rounded out the system. As the review unit included nearly all the options offered by Opus, I could exploit the system to the fullest.

The coprocessor card, the hardware star of the show, is an engineering marvel. The combination of main board and daughtercard can accommodate up to 24 MB of memory. As shown in the photo on page 170, the 88000 RISC processor is not one chip, but three in this configuration. The 88100 chip is the CPU, containing integer and floating-point circuitry, while a pair of 88200 memory management unit chips handles memory addressing and the dual caches. Power is drawn from the 16-bit connector; it is

continued

Personal Mainframe Model 8140-PM

Company
Opus Systems
20863 Stevens Creek Blvd.
Building 400
Cupertino, CA 95014
(408) 446-2110

Components
Processors: 25-MHz 88000; 20-MHz 386
Memory: 16 MB for the 88000; 4 MB for the 386
Mass storage: 330-MB ESDI hard disk drive, 1.44-MB floppy disk drive, 150-MB cartridge tape drive
Display: 1280- by 1024-pixel, 19-inch analog color display; intelligent graphics coprocessor
Keyboard: 101-key PC compatible
I/O interfaces: Two serial ports; one parallel port; game port; video port; Ethernet port; 12 ISA bus slots

Price
Base system: $18,995
System as reviewed: $25,190

Inquiry 871.

also through this channel that all data flows to and from the I/O processor.

Getting It off the Ground

Configuring the PM is easy—you don't. The system arrived fully configured, with every option tested and working. When a power glitch or similar problem caused the system to fail to boot, I called Opus's technical-support department. An individual who clearly knew her way around the system walked me through reinstalling and restoring my backup tape and helped me determine that the problem was a transient one. Opus's technical support impressed me greatly.

There's more going on than meets the eye with Opus's Unix implementation. The heart of the I/O server is Opmon, Opus's DOS-based I/O monitor program, which handles the communication between the Intel host processor and the 88000 CPU. It also routes all I/O requests to the appropriate devices. Typing `unix` loads Opmon and instructs the PM card to test itself. Opmon then uploads the Unix operating-system kernel to the board from a DOS file. If the upload is successful, Unix takes control.

Once Unix starts running, the Intel processor keeps chugging away, looping through the Opmon program and waiting for I/O requests from the 88000. A DOS file that Opmon reads at start-up maintains the machine's hardware configuration. Changing the Unix configuration rarely requires relinking the Unix kernel, because Opus has compiled in support for all Opmon-supported devices.

Smooth Operator

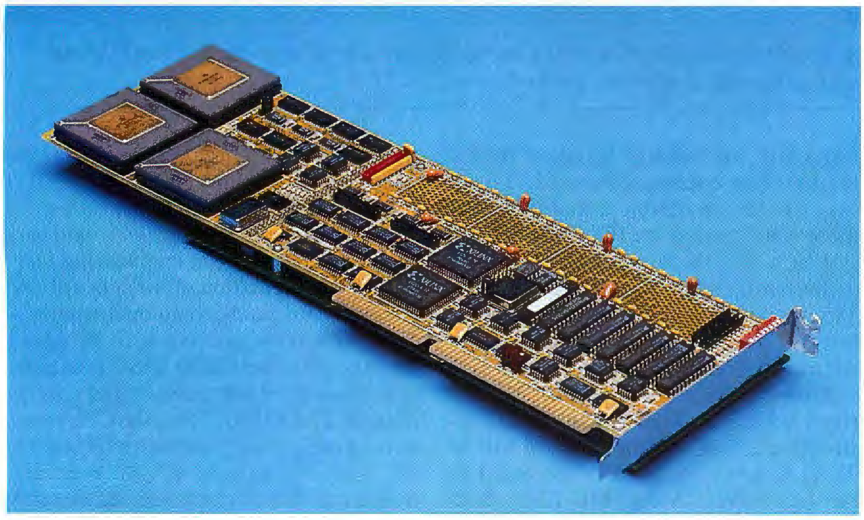
As precarious as it seems, all these layers work together smoothly. Opus loaded the 8140-PM with a hard disk drive, a tape drive, serial and parallel interfaces, a mouse, an Ethernet adapter, and a graphics coprocessor. Under a normal load, the 386 juggled the I/O requests admirably. But once I ran tests intended to strain the I/O subsystem, degradation came swiftly and severely. (See "The BYTE Unix Benchmarks," March BYTE.)

The most serious bottleneck resulted when the X Window System ran while some I/O-intensive task worked in the background. When I accessed the floppy disk drive or tape drive, response time in X Window System fell to a disturbing low. The problem was DOS. Its single-threaded nature does not suit it to I/O serving. It's a feat that Opus's engineers were able to pull as much performance out of DOS as they did.

The worst problem with I/O was that at times the system seemed to freeze completely. The tape drive is the worst culprit, forcing the rule of thumb that backups and restores be performed while in single-user mode. It's simply impossible to get anything else done while the tape is spinning, and the floppy disk drive has a similar impact on performance.

There can also be momentary pauses in character output when large amounts of cached data are written to disk, but some simple tuning of the Opus Unix kernel keeps this from getting in the way. I look forward to Extended Industry Standard Architecture- or Micro Channel architecture-bus implementations of the Opus cards, and perhaps an OS/2 (or even Unix) I/O server implementation, so multiple I/O channels can be managed more effectively.

The I/O layers are a great convenience, allowing DOS and Unix to share devices without hassle. The Unix system can use a separate disk partition for its data, but it can also build a file system in a DOS file, so you can run both DOS and Unix on the same disk without repartitioning. Unix uses the host system's DOS BIOS for all disk accesses, so virtually any disk drive controller that works with DOS will run with Unix, even if a DOS device driver is required.



The Opus 88000 coprocessor card. The three large, brass-centered chips are the 88100 CPU and the dual 88200 cache/memory management units.

Trolling Through Unix

Opus's implementation of Unix, referred to as Opus 5, is solidly built and performs remarkably well. Those accustomed (as I am) to running Unix on 386 systems will be pleasantly surprised by the quality and speed of Opus 5. I'm irked that Opus, like so many other companies, chose to make Unix documentation an option, but any AT&T or Prentice-Hall documentation covering System V release 3.1 will suffice. Opus plans to have release 3.2 available by the time this review appears in print, and work on System V release 4 is also under way.

In addition to the traditional System V commands and utilities, Opus provides a smattering of BSD Unix enhancements. The C shell is there, of course, but the real prize is the Berkeley socket library. This set of functions handles interpro-

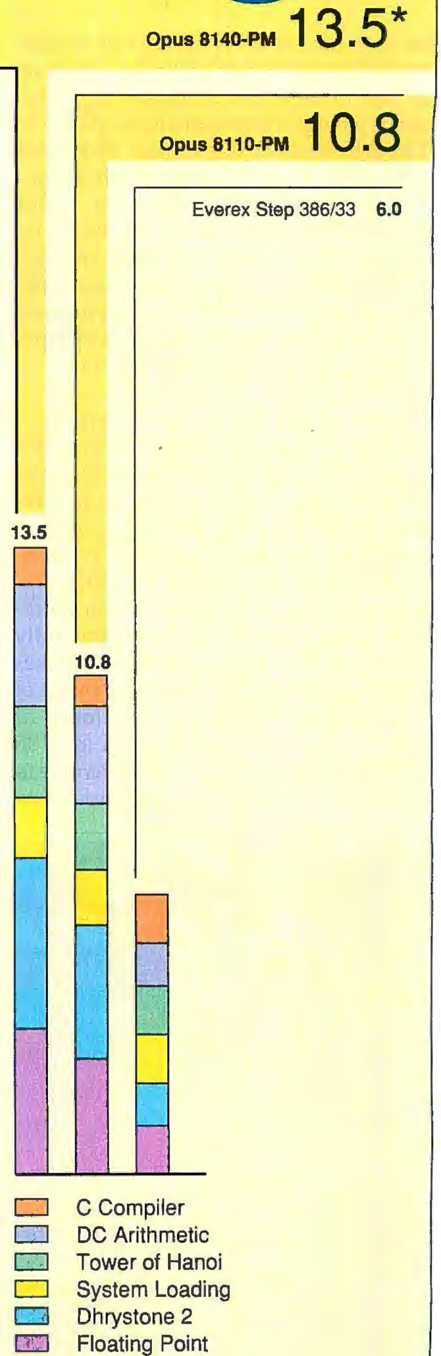
Opus 8140-PM, 8110-PM

HIGH-LEVEL PERFORMANCE

	Opus 8140-PM		Opus 8110-PM		Everex
	Time	**Index**	**Time**	**Index**	**Time**
C Compiler	2.50	0.83	3.33	0.62	2.08
DC Arithmetic	0.25	2.52	0.30	2.10	0.63
Tower of Hanoi (17-disk problem)	0.28	2.00	0.37	1.51	0.56
System Loading[1]					
1 concurrent background process	1.93	2.10	2.33	1.74	4.06
2 concurrent background processes	3.27	1.77	4.17	1.39	5.80
4 concurrent background processes	6.27	1.53	8.07	1.19	9.60
8 concurrent background processes	12.57	1.38	16.00	1.08	17.30

LOW-LEVEL PERFORMANCE

	Opus 8140-PM		Opus 8110-PM		Everex
	Time	**Index**	**Time**	**Index**	**Time**
Dhrystone 2 (without registers; Dhry./sec.)	50,385	3.64	41,218	2.98	13,487
Arithmetic (10,000 iterations)					
Arithmetic overhead	0.15	4.80	0.20	3.60	0.72
Register	1.95	1.50	2.48	1.18	2.92
Short	2.00	1.76	2.50	1.41	3.52
Integer	1.95	1.60	2.45	1.27	3.12
Long	1.93	1.62	2.48	1.26	3.12
Floating Point	3.83	3.11	4.80	2.48	11.92
Double	3.52	3.76	4.47	2.96	13.22
Throughput					
System call overhead (5 x 4000 calls)	1.98	0.56	2.57	0.43	1.10
Pipe throughput (read and write 2048- ×512-byte blocks)	1.40	0.66	1.80	0.51	0.92
Pipe-based context switching (2 × 500 switches)	0.80	0.79	1.02	0.62	0.63
Process creation (100 forks)	1.40	0.88	1.90	0.65	1.23
Excel throughput (100 execs)	2.07	1.66	2.67	1.28	3.43



Note: All results are in seconds, unless otherwise specified. Indexes show relative performance. For all indexes, an Everex Step 386/33 running Xenix 2.3.1 = 1.

[1] System loading was performed using Bourne shell scripts and Unix utilities.

* Cumulative index is formed by summing the indexed performance results for C Compiler, DC Arithmetic, Tower of Hanoi, System Loading (with eight concurrent background processes), Dhrystone 2, and Floating Point tests.

cess communications between processes not only on the host system, but also across network connections.

Once you start working with the PM, you quickly see that it's tuned for software development. The socket library could have been left out with no impact to users, but developers will find it a boon. Two other extras are of particular interest to this crowd: The DOS interface library, and the Diab C compiler.

The DOS interface library provides functions for transferring data to and from DOS media, as well as routines that manage communications between Unix and DOS. Surprisingly, the library also includes a facility for executing DOS commands while Unix is still running. This interface exists on the command line, too. When you invoke it, the interface either executes a single DOS command and returns to Unix, or calls up a command shell and executes interactively until you enter `exit`.

Opmon is large, so any DOS program invoked via this method will have to fit into 256K bytes or so. If your host system has enough memory, it's possible to have a full 640K bytes available through the use of IGC's VM/386 multitasking software. This works well enough, but most of Opus's disk I/O optimizations are lost when VM/386 is used. Normally, a DOS session suspends Unix, but there is an option to run DOS commands concurrently as well.

Typically, System V implementations use AT&T's Portable C Compiler. While it is competent for most applications development, it lacks the low-level, CPU-specific optimizations that can crank up

continued

performance-intensive programs to their peak. Opus responds to this by including an optimized RISC compiler from Diab that is a plug-in replacement for AT&T's. The difference is staggering: Dhrystone 2.0 numbers nearly doubled when optimized through the Diab compiler. Is this cheating? Hardly. Most compilers, including AT&T's, produce code intended for traditional complex-instruction-set-computer (CISC) CPUs. It's appropriate to have a compiler that is aware of pipelines and other RISC-specific traits.

Throwing the Workstation Switch

My review system included a graphics coprocessor card from Control Systems. To accompany it, Opus offers an X Window System port from Age, which uploads to the graphics card and runs native on the Texas Instruments 34010 processor. The Age software was in prerelease when I reviewed it, but it generally performed well. The zippy 88000 makes short work of the enormous overhead of X11 and OSF/Motif (a prerelease of which was also included), even at 1280 by 1024 pixels in 256 colors. I was able to open new windows—even the notoriously sluggish `xterm`—more quickly than under any other X11 release 3 implementation I've seen.

The Age X11 port shows its power in drawing graphics, too. The X11.3's Achilles' heels, unfilled arcs and wide lines, popped onto the screen, and the Age port computes and displays full 256-color scanned images with rare speed.

I could have spent hours playing with `xgif`, a public domain image-display utility. Its best feature is the ability to adjust the size of an image when the window containing it is resized. This generally takes some time, but on the Opus system, most pictures simply snapped back into the resized window as soon as its new size was established.

Trail Blazer

The Opus PM series is a well-conceived, well-executed solution to the lack of affordable high-performance systems. The PM's ability to integrate into existing DOS-based systems extends the useful life of those machines, and Opus's preconfigured systems are both functional and reasonably priced. With growing interest in Unix, systems like these are finding their way into places that, until recently, would have seemed unfit for such complex and capable computers. Opus has blazed a trail.

Opus subscribes to 88/Open, an organization that certifies that applications written to its specifications will run on any 88000-based machine. The 88000 is gaining ground, backed by an aggressive campaign by Motorola, and Opus provides a path by which even small developers can cash in on the future of RISC.

The cost of Opus's innovative design is I/O performance, but that doesn't diminish the value of the system. While the I/O bottleneck precludes the PM from acting as any but an informal file server, it is impressive as a stand-alone system.

For software developers and workstation users, this system is a bargain and must be considered seriously against anything the "big boys" have to offer in the same price range. Things may change, but for now, the Opus PM is a best buy for those who need big-iron performance. ■

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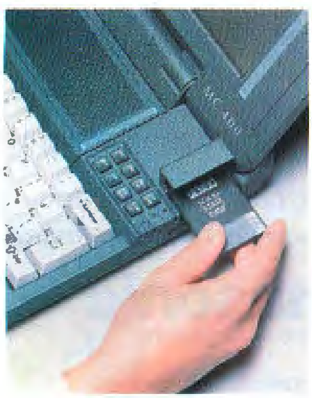

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More Than Upside-Down Mice

Five new trackballs vie for the attention of die-hard mousers

Bradley Dyck Kliewer

Five new trackballs (clockwise from lower left): the Mouse Systems PC Trackball, MicroSpeed PC-Trac, Logitech TrackMan, CH Products RollerMouse, and Kensington Expert Mouse.

A mouse that's lying still and on its back may be one of two things: a late rodent or, if it's connected to a computer, a trackball. But despite the popular description of a trackball as an upside-down mouse, substantial differences exist in the designs and uses of the two pointing devices.

New trackballs have recently hit the market with sleek designs that capitalize on those differences. I'll evaluate five of these mouse alternatives: the CH Products RollerMouse, Kensington Expert Mouse, Logitech TrackMan, MicroSpeed PC-Trac, and Mouse Systems PC Trackball.

Trackball Basics

Both mice and trackballs use a ball to move a cursor, but you move the entire mouse to indirectly move the ball, while with the trackball, you move only the ball. In theory, trackballs should be more comfortable to use because your arm doesn't need to move as you move the cursor. In addition, a mouse requires a clear area on the desk on which to roam; a trackball remains stationary. But most trackballs are much larger than mice, and the footprint of the larger trackballs roughly matches the clear area required by a mouse. Also, I slide my mouse out of the way when not in use; the trackballs' rubber feet kept them from easily sliding out of the operating area.

All the reviewed trackballs use opto-mechanical sensors. That is, the external ball rolls against two internal sensing rollers: one mounted to sense horizontal movement and one mounted for vertical movement. The rollers, in turn, connect to a slotted or striped wheel, which opens or breaks two paths of light between LEDs and detectors. The roller mechanism is one of the most important factors in overall trackball performance, because a bad design can lead to rough action or slippage between the ball and rollers. In the latter case, the cursor's movement may be halting or jumpy. My test group showed differences in roller size, materials, and placement; thus, some trackballs performed better than others where these areas were concerned.

Also important are the number and placement of buttons, which let you highlight text, select a menu item, and perform other tasks. In this regard, I noted some marked differences between trackballs and the mouse, and even among the individual trackballs. I found click-and-drag operations particularly awkward with a trackball. I'm obviously not alone in this opinion—most of the trackballs included some button-locking method. A few trackballs have one or two extra buttons for activating the lock, a feature I prefer. Button placement is important and one of the key areas that vendors use to distinguish products, but it's not an overriding factor: The trackball I liked best overall (the Mouse Systems PC Trackball) had the button placement I liked least.

Trackball resolution, usually rated in dots per inch, expresses the ratio of ball size to roller size and the number of slots in the wheel, which determines the number of on/off cycles per inch of movement. The higher the dpi, the less movement that's required to move the cursor. With the exception of the 300-dpi Logitech TrackMan, all the trackballs offered about 100 dpi at the detection level. However, the 100-dpi trackballs convert the signals to 200 dpi for compatibility

continued

	RollerMouse	Expert Mouse	TrackMan
Company	CH Products 970 Park Center Dr. Vista, CA 92083 (619) 598-2518	Kensington Microware, Ltd. 251 Park Ave. S New York, NY 10010 (800) 535-4242 (212) 475-5200	Logitech, Inc. 6505 Kaiser Dr. Fremont, CA 94555 (415) 795-8500
Footprint	5 × 5 inches	4½ × 5½ inches	5⅜ × 4¼ inches
Hardware Needed	IBM XT, AT, or PS/2; Apple II or Macintosh; one disk drive; serial port (9-pin or 25-pin)	IBM PS/2 or compatible with pointing device port; 3½- or 5¼-inch disk drive	IBM PC, XT, AT, PS/2 (with available 9-pin or 25-pin RS-232C serial port), or compatible
Software Needed	DOS 2.0 or higher	DOS 3.0 or higher	DOS 2.1 or higher
Price	IBM XT, AT, and PS/2 model: $129.95 Apple II and Macintosh model: $119.95 PC bus model: $149.95	$169.95	Serial version: $139 Bus version: $149
	Inquiry 862.	**Inquiry 863.**	**Inquiry 864.**

with standard mouse drivers.

A trackball's driver software may modify the movement signal before it reports the results to the application. These modifications are known as *sensitivity*, *acceleration*, and *ballistics*. Basically, the driver software watches the signals coming from the trackball, and as the speed of movement increases, the driver may exaggerate the effect. This allows the cursor to cover large portions of the screen in a single, short, high-speed burst from your fingers. When you slow down, the driver returns to dot-per-pixel operation, or it may even drop signals to allow more detailed work.

If you will be using a trackball extensively, look for one that lets you tailor the acceleration curves. The process can be rather involved, but in the end your daily work will be more comfortable.

Test Track

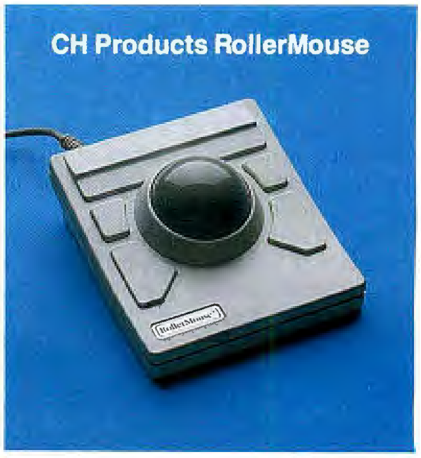
Trackball "feel" is difficult to quantify. Our physical traits affect our opinions. In my case, I'm right-handed and have larger-than-average hands. I'm also accustomed to the mouse; I've been using one for six years.

Four of my test trackballs used a serial port connection; the Kensington Expert Mouse used the PS/2 mouse port. I ran most of the serial trackball tests on an IBM AT with an Inboard 386, 6.5 megabytes of RAM, and a VGA display adapter. For the Kensington Expert Mouse and for the serial AutoCAD tests, I used an IBM PS/2 Model 80-111 with 4 MB of memory and an 8514/A high-resolution graphics coprocessor. The AutoCAD tests ran on the 8514/A at 1024- by 768-pixel resolution. All other tests ran on the VGA display.

Software tests included AutoCAD release 10, Lotus 1-2-3 release 2.2, Lotus Symphony 1.2, Microsoft Word 5.0, OS/2 1.1 Presentation Manager, Microsoft Paint, and Microsoft Windows/386. I tried Aldus PageMaker 3.0 and Microsoft Excel under Windows. The trackballs passed all tests, with a few problems that I've noted in the individual reviews below.

I used Lotus 1-2-3 and Symphony to test the mouse shells, programs that allow trackballs to operate with character-mode-based applications that do not support mice. With the Windows applications, I tested general pointing, highlighting, and click-and-drag operations. The tutorial lessons in AutoCAD helped me develop a general feel for the trackballs. Microsoft Word was useful for button combinations, and it gave me a chance to try operations I've been using regularly for years. Paint gave me a feel for freehand drawing and cursor precision; the major test here was writing my name.

When I was not satisfied with a trackball's performance under a particular application, I adjusted the acceleration curve until I found the combination that felt best.



- **Roller mechanism among the smoothest**
- **Best button design and placement**
- **Independent horizontal and vertical sensitivity adjustment**
- **Primitive Lotus 1-2-3 shell**

Under Paint, the RollerMouse created somewhat rough characters with a slight staircase effect. This was probably due to uneven 100- to 200-dpi translation rather than to ball slippage, which I did not notice. The RollerMouse felt smooth and silky and was quieter than the other trackballs. The 2⅓-inch-diameter ball was among the largest tested and, as a result, among the most comfortable to use.

I preferred the RollerMouse button placement and operation (four buttons in

PC-Trac	PC Trackball
MicroSpeed, Inc. 44000 Old Warm Springs Blvd. Fremont, CA 94538 (415) 490-1403	Mouse Systems Corp. 47505 Seabridge Dr. Fremont, CA 94538 (415) 656-1117
3⅞ × 7 inches	3⅞ × 5½ inches
IBM PC, XT, AT, or PS/2 (with either serial, bus, PS/2, or In Port interface)	IBM PC, XT, or AT (with available 9-pin or 25-pin RS-232C serial port)—Mouse Systems plans PS/2 mouse connector version; EGA or VGA card for Presentation Magician (software included with the trackball)
DOS 2.0 or higher	DOS 2.1 or higher
Serial, PS/2, and In Port model: $119 Bus model: $139	$119
Inquiry 865.	**Inquiry 866.**

all, two on the left and two on the right) to those of the other trackballs, with the possible exception of the MicroSpeed PC-Trac's. The RollerMouse's upper buttons provide a click-lock, while the lower ones act as conventional buttons. The left and right button signals can be swapped via a switch setting on the bottom of the unit.

The RollerMouse produced garbage on the screen when I ran Word 5.0. Sometimes, the cursor masked screen characters or changed colors. The problem disappeared when I used the mouse driver included with Word 5.0.

With the RollerMouse, you can independently adjust horizontal and vertical sensitivity on a scale from 0 to 100. You can change the setting at any time from the DOS command line. You can also set the acceleration trigger level for double speed; however, acceleration is limited to normal or double speeds only.

The mouse shell program (with the Lotus 1-2-3 overlay) worked effectively with 1-2-3, but it required extensive modification to run with Symphony (no Symphony overlay was provided). The company did a good job documenting the menu-file format for those who want to make modifications. The 1-2-3 menu is one of the more primitive ones I've tested, limited to the menu key (/), the Edit key (F2), and the Enter, Backspace, and Escape keys. The button operation changes with the current 1-2-3 mode. Moving the ball moves the cursor within the spreadsheet or menu.

The RollerMouse ball is hard to clean. Cover screws hide under the adhesive rubber feet (the manual suggests cleaning the surface of the ball without removing the cover).

Kensington Expert Mouse

- **Click-locking awkward under Word**
- **Metal rollers showed the most slippage**
- **Exceptional Lotus 1-2-3 and Symphony shells**
- **Acceleration adjustable from within an application**

The Expert Mouse sports a two-button design with a large (2¼-inch) ball. You set right- or left-button operation via switches on the trackball's back or through the control-panel software. You can plug the cable into either the left or the right side to accommodate either right- or left-handed users. The standard cable stretches a generous 8 feet.

The Expert Mouse does not have a click-lock button as such. However, you can set the trackball to activate click-lock by chording (pressing the buttons simultaneously), or you can even use the right or left button as a lock. I found this method annoying under Word, which uses all three of the button combinations. With chording set to lock the next button I pressed, Word required a double chord and then a third button press to activate the chord. But the click-lock was convenient with the other software. The Expert Mouse produced garbage under Word in graphics mode. As with the RollerMouse, using the Microsoft Mouse drivers solved the problem.

The Expert Mouse's trackball slipped more than any of the others. The Expert Mouse uses metal rollers (rather than plastic or rubber), and this may partially explain the slippage. Not surprisingly, I had trouble with fine control under Paint. Windows felt most comfortable at the lowest mouse sensitivity setting because of the rough handling.

The Expert Mouse includes pop-up control-panel software that lets you set button operation and acceleration parameters (on a scale of 0 to 9) while you're in an application. You can also adjust the acceleration curves with the MSPEED program. The curves from acceleration levels 1 to 9 can be individually tailored (the scaling factors affect the horizontal and vertical axes simultaneously).

The Lotus shells were among my favorites (they are nearly identical to the Mouse Systems menu shells). In 1-2-3 and Symphony, the trackball moves the cursor. The left button calls a mouse menu, the right button acts as the Enter key, and chording acts as the Escape key. The mouse menu has selections for activating the Lotus menu or choosing common commands (such as typing in mathematical operators and function keys).

While these multiple keystrokes may seem awkward, I found the operation natural and flexible. I prefer the consistent button actions over shells that reduce the number of keystrokes with constantly changing button definitions. I would definitely use this shell under Lotus 1-2-3 and Symphony. In fact, the Kensington Expert Mouse's performance with these two products helps overcome the limitations of its two-button design.

Cleaning is easy: The ball simply lifts out of the casing.

continued

Logitech TrackMan

- **Unique thumb control of ball**
- **Excellent engineering—no ball skidding**
- **Favors right-handed users**
- **Lacks fine acceleration-curve control**

The TrackMan is unique in its use of the thumb as the $1\frac{2}{5}$-inch ball's controlling digit (I controlled the others with my index and middle fingers). The index, middle, and ring fingers rest on the TrackMan's three buttons. Although Logitech doesn't include a click-lock, it was generally easy to hold these buttons for click-and-drag operations; still, my finger inadvertently released the button in some situations.

The design is decidedly for right-handed users, and as of press time, a left-handed model was not available. You can set the driver for left-handed use, but the instructions are fairly complicated, and even then, lefties must contend with buttons that sit on the left side and away from them. I found the thumb-based design the most difficult to control. After about an hour of practice, my accuracy improved, but I never did feel comfortable with vertical motions. Even with the trackball at the lowest sensitivity settings, it was hard to get fine control under Paint. Some people might prefer thumb control, but I am not one of them.

I didn't notice any ball skidding, however. In fact, Logitech's roller-mechanism engineering is excellent. I wish the designers had applied it to a more traditional layout. The rollers are soft rubber, and springs push them against the ball. The ball pops out easily with a push from behind for cleaning. (In terms of desktop real estate, the TrackMan requires a space approximately $5\frac{1}{3}$ by $4\frac{1}{4}$ inches, making it one of the most compact units that I looked at.)

The TrackMan was the only reviewed model that did not follow Microsoft hardware conventions. You need Logitech-specific drivers for Windows and OS/2. The control panel can pop up within an application to set sensitivity (from a scale of 0 to 10) and ballistics (off, low, or high). However, Logitech doesn't provide a way to fine-tune or customize acceleration curves. I might have liked the TrackMan better if I could have flattened the acceleration curves more at the lower levels.

The Symphony shell for the menu program is fairly well designed. However, I thought the 300-dpi TrackMan was much too sensitive for text-based work, even at its lowest settings. The product includes a Mouse-2-3 shell for Lotus 1-2-3 releases 1.x and 2.x (you must use the menu program for 3.0). I liked the shell: Common operations such as "sum all cells above" and "sum all cells left" are just a few keystrokes away, and the menus can be customized. But the shell remaps the gray plus and gray minus keys as right and down arrows to accelerate data entry. This does help data entry, but it can be annoying for formula entry.

MicroSpeed PC-Trac

- **Among the best for smooth operation**
- **Independent horizontal and vertical acceleration adjustment**
- **Convenient button placement**
- **Simplistic key-mapping software**

The PC-Trac I reviewed was a preproduction unit, although the circuit board appeared to be in final form and the documentation was typeset. [Editor's note: *BYTE normally restricts reviews to production versions of products. We made an exception in this case to provide a more complete product sampling and because our test unit lacked only cosmetic refinements.*] This is another $2\frac{1}{5}$-inch ball, although the case provides for a smaller available surface than with the other trackballs of that size.

The PC-Trac's action ranks at the top, along with the RollerMouse, for smoothness. I especially liked the way this design fit my hand. Also, the left and right buttons are within easy reach from any position, and they're contoured around the ball. However, with a footprint of almost 4 by 7 inches, the housing is large and may be too big for smaller-than-average hands. (My wife, who's also a computer user, tried PC-Trac, and she thinks that the housing is much too large for her hands.)

The click-lock is the middle of three buttons—a convenient position. You can also define the third button to act like the center button of a three-button mouse. The click-lock defaults to the left button, but it can be switched with a simple button-click sequence. The click-and-drag works fairly well even without the lock feature.

Fine control under Paint was a bit rough, but handling was smooth under the other applications. As with the RollerMouse, the Paint roughness may be due to the 100- to 200-dpi conversion. The driver software caused problems with the Word graphics screen, but once again, the Microsoft drivers solved the hang-up.

The PC-Trac's KEYMAP is a simple program that directly maps trackball movement and button clicks to specific keystrokes. You can select various mappings for several popular applications. However, when I loaded Symphony, KEYMAP became disabled.

I did not like the default selections for Lotus 1-2-3. The program's simplicity places severe restrictions on its abilities, in part because it doesn't offer the flexibility of pop-up menus or the ability to redefine button actions for different applications. At this point, the software makes the PC-Trac much better suited for applications already designed for a mouse.

You can tailor the acceleration curve to your own tastes. This is the only trackball that I tested that had complete and independent tailoring for the horizontal and vertical axes. The process is rather inconvenient, however. The SETBGT (set ballistic gain table) program modifies the device driver, so that you have to reboot the system to apply the new settings. You can select either your custom acceleration table or the default table from the DOS command line. You can also change the sensitivity from the command line (using a setting of 0 to 9 that selects a scaling factor for the acceleration curve).

The trackball cover is attached with three screws. Removing the cover to clean inside is a simple operation.

continued

Mouse Systems PC Trackball

- **Best overall performance**
- **No ball skidding**
- **Easily adjusted sensitivity controls**
- **Awkward button placement**

The PC Trackball uses a medium-size ball ($1\frac{4}{5}$-inch diameter), and only a relatively small percentage of the ball is exposed. Because its small exposed surface limits stroke size and, hence, movement, I found the default sensitivity setting too low. But I could easily adjust it by pressing Alt/Ctrl/left-mouse-button followed by a number (from 0 to 9) on the keyboard. The small exposed surface probably keeps skidding to a minimum (I didn't notice any) by directing most pressure downward onto the rollers.

Of all the trackballs I reviewed, the PC Trackball gave me the best cursor control and smoothest operation overall. I was able to produce a smoothly curved signature under Paint. I was not happy with its button placement and control, however. The left and right buttons are quite close to the ball. Clicking the center button was awkward. Furthermore, to use the center button as a click-lock, you have to hold the left or right button and then click the center button (reversing the order will not work). To release the click-lock, you have to click the center button again. Sometimes I forgot that the lock was on and thought the buttons had quit working. The company also offers left-handed drivers to let you swap button definitions.

Initially, I was not pleased with the response under AutoCAD. At the highest sensitivity level, it took too many strokes to move the cursor across the screen. But the acceleration curves can be tailored with the ULTRARES program. I found an acceptable setting by sharply accelerating the slower rates and leveling off acceleration at higher speeds.

The PC Trackball's menu and control software is nearly identical to the Kensington Expert Mouse's. The notable exception is 1-2-Click, which is a special Lotus 1-2-3 shell. 1-2-Click adds drop-down menus to 1-2-3 (although it does not contain all the 2.2 commands). The shell adds some useful features to 1-2-3 and can be disabled or reestablished with a click. I prefer the menu shell, but it's nice to have two choices, and I'm sure others will prefer 1-2-Click.

Despite the buttons, this was my favorite trackball. I think this comes down to the ball design, since I used the trackballs mostly to move the cursor around the screen and only occasionally clicked on the buttons. The ball and cursor movement was the most comfortable, and the acceleration was the best I tested: Stepping up from low to high speed was smooth. (The cover attaches with four screws, so the unit can be easily opened for cleaning.)

Final Tally

In the end, the Mouse Systems PC Trackball gets the highest marks for comfort, smooth operation, and cursor control. The MicroSpeed PC-Trac ranks a close second for comfort, and it may be my preference for CAD, Windows, or other applications that already provide support for a mouse.

The CH Products RollerMouse performed well in applications that didn't require a lot of detail or pixel-by-pixel control, including text-based applications. Personally, I wasn't a fan of the Logitech TrackMan's thumb-control design, but the 300-dpi unit worked well in my high-resolution, 8514/A environment.

I found the Kensington Expert Mouse to be the most limited of the five units, primarily because of its two-button design and the skidding ball. However, it worked fine under Windows, and it was especially good in Lotus 1-2-3 and Symphony.

None of the units in this new round of trackballs will lure me away from my mouse, which is proof that I'm a die-hard mouser. But if you're uncomfortable with a mouse, or if you're a beginning mouse user, these alternatives are worth a try. ■

Bradley Dyck Kliewer is the author of EGA/VGA: A Programmer's Reference Guide *(New York: McGraw-Hill, 1988) and principal of DK Micro Consultants, a microcomputer consulting business in Bloomington, Indiana. He can be contacted on BIX as "bkliewer."*

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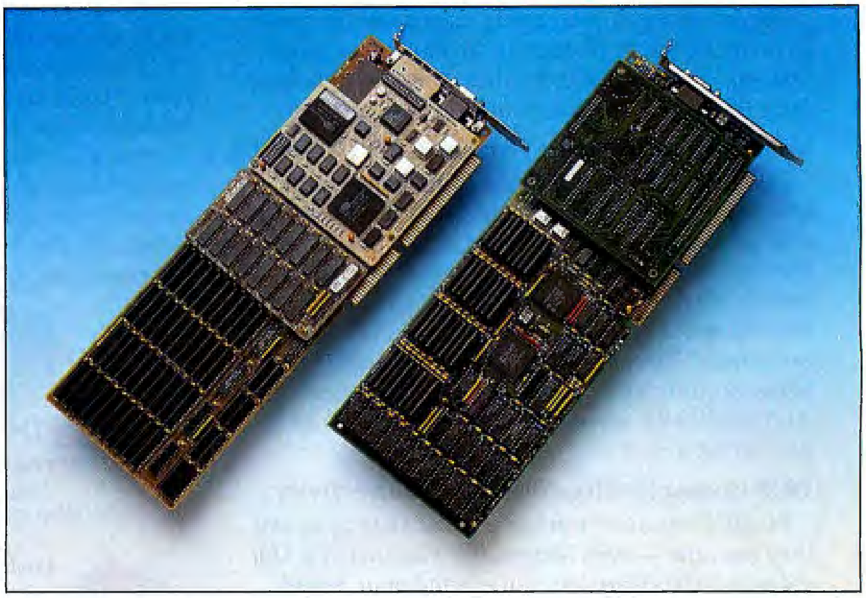
New CAD Test Shuffles 34010 Pack

Improved tests and new drivers revise the results of our graphics board roundup

Steve Apiki



Intelligent 34010-based graphics boards: The Artist Graphics Artist TI12 (left) and the Renaissance GRX Rendition II.

Last November, the BYTE Lab evaluated AutoCAD and PageMaker performance of 34010-based intelligent graphics boards ("The Brains Behind the Graphics," November 1989 BYTE). Since then, we've improved our AutoCAD benchmarks and received new driver releases, so it's time to take a second look at the CAD results of these boards.

Three major changes have occurred since November. First, some of the manufacturers have released newer Autodesk Interface drivers, which allows us to test the boards more consistently. Our November tests used either ADI 3.1 or ADI 4.0 drivers, depending on availability. Our current tests use only ADI 4.0 drivers.

Second, we modified our test file. Our original drawing test had AutoCAD's OSNAP (object snap) feature turned on. Although this is not atypical, it added a large constant factor to each result and magnified the differences between ADI driver versions. Our new test drawing consists of last November's small AutoCAD drawing with the OSNAP parameter removed.

Finally, we relaxed the 512K-byte limitation on display-list memory size to simulate a more realistic high-end CAD environment. We tested each of the boards with as much on-board memory as possible and provided 4 megabytes of expanded memory for additional display-list storage.

The figure shows the results of these new AutoCAD release 10 tests. As in November, we split the times between boards with 1280- by 1024-pixel (high) and 1024- by 768-pixel (medium) resolutions. We tested all the boards in 256-color configurations with a Nanao FlexScan Model 9500 monitor. (Last November's top-performing high-resolution board, Number Nine's Pepper Pro1280, was unavailable for this review. Instead, we've included Number Nine's Pepper Pro1024 in the medium-resolution group.)

Among the high-resolution boards that we tested, the Artist Graphics (formerly Control Systems) Artist TI12 was a clear standout. The new TI12 GT driver, using on-board memory for display-list storage, pushed the Artist TI12 beyond the similarly configured Matrox PG-1281 and IMAgraph TI-1210-8. The Matrox board finished ahead of the IMAgraph unit, but the timings of all the boards were clustered fairly tightly. One oddity with the Artist TI12 was that, because of the display-list structure, you can't pan as far horizontally as you can on the other boards and still remain within the display list.

With its new software, Artist Graphics added more than top performance. The Artist TI12 has the sharpest configuration utility of the tested boards, and its control-panel interface to the display-list features is convenient. (For all the graphics boards, installation and use was straightforward, although the Pepper Pro1024's installation program is somewhat clumsy.)

The high-resolution boards have similar prices for similar configurations. All three boards generate a superior display and run trouble-free, but speed and a

AT A GLANCE

1280- BY 1024-PIXEL RESOLUTION

Artist TI12
Artist Graphics
A Control Systems Company
2675 Patton Rd.
St. Paul, MN 55113
(612) 631-7800
As reviewed (includes 1.25 MB of video RAM, 3 MB of DRAM, and VGA module): $6685
Inquiry 854.

PG-1281
Matrox Electronic Systems, Ltd.
1055 St. Regis
Dorval, Quebec, Canada H9P 2T4
(514) 685-2630
As reviewed (includes 2 MB of Video RAM, 1.5 MB of DRAM, and Matrox PG-51-ACAD10/05 2.01 driver): $3945
Inquiry 856.

TI-1210-8
IMAgraph Corp.
11 Elizabeth Dr.
Chelmsford, MA 01824
(508) 256-4624
As reviewed (includes 1.25 MB of video RAM, 1 MB of DRAM, and IMAzoom 2.00 driver): $4585
Inquiry 855.

Note: Configurations are for 256-color operation at the maximum supported resolution.

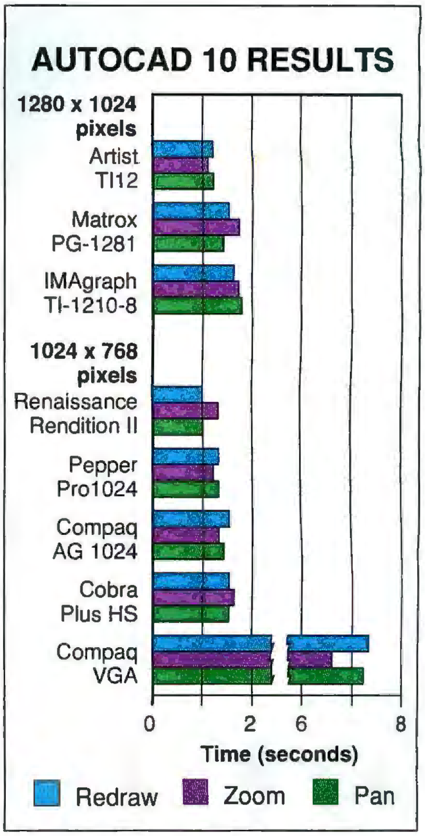
1024- BY 768-PIXEL RESOLUTION

Advanced Graphics 1024 Board
Compaq Computer Corp.
20555 SH 249
Houston, TX 77070
(713) 370-0670
As reviewed (includes 1 MB of video RAM and 128K bytes of DRAM): $2098
Inquiry 857.

Cobra Plus HS
Vermont Microsystems, Inc.
11 Tigan St.
P.O. Box 236
Winooski, VT 05404
(802) 655-2860
As reviewed (includes 768K bytes of video RAM and 512K bytes of DRAM): $3395
Inquiry 860.

Pepper Pro1024
Number Nine Computer Corp.
725 Concord Ave.
Cambridge, MA 02138
(617) 492-0999
As reviewed (includes 1 MB of video RAM, 1 MB of DRAM, and Power9/ACAD 3.0 driver): $2940
Inquiry 858.

Rendition II
Renaissance GRX, Inc.
Cedar Park
2265 116th Ave. NE
Bellevue, WA 98004
(206) 454-8086
As reviewed (includes 1 MB of video RAM, 512K bytes of DRAM, and VGA module): $2695
Inquiry 859.



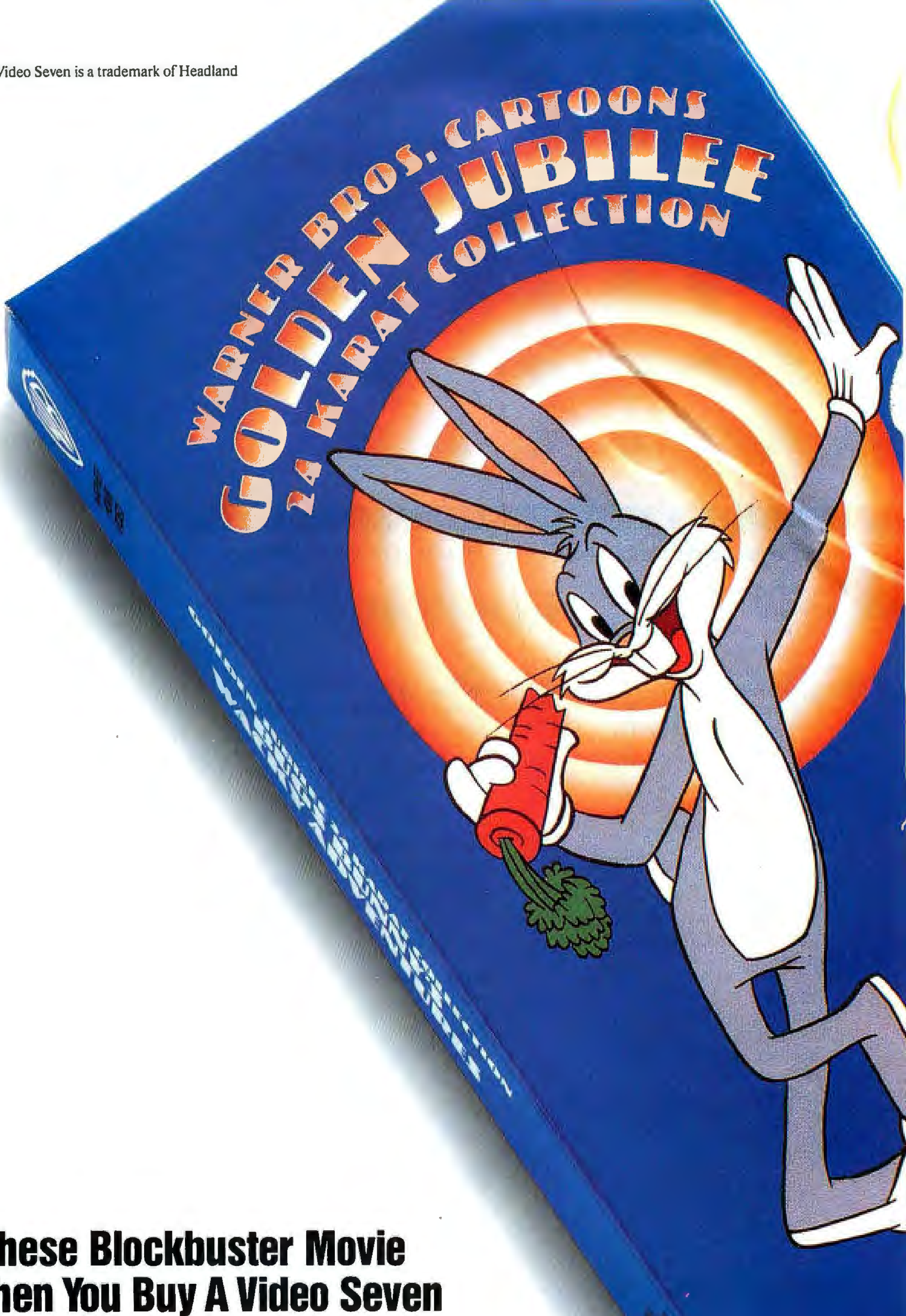
Although the Artist TI12 and Rendition II proved to be the top performers under AutoCAD release 10, the results put all these 34010-based boards in a relatively tight cluster. Benchmarks on the Compaq VGA, included here for comparison, illustrate the dramatic performance gain that a display-list processor can provide.

good interface make the Artist TI12 my favorite.

Renaissance GRX's Rendition II (see "Reviewer's Notebook," December 1989 BYTE) outpaced the rest of the medium-resolution pack. Here, too, the difference between the fastest and the slowest boards was not great; all the boards finished within a half-second of one another.

With a base price of $2095 (256-color version with 384K bytes of DRAM included), the Rendition II is the clear medium-resolution pick. All the boards turned in excellent performances, but the Rendition II offers it all at a very attractive price. ■

Steve Apiki is a testing editor for the BYTE Lab. You can contact him on BIX as "apiki."



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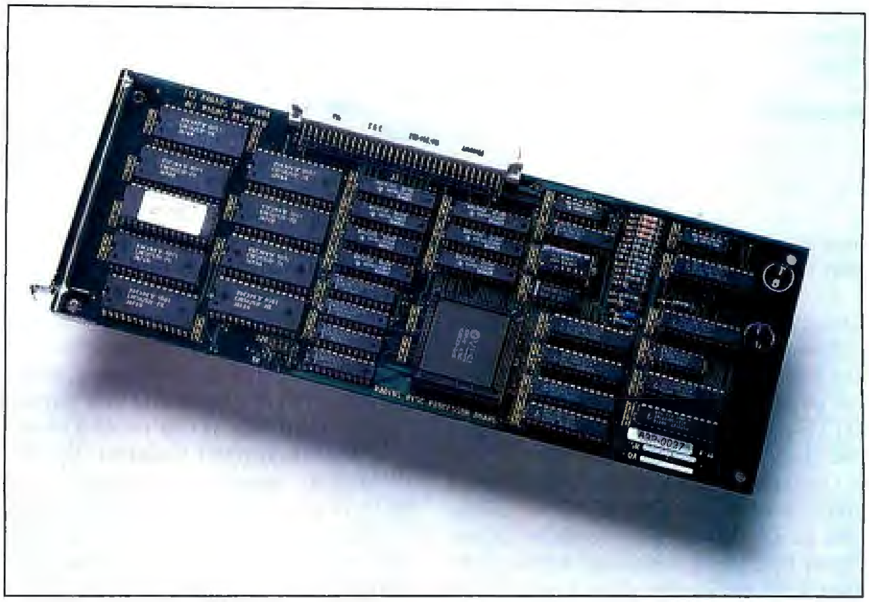
Macintosh CAD Comes of Age

Radius's display-list processor helps Macs match fast PCs for CAD

Jon Udell



Blink and you've missed it. That's how fast AutoCAD for the Macintosh and the Radius QuickCAD Graphics Engine can redraw the BYTE Pantheon, our architectural modeling test. As a result, Radius's $1495 NuBus board answers CAD users' pressing need for a Macintosh-based display-list processor (DLP).

Ironically, CAD has been the Achilles' heel of the otherwise graphically sophisticated Macintosh. A fast 386 PC arguably makes a more cost-effective CAD workstation than a 68020 or 68030 Mac. Equip the PC with a 34010-based coprocessor, and it can blow the doors off any Mac on pan, zoom, and redraw operations. Now, there's an equalizer. QuickCAD, with its VL86C010 integer RISC chip, manipulates display lists (sets of line segments or vectors) and renders them into the Mac's frame buffer.

Currently, QuickCAD works with three Macintosh CAD programs: Autodesk's AutoCAD, Versacad's VersaCAD Design, and IGC Technology's Pegasys. QuickCAD's code runs in the 256K bytes of static RAM on the board. The display list resides in system RAM, and it can overflow to disk, Radius says.

QuickCAD's benefits and limitations match those of PC-based DLPs. A display list is a special kind of cache (see figure 1). It stores endpoints that define the line segments of a CAD image. Abstract shapes rather than screen coordinates represent those points. The process of building that virtual display—a regen—requires traversal of the CAD database and, in the case of three-dimensional CAD programs, a laborious mapping that projects a 3-D model onto a 2-D display plane. A regen proceeds slowly and, because it rewrites the display list, gains nothing from a DLP. But once you've built a display list, the DLP kicks in. There is no need to revisit the database or repeat the vector calculations. Want to redraw the image? The DLP just rattles through the list of cached vectors and redisplays them. Pan or zoom? The DLP clips or scales the vectors on their way to the screen.

Life's great until you invalidate the cache by zooming beyond the limits of the virtual display or rotating a 3-D model. Since most popular CAD programs handle 3-D models, that's an important restriction. A DLP won't enable your PC or Mac to spin fully rendered teapots, Volkswagens, or Pantheons in real time. That can't happen until the CAD programs maintain 3-D display lists that FPU-assisted graphics coprocessors can manipulate. DLP vendors don't emphasize this restriction, for obvious reasons, and it's not as well understood as it should be. So caveat emptor: A DLP like QuickCAD can come in handy, depending on the kind of work you do, but it's not a plug-in 3-D engine.

Tips and Tricks

I tested the QuickCAD on a 5-megabyte Mac II equipped with two monitors. The primary monitor was a 19-inch Radius Color Display driven by a DirectColor/24, Radius' 32-Bit QuickDraw board. The second monitor was a standard 13-inch Mac II display with an Apple 8-bit video board. QuickCAD comes with an INIT/cdev, which loads the RISC processor's static RAM with the code that traverses a display list, transforms vectors, handles NuBus arbitration, and shoves pixels into a frame buffer (or, in the case of multiple monitors, several frame buffers). The cdev provides two controls—a master switch and a Caps Lock switch. When you enable the latter, you can toggle QuickCAD on and off

continued

QuickCAD Graphics Engine

Company
Radius, Inc.
1710 Fortune Dr.
San Jose, CA 95131
(408) 434-1010

Hardware Needed
Mac II with a Radius 8-bit color display, or an Apple 8-bit Mac II video card and a 13-inch RGB color monitor

Software Needed
Mac CAD applications that support QuickCAD

Price
$1495

Inquiry 881.

interactively with Caps Lock. It's a handy way to gauge the effect of the board.

QuickCAD is a superset of Radius's QuickColor accelerator board (for more information about the accelerator, see the text box "The QuickColor Option" on page 194 in the December 1989 BYTE). Because QuickCAD subsumes the QuickColor accelerator, there's also a QuickColor INIT/cdev. QuickColor's INIT works like QuickCAD's, except that its job is to replace certain QuickDraw bottleneck routines. Applications that rely exclusively on QuickDraw needn't know about QuickColor. Its benefits—fast scrolling of deep-color and bit-mapped images—come automatically. QuickCAD, by contrast, operates outside QuickDraw's scope. A program wanting to export a display list must know a DLP is available to handle it.

As it turned out, a QuickColor board already resided in my Mac II, and its INIT/cdev still sat in the System Folder. So QuickCAD's installer overwrote it and added the QuickCAD INIT/cdev. I rebooted the Mac, turned QuickCAD on, fired up AutoCAD, loaded the Pantheon model, and issued a `redraw` command. No dice—it wasn't any faster than a normal redraw.

After a phone call to a beta user, I tried again without the QuickColor board (it fights with QuickCAD and is redundant, anyway). Still no dice. Spelunking around, I found that the primary monitor, the Radius Color Display, was set for 16-bit pixel depth. I dropped back to 8-bit pixel depth (as, in fairness, a READ.ME file instructs you to do) and tried once more. That did the trick: Redraws, pans, and zooms became nearly instantaneous (see the photo on page 190).

Figure 2 tells an interesting story. Running BYTE's AutoCAD benchmark, an unassisted Mac II can't hold a candle to a VGA-equipped Compaq 386/20. When you equip both machines with DLPs (I used the 34010-based Advanced Graphics 1024 on the Compaq), the Mac runs the redraw, pan, and zoom tests nearly as fast as the PC. QuickCAD accelerates VersaCAD and Pegasys by a comparable factor, according to the vendors of those programs. Note, however, that the Compaq retains more than a fourfold advantage over the Mac on the regen test, with or without a DLP.

One thing puzzled me. On the PC, AutoCAD's video-configuration menu includes an AutoCAD Display Interface option that directs the program to use a DLP. That option doesn't appear in the Mac version of AutoCAD, and QuickCAD didn't come with any application-specific drivers. How did AutoCAD link up with the Radius accelerator? The answer suprised me: QuickCAD's installer had silently patched AutoCAD's INIT. Radius isn't happy with that scheme, according to a product manager I spoke with. The other two supported programs, VersaCAD Design and Pegasys, will come bundled with QuickCAD INITs, and Radius hopes that AutoCAD will do the same.

The personalities of the two Radius boards—QuickColor for bit maps and QuickCAD for vectors—aren't really complementary. A CAD program that does true-color rendering (Intergraph's MicroStation, which doesn't yet support QuickCAD, is one such program) isn't bound by bit-transfer rates, as are image-processing programs. Sorting polygons and computing light intensities take much longer than pushing pixels—even very deep ones—to the screen. QuickCAD does not include QuickColor for the sake of CAD programs. It's there

continued

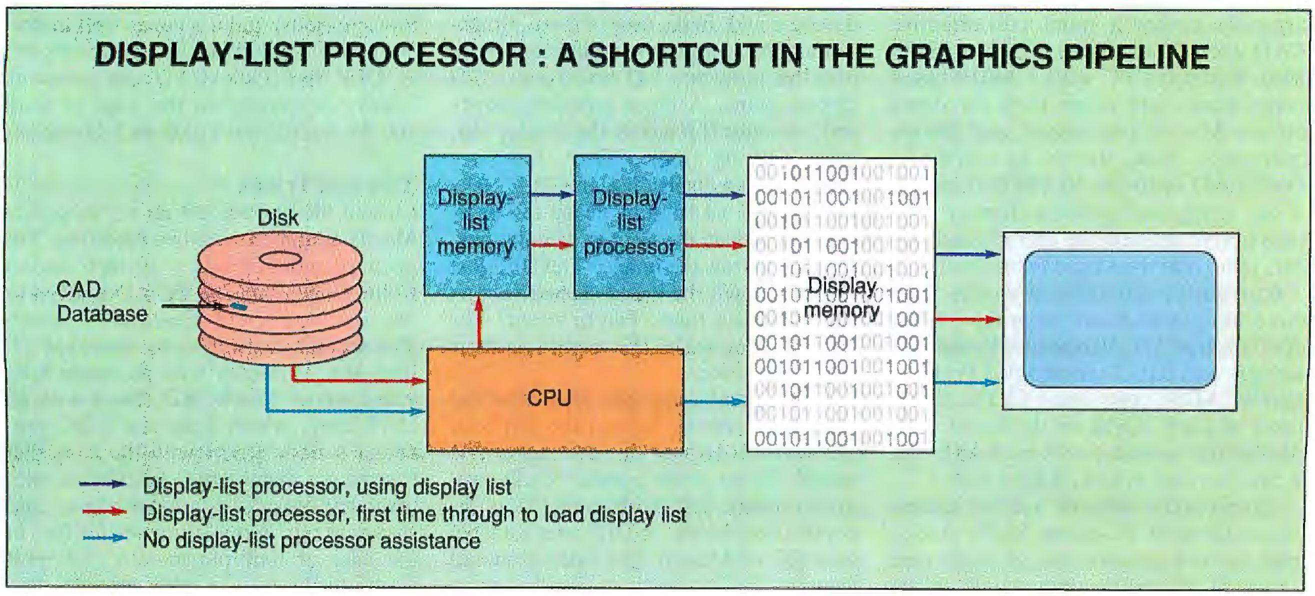


Figure 1: *A display list is a special kind of cache that stores endpoints to define the line segments of a CAD image. Once you've built a display list, there's no need to revisit the database or repeat vector calculations. This makes most pans, zooms, and redraws almost instantaneous.*

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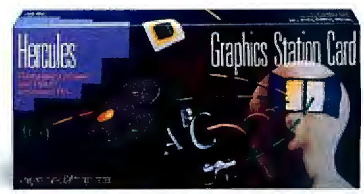

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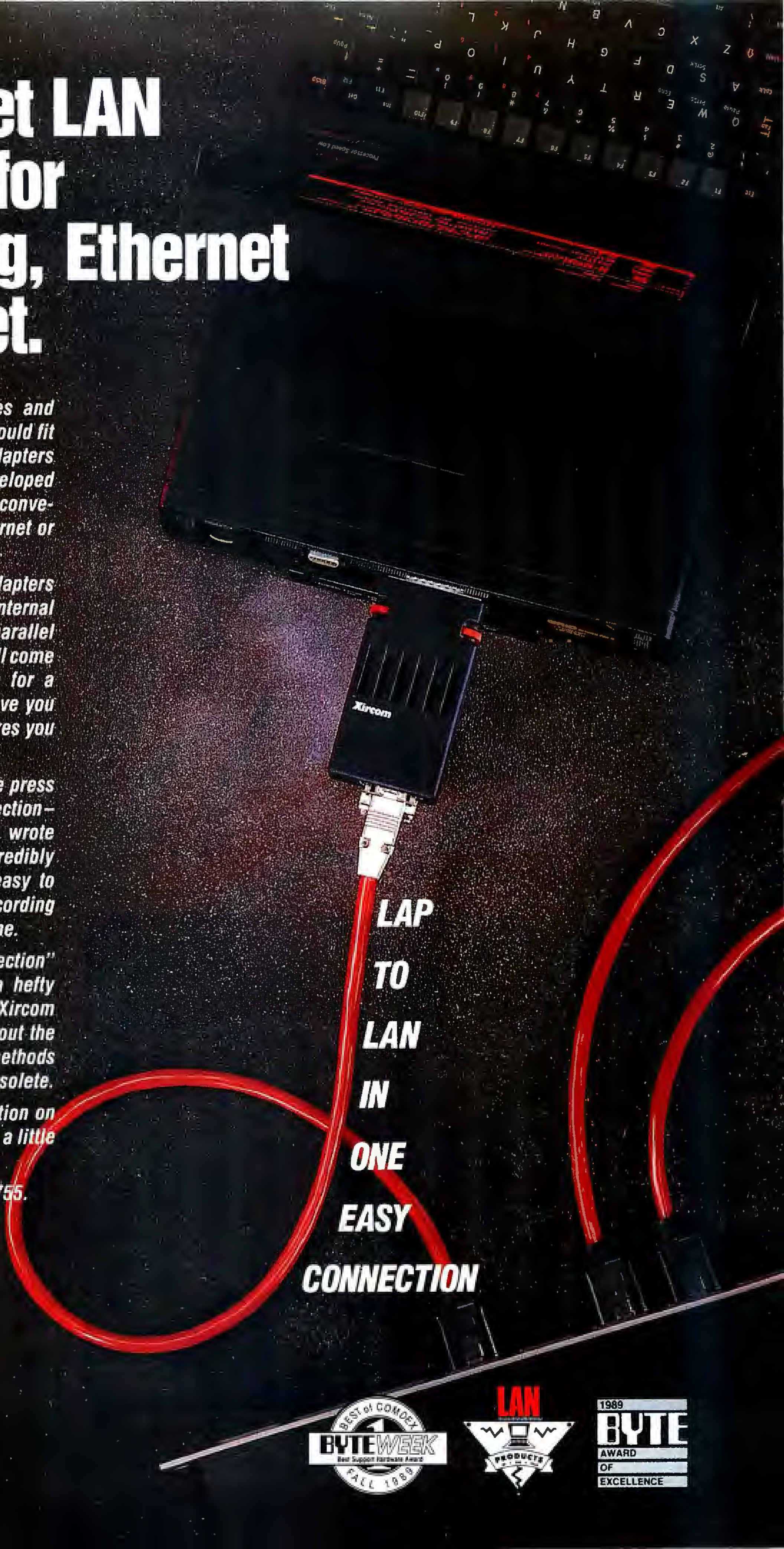

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because extending QuickColor's code, essentially an operating system for the RISC board that can multitask with the Mac operating system, was safer than replacing it.

The net result is that QuickCAD lets you do everything that a QuickColor board does. I loaded a 24-bit-deep color photo into PageMaker and observed noticeably faster scrolling with QuickColor enabled. Architects and others who create intricate CAD models and glossy presentations will find both halves of the board useful. Note, however, that you have to switch between 8-bit and 16-/24-bit color modes.

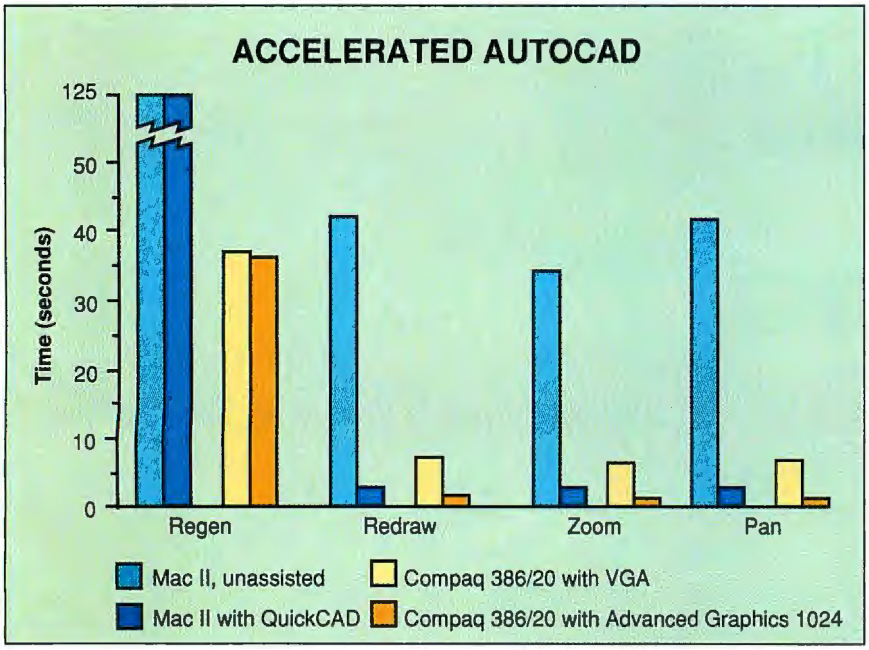
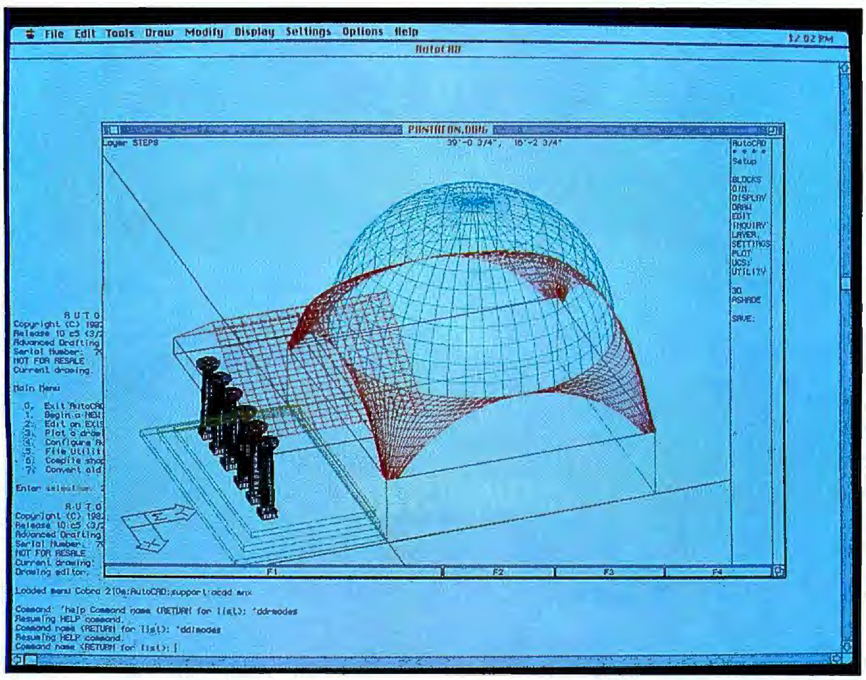


Figure 2: *BYTE's AutoCAD benchmark tells the story: When both machines are unassisted, the Compaq 386 wallops a Mac II. But the Macintosh/QuickCAD duo stands shoulder to shoulder with a Compaq 386/34010 combo in those operations that can benefit from a display-list processor.*



When running QuickCAD under AutoCAD, redraws, pans, and zooms on the BYTE Pantheon model became nearly instantaneous.

It's conceivable, of course, that you'll want fast bit maps and fast CAD at the same time. Imagine a compound document that's a mixture of richly formatted text and rendered CAD images. Applications don't do that yet, but they probably will, so Radius plans to make QuickCAD compatible with at least 16-bit color. What if you already own QuickColor but now find that you require a CAD accelerator? Radius says that it's considering an upgrade for the difference in price between the two.

Newton's Apple

Initially, QuickCAD enjoys only limited software support. Will more Macintosh CAD vendors embrace the board? Undoubtedly, although it'll be harder for some than for others. Programs that already maintain display lists and don't depend heavily on Mac-specific optimizations will convert easily. (Significantly, none of the programs that now support QuickCAD grew up on the Mac.) Others face a more difficult challenge. Intergraph's MicroStation falls into this category. It images directly into off-screen buffers, which makes the program responsive but leaves no convenient hook for a coprocessor. Intergraph and Radius are studying how to proceed.

The biggest obstacle, of course, is the lack of 2-D and 3-D graphics standards. Thus far, Apple has protected Mac users from the hair-raising incompatibilities that plague the PC world. For example, Mac programs written for 8-bit color generally work transparently with 32-Bit QuickDraw. Mac users take this for granted, which amazes PC folk. Apple's dictatorship has clearly paid rich dividends. But the Mac hasn't done well in the engineering market. Hardware innovators like Radius now hold the key to Apple's future there.

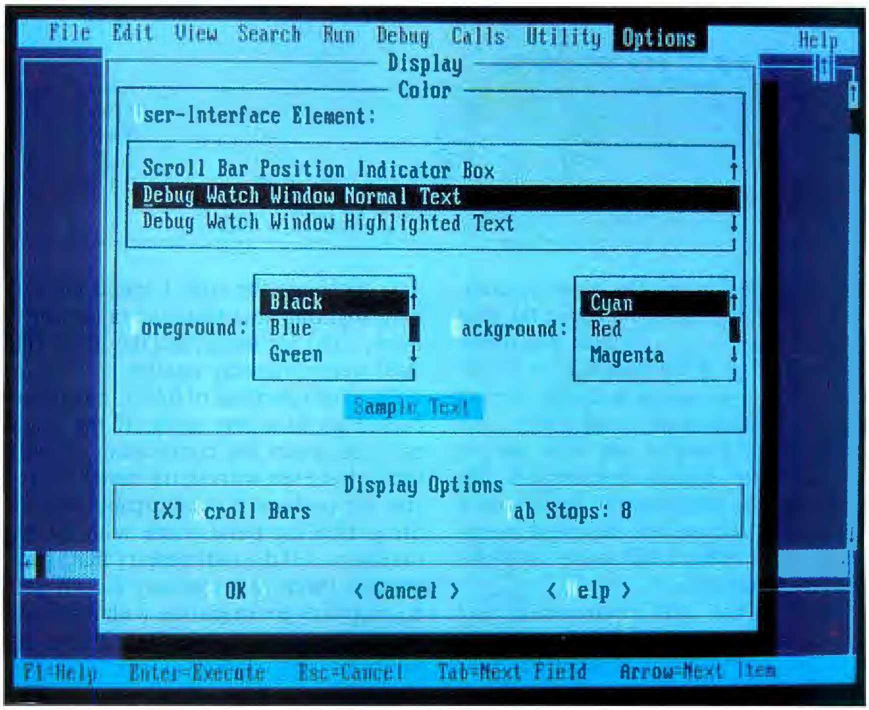
QuickCAD, and products like it, will surely help sell Macs as CAD workstations. That'll mean a certain loss of innocence, though, as application/driver/board combinations multiply. Apple should embrace QuickCAD and, as with 32-Bit QuickDraw, move quickly to establish a standard that fosters creative diversity among hardware vendors while preserving the simplicity that makes the Mac great. ■

Jon Udell is a BYTE senior technical editor at large. He can be reached on BIX as "judell."

Help for the C Sick

Microsoft BASIC PDS 7.0 may be the antidote you're looking for

Mike Wiggins



Microsoft BASIC PDS 7.0 adds, among other things, a mouse-driven, character-based user interface.

Microsoft has once again given us what seems to be a natural evolution from its QuickBASIC environment. The Microsoft BASIC Professional Development System 7.0 is packed full of new and enhanced features to whet every BASIC programmer's appetite. BASIC PDS 7.0 enhancements include the Microsoft QuickBASIC Extended (QBX) environment, support for OS/2, EMS 4.0 support, add-on financial libraries, user interface toolboxes with source code, and the new Microsoft Professional ISAM (indexed sequential-access method) database engine. Compiler junkies will like the improved code generation, which creates tighter, faster code. Heck, even C snobs will find this package interesting.

Microsoft has finally listened to professional BASIC programmers who've been demanding professional-quality development tools for years. Microsoft endowed PDS with a feature-rich environment for fast code development without loss of program performance. Many of the limiting factors typically associated with BASIC have been addressed in this package. For example, you can now have larger code and data sizes, do string moves into far memory, and make .EXE files as large as 16 megabytes. The new language enhancements provide greater control over DOS files, static arrays, error handling, and the communications port. BASIC PDS 7.0 also comes with the Microsoft Professional Editor and the CodeView window-oriented debugger. If you are serious about developing big BASIC programs but have been running into limitation problems with other compilers, then you should take a look at BASIC PDS 7.0, because it can make your code jump through hoops.

The main thrust of the package is toward the business application programmer. BASIC has evolved from a beginner's language into a more structured and modular one, making it ideally suited for group programming projects. Companies with programming staffs will find BASIC PDS 7.0 well suited for many of their programming requirements. Although I wouldn't throw out my C compiler just yet, or translate all my C code to BASIC, I would seriously consider writing some of my small- to medium-size projects in BASIC using this compiler. While BASIC PDS 7.0 has an excellent help system, it does not come with a tutorial, so the novice and hobbyist would be better off sticking with QuickBASIC 4.5 for experimentation.

QBX Environment

For those not familiar with the Microsoft QBX environment, it's what Microsoft calls an "instant development environment," which uses a threaded p-code technology. The environment offers the developer integrated editing and debugging for fast code development. QBX has a pull-down menu interface that can be controlled via the keyboard or an optional mouse. This is a full-screen editor with all the editing features needed for

continued

BASIC PDS 7.0 VS. QUICKBASIC 4.5

BASIC PDS 7.0's I/O performance is improved over previous compilers', particularly with commonly used sequential files. (All times are in seconds.)

Sequential disk I/O on a 1-MB file

Record length (in bytes)	BASIC PDS 7.0 Write	BASIC PDS 7.0 Read	QuickBASIC 4.5 Write	QuickBASIC 4.5 Read
1	689.26	1084.12	787.36	1178.92
10	103.47	136.66	136.21	169.50
100	38.62	39.05	71.40	71.40
1000	34.77	38.50	70.97	70.85

Random disk I/O on a 10K-byte file

Record length (in bytes)	BASIC PDS 7.0 Write	BASIC PDS 7.0 Read	QuickBASIC 4.5 Write	QuickBASIC 4.5 Read
1	32.84	32.19	33.94	33.34
10	3.36	3.24	3.40	3.41
100	0.49	0.39	0.39	0.38
1000	0.16	0.22	0.16	0.17

fast code production. Once you've completed your program, you select the Run option on the menu to compile it in memory or into an .EXE disk file. An integrated debugger makes it easy to correct any compilation or program errors. The environment provides you with greater capability for system development. By shrinking the environment down with a "No Frills" switch, you can create megaprograms of up to 16 MB while inside the QBX environment.

Don't let the QBX environment fool you. This is a serious compiler, and it can easily handle large database applications like customer tracking, inventory control, and publication mail listings. Microsoft set out to produce an environment for serious developers, and it has created a monster language to rival even the great C serpent for speed and power.

BASIC PDS 7.0 has a complete on-line documentation system managed by the Microsoft Advisor help system. This context-sensitive help system has hypertext links that let you move quickly among key concepts. This is truly a complete system, and if you can find it in the manuals, you will find it on-line. You can even add your own help files to the system with the HELPMAKE utility.

Simply BASIC

The compiler has been improved in many areas: math, I/O, event handling, code generation, and optimization. Microsoft claims that these enhancements can increase the speed of your programs to up to 1900 percent and can decrease code size to up to 68 percent over QuickBASIC 4.5. Although the code I tested did not have anything near that kind of improvement, it did run faster, and the .EXE file sizes were noticeably smaller.

The math portions of BASIC have been beefed up in a few spots. If the math package senses the coprocessor, it will use it. But even without the hardware assist, the package is quite capable of handling floating-point math with 64-bit precision. All the rudimentary math programs I threw at it ran very fast. If you develop only for machines with math coprocessors, you can compile with the coprocessor-only option to eliminate the emulation package, thus reducing the size of the .EXE file.

Getting data in and out of any program can often cause bottleneck problems. BASIC PDS 7.0's I/O routines have been fine-tuned as part of the upgrade. I tested both sequential and random-disk-access writing and reading from a 1-MB file with record lengths of 1 to 1000 bytes. BASIC PDS 7.0 access is faster than QuickBASIC 4.5 during sequential access, but it was only marginally better during random access (see the table).

There is built-in screen support for a variety of adapters, including the Olivetti color adapter, Hercules graphics card, MCGA, CGA, EGA, multicolor graphics array, and VGA. It supports the VGA and MCGA adapters in 320- by 200-pixel resolution with 256,000 colors in mode 13. Again, there is a slight improvement in output to the screen over QuickBASIC 4.5, but nothing mind-boggling.

The event handling no longer has to check for events after executing each line. By using Event On and Event Off, you can minimize the amount of checking done in your program.

Microsoft has improved the code-generation algorithms called "Thunking" and "Peep-holing." Thunking looks for frequently occurring code patterns, and then it generates an assembly subroutine in near memory for quick access. Peep-holing looks for local string-related code patterns for optimization. These routines contribute to the compiler's overall ability to generate executable files that are small and fast.

A few new command-line switches have been added to the BASIC compiler's stand-alone operation. The `/G2` switch tells the compiler to generate optimized code for the 286 processor. This lets your program take advantage of the 286's expanded instruction set. The `/OT` switch is used to optimize the calling procedure for your SUB, FUNCTION, and DEF FN routines. The `/Fs` switch is for far string operations, and only objects compiled with this switch set are compatible. The `/Ix:` switch controls memory management for the new ISAM database.

On the Financial Front

Some of BASIC PDS 7.0's new features offer greater power specifically to the business application developer. The new library routines come in both standard (.LIB) and Quick (.QLB) library formats. These financial libraries consist of formulas, numeric formats, and serial number generators. The financial library (FINANCER.QLB) offers commonly used business formulas, such as depreciation, interest, rate of return, and principal and interest payments. The date/time library (DTFMTER.QLB) delivers a way to generate serial numbers from date and time arguments. Finally, the format library (DTFMTER.QLB) returns properly formatted strings from numeric data types, including the new Currency data type.

The Currency data type is perfect for accounting and other financial applications. The currency number is stored as an 8-byte integer, and it can represent numbers with a range of ±9.22E14 with 19-digit accuracy. Now you can represent money the way you're used to seeing it: in dollars and cents.

Application Toolbox

The Matrix Math, Presentation Graphics, and User Interface toolboxes can give your programs some pizzazz. These toolboxes come with source code that you can use in your program development.

continued

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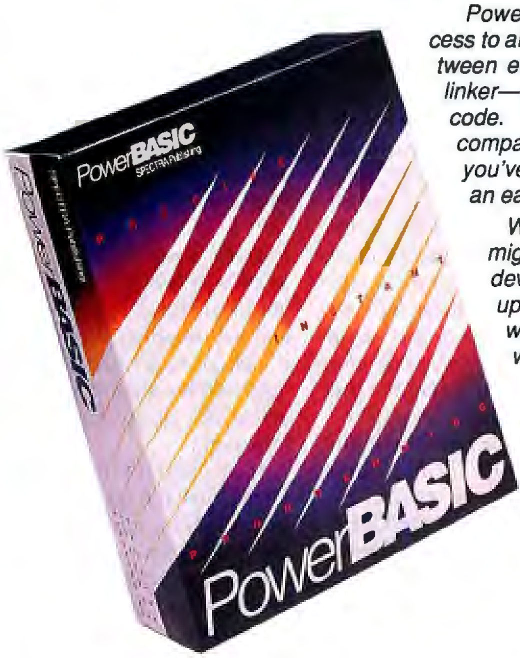

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BASIC PDS 7.0

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(206) 882-8080

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Software Needed
DOS 3.0 or higher; OS/2 1.1 or higher; compiled programs will run on either DOS or OS/2

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However, Microsoft notes that "these are examples only and should not be relied upon as a fully tested add-on library." You might want to give the programs the once-over before you use them.

The Matrix Math toolbox demonstrates how math can be performed on two-dimensional matrices. Gaussian elimination, determinant and inverse of a square, and the BASIC math functions are included in the toolbox. You can perform these operations on most of the numeric data types in BASIC PDS 7.0.

The Presentation Graphics toolbox produces a variety of business-style graphics. Whether you need a scatter chart or a simple pie chart, there is sure to be a toolbox routine you can draw on. What good are charts without words? The Font toolbox is included as part of the Presentation Graphics toolbox. Two fonts are supplied (Helvetica and Times Roman), and you can also use Windows/286 bit-map .FON files with the Font toolbox.

The User Interface toolbox should be very popular. It gives your application a professional-looking user interface with character-based windows, pull-down menus, and mouse control. The interface has many of the features of the QBX environment. All three of these toolboxes will save the professional business programmer a bundle of development time.

The ISAM on the Cake

The Microsoft Professional ISAM database engine is simply the most amazing addition to the BASIC language that I have seen in years. It seems to be a complete implementation of ISAM. The last time I worked with ISAM was in COBOL a few years back. This is a very good implementation of ISAM, and professional programmers who need database functionality in their programs could save months of development time by using it. Mind you, it has a bit of overhead, so it is not the answer for all your database problems.

The smallest ISAM data file generated is 64K bytes, but it has the power to handle larger database files of up to 128 MB in size. That 64K-byte initial file size has 39K bytes reserved for file management, leaving 25K bytes for new indexes, tables, and data. When the file needs to expand, it allocates 32K bytes at a time.

All the information for the handling of the database is stored in one file along with your data. The ISAM file is a series of tables and indexes. The tables consist of the actual data records, and the indexes provide quick access to table data. You can create an index on any field or combinations of fields in a table. Multiple tables can be stored in one database file offering greater flexibility for applications. Records are stored in a table in the order in which they were entered. If you want to access a record differently, simply create an index for that table that changes the access order or record key.

There are a few ways that you can install ISAM for use with your programs. Microsoft supplies two TSR-style programs, PROISAM and PROISAMD, or you can link your program directly with the ISAM library. PROISAM has full access to the database but lacks the ability to create or delete indexes and tables. PROISAMD has no file access restriction. By running a TSR, you can have access to the ISAM engines while in the QBX environment. This lets you develop and test your code without having to link in the large database library.

Some new keywords added to the BASIC language support ISAM. These keywords are a smooth and natural extension to the language. Take the OPEN statement, for example: `OPEN database$ FOR ISAM tabletype tablename$ AS filenumber%`. This is a natural replacement for a regular OPEN statement. Microsoft provides useful ISAM program examples in source code.

BASIC PDS 7.0 has four ISAM utilities for importing and maintaining ISAM files. One of the biggest problems with creating a large database is ensuring its integrity. With all that complex data crammed into a single file, the database structure is quite fragile. Two of the utilities, ISAMREPR and ISAMPACK, give you a way to repair corrupted database files and optimize the size of the database file for better performance. The other two utilities allow you to convert your old database files. These programs can convert dBASE, Btrieve, ISAM, and ASCII files. If you're looking for a little more power from your database, you might want to consider BASIC PDS 7.0.

Pithy Stuff

Overall, I like the new QBX environment. The pull-down menus provide great control over the environment. Although you don't need a mouse, it comes in handy when using the menus or moving chunks of text around in large programs. The fast response of the QBX interpreter let me create and debug my test programs quickly. The Microsoft Professional ISAM engine is useful for creating any business applications that require fast access to stored data.

I had no trouble running BASIC PDS 7.0 on an 8-MHz 286 AT compatible with 1 MB of memory. If you're planning to write ISAM applications, I recommend a faster 286 or 386 with a minimum of 2 MB of EMS 4.0 memory and a 40-MB hard disk drive. QBX and the ISAM engine are geared to use EMS 4.0 memory, if it's present. BASIC PDS 7.0 also generates OS/2-compatible code, but because of my system's configuration, I was unable to test this capability. Some of BASIC PDS 7.0's operations—most notably the ISAM engine—are not supported under OS/2, and there's no direct support for Presentation Manager.

Satisfy Your BASIC Urges

Microsoft BASIC PDS 7.0 is right on target in my book. Microsoft has produced another winning version of BASIC, and it's about time. BASIC PDS 7.0 is a feature-rich package with all the speed and versatility to rival any other high-level language.

If you haven't used BASIC in a while, take a look at it now. You'll be pleasantly surprised. I would recommend this package to anybody who needs to develop clean, structured code quickly. Both business and scientific application programmers will benefit from all the improvements in BASIC PDS 7.0. So, if you're tired of writing dBASE code, or just plain "C sick," reconsider working in BASIC. ■

Mike Wiggins was a founding member of Multimate and currently operates Hindsight, a consulting firm in South Windsor, Connecticut. He can be reached on BIX as "mwiggins."

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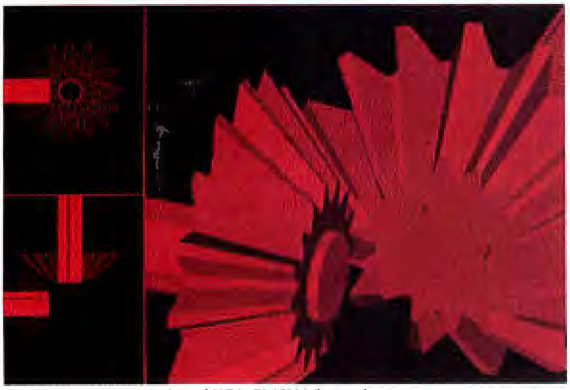

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Desktop Supercomputing

About 20 years ago, in the research labs at IBM, computer scientists were working on a 1-foot cube that in 10 years, they said, would contain the computing power of a room full of computers. We were the latest crop of new hires, and we didn't think it was possible. We were wrong. Nearly 10 years ago, a descendant of that box became the IBM PC.

Today, the desktop supercomputer is becoming a reality. Bit by bit, microcomputers are chipping away at the power of the supercomputer by borrowing its techniques and concepts. In "Separated at Birth," Bob Ryan discusses areas in which microcomputers are approaching the big boys, and areas they have not yet conquered.

One of the techniques used extensively in supercomputers that holds great promise for microcomputers is multiprocessing. You've seen the announcements for the Compaq Systempro, the Zenith Z-1000, and others that contain more than one CPU. But you don't necessarily have to go out and buy a multiprocessor system to get multiprocessing power. If you're on a network, you already have access to a supercomputer. In "Spending Your Free Time," David Gelernter and James Philbin explain how to use the idle machine cycles of a network's many computers for parallel processing.

Parallel processing is often used to describe any kind of multiprocessing. But true parallel processing is a refinement of it—a subset, perhaps. Multiprocessing refers to the simultaneous processing by more than one processor of different applications, programs, or processes within a program. True parallel processing is the simultaneous execution by more than one processor of different instructions within the same process, or even of iterations of an instruction within a single loop. It's a difference of granularity: Multiprocessing runs the spectrum from coarse to fine-grained; parallel processing implies fine-grained.

Most multiprocessing machines can run standard software, but to really take advantage of the power of multiprocessing, you need appropriate systems software. In "A Fearful Symmetry," Craig Keating discusses MPX, a multiprocessor extension to SCO Unix that enables you to get multiprocessor performance from standard Unix applications without modifying them.

Parallel processing is another technique microcomputers are borrowing from supercomputers, as is specialization. You've heard of dedicated file servers on a network; now there is a dedicated computational server. In "Supercomputers Get Personal," Sam Bogoch, Iain Bason, Jeff Williams, and Mike Russell explore this concept in a specific application: the new ComputeServer from Torque Computers, which uses i860s for parallel processing.

Another aspect of specialization is dedicating certain processors to certain jobs. One of the most CPU-draining jobs is handling I/O. Like supercomputers, in recent years microcomputers have begun to pack this task off to the new intelligent bus masters, leaving the CPU for more "important" work. In "Join the EISA Evolution," Min-Hur Whang and Joe Kua describe the EISA bus master.

Dedicated coprocessors can also be useful. Math coprocessors are essential for heavy-duty number-crunching applications. Graphics coprocessors are becoming the norm rather than the exception. And in "A Calculating RISC," Trevor Marshall tells how RISC coprocessors will soon bring supercomputing power to the desktop.

Perhaps today in the research labs at IBM or Cray or DEC, new hires are looking at rooms full of supercomputers and being told that in 10 years, that power will be available in a 1-foot cube. This time, I'd believe those scientists. But then, this is just hypothetical. Or is it?

—Jane Morrill Tazelaar
Senior Editor, State of the Art

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Separated at Birth

The design of your desktop computer is beginning to show more than a passing resemblance to that of a supercomputer

Bob Ryan

It's funny how things work out. At the same time that Steve Wozniak and Steve Jobs were building Apple I boards in a garage, Cray Research was putting the finishing touches on the Cray 1. At that time, the Apple I and the Cray 1 demarcated the lower and upper bounds of computing power and sophistication. Today, the inheritors of the Apple I tradition are making inroads into areas once considered the sole preserve of supercomputers.

Simply put, supercomputers are the most powerful computers in the world. By using a number of sophisticated design techniques, the fastest supercomputers are able to maintain a sustained throughput of over 1 billion floating-point operations per second (1 GFLOPS) while performing real-world applications. By contrast, the shiny new 25-MHz 486 machine on your desktop can sustain about 1 million floating-point operations per second (1 MFLOPS), or one one-thousandth the throughput of a supercomputer. However, desktop machines are closing the gap, primarily by incorporating some of the same architectural features used in supercomputers.

Making a Computer Super

Computer designers know lots of ways to boost throughput on a computer. The most obvious is to boost the clock speed. For example, the Cray Y-MP has a clock period—the amount of time it takes to execute one cycle—of 6.3 nanoseconds. HNSX Supercomputers' SX-X, due to ship this year, reports a clock period of 2.9 ns. In contrast, a 25-MHz 486 system has a clock period of 40 ns. Obviously, if you could get the 486 to run at supercomputing clock speeds, you would get 10 times its current performance.

Another major advantage supercomputers enjoy over personal computers is pipelining. Successful supercomputer designs ensure that the processor spends most of its time processing. The processor prefetches instructions and data to ensure that it is never idle. Part of the pipelining concept is embodied by intelligent I/O. In a supercomputer, I/O is handled by either a dedicated processor or a separate computer. The supercomputer's arithmetic processors are reserved exclusively for crunching data.

Another important supercomputing concept is matching processor design to the task at hand. Most supercomputing applications involve vector processing, which performs one or more operations on many different pieces of data at the same time. Consequently, supercomputers are optimized to handle vector problems, although they aren't bad at scalar processing, either.

One last feature of supercomputers is

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parallelism—both macro- and microparallelism. (In fact, supercomputing is becoming synonymous with parallel processing.) For example, the SX-X has up to four arithmetic processors sharing a common memory space—an example of macroparallelism. These processors consist of a vector and a RISC scalar unit, with each vector unit consisting of one, two, or four sets of vector pipelines. Each set consists of two add/shift pipelines and two multiply/logical pipelines. Because the pipelines operate simultaneously—an example of microparallelism—each SX-X processor can execute up to 16 FLOPS. That's a theoretical maximum of 5.5 GFLOPS per arithmetic coprocessor. No wonder they call these machines super.

PCs in the Balance

When first introduced, desktop computers were primitive by supercomputing standards. They used slow clocks (the Apple II had a clock period of nearly 900 ns), employed no pipelining or intelligent I/O, enjoyed none of the benefits of specialized coprocessors, and exhibited neither macro- nor microparallelism.

The situation today is far removed from what it was in 1976. The differences between desktop machines and supercomputers are more a matter of degree than a matter of type. The design of most desktop computers exhibits many of the properties that you associate with supercomputers. The increased incorporation of supercomputing features into desktop machines will continue to narrow the gap between desktop and supercomputing performance.

Peddling Faster

Take clock speed. Intel has already begun shipping 33-MHz (30.3-ns clock period) versions of the i486. By the year 2000, Intel expects to be shipping a processor with a 4-ns clock that will still be compatible with the i486. Disregarding all the architectural improvements you can expect in such a chip, the decrease in clock period alone will result in a tenfold increase in speed. Supercomputers can't look forward to a corresponding decrease in clock period. They are already closely bound by the speed of light, which travels about 1 foot in 1 ns.

In the near future, however, it will be advances in architecture, not faster clocks, that bring supercomputing performance to desktop machines.

The Pipes Are Calling

Pipelining—always a feature on supercomputers—is becoming indispensable

Most PCs exhibit many properties that you associate with supercomputers.

to desktop machines as well. One of the most important features of the i486, for instance, is a 5-stage instruction pipeline that helps keep the processor consistently busy. The new Motorola 68040 goes even further. It maintains separate instruction and data pipelines inside the processor, with separate caches for each.

Although the complex-instruction-set-computer (CISC) processors are catching up, pipelining has had its biggest impact in RISC processors. These usually feature two or more processing units, each with its own pipeline. The units execute in parallel, allowing RISC machines to execute multiple instructions simultaneously. Some RISC processors also feature separate external buses for data and instructions.

Another area where desktop machines are finally emulating supercomputers is in intelligent I/O. Until recent years, most desktop machines used the central processor to move instructions and data between main memory and peripheral devices. Recently, however, sophisticated I/O buses such as the Micro Channel and Expanded Industry Standard Architecture have freed central processors from having to worry about moving bytes around the system. The processor is able to concentrate on processing.

Sharing the Burden

Supercomputers have always featured specialized processors for specialized tasks. Likewise, desktop computers have used specialized coprocessors for years. For example, math coprocessors are available for all popular Intel and Motorola CPUs. The difference is that these processors are now being built onto the microprocessor chip itself. The performance advantages of this integration—as evidenced by the i486 and the 68040—are substantial.

In addition, many companies offer general-purpose and special-purpose coprocessor boards for different desktop machines. These boards perform tasks faster than the host CPU, thus speeding up the system. Some coprocessors offer better overall performance than the host and simply take over the system. Others, such as array processors, are designed to perform a specific task much faster than the host.

Side by Side

Advances in clock speed, pipelining, intelligent I/O, and coprocessing will all substantially increase the performance of desktop machines in the near future, but parallel processing will surpass all of them in importance. Supercomputers feature both micro- and macroparallelism. Both forms are also showing up on desktop machines.

Microparallelism is the presence of multiple execution pathways within the same processor. For example, the Intel i860 contains three separate pathways—integer, floating-point addition, and floating-point multiplication—that perform math functions. Each pathway has its own pipeline, and they can execute simultaneously. In addition, the floating-point adder and multiplier can be combined to form a vector processor. The i860 represents a trend toward multiple independent execution pathways in a processor, allowing the execution of more than one instruction per clock cycle—a type of architecture called *superscalar*.

As the name implies, macroparallelism does not take place within a single processor, but involves tying together multiple processors of the same type. If the individual processors also feature microparallelism, so much the better. Processors in a macroparallel machine are tied together in two different ways, with a common bus and with point-to-point connections.

Magic Bus

When connected by a common bus, processors communicate by using shared memory; such machines are thus called shared-memory machines. A good example is the Cray Y-MP, which allows up to eight processors to access the same memory space.

Recently, several companies have produced shared-memory machines based on microprocessors. The Zenith Z-1000 and the Compaq Systempro are the two most notable examples. While shared-memory machines are relatively easy to program, they do have limitations. The biggest is that performance doesn't increase linearly as processors are added.

The more processors there are in a shared-memory system, the more time they spend contending for the bus and keeping data coherent, and the less time

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they have to actually process data. As a result, such systems can only scale up so far before the addition of more processors would simply saturate the bus.

Message in a Bottle

The second form of macroparallelism is called message passing. Here, processors don't share a common memory space; rather, they use their own memory and communicate via messages—usually sent over serial links. Arbitration and coherency are not a problem with such systems, but synchronization is. If one processor needs data from another, and the first hasn't finished its computations yet, the second processor must wait until the first processor finishes. The advantage of message-passing systems is that they can theoretically accept an infinite number of additional processors and still obtain linear or near-linear performance increases with each.

Although they are harder to program than shared-memory systems, message-passing systems are showing up both on desktops and in supercomputing centers. Perhaps the most famous example of a message-passing machine is the Connection Machine from Thinking Machines. This massively parallel machine features over 64,000 identical processors. Recently, Intel announced a message-passing machine—the iSPC/860—that uses from 16 to 128 i860s and can deliver up to 7.6 GFLOPS.

On the desktop, message-passing parallel systems are best represented by transputer-based coprocessing cards. The Inmos transputer is designed specifically as a message-passing processor. Its low cost makes it a natural for desktop systems.

The best thing about parallel-processing technology is that its effects are cumulative. If you increase the clock speed of the individual processors, you increase the speed of the system. Improved pipelining and better use of coprocessors within the individual processors also give a nice boost to system performance, regardless of any improvement to the parallel architecture itself.

Cray Me a River

With most of what makes a supercomputer "super" showing up in desktop machines, you can expect to be able to perform more and more supercomputing tasks on your desktop. Actually catching up with the Crays of the world is a more difficult proposition. To supercomputer buyers, the cost is secondary to the performance. Thus, supercomputer manufacturers can use the latest technology, no matter what the cost, to achieve ever-increasing performance.

The Cray Y-MP, for instance, uses high-speed, expensive ECL chips for main memory, instead of the MOS chips used in desktop machines. The SX-X uses BiCMOS static RAM. Both use high-speed bipolar elements throughout. Who will be the first to produce a machine based entirely on gallium-arsenide technology? It will be a supercomputer manufacturer; you can count on it.

Although you'll certainly be able to perform many functions once reserved for supercomputers on your desktop, matching the performance of the latest and greatest supercomputer is currently prohibitively expensive. But don't be discouraged; time is on your side. ■

Bob Ryan is a BYTE technical editor. He can be reached on BIX as "b.ryan."

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Spending Your Free Time

A parallel system of supercomputer power is free for the taking in the idle machine cycles of a network's processors

David Gelernter and James Philbin

One way to solve a difficult problem fast is to break the problem into separate pieces and work on all the pieces at the same time. This idea is the whole basis for parallel computing. A parallel program breaks a difficult problem into pieces and then distributes them to a crowd of waiting processors. All the processors work together to find a solution.

Parallelism is a tested and proven way to speed up the process of solving difficult problems. While we used to hear claims that it would be hard to find programs that could be "parallelized," in fact, it has been harder to locate large programs that *cannot* be. Parallel programs are being used in areas such as numerical problem solving, graphics, databases, simulation of large physical and engineering systems, and financial modeling. Today, if you're interested in running programs quickly, you're interested in parallelism, whether you know it or not.

A parallel computer is a single machine that can bring multiple processors to bear on one or more tasks. There are many parallel computers on the market, ranging from workstations with a small handful of processors to huge supercomputers with thousands of processors. Parallel computers are powerful, tend to be relatively simple, and will be a dominating factor in computer architecture in the 1990s.

Parallelism's most important arena, however, may have nothing to do with these machines. With appropriate software and a network, your existing computers can act as a powerful parallel computer.

Hyperactive

To run a program in parallel, you need at least two processors, preferably more, connected together. A parallel computer meets these requirements, but so does a computer network. Whether the processors occupy one box or are strung out across the country, you can take a tough problem, break it into pieces, and hand one piece to each of *n* processors.

Take a medium-size organization, for example, with a network of 100 workstations or personal computers. How busy are the machines? What portion of processor cycles is actually idle? Assume that during normal work hours, the machines are idle, on the average, about half the time. The real amount of idle time may be a lot higher, however. Even if you run a lot of compute-intensive problems, you also read your mail, edit files, think, eat lunch, and so on. But assuming an average idle time of 50 percent, this organization also owns, on average, a 50-processor (or 50-node) parallel computer, and that's during the workday. Overnight and

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on weekends, it might own a 90- to 100-node parallel computer.

How can you use this essentially free parallel computer? When some node on the network has a parallel program to execute, it can offer pieces of the program to other nodes. Some of them will be idle, accept a piece, and begin work. When they are finished, if they are still idle, they will accept another piece and keep going. Some nodes will be too busy to accept a piece. Others will be fairly busy, accept a piece, and progress slowly on it. Through this processor sharing, you can take advantage of quite a bit of the network's unused capacity.

We refer to this kind of network-based parallel computer as a *hypercomputer.* A hypercomputer isn't merely a computer network by another name; it's the parallel computer that *emerges from* the idle portion of the network, like a genie from a bottle. The hypercomputer grows and shrinks depending on the network's unused capacity. It doesn't live in a single box; it takes up temporary residence inside all the network nodes that happen to be available at a given time. You can describe the hypercomputer in statistical terms: its average power and its average size. Whenever the network expands or machines are upgraded, the hypercomputer's power pool grows.

Processors inside a single-box parallel computer can usually communicate at much greater speeds than networked processors can, but the principle of parallelism is the same in both cases. Because of the difference in communications speed, some programs that run well on parallel computers do not run well on networks. But there appear to be many applications that succeed in both environments.

While hypercomputers can be built on many different network protocols, you need appropriate software to release the genie from the bottle. Hypercomputer Linda, from Scientific Computing Associates, is one example of such software. It is built on top of the Network Computer System/Remote Procedure Call protocol. NCS/RPC, from the Apollo division of Hewlett-Packard, takes care of data conversion between heterogeneous machines. It also takes care of protocol conversion between different network architectures. It runs on LANs and wide-area networks (WANs) and can encompass all sorts of machine architectures. (Benchmarks of hypercomputer Linda are presented in reference 1.)

Getting Coordinated

Ordinary programming languages aren't geared for writing parallel programs; you need a parallel language or programming environment. A good parallel-programming environment should augment, not obsolete, your favorite languages.

Linda is a coordination language. It supplies the glue that enables you to cement a bunch of independent processes together into a single parallel program. The separate computations can be expressed in any language. A coordination language (e.g., Linda) can be combined with a computation language (e.g., C) to produce a complete parallel-programming language (in this case, C-Linda, also from Scientific Computing Associates). C-Linda systems exist for a variety of shared-memory and distributed-memory parallel systems.

A good parallel-programming environment exists at the language level, not system level. A coordination language

continued

Meet Linda

Linda is an elegant and easy-to-use parallel language. Its power and expressivity result from its use of *tuple space* for interprocess communications and synchronization. Tuple space is a global, associative, object memory that holds *tuples*. A tuple is a sequence of typed fields, where each field is an expression that has a value or a *potential* value. For example,

```
("person", 23, ?x)
```

is a tuple with three fields. Two are values—the string "person" and the integer 23; one is a potential value—the variable x.

Tuples can be inserted into, read or removed from, and evaluated (computed) in tuple space. Four operations accomplish these functions.

$\mathtt{out}(f_1, \ldots, f_n)$	adds a tuple
$\mathtt{in}(f_1, \ldots, f_n)$	removes a tuple
$\mathtt{rd}(f_1, \ldots, f_n)$	copies a tuple
$\mathtt{eval}(f_1, \ldots, f_n)$	evaluates a tuple

The argument to each operation is a tuple, composed of fields f_1 through f_n. Each operation is atomic, so many different programs can safely manipulate tuple space simultaneously.

Adding to Tuple Space

The out operation adds a tuple to tuple space. The value of each tuple field is computed before adding it to tuple space. These are called passive tuples. The eval operation behaves like out, except that field values are determined *after* adding the tuple to tuple space; they are computed concurrently. These are called active tuples. An active tuple turns into a passive tuple when the values of its field expressions have been determined.

Typically, the fields of an eval operation contain procedure calls. For example, if sqrt(n) is a procedure that yields the square root of *n*, then

```
eval(sqrt(4), sqrt(9), sqrt(16))
```

creates an active tuple with three field expressions and adds it to tuple space. Once in tuple space, the active tuple creates a new thread of control (a process) for each field and computes its value in that thread.

The active tuple above turns into the following passive tuple once all its field values have been determined:

```
(2, 3, 4)
```

Computing a field value in an active tuple may invoke other Linda operations, including eval, to communicate with other processes.

Retrieving from Tuple Space

The in and rd operations retrieve tuples from tuple space. The in operation removes a tuple; rd copies one. Tuples have no names or addresses; rather, in and rd use *associative matching* to locate them. This is similar to the kind of matching that occurs in a relational database.

The arguments to the in and rd operations form a *tuple template*. Templates are formed in the same way that tuples are formed and have the same syntax, but they aren't put into tuple space. Instead, they're used to get tuples out of tuple space. Only passive tuples can match a template; thus, in and rd never obtain active tuples. If no matching tuple is available, in and rd will wait until one shows up.

A field in a tuple can contain a value or a potential value. Potential values have a "?" in front of their field expressions. For example,

```
in("account", id, ?name, ?amount)
```

is an in operation with a tuple template containing four fields, two with values (the string "account" and the variable id) and two with potential values (the variables name and amount). When this template matches a tuple in tuple space, the values of its third and fourth fields will be assigned to the variables name and amount.

Computer Dating with Tuples

If a tuple and a template have the same numbers of fields and their corresponding fields match, then the tuple and the template also match. For a tuple field and a template field to match, the fields must have the same type, and either both fields contain equivalent values or one field contains a value while the other is a potential value.

For example, the tuples

```
("example", i)
( ?s , 3)
(example , ?j)
```

match each other if the variables have the following declarations:

```
int i = 3;
int j;
char example[] = "example";
char s[8];
```

Programs that are designed to use tuple space are portable across widely divergent parallel architectures, including shared-memory, message-passing, and network-connected systems.

FURTHER READING

C-Linda Users Guide and Reference Manual, Scientific Computing Associates, Inc. (246 Church St., Suite 307, New Haven, CT 06510).

supports process creation and interprocess communications. Both services are usually available directly from the operating system in one form or another. Thus, you could bypass coordination languages and rely directly on the operating system for the parallel-programming support that you need. This strategy is simple; unfortunately, however, it is also primitive.

A coordination language is supported by a compiler and a program-development environment; an operating-system library is not. (The C-Linda compiler, for example, is the most important piece of the C-Linda system. It is implemented as a precompiler generating standard C language code.)

The C-Linda compiler supports clean syntax, compile-time error checking, and high-level run-time debugging and visualization. Most important, it is an optimizing compiler, so it can support Linda operations efficiently with minimum run-time expense. A communications model like Linda's would be impossible without compile-time optimization. Even a first-rate distributed operating system like Mach is no more a substitute for Linda than it is a substitute for C. Mach and Linda have different purposes. (On the other hand, Mach is an excellent foundation for Linda.)

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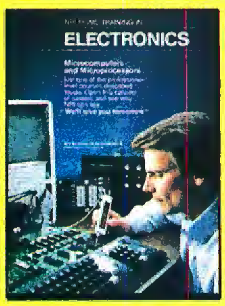

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A good parallel-programming environment must be portable. It must run on any reasonable parallel computer and on any collection of network hosts. Most important, it must be easy to use. Where hypercomputers are concerned, this entails some special requirements.

A Harmonious Match

Parallel programs for hypercomputers face some special conditions. For one, you don't know which processors a given program will run on. For another, you don't know *how many* processors it will run on—a program must be able to take advantage of whatever processors are available at the moment. In addition, network nodes may enter and leave a computation as it progresses.

A tuple space is an object that exists, but you can't say exactly where.

One approach to handling these conditions is to use the "master/worker" programming paradigm. A master process breaks a program into pieces, or tasks. Each of a collection of identical worker processes grabs a task, performs it, sends the result back to the master process, grabs another, and so on. When no tasks remain, the job is finished.

To build this kind of program with Linda (see the text box "Meet Linda" at left), tasks are dropped into Linda's *tuple space*, one task per tuple. When a worker process needs a task, it simply reaches into tuple space and grabs one. (Tasks can be started in a particular order, if necessary, by using an appropriate data structure. See reference 2.) Tuple space can hold input data or intermediate results as well. When a worker process finishes a task, it drops the result into tuple space, and the master process scoops it out.

This kind of Linda program works the same way regardless of where the worker processes are, or how many there are (as long as there is at least one). Tasks are scheduled dynamically. As a result, the program works the same way with one worker or 100 (100 workers merely run through the pile of tasks faster). Reasonable load-balancing occurs automatically—one worker process may complete a dozen short tasks while another works on a single long one.

Joining and leaving computations become simple, in principle. A node that was busy but is momentarily free simply grabs a task and begins work on it. A worker process can easily leave between tasks. (Although a worker cannot formally resign from a computation, higher-priority local demands can slow its progress. To cope with this possibility, the master process might reissue tasks under some circumstances.)

Consider the interesting conceptual harmony between hypercomputers and tuple spaces. A tuple space is a kind of shared memory, but unlike other shared memories, the objects in a tuple space have no addresses—they are retrieved by relational database-style matching. So, the physical location and the relative ordering of the tuples are irrelevant.

A tuple space is merely a flock of free-floating tuples; they have no physical addresses to tie them down. A tuple space as a whole is a physical object that exists, but you can't say exactly where.

This same freedom holds for hypercomputers. They exist and can solve problems, but they aren't tied to any particular location, any particular processor. As such, they are in perfect harmony with Linda.

As Invisible as Possible

In a hypercomputer, a node can be anything from a single-processor PC to a shared- or disjoint-memory parallel supercomputer. We'll use the term *node* to refer to any machine connected to the network.

The Linda-based hypercomputer had two principal design goals:

1. It should be invisible to network users who are not hypercomputer users; it shouldn't affect the efficiency or responsiveness of any network node.
2. It should recover as many idle machine cycles on the network computers as possible without compromising the first goal.

The principle of invisibility is very important. You don't want to donate your unused machine cycles to the hypercomputer if your local environment suffers. In practice, you can't achieve total invisibility, but you can come close.

There are three ways in which the hypercomputer can degrade the performance of a network node:

continued

1. It can grab processor cycles that you could have used locally.
2. It can overload the network with hypercomputer traffic.
3. It can force nonhypercomputer programs out of main memory.

If each node can decide when and on what basis it is available, the hypercomputer cannot grab locally needed cycles. A node's local owner decides on an availability policy, and the node announces it to the hypercomputer. Furthermore, hypercomputer processes are scheduled with background priority; therefore, they run only when the node has nothing else to do.

We don't believe that hypercomputer-generated network traffic will be a serious problem. Most networks operate with large reserves of communications capacity. These reserves will be even larger with high-bandwidth fiber-optic networks.

Even in high-traffic networks, communications demands tend to be high only during specific periods of the day (e.g., during network backups). In addition, hypercomputer programs tend to be coarse-grained, to do as much computing as possible between communications operations. Excessive hypercomputer-generated communications affects both the users and the hypercomputer applications adversely, so applications developers will probably avoid it.

Forcing nonhypercomputer programs out of main memory isn't a factor for idle nodes. But for nodes in interactive use, this effect may be noticeable, particularly when you stop interacting with the computer for several minutes and then start again. If you notice this effect and don't like it, you can change the availability policy for your node.

Getting Down to Basics

Configuring the hypercomputer requires listing all member nodes and describing the hardware configuration and availability policy of each. It is becoming increasingly common for LANs and WANs to be interconnected with other networks. Where this is so, nodes must be associated with the hypercomputer they belong to. A node can belong to only one hypercomputer at a time (although it is possible for a node to be part of one hypercomputer during the day and another at night). The hypercomputer configuration file specifies which nodes are potential members of the hypercomputer.

After establishing the configuration, the local-node configuration file must be set up; each potential hypercomputer node needs its own copy of this file. It has two parts: the local node's hardware description and its availability policy.

The hardware description contains entries such as processor genus and species (e.g., genus Motorola MC68000, species MC68030), number of processors, MIPS (millions of instructions per second) rating for each processor, presence or absence of floating-point accelerators, and (if they are present) their MFLOPS (million floating-point operations per second) rating. The hypercomputer knows this information for most common processors.

The availability policy specifies when the node is available to the hypercomputer. The options include the following:

- time period when the node is available;
- load average above which the node becomes unavailable;
- whether or not the node is available if someone is logged onto it, and if so, after how many seconds of no interaction (this option is mainly for PCs and workstations); and
- maximum number of hypercomputer processes allowed on this node.

If any of the availability criteria is unsatisfied, the node is unavailable.

Daemon Run

The hypercomputer needs a way to distribute the processes among its various processors. The hypercomputer *daemon* (a process that runs continuously in the background) performs this distribution; it has two parts—the scheduler and the allocator. Every node in the hypercomputer runs the daemon. When it starts up, the daemon loads the configuration file to determine which nodes belong to the hypercomputer. If a particular node is a designated scheduler node, the daemon checks with the network location broker. Then the scheduler part of the daemon sits back and waits for nodes to declare themselves available.

The scheduler must be running for the hypercomputer to be available. If the network is up, the hypercomputer can and probably should be available. To ensure this level of reliability, it's a good idea to replicate the scheduler so it can run on more than one node. But it's not necessary; the scheduler can run as a single, unreplicated server. If it is replicated, each scheduler knows where its peer schedulers reside. They communicate among themselves, ensuring that each has an up-to-date copy of the available processor database. If one of the schedulers fails, the daemon will start a peer to replace it.

The allocator part of the daemon reads the local-node configuration file on start-up, then queries the location broker for the scheduler's address, and registers its node with the scheduler. The registration message includes the node's address and its configuration information. At this point, the scheduler knows that the node is part of the hypercomputer but is not yet available. Next, the allocator determines whether the node is available, using its local availability policy as a guide. If the node is not available, the allocator becomes inactive for a while. It wakes up every so often to keep checking availability.

If the node is available, its allocator sends a message to the scheduler noting current load average and an availability time-out period. The scheduler makes a new entry in its node queue, which is ordered on load average, with least-loaded nodes first. Local allocators send the scheduler refresher messages every so often as notices of their continued availability. If the scheduler doesn't receive such a message before the end of a time-out period, it assumes that the node in question is no longer available. It will assign no further work to that node until it receives a new availability message.

Handing Out the Work

Linda programs create processes on the hypercomputer with the `eval` operation. When a Linda program wants to create other processes, a request is sent to the local allocator. The message requests one or more processors and may contain processor-specific information such as processor type or minimum MIPS or MFLOPS rating. The message also gives the name of the program (or programs) to run on the allocated processors.

The allocator forwards the message to the scheduler. The scheduler then selects appropriate processors, marks them unavailable, and sends messages to the allocators on each of the selected processors. These messages request that the allocator create a new process and run the specified program.

The local allocator is responsible for creating any hypercomputer processes that are allocated on the local node. When it receives a creation message from the scheduler, the allocator creates a new process, with a background priority, and runs the specified program in it.

A node can run more than one hypercomputer process at the same time. Before sending the "create process" message, the scheduler marks the allocated node unavailable. After creating the new process, the allocator continues to check its node's availability. If it is still available, the allocator informs the scheduler.

Users access the hypercomputer through its shell. This shell includes commands to run Linda programs, compile them for different processor types, show the status of processes and processors, kill a process on any node, kill a program and all its associated processes, and submit programs to be run at a later time. (The hypercomputer software also includes a hypercomputer tuple scope, which is a graphical interactive debugging and analysis utility for use with Linda programs.)

Uncorking the Bottle

Although parallel computing has usually implied multiple processors in one box, it is no longer restricted to this view. The many processors in a network can be harnessed and used for parallel processing as well. You need appropriate software to access this hypercomputer, but other than that, it is essentially free for the taking by using unused, but available, machine cycles from the various processors on the network.

As networks proliferate in the workplace, hypercomputers can use this wasted power. While communications between processors within a single box may be faster, the concept of parallelism works the same way across the network. Hypercomputer Linda is one example of the kind of software that can access this power and let the genie out of its bottle. ■

ACKNOWLEDGMENT

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David Gelernter is an associate professor of computer science at Yale University (New Haven, CT). James Philbin is a research scientist and product manager for Scientific Computing Associates, Inc. (New Haven, CT).

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A Fearful Symmetry

Watch out, uniprocessor systems—here's systems software that can harness the power of multiple processors

Craig Keating

Multiprocessing is hot. With companies like Compaq and Zenith Data Systems now selling systems that harness the power of multiple microprocessors, personal computers can compete in areas formerly reserved for much larger systems. To complement their multiprocessing hardware, some of these companies are turning to MPX from The Santa Cruz Operation (SCO) as one means of providing multiprocessing software.

MPX—a multiprocessor extension to SCO Unix—is based on smp (for symmetric multiprocessor) from Corollary. It is an off-the-shelf software package that runs on several multiprocessing computers, including the Corollary 386/smp and 486/smp, the Compaq Systempro, the Zenith Z-1000, the Mitac Series 500, and the Apricot MC486. MPX is designed to let you run software developed for SCO Unix on a multiprocessing system without modification. It also lets you take advantage of standard peripheral devices by running unmodified device drivers. A look at it points out the problems inherent in designing multiprocessing systems.

MPX Roots

Corollary has been developing multiprocessor software and hardware for over four years. Its primary goal is to provide core multiprocessor systems that take advantage of off-the-shelf third-party software and peripherals (see the text box "The smp Hardware" on page 222). For this reason, the company discarded software solutions that involved message-passing and proprietary operating systems. Instead, smp consists of numerous enhancements to an already popular operating system—SCO Unix System V/386. SCO Unix was used as the base for smp because of its dominant market position, its large installed base, and the many software applications and device drivers available for it.

To maintain compatibility with SCO Unix applications, Corollary restricted all multiprocessing modifications for smp to the kernel. The smp kernel consists of one text segment and one data segment, just like the uniprocessor kernel. All CPUs in the system run a single copy of the kernel text and share the same kernel data. The smp kernel runs standard off-the-shelf Unix applications.

In addition, the smp kernel supports AT-bus peripheral devices with off-the-shelf Unix device drivers. This software and hardware compatibility doesn't require any source code changes or recompilation. The fact that an smp system is running with more than one CPU is transparent to the user in every way except performance.

continued

The smp Hardware

On the hardware side, Corollary provides a core computer system consisting of CPUs, caches, memory boards, and buses. This technology, termed 386/smp and 486/smp, lets you add more than one CPU to a PC architecture. In fact, the first CPU in the system is completely PC compatible; it has access to global shared memory and an AT bus. Since the AT bus is not suitable for multiple CPUs, the smp architecture includes a second bus called the C-bus (cache bus). The AT bus is used for booting the system and for third-party peripherals, while the C-bus provides increased memory bandwidth, cache coherency, and fair arbitration.

To satisfy the memory bandwidth that multiple CPUs require, each CPU comes with a local 256K-byte direct-mapped, write-back cache that transfers written cache data to the common shared memory only when needed. The write-back cache reduces bus and memory contention by approximately a factor of five when compared to a comparable write-through cache. Minimizing bus traffic lets you connect up to 10 CPUs to the shared memory while keeping the bus utilization under 50 percent.

The 486/smp is a global shared memory architecture (see figure A). Each CPU may or may not have I/O interfaces associated with it. Figure A shows two CPUs with serial I/O, one with a SCSI port, and one with an AT bus. This not only prevents I/O bottlenecks by distributing the I/O among different CPUs in the system, but also minimizes the number of slots needed to create a powerful system. Performance-critical I/O (i.e., disk and serial I/O) has been moved to the additional CPUs. This utilizes the significant bus-speed advantage of the C-bus while freeing up the scarce bandwidth of the AT bus. The SCSI disk adapter, in particular, was designed with scatter-gathering DMA logic and specialized to take full advantage of the C-bus.

The smp hardware is used in the Zenith Data Systems Z-1000 and Mitac Series 500, as well as in Corollary's 386/smp and 486/smp.

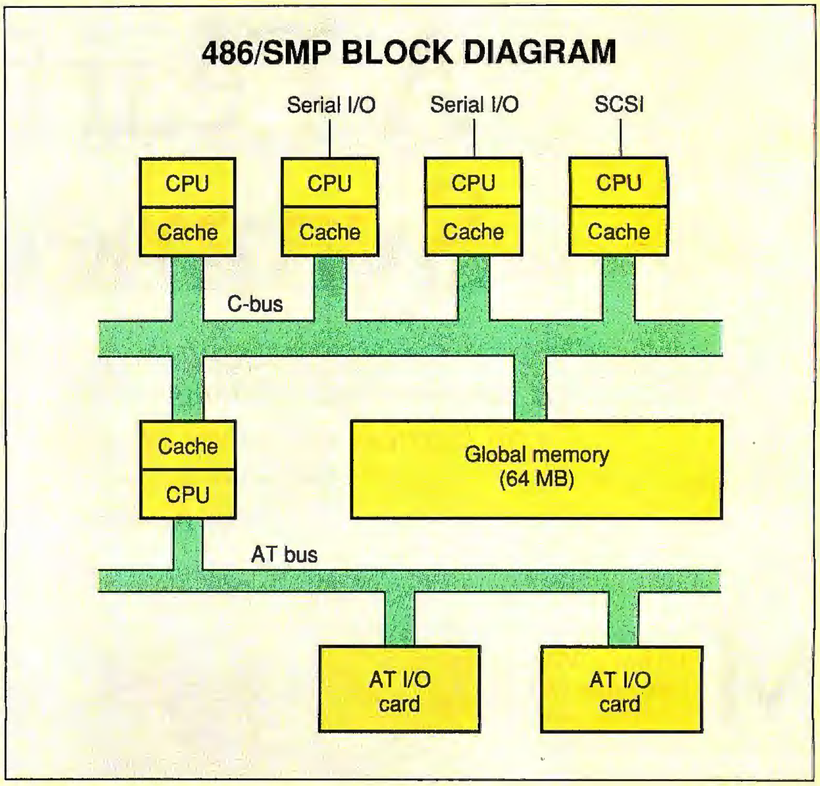

Figure A: *The 486/smp block diagram shows the dual-bus nature of the smp hardware. The default CPU provides access to standard peripherals via its connection to the AT bus. The high-speed C-bus connects the processors to each other and to the shared memory. Optionally, the processors can also provide direct I/O to the C-bus.*

Shadowed Structures

Because existing Unix utilities and device drivers access routines and data structures in the kernel and rely on their results or contents, certain parts of it could not be modified for smp. To maintain full compatibility with all Unix applications and device drivers, the file system layout, system call interface, object and executable file format, kernel data structures, and kernel routine parameters, actions, and return values remain unchanged. However, the kernel must maintain more information than the standard Unix data structures contain to allow multiple CPUs to run tasks simultaneously. This additional information is kept in new data structures established in parallel to the standard ones; this maintains both applications software and driver compatibility.

You install the smp kernel by installing new object files into the Unix Link Kit and rebuilding the kernel. Booting the smp kernel is the same as booting a standard Unix kernel on a 386 or 486 machine: The BIOS ROM loads the kernel into memory and passes control to it. Once booted, the smp kernel determines the multiprocessor-platform type (e.g., 486/smp, Systempro, or Z-1000) and the number of CPUs in the system.

The smp kernel was designed to meet a number of important goals. It must provide both source code and binary compatibility with existing Unix applications and device drivers. It must also require minimal changes to the uniprocessor Unix kernel, take an incremental approach to multiprocessing modifications, provide hardware portability, and result in increased performance under intensive work loads as the number of CPUs increases from one to 16.

Kernel modifications for smp were made strictly to support multiprocessor technology. For the most part, these

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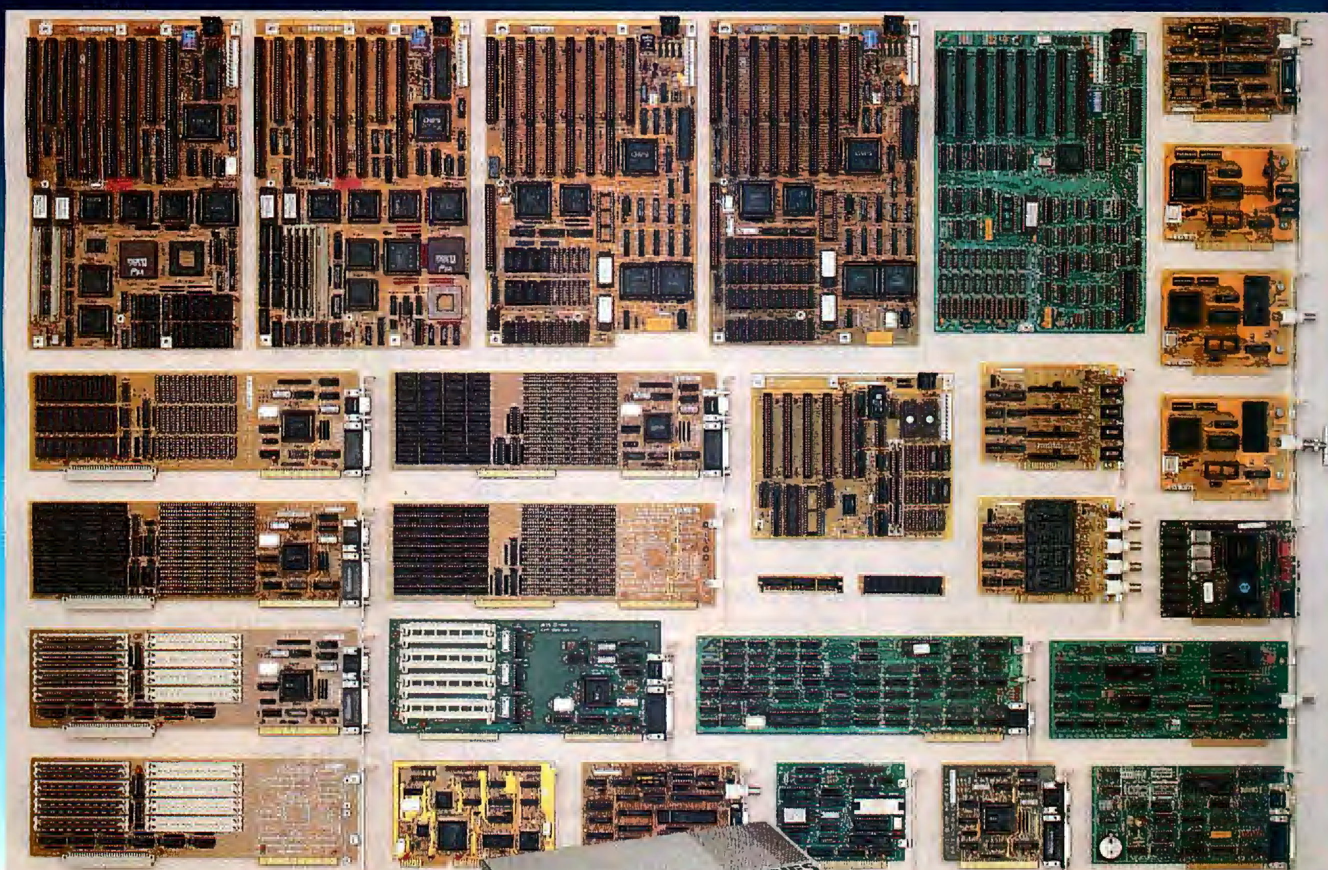

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changes involved making areas in the kernel reentrant, not rewriting large portions of it. The minimal changes involved in producing reentrant code reduce the risk of incompatibility. In addition, minimizing kernel changes simplifies the task of tracking future Unix releases.

Multiprocessor technology greatly increases the number of users the system can handle. An smp system can start out supporting a few users and incrementally grow to support over 200. This additional capability forced some kernel profiling and resulted in optimizations that provide increased performance without compromising compatibility.

The Quest for Compatibility

Compatibility is achieved by restricting modifications made to the kernel and by establishing certain guidelines for those modifications. In keeping with the philosophy that multiprocessing should be transparent to the user, you don't need to modify application programs to take advantage of multiple CPUs. Thus, the smp kernel can run all the standard Xenix/Unix applications available from third-party software vendors.

Maintaining driver compatibility is a more difficult task. To ensure it, kernel header files, routine parameters, and return values are left unaltered. This allows the smp kernel to run device drivers from third-party hardware vendors unmodified. In fact, the device-driver source code doesn't even require recompilation.

The Incremental Approach

In its earliest development stages, the smp kernel was not very symmetric. Only the CPU that booted the system (the "default" CPU) could execute system code; the other CPUs executed user code only. During the design process, some added testing using commercial applications determined the frequency with which each system call was used. Then, on an incremental basis, the system calls that composed 80 percent of the total call frequency were modified so that any CPU could execute them. However, the default CPU must still execute the remaining system calls. The system uses a table—established at link time—to determine (at run time) whether a given system call can execute on any CPU in the system or only on the default CPU.

At first, the smp kernel also restricted device drivers to the default CPU, so you could link any device driver to the kernel without modifying or even recompiling it. However, now you can modify performance-critical device drivers so that any CPU in the system can execute them. (Unmodified drivers will still run only on the default CPU.) The system maintains a table that shows which device drivers have been modified. The smp kernel can thus determine at run time—just before calling a device driver—whether any CPU or only the default CPU can execute its code.

The incremental approach used to modify system code and device drivers points out the advantages of having a default CPU. This CPU provides the hardware and software environment that standard drivers expect; thus, all existing or future device-driver code can execute unmodified. Letting you take advantage of the latest innovations in driver software as it becomes more advanced is an important feature of smp. The default CPU also minimizes engineering risk by letting Corollary and third-party device makers test each modified driver or newly distributed system call.

Scheduling User Processes

Once you boot the smp kernel, the system can execute any user program (i.e., process) on any of the CPUs in the system. The scheduler code chooses the process to be executed next by selecting the one with the highest priority. The scheduler is multithreaded, so all CPUs can execute it simultaneously. Each CPU is thus self-scheduling: Each is responsible for selecting which process it will execute. The alternative would be to have a single controlling CPU using a complicated load-balancing algorithm to migrate processes to the individual processors.

Like its uniprocessor cousin, the smp kernel has a single run queue that all the CPUs in the system share. The run queue is a linked list of all processes that are ready for immediate execution. When a CPU is available, it removes the highest-priority process from the run queue and executes it. When the process is no longer executable (e.g., when it is waiting for I/O), the CPU returns it to the run queue and chooses another process.

The scheduler in the smp kernel uses the standard Unix priority algorithm to select a process. It has only been modified to accommodate the default CPU. When a CPU other than the default encounters unmodified device-driver code or a nonmultithreaded system call, it returns the process to the run queue after marking the process as one that can run only on the default CPU. The scheduler will let only the default CPU select a process that is marked. As soon as the default CPU executes the marked section of code, the process is once again marked as executable by any CPU.

The default CPU chooses marked processes before any others, regardless of the priorities of the unmarked processes. If it finds no marked processes, it will execute the highest-priority unmarked process. The default CPU must search the run queue only once to determine its next process, regardless of whether it chooses a marked or an unmarked process.

The smp system provides the scheduler with additional multiprocessor system-control features through a pseudo-driver. You invoke these additional control features using calls to the driver. Unlike using additional system calls, using a driver doesn't compromise compatibility. The pseudo-driver supports the following additional features:

- enable/disable CPUs from executing processes;
- lock a process to be executed by a specific CPU; and
- force a CPU to execute only processes that are locked on it.

These features were crucial initially for smp kernel development and debugging. Because of this, the system still furnishes both the interface to these driver calls and an application program that uses them. In general, however, the scheduler performs markedly better without using these features.

Getting in Sync

In a multiple CPU environment, processors execute common kernel code and operate on common data structures. The mechanism that guarantees mutual exclusion to code and data is called *synchronization*.

Many sections of code—called critical sections—cannot tolerate more than one CPU executing them at the same time. There are a number of ways to provide mutual exclusion using software-locking mechanisms, but they are costly and impose a lot of extra overhead. The smp kernel requires synchronization support in hardware.

Specifically, the smp kernel requires that the hardware support "test and set." This is typically supported with the xchg instruction in the 386 and i486 processors. These chips have a lock signal that the hardware can use to support indivisible bus cycles. The xchg instruction will assert LOCK for the duration of the instruction; therefore, no other CPU can access memory between the read and the write exchange.

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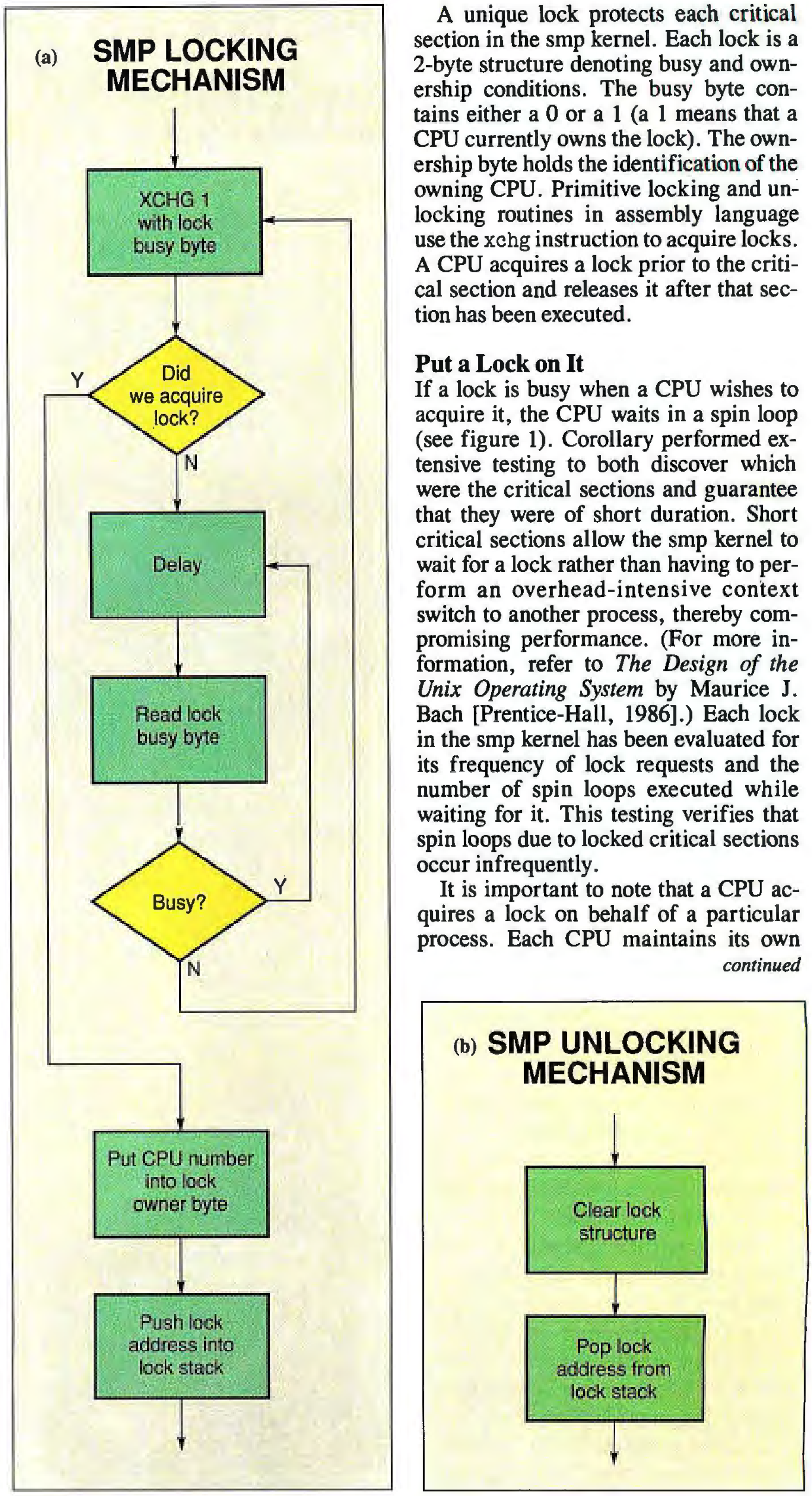

Figure 1: *Locks on critical sections of kernel code keep individual processors from corrupting the common shared kernel data.* **(a)** *Acquiring a lock can involve a spin loop when another processor already owns the lock.* **(b)** *Freeing a lock is straightforward.*

A unique lock protects each critical section in the smp kernel. Each lock is a 2-byte structure denoting busy and ownership conditions. The busy byte contains either a 0 or a 1 (a 1 means that a CPU currently owns the lock). The ownership byte holds the identification of the owning CPU. Primitive locking and unlocking routines in assembly language use the `xchg` instruction to acquire locks. A CPU acquires a lock prior to the critical section and releases it after that section has been executed.

Put a Lock on It

If a lock is busy when a CPU wishes to acquire it, the CPU waits in a spin loop (see figure 1). Corollary performed extensive testing to both discover which were the critical sections and guarantee that they were of short duration. Short critical sections allow the smp kernel to wait for a lock rather than having to perform an overhead-intensive context switch to another process, thereby compromising performance. (For more information, refer to *The Design of the Unix Operating System* by Maurice J. Bach [Prentice-Hall, 1986].) Each lock in the smp kernel has been evaluated for its frequency of lock requests and the number of spin loops executed while waiting for it. This testing verifies that spin loops due to locked critical sections occur infrequently.

It is important to note that a CPU acquires a lock on behalf of a particular process. Each CPU maintains its own

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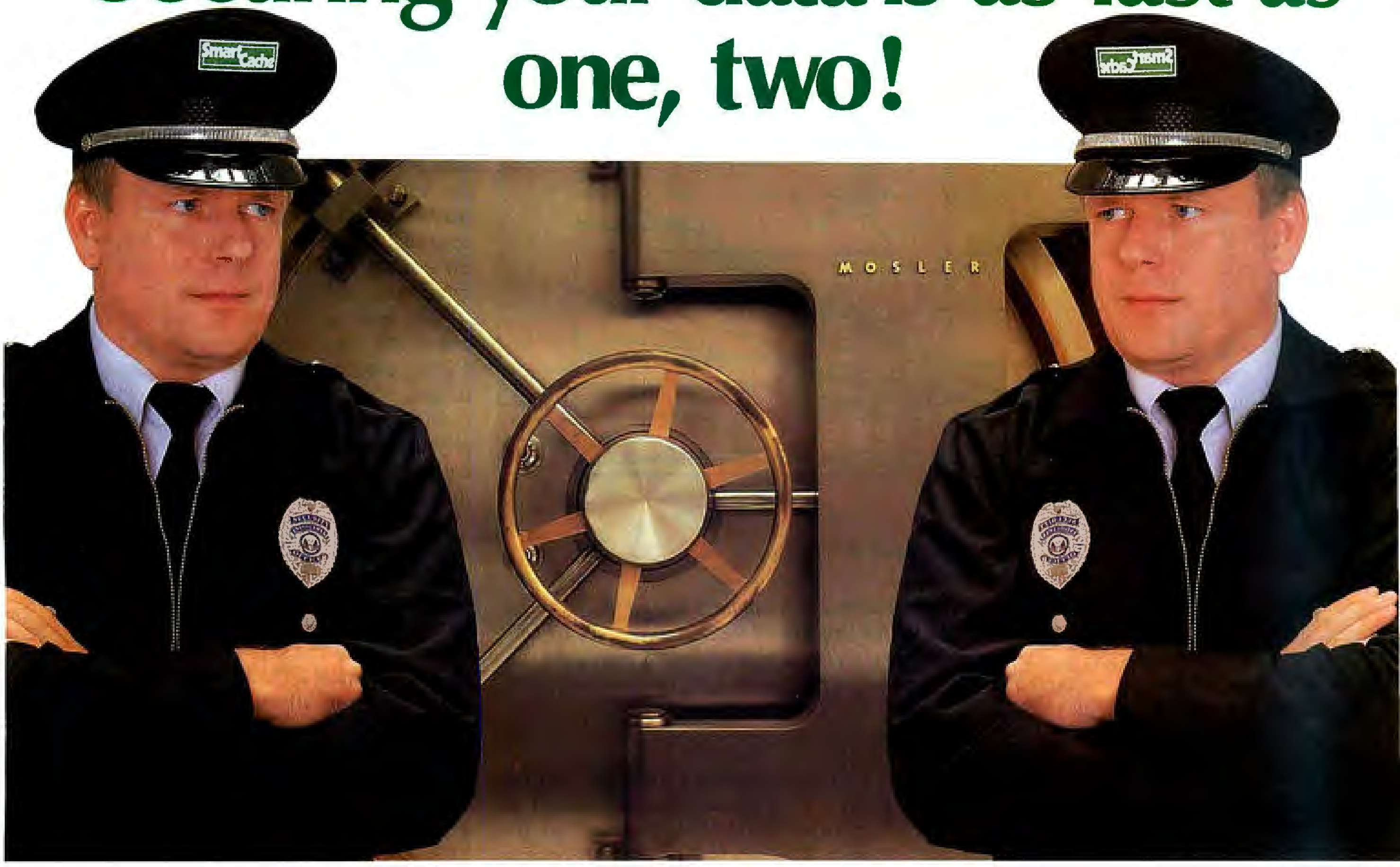

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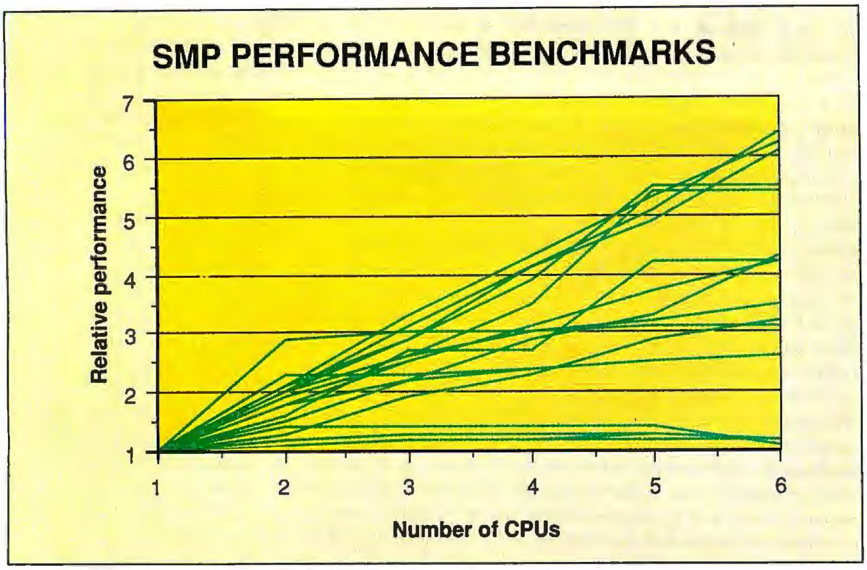

Figure 2: *Graphing the results of the Neal Nelson and Associates Business Benchmark reveals how performance under the smp kernel increases as more CPUs are added to the system. Each line represents a different type of task. Some of the tasks show a near-linear increase. The flat lines represent disk-access time tests; disk access doesn't improve as you add CPUs.*

lock stack so that it knows about all the locks acquired for a particular process. Just as important, being a stack, it also maintains the exact order in which the processor acquired the locks. To avoid system deadlock, some critical sections have an imposed lock hierarchy, and their locks must be acquired in an exact sequence.

When a process in the smp kernel suspends itself by calling `sleep()`, all the locks it holds at that point must be released or the system could deadlock. Because the lock stack maintains acquired locks, releasing them is a simple procedure: The system copies the current state of the lock stack to the executing process's kernel stack and then releases the locks. This gives other CPUs access to the locks. When the process resumes, the system uses the saved lock stack to reacquire the same locks. The process then continues executing from the critical section where it suspended itself.

The smp kernel doesn't add any new situations that cause a process to suspend itself that aren't in standard Unix. This is another factor that lets the smp kernel work with multiple CPUs without extensive modifications to standard Unix. It also makes tracking future releases of Unix as easy as possible.

You can think of some of the kernel's critical sections as a group of critical sections with small pieces of reentrant code in between. Rather than acquiring and freeing locks on many small sections, the process acquires a single lock for the group. This allows the smp kernel to minimize the locking overhead in the system. The lock is acquired only once as long as the reentrant portion of the critical section is short.

The lock and unlock routines are the only parts of the kernel that are responsible for acquiring and releasing locks, and for maintaining the lock structure and lock stack. Both routines are coded in assembly language and streamlined for the typical case: lock availability. Timings with a 25-MHz 386 CPU determined that a lock takes 16.6 microseconds and an unlock takes 12.1 μs. On a 25-MHz i486 CPU, these figures drop to 6.6 μs for a lock and 4.8 μs for an unlock.

The Other Half

The smp kernel was originally designed for Corollary's 386/smp and 486/smp products. Currently, however, it also runs on other systems. Ports to other hardware systems took place as manufacturers began searching for multiprocessor systems software. Because the hardware-dependent portions of the smp kernel were segregated into a couple of kernel source files, initial ports typically took weeks.

Since then, the smp kernel has been further modularized to support new multiprocessor platforms without smp kernel source code. A single file of 10 to 20 short hardware-specific routines and an entry in a hardware-platform multiprocessor switch table are all you need. Because of this modularization, ports can now be done in a matter of days.

The smp kernel doesn't exist in a vacuum. No matter who the manufacturer is, the kernel requires that the underlying hardware architecture include four vital features: global shared memory, support for test and set, individual CPU-to-CPU interrupts, and cache transparency.

You need global shared memory because the smp kernel requires that all CPUs have access to all memory. In addition, all CPUs must view memory identically: They must all see the same physical byte of memory at the same location. Also, the smp kernel assumes that there is no "distant memory" for any of the CPUs.

The smp kernel uses test and set as the mechanism that ensures that kernel data structures and critical sections are protected. This capability must be present in the hardware. The smp kernel further requires that each CPU be able to individually interrupt all other CPUs and that this interrupt be maskable to ensure the protection of critical sections of software.

Most multiprocessor architectures feature CPU caching designs to maintain high system performance. The smp requires that the hardware provide for cache coherency and that, other than initial cache flushing and enabling, the coherency scheme be transparent to the kernel.

Compatibility Plus

While the smp kernel was designed with compatibility as the highest concern, performance was not overlooked. As figure 2 demonstrates, performance under a 60-user work load increases significantly as you add CPUs to the system.

The popularity of SCO Xenix and Unix means that a large proportion of Unix implementations use Intel-based platforms. Adding multiprocessor technology provides these machines with a growth path. It gives you the ability to increase performance as your system needs change.

The Corollary smp kernel, as incorporated into SCO MPX, provides a growth path that is compatible with PC platforms and SCO Unix. In addition, the kernel offers a binary-compatible operating-system platform that you can run on powerful multiprocessing platforms. ■

Craig Keating is manager of multiprocessor software for Corollary, Inc. (Irvine, CA). He can be reached on BIX c/o "editors."

Supercomputers Get Personal

Torque's new i860-based ComputeServer is fresh and fast—an attractive way to serve up computational power

Sam Bogoch, Iain Bason, Jeff Williams, and Mike Russell

Bringing supercomputer performance to your desktop is not so much a question of technology as it is one of economics. Many companies build workstations and coprocessors that, at least in some areas, deliver supercomputing performance from desktop machines. The problem is that you can spend a fortune trying to outfit everyone in your organization with high-priced hardware. The ComputeServer from Torque Computer offers an affordable alternative.

The ComputeServer (see the photo on page 233) is a parallel-processing computing engine that delivers supercomputing performance by putting a "desktop supercomputer" on a LAN. As a peripheral resource for personal computers and workstations, it is analogous to already-popular print and file servers found on most LANs. In fact, it is the large installed base of standard networks (the ComputeServer uses Ethernet) that makes the computational server concept viable. The server approach is also consistent with the needs of most desktop "power" users who wouldn't use a supercomputer full-time but would require its power in bursts.

Client-Server Computing

The ComputeServer uses a client-server architecture—much like the database servers that are becoming so popular on LANs. Applications are split into client and server portions. The client portion runs on your desktop machine and provides the user interface for the application. The server portion consists of computationally intensive code residing on the ComputeServer. The client calls this code as needed, and the server returns the results (see figure 1).

While the ComputeServer is transparent to users, it is not transparent to programmers. Applications must be modified to take advantage of its power. Fortunately, many programmers are already using structured-programming techniques to divide user-interface modules from computationally intensive ones, so converting code to support a true client-server approach is not difficult.

The system software takes advantage of modular programs by using the Linda memory model originated by David Gelernter at Yale (see "Getting the Job Done," November 1988 BYTE). Linda adds just six statements to a conventional language such as C, yet it easily splits client and server functions and handles all the communications between the two. Just as important, Torque's Linda implementation allows multiple server subtasks to execute simultaneously on the ComputeServer's multiple processors.

Linda automatically handles the two main problems in getting one or more

continued

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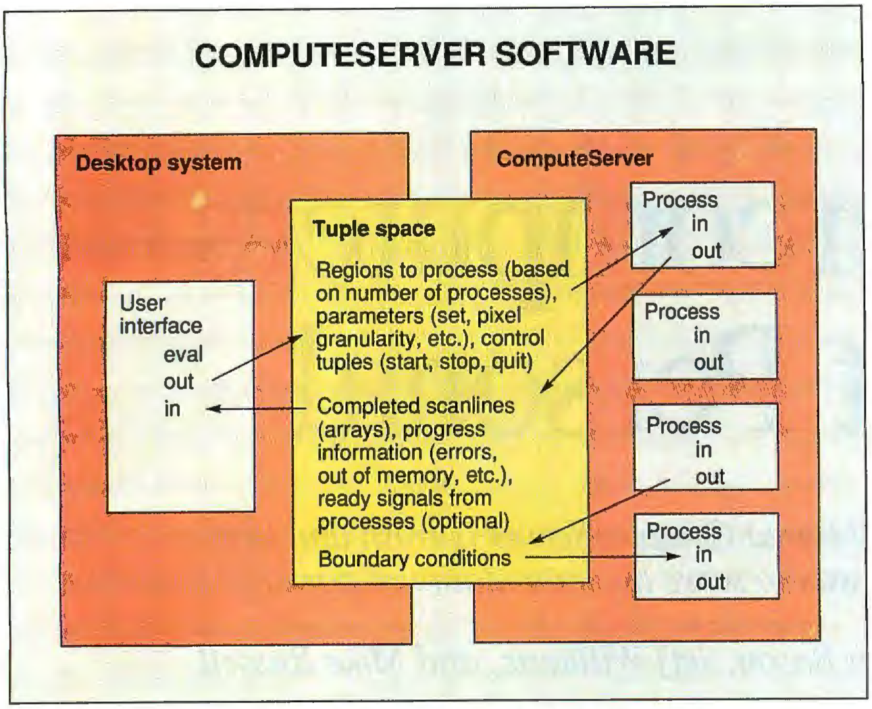

Figure 1: *A ComputeServer application exists on both the client and server machines. Communication between the two parts occurs in tuple space.*

applications to run on multiple processors: process creation and data consistency. It spins off tasks to run on the different processors and makes certain the tasks send and receive the right data at the right times.

Torque's implementation of the Linda model asynchronously spins off C functions, as well as linked code in FORTRAN 77 or other languages, onto one or more remote processors. Linda treats the multiple CPUs as a processing pool. It can allocate any processor to one or more subtasks that the application programs create.

Linda also creates software-based global memory for passing data between the client machine and the ComputeServer's multiple processors. The system subdivides the available processor pool on the fly among multiple clients and keeps each client's memory space separate during execution.

End of the Rainbow

The processors at the heart of the ComputeServer supply its supercomputing power. The system contains from one to 16 Intel i860s, which offer marked performance advantages over other current RISC and complex-instruction-set-computer processors (see "Intel's Cray-on-a-Chip," May 1989 BYTE).

The 1-million-transistor i860 includes a RISC core, a vector-capable 64-bit FPU, 4K-byte and 8K-byte data caches, and hardware support for three-dimensional graphics primitives. The tight coupling of these functions within a single chip via fast, wide (up to 128 bits) on-chip buses provides much faster floating-point performance than the multichip sets needed to implement other RISC architectures.

The i860 can reach 66 million floating-point operations per second at peak performance, although only a few applications, such as neural-network simulations, can effectively harness all the potential of the microprocessor's multiply-accumulate pipeline. A more realistic performance figure is the 17 MFLOPS quoted by Intel for running an optimized LINPACK suite. The processor should be able to sustain 10 MFLOPS in most nonoptimized applications.

So, a ComputeServer with 16 processing units is capable of more than 1000 MFLOPS at peak performance, and 160 MFLOPS sustained. By comparison, a Mac IIx can sustain 0.4 MFLOPS; a SPARCStation 1, 1.2 MFLOPS; and a Cray X-MP with four processors, 200 MFLOPS. A uniprocessor ComputeServer for $20,000 runs nearly as fast as the original Cray 1 on many applications.

The i860 also offers an upgrade path to superscalar technology, also known as very long instruction word technology (see "VLIW: Heir to RISC?" August 1989 BYTE). A superscalar architecture features multiple integer and floating-point arithmetic units within a single processor. Advanced compilers can simultaneously assign different jobs to these processors. Superscalar is a form of parallel processing called *microparallelism*, which, unlike the *macroparallelism* of the ComputeServer's multiple processors, is transparent to the programmer. As superscalar technology matures, future Torque machines will continue to incorporate both microparallelism and macroparallelism.

Ties That Bind

One of the central concerns in parallel processing is how to most effectively tie multiple processors together. In distributed-memory architectures, each processor has private RAM and communicates with the other processors via messaging links. In shared-memory architectures, processors share the same bus and main memory.

Often, software development issues obscure the debate about the underlying pros and cons of each of these hardware architectures. The key issue becomes which architecture is easier to program for a given job, rather than which one is inherently better. Because programming a shared-memory machine is often easier than programming a message-passing one, most people are willing to live with the higher hardware costs and lack of scalability associated with the former.

However, C-Linda and other new development tools have made these architectures interchangeable from a programmer's point of view. Either architecture, or a hybrid of the two, can perform most parallel-programming tasks handily. Linda has shown that the real key to successful parallel processing is a machine's ability to provide high bandwidth and low latency for interprocessor communications.

The Virtual Tree architecture used in the ComputeServer combines many of the advantages of shared-memory and message-passing architectures. Developed by the ComputeServer design team in 1987 for the multi-8086 Parallon processor, the VT uses a layered hierarchy of messaging buses optimized for burst-mode transmission. The tree is called "virtual" because each branching layer is implemented as a fast-messaging bus rather than as many slower point-to-point links.

Unlike the buses on shared-memory systems, the fast-messaging buses pass messages rather than access and arbitrate shared-memory locations. Thus, you don't need the complex bus-snooping hardware of shared-memory systems, and processors on one bus do not need knowledge of transactions occurring on other buses.

The kicker is that, because the system passes messages by way of these very fast shared channels, it can adapt to changing communications loads without employing any complex routing overhead. The VT also provides a hardware-broadcast facility that dramatically improves bus utilization when you have to share data among many processors.

The single-layer VT bus used in the ComputeServer is 64 bits wide, features burst mode, and is capable of 66-megabyte-per-second point-to-point transfers and 1-gigabyte-per-second effective broadcast transfers when all 16 processors are "listening." The bus supports up to 32 devices within a given layer. The system can employ addresses that the processors don't use to accommodate parallel I/O devices such as multiple disk drives, frame buffers, and real-time data acquisition systems.

Each processor board contains one or two complete i860 processing units, each with up to 16 MB of local static-column DRAM, and interfaces to both the VT and the system I/O bus (see figure 2). The ComputeServer backplane can hold up to eight processor boards (16 CPUs). This modular architecture allows board-level upgrades to increase the number of processors, or board swaps to new CPUs. For instance, if you have an earlier, transputer-based ComputeServer, you can upgrade to an i860 system for the cost differential between the new system and your current one.

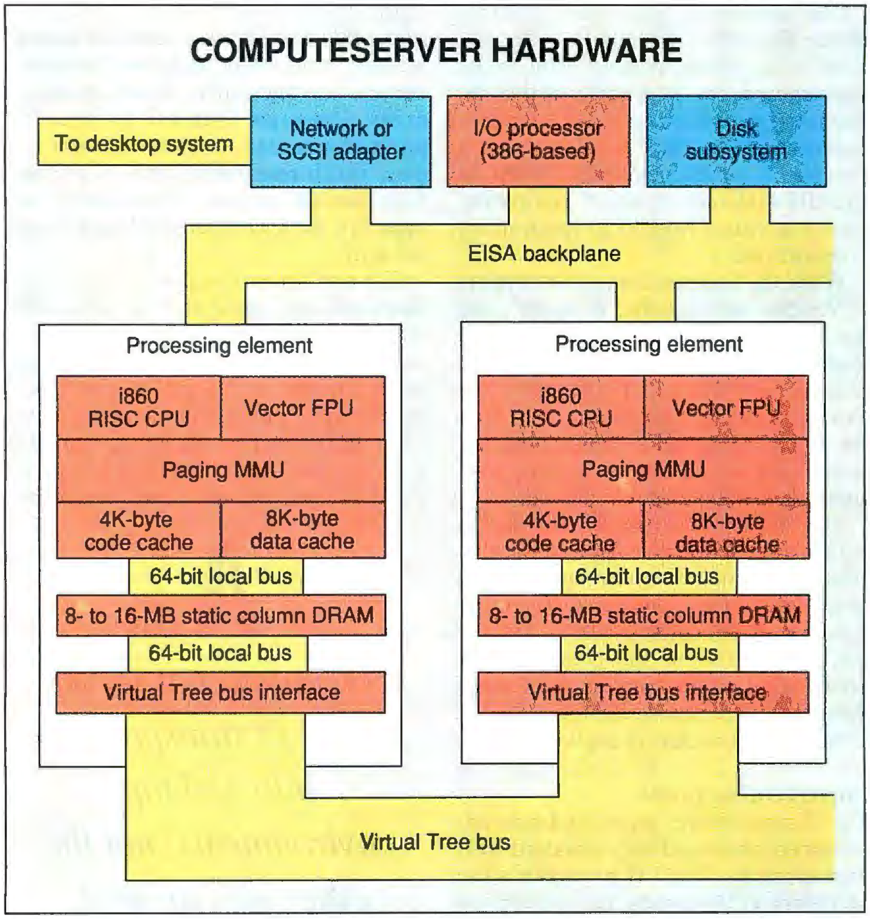

Figure 2: *The ComputeServer uses an industry-standard I/O bus and a proprietary fast-messaging bus. Each processor has its own local memory.*

ComputeServer I/O

Central to the computational-server concept is the ComputeServer's ability to connect to standard networks. Although the I/O requirements for a computational server are less complex than those for file and database servers, rapid response to input tasks and sustained network performance are still critical. The system employs a dedicated 386-based processor to handle I/O functions, and it features an Extended Industry Standard Architecture backplane to ensure compatibility with both current and future high-speed networks.

The I/O processor runs Unix System V/386 and manages the ComputeServer's built-in hard disk, which stores both executable code and temporary data files. The widespread availability of networking hardware and drivers for this I/O processor and bus combination means that the ComputeServer can support new networks without redesign. The high-level system software must simply be ported to the new I/O boards.

Software Architectures

For all its high-tech hardware, the ComputeServer would be useless without software capable of harnessing its power. One option considered was to implement a system using the X Window System's (referred to as X Window hereafter) smart-terminal model of computation.

The X Window model has a limited set of primitives for the desktop machine (the "window server" in X Window terminology) to execute, and it effectively runs the entire application on the server (the "window client"). These standard primitives express any communication between client and server. This places the desktop system in the role of intelligent terminal; it translates your input into primitives that the server uses, and primitives from the server into on-screen graphical elements.

continued

The Torque ComputeServer connects to standard networks to deliver unparalleled computing power to Macintosh, DOS, and SunOS clients.

One problem with this model is that response time and interactivity suffer because of the communications load on the intervening network. Another is that the user interface is defined by the computational-server "client," not the desktop "server," sometimes forcing you to straddle different styles of computing when you switch from local applications to remote ones.

While the ComputeServer can support X Window applications, it doesn't use the X Window model as its primary mode of communications. A true computational server should fit transparently into desktop environments, rather than the other way around. You should not have to log onto a remote system; your applications should do that for you.

The desktop machine should run the bulk of a server-capable application; this ensures the highest system responsiveness. Only those routines that require sustained computation should be farmed out, on the fly, to the computational server. One of the biggest challenges, therefore, is to provide the tools needed to build this new class of applications.

Implementing Linda

The ComputeServer layers its Linda environment above industry-standard software elements. The I/O processor's use of System V/386 means that you can log onto the system under Unix. In this capacity, the system can be used as an X Window client.

More important, the ComputeServer uses TCP/IP as the lowest internal layer of Linda communications between desktop machines and the ComputeServer. When compiling a client/server application, the system links the appropriate communications stubs into the run-time libraries at each end. The exception to this rule is the SCSI direct-connect option, which lets you connect directly to the ComputeServer, monopolizing all the processing power in the system. This connection uses a more direct transport mechanism.

Client/server applications handle all connectivity between the ComputeServer and desktop machines. You don't have to modify or bypass your desktop computer's system software. You also don't have to install dedicated drivers or update ComputeServer applications when you upgrade to a new version of your desktop operating system.

Sharing, Not Shared, Memory

Linda uses *tuple space* to maintain data consistency among far-flung processes. In effect, tuple space is a database that is shared by processes within a Linda program. It lets you think in terms of shared memory even when, as in the ComputeServer, no physically shared memory exists. Processes spun off by a Linda program can read, extract, or insert tuples, which resemble records in a database (see the text box "Meet Linda" on page 216 for a summary of Linda functionality).

For performance reasons, Torque implements tuple space as hash tables distributed among the ComputeServer processors. A client computer accesses tuple space through a "proxy" in the ComputeServer, which automatically converts all data types—including complex C structures—from the i860's format to the desktop computer's and vice versa.

A true computational server should fit transparently into desktop environments, not the other way around.

Programs running on your desktop computer and the ComputeServer look the same, but the ComputeServer can access tuple space faster—by orders of magnitude—than a desktop client can.

At the lowest level, ComputeServer processors access tuple space by using burst-mode transfers over the VT bus. The system divides tuples into small packets that it sends at speeds approaching the maximum transfer rate of the VT: 66 MBps. Round-robin arbitration gives every processor a turn to transmit a packet. Using packets to transmit tuples reduces latency by interleaving large and small transfers across the same channel. Otherwise, transferring large tuples (for example, a 10K-byte array) would generate unacceptable delays for other, smaller transfers waiting their turn.

To reduce hardware complexity, the transfer mechanism is actually implemented in software using the i860's register/memory block-copy instructions. The system first synchronizes the processors involved in a given packet transfer. Then the transmitting processor begins a block memory-to-register copy (thus reading from its memory). The synchronized receiving processors begin register-to-memory copies (writing to their memories) at the same time. As each processor increments its respective address bus, 64-bit-wide buffers simply "pour" the resulting data from one memory to another across one or more layers of the VT bus. Because the i860 is capable of driving even static column RAM at its full bandwidth, this method is as fast as any custom-designed DMA controller.

Optimizing Linda

A bare-bones Linda system is similar to a simple distributed database, with each processor in the system storing the tuples created by `out()` statements within its resident processes. When a request for a tuple can't be satisfied locally, the processor broadcasts the request to all the other processors.

If the request is an `inp()` or an `rdp()`, each processor replies immediately with either a matching tuple or a "no match" message. If an immediate match is not found, the remote processors store the request. The originating processor can periodically flush its old requests from the other processors. Aside from synchronization details, that's all there is to a basic Linda system.

One optimization employed on the ComputeServer is used by most Linda systems. It involves separating tuples into different partitions. In a given Linda program, `out()` operations put tuples into tuple space, while `in()` and `rd()` retrieve them from it.

Cursory inspection usually reveals that some `out()` statements produce tuples that can't possibly be retrieved by certain `in()` statements. For instance, `out("Torque", 5.5)` produces a tuple that `in("Computer", ? & real)` just won't read. Most Linda programs tend to have at least three or four natural partitions in their tuple space. Storing these separately improves the speed of the Linda run-time kernel on each processor.

A more sophisticated optimization is the pre-send. This technique uses the VT's hardware broadcast to send newly generated tuples to other processors before they are requested. No matter which process requests the tuple, it will find the information already resident on its processor. The principle is similar to that used by some disk-caching systems, which prefetch data blocks from the disk. In most cases, pre-send is best used sparingly, since the extra tuple copies it generates can rapidly fill system RAM.

continued

Why Experienced Computer Users Don't Think Very Much About Modems

Our research shows that knowledgeable MIS managers, PC coordinators, and end users simply don't want to think of modems at all.

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Fortunately, there are simple ways to limit this aggravation. Our research suggests a few points to keep in mind.

The cost of the modem is not the modem's cost.

The fixed price of the modem is relatively insignificant. Ongoing costs matter far more.

In the long run, for example, a high-speed modem can save you a small fortune on phone bills. More data sent in less time means less money to the phone company.

You can also save with more reliable and robust modems that communicate over a wide range of telephone line conditions.

Resending data costs both time and money. The less time you spend transmitting data, the more time you have to spend on your business.

Downtime and adaptation time can also cost you dearly.

Be sure to ask if the modems are compatible with their earlier generations. You don't want to start with suppliers who regularly obsolete their own products, or who don't offer you an upgrade path.

Modem support can be a real hassle with the wrong vendor.

Setting up and installing your modem can affect both your budget and your sanity. Many manufacturers forget to make their modems easy to use!

This becomes expensive when you want to start up fast or need to support a large number of users.

Dip switches, on-line help screens, and easy-to-use manuals should be demanded. It also helps to have a quick-reference guide printed on the bottom of the case.

In sticky situations, it's vital to have toll-free support and applications engineering.

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Not everyone needs the same modem.

The best way to keep modems from wasting your time and money is to buy them from a reliable supplier with a broad product line. Those with limited lines sometimes try to cram square pegs into round holes.

People with differing applications have differing requirements. Dealing with a broad-line supplier simplifies ordering, reduces training/support time and cost, and limits hassle and coordination.

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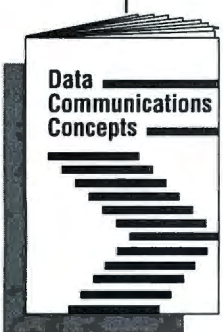

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The ComputeServer system decides which tuples to pre-send based on a mix of compile-time and run-time factors. For instance, it's better to pre-send tuples that `rd()` operations are going to match, since they leave the tuple around for other operations. The `in()` operation removes it.

The ComputeServer also minimizes network communications by having one of its processes act as a proxy for the desktop computer. All tuple searching and synchronization are performed between the proxy and the other processors in the ComputeServer. When a tuple is chosen, it's sent back to the desktop computer.

These kinds of optimization are critical in sustaining a sense of tuple space as a global resource, while at the same time providing you with a responsive system. If application code must be optimized around a system's shortcomings, then that system is meeting the Linda model in name only. In fact, an ideal multiprocessor system should go out of its way to accommodate "mistakes."

One example of this approach is dynamic load balancing. Because a distributed Linda kernel can both allocate time slices and monitor processes, it could actively seek out execution bottlenecks and take appropriate actions. For instance, an iterative process that repeatedly holds up others could be given successively larger time slices to minimize overall execution time.

You can create client-server applications without buying ComputeServer hardware.

Tools of the Trade

You can create client-server applications without having to buy ComputeServer hardware. The Torque developer's toolkit is a self-contained C-Linda implementation running on the client machine that allows code to be compiled, tested, and debugged as multiple threads on that system. The Linda primitives incur a very small speed penalty—typically 2 percent to 5 percent—when the application runs completely on the client.

Thus, it's reasonable to maintain only one version of an application's source code that can be compiled for client-only or client-server operation. Once the code has been debugged on the desktop, it can be recompiled on the ComputeServer for client-server operation. Likewise, source code developed for the earlier transputer-based ComputeServer can be recompiled for the new machine without modification.

Mechanically, compilation for client-server operation is a matter of adding a few lines to the make file, because the ComputeServer compilers are themselves Linda applications that run from the desktop. Error messages from the Torque compilers are displayed within the standard programmer environments (MPW on the Mac, Microsoft's on the PC, and SunTools on the Sun).

The ComputeServer supports languages other than C-Linda. It does so in two ways: either by using a traditional, single-threaded syntax callable from a C-Linda framework, or as intrinsically parallel superstructures running above the Linda run-time environment. Examples of the former include FORTRAN 77 with VAX extensions and ISO Pascal. Examples of the latter are Paralogic's n/Prolog, which is a multiprocessor interpreter written in C-Linda, and Strand's Strand88, a parallel language with sophisticated job-control functions. Finally, several high-level graphics tools are under development for the system, including the PPSE parallel CASE tools developed at Oregon's Advanced Computing Institute.

Join the Party

Torque has concentrated its efforts on applications that combine an advanced user interface with sustained number crunching. Most of these involve 3-D graphics, simulation, and image processing. Several prominent vendors have pledged support for the system, including MacroMind (Three-D 1.1) and Wolfram Research (Mathematica kernel). Smaller niche vendors are also supporting the system, including Market Engineering (Crystal Ball, for Monte Carlo forecasting), and Pre-Press Technologies (SpectreSets color-separation software).

ComputeServer-capable versions normally cost more than their desktop counterparts, but they provide considerably higher performance and support multiple users. A number of embedded applications are also in the works, including exposure control for submicron lithography at Lepton (an AT&T spin-off).

Third-party ComputeServer developers represent a collection of seemingly unrelated specialties, with little in common except the need for speed. In fact, support for this system by "mainstream" applications is almost an oxymoron: If a product performs well enough to be sold by the millions on today's desktops, it probably does not need the ComputeServer. Rather, we expect that the ComputeServer will help bring today's niche products into tomorrow's mainstream.

There's nothing to keep ad agencies from ray-tracing animated sequences if each frame takes only minutes to produce. There's nothing to keep financial analysts from running 100 Monte Carlo variations on a spreadsheet if the job takes only slightly longer than a single recalculation. And there's nothing to keep desktop publishers from running color separations alongside Linotronic output when the job no longer takes hours to complete. Such applications will become commonplace when access to the necessary computing power becomes available.

A new kind of computer, the computational server, will complement desktop machines for compute-intensive applications. By treating computational power as a shared resource, the ComputeServer delivers lots of FLOPS at a reasonable price per desktop, and it does so without forcing you to sacrifice the computing environment you're comfortable with. Given the ever-increasing importance of LANs, the ComputeServer is truly a machine for the 1990s. ■

Sam Bogoch, Iain Bason, Jeff Williams, and Mike Russell design and develop computational servers for Torque Computer, Inc. (New York). They can be reached on BIX as "sbogoch."

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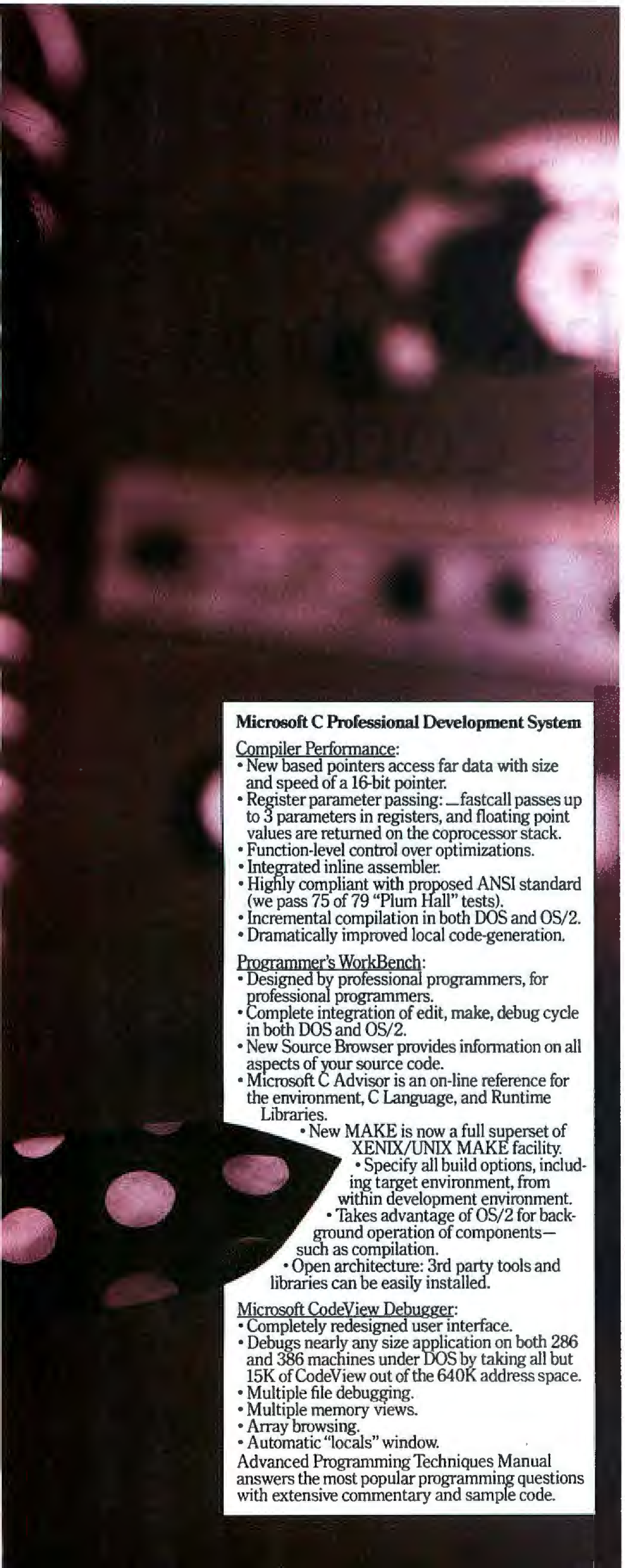

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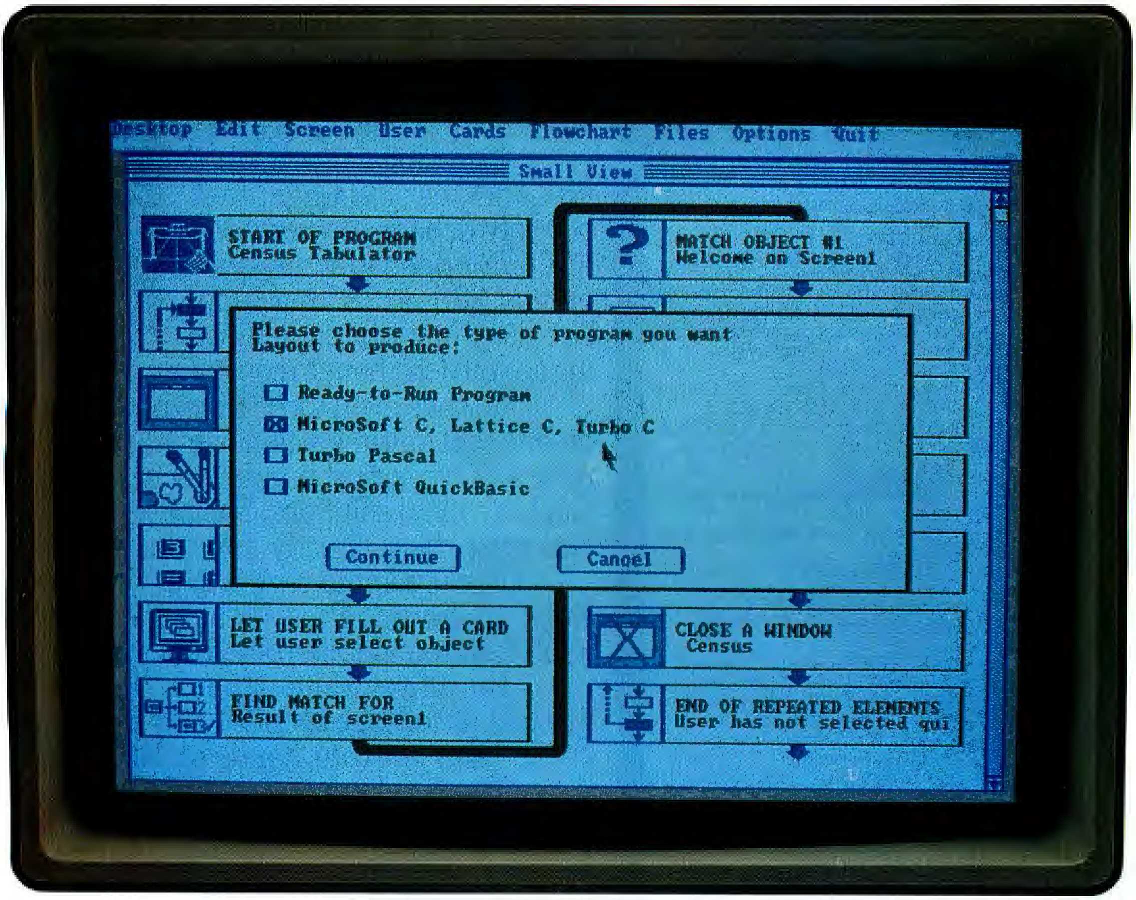

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Join the EISA Evolution

The EISA bus is breaking up that old "Gang of Nine"

Min-Hur Whang and Joe Kua

Supercomputing has a definite ring to it. It even has a magical quality. It makes you think of the HAL 9000 or of buildings full of giant computers that make the earth spin or change gravity. But when you analyze the concept of supercomputing, you find a combination of elements, each of which contributes to the whole.

The goal of any supercomputing architecture is to obtain increased performance through increased system throughput. One of the more important ways to increase throughput is to free up your processor (or processors) from such mundane tasks as system I/O. Supercomputers use either a separate I/O processor or a separate computer (often a minicomputer) to handle I/O to and from main memory.

Until the advent of sophisticated buses such as the Micro Channel architecture from IBM, Extended Industry Standard Architecture from a collaborative effort nicknamed the "Gang of Nine" (AST, Compaq, Epson, Hewlett-Packard, NEC, Olivetti, Tandy, Wyse, and Zenith), and NuBus from Apple, personal computers handled I/O the old-fashioned way, by moving every byte through the processor when performing I/O with main memory. Now, however, the new buses perform I/O without tying up the CPU. The EISA bus master is the latest example of using such a scheme to improve I/O for microcomputers.

EISA, as the name suggests, is an extension of the original Industry Standard Architecture bus (the PC AT bus). Since EISA evolved from ISA, it kept all the preceding technology. Thus, you can use your current IBM-compatible expansion cards on an EISA machine. The Micro Channel architecture doesn't offer this evolutionary approach, so simple items like network cards, SCSI adapter cards, and modems have to be specially designed to support its I/O bus. EISA, however, is already supported.

A Backward Glance

The system bus for the original IBM PC was an 8-bit extension of the Intel 8088 microprocessor. The 8088 has only 20 address lines, restricting the amount of addressable memory on the PC to about 1 megabyte. Since today's memory-hungry operating systems (e.g., OS/2, Unix, and Novell NetWare) require more memory than that, the 8-bit system has become obsolete. In addition, the original 8-bit system bus offered only an eight-level edge-triggered interrupt and four DMA channels whose transfer speeds ranged from about 250,000 bps to 500,000 bps.

The next generation of bus was the 16-bit PC AT bus, which became the ISA

continued

ILLUSTRATION: CARY HENRIE © 1990

Requesting A Transfer

An EISA bus master supports two types of data transfer cycles for moving data between itself and main memory or an I/O slave. The cycles are either standard or burst. A third cycle type, the compressed cycle, is available only to the CPU. EISA cycle types are summarized in table A.

In a standard cycle, an EISA bus master is completely synchronous with the bus clock (BCLK), which provides synchronization with the main system clock. The bus clock usually operates at frequencies of between 8.33 MHz and 6 MHz, although its period is sometimes extended to synchronize with the host CPU or other motherboard devices.

An EISA bus master drives nine signal lines on the bus and monitors five others (see table B). Using these signals, you can examine how a bus master transfers data to memory or to I/O slaves within a standard cycle. To follow the events in a standard transfer cycle, the numbers in the discussion below refer to the circled numbers in the timing diagram in figure A.

CYCLE TYPES AND TIMES

Table A: *EISA supports three types of bus transfers, of which only two—standard and burst—are available to bus masters. This table lists the average number of bus clock cycles it takes to complete a data transfer cycle. (N/A = not applicable.)*

Cycle	Speed	Standard cycle	Compressed cycle	Burst cycle
EISA	32-bit	2	1.5	1
One-wait-state ISA	16-bit	3	N/A	N/A
	8-bit	6		
Zero-wait-state ISA	16-bit	2	N/A	N/A
	8-bit	3		

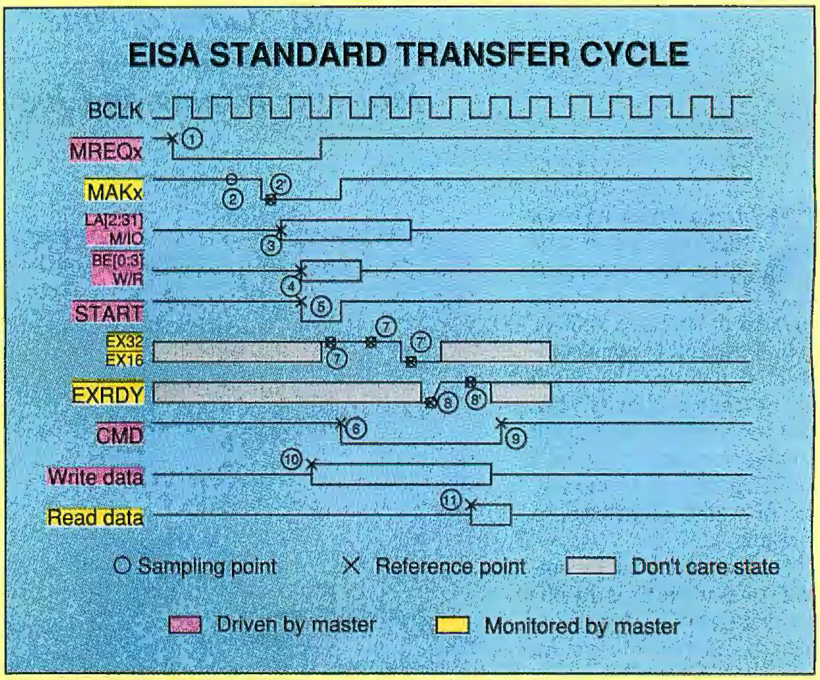

Figure A: *This timing diagram of a standard data transfer cycle shows how the master and slave use signals to synchronize their activity. When writing, the master dumps the data onto the bus when it starts the transfer. The slave reads the data and indicates when it is through using the EXRDY line. When reading, the master waits until the slave indicates it is done before sampling the data bus.*

Let the Games Begin

When a bus master wants to initiate a transfer, it requests control of the bus by asserting the MREQx signal (1). It then monitors the MAKx line (2) until the EISA arbitration system grants its request (2′).

Next, the bus master places the target address on the bus and indicates whether it is initiating a transfer with system memory or with an I/O slave (3). Then, it indicates whether it is reading from or writing to the indicated address, and which bytes of the 32-bit-wide data path it wants to transfer (4).

At the same time, the master drives the START signal to initiate the transfer cycle (5). At the end of the START signal, which lasts one BCLK cycle, the bus master negates the CMD line (6).

bus. Improvements in the microprocessor (with Intel's 286) and in the number of addressable memory locations (with 24 address lines) brought the total available memory to 16 MB. The edge-triggered interrupts increased from eight to 15 levels, and the DMA channels from four to seven.

The speed of the 286 supports 8-bit and 16-bit modes with DMA data transfer rates of 100,000 bps to 400,000 bps, and 400,000 bps to 800,000 bps, respectively. Note that the new 8-bit DMA mode is slower than the original PC bus. Intel had to sacrifice some speed to maintain downward compatibility to 8-bit devices. One benefit of the 16-bit bus is that you can continue to use any 8-bit cards you have, because ISA is a superset of the 8-bit PC bus.

From a technological point of view, the problem of I/O bus design became obvious with the arrival of the Intel 386 and i486 processors. ISA just doesn't cut it. An I/O bus for these applications workhorses needs the following additional capabilities:

- more memory capacity;
- multiple bus-master devices with

EISA BUS-MASTERING SIGNALS

Table B: *The EISA bus features special signals that enable a master to take control of the bus. If both the master and slave are burst-capable, the signals also enable burst transfers.*

Controlled by a master

$\overline{\text{MREQx}}$	Asserted by a bus master when requesting use of the bus. The x is the master's slot number.
$\overline{\text{MAKx}}$	Indicates that the master in slot x has control of the bus.
LA[2:31]	Address lines.
M/IO	Indicates whether the transfer involves main memory or a slave device.
$\overline{\text{BE[0:3]}}$	Indicates which bytes of the 32-bit-wide bus are used in the current bus cycle.
W/R	Indicates whether the master is writing or reading data.
$\overline{\text{START}}$	Indicates the start of a bus-mastering cycle.
$\overline{\text{CMD}}$	Asserted by a master during a transfer cycle.
$\overline{\text{MSBURST}}$	Indicates that a master is capable of controlling burst transfers.

Monitored by a master

D[0:31]	Data lines.
$\overline{\text{EX32}}$	Indicates that the slave handles 32-bit transfers.
$\overline{\text{EX16}}$	Indicates that the slave handles 16-bit transfers.
$\overline{\text{EXRDY}}$	Indicates that the slave has completed its function and is ready to terminate the cycle.
$\overline{\text{SLBURST}}$	Indicates that a slave is capable of burst transfers.

Following the confirmation of $\overline{\text{START}}$, the bus master samples $\overline{\text{EX32}}$ and $\overline{\text{EX16}}$ (7) to determine whether the slave is a 32-bit or a 16-bit device. Once it determines the type of slave (7'), it checks for $\overline{\text{EXRDY}}$ from the slave. When the slave is ready to terminate a transfer cycle, it drives the $\overline{\text{EXRDY}}$ signal (8). When the master confirms $\overline{\text{EXRDY}}$, it negates $\overline{\text{CMD}}$ to finish the cycle (9).

When writing, the data from the bus master is valid once it drives the $\overline{\text{START}}$ signal (10). When reading, the master samples the data lines on the first rising edge of BCLK after the slave asserts

continued

high-speed burst-transfer rates;
- a 32-bit data transfer rate for the CPU, DMA, and bus-master devices;
- enhanced DMA arbitration and transfer rates;
- level-triggered (shareable) interrupts; and
- automatic configuration of system and expansion boards.

To promote these features, two completely new bus architectures, IBM's Micro Channel and EISA, were introduced. A generation gap exists between EISA and the current reigning ISA buses.

The Bus Stops Here

When the specifications for implementing EISA were released, the bus standard attracted a lot of attention. The intent of EISA was to develop a 32-bit architecture that, unlike the Micro Channel, would be downward-compatible with the existing AT bus. Systems using EISA would *still* be able to use 8-bit and 16-bit boards. The EISA standard adds many functional and performance enhancements, such as improvements in DMA handling, but it retains a subset of the features available in the ISA bus.

EISA's data path can be 8, 16, or 32 bits wide. The number of address lines is increased to 32, which theoretically allows access to up to 4 gigabytes of memory, depending on the system design. This larger amount of addressable memory better meets the needs of today's memory-hungry applications, such as multiuser systems, network-server systems, AI CAD/CAM simulations, and even computer hardware design.

Not only can the CPU fully implement EISA's entire 32-bit address space, but so can the 32-bit bus-master and DMA devices on the EISA bus. EISA's 32-bit DMA functions allow today's 16-bit ISA DMA products to use the 32-bit address space by adding a simple software device driver. In other words, you can keep your system's old equipment *and* improve its performance.

The EISA bus master includes a dedicated I/O processor and local memory. This specialized processor drives the address, data, and control signals for intelligent peripherals, which become slave devices, during a bus cycle. Bus masters improve system performance by taking on simple tasks that would otherwise fall to the host processor. Thus, they reduce the main processor's work load (the beginning of multiprocessing, perhaps?). To understand the benefits of the bus master, it is important to grasp the mechanics of transferring data between the bus masters and their slave devices (see the text box "Requesting a Transfer" at left).

The capabilities of the EISA bus master are aimed at sophisticated I/O peripherals that require optimum performance or advanced memory-access functions (e.g., non-ordered scatter/gather data operations). As a result, EISA is primarily intended for 32-bit devices, which typically contain dedicated I/O processors and require the fastest data transfer rate available through the bus. For this purpose, a fast burst-transfer mode is available to bus masters, in addition to the more typical timing of I/O and memory cycles.

In one scenario, a system could have several bus-master peripherals running

continued

EXRDY (11).

If the slave does not reply immediately to the bus master, it will wait another BCLK cycle. In the example, EX16 or EX32 missed the call from the bus master, thus incurring two wait states (7), and the master missed EXRDY, adding another wait state (8'). The result is a three-wait-state cycle. A standard cycle with no wait states lasts only two BCLK cycles.

Burst of Power

In a burst cycle, a burst-capable bus master uses all the signals defined for the standard bus master, in addition to driving the MSBURST signal and monitoring the SLBURST signal from the slave device. The numbers in the discussion below refer to the circled numbers in figure B.

A burst cycle follows the same sequence as a standard cycle until after the master asserts START. At this point, the master begins sampling SLBURST, as well as EX32 and EX16. As before, once the slave affirms EX32 or EX16, the master starts sampling EXRDY. However, if the slave is burst-capable, it asserts SLBURST (1) in addition to EX32 or EX16. When this happens, the master negates MSBURST (2) and begins the burst cycle.

As before, data from the master is valid when START is asserted (3). Data from the slave is valid (4) until CMD ends the cycle.

After the cycle begins, the bus master provides the next LA[2:31], M/IO, BE[0:3], and W/R when it samples EXRDY. It also samples MSBURST at every rising edge (5) unless EXRDY is not accessible (6). For the burst cycle, each wait state must have one BCLK cycle.

The master ends the cycle by disasserting MSBURST (7) and inverting CMD (8). As with the standard cycle, CMD is first negated at the end of the START signal. In a zero-wait-state system, a burst-mode cycle will take only one BCLK cycle with the exception of the initial cycle, which requires two BCLK cycles.

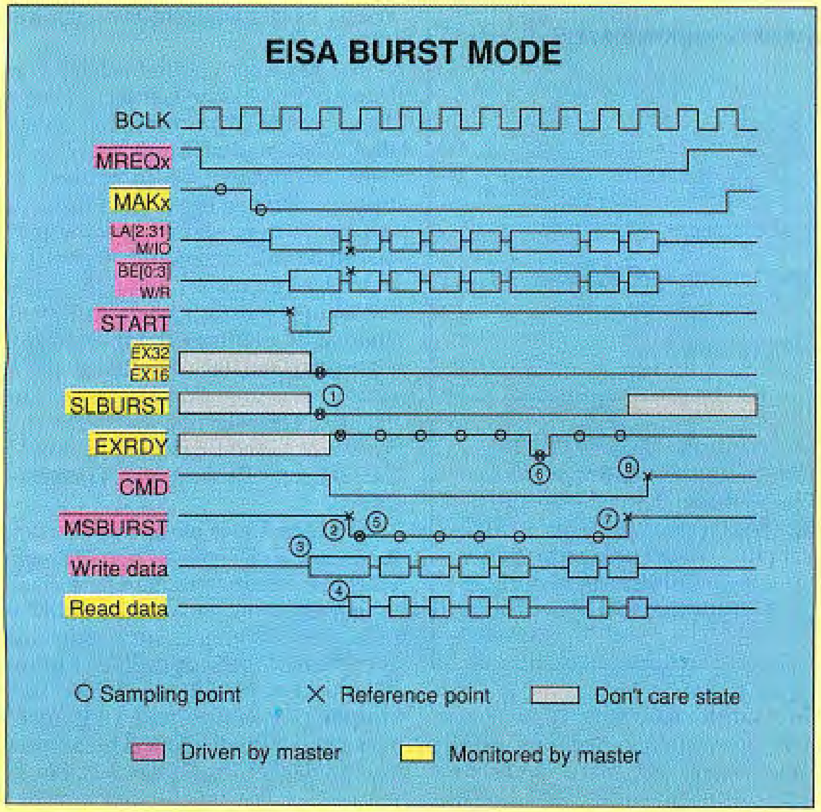

Figure B: *Whereas standard mode requires that the master and slave synchronize for every 16- or 32-bit transfer, burst mode requires that they synchronize just once, before the first transfer. The average cycles per transfer in burst mode is thus very close to one.*

on a network file server, each dedicated to a special application, such as distributed database processing. EISA can support up to 15 bus masters with an arbitration method that determines the latency of each device. Using this latency, the response time for requests from expansion-bus devices can be determined.

Knowing Your ABCs

In EISA systems, DMA devices have seven channels, just like they do in ISA systems, but the EISA transfer rate is much faster. The DMA controllers support 8-, 16-, and 32-bit data transfer sizes. They have four cycle-control sequences for transferring data between the DMA device and memory. These four cycles are

- the ISA-compatible cycles, which execute one transfer cycle in eight bus cycles;
- Type A cycles, which execute one transfer cycle in six bus cycles;
- Type B cycles, which execute one transfer cycle in four bus cycles; and
- Type C (burst DMA) cycles, which execute one transfer cycle in one bus cycle.

Types A, B, and C support 8-, 16-, and 32-bit DMA devices and perform automatic data-size translation for transfers to mismatched memory. Table 1 indicates peak data transfer rates and compatible DMA devices for each DMA cycle type. Moreover, most ISA-compatible DMA devices can transfer data 130 percent to 200 percent faster by programming the EISA controller to use Type A and B transfers instead of ISA-compatible timing.

How is this increased performance and efficiency provided? By enhanced arbitration, which shortens the time between the DMA device's request and grant events. This enhancement does not imply a decrease in compatibility. Existing hardware and software can take advantage of it without modification, so it actually improves compatibility with older systems.

Fringe Benefits

The original PC and ISA buses used edge-triggered interrupts, which are easy to implement but susceptible to false triggering and cannot be shared with other peripherals. In addition to supporting these edge-triggered interrupts to maintain compatibility, EISA also provides level-triggered interrupts, which are less susceptible to noise and allow

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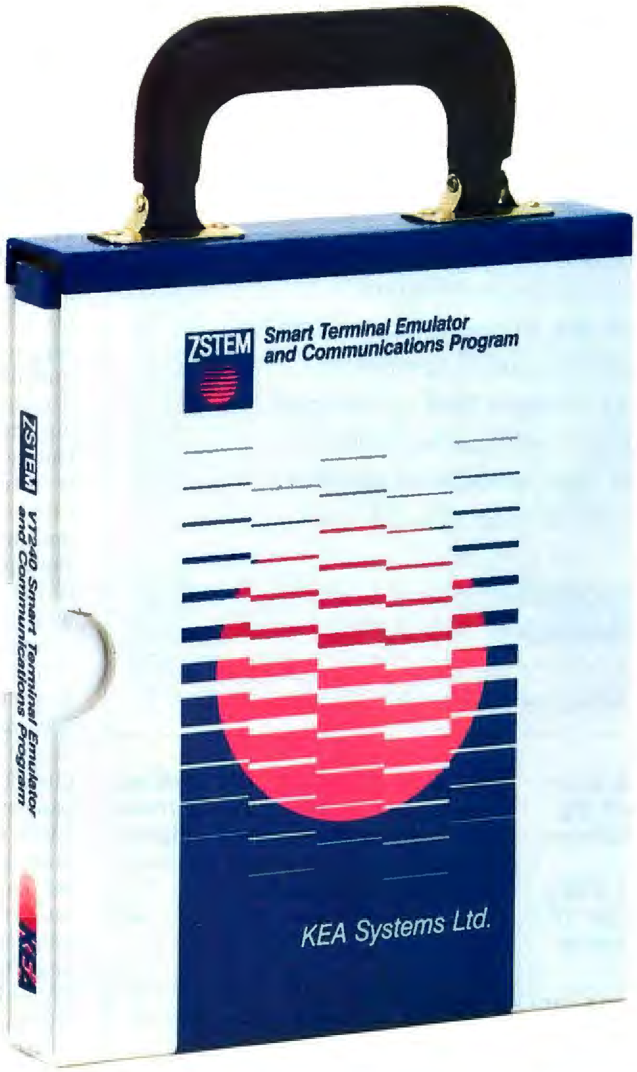

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multiple peripherals to share the same interrupt level. Theoretically, level-triggered interrupts can have an infinite number of levels.

Another practical benefit that EISA provides is automatic configuration of system resources and expansion boards. That means an end to DIP switches, jumpers, and installing configuration files. A system that supports plug-and-play peripherals improves efficiency (switch configurations for ISA or EISA products are still allowed, if you need them).

EISA also includes a product-identification mechanism for systems and expansion-board products. As you turn the system on, the computer automatically runs a power-up sequence of self-tests. When it does, it interrogates each device for the product identifier, compares that with those stored in RAM, and configures the board according to the setup data stored in ROM.

Micro Channel vs. EISA

The Micro Channel's design is similar to that of EISA, and it includes support for the 386 and i486 microprocessors. It also supports up to 15 bus masters and can transfer data in burst mode. The Micro Channel also replaces DIP switches and jumpers with a self-configuring system. Unlike the ISA bus, the Micro Channel's level-triggered interrupts and sophisticated DMA-arbitration scheme allow multimaster operation. The major disadvantage of the Micro Channel, however, is that it is not downward-compatible with the ISA bus.

Supporters of the Micro Channel architecture argue that you won't want to migrate your original expansion cards to new machines. However, even if you don't, there are tens of thousands of application programs and thousands of expansion boards on the market today that EISA supports that the Micro Channel does not. In addition, most Micro Channel–based systems have basic features built into the machine, such as graphics adapters, mouse/serial/parallel ports, and floppy and hard disk controllers. These built-in features limit your future choice of products.

Micro Channel systems transfer data between the CPU, memory, and 32-bit peripherals at a maximum rate of 20 megabytes per second. That's less than two-thirds the speed of an EISA system, which normally performs at about 33 MBps. The Micro Channel offers a maximum of eight expansion slots, compared to EISA's 15.

Physically, the form factor of a Micro Channel board is about half the size of an EISA board. This makes Micro Channel product design more difficult and expensive. Since the board is smaller, the circuitry must also be smaller. In some cases, this means expensive application-specific ICs or surface-mounted ICs are necessary.

In addition, the Micro Channel's card has less than half the power of an EISA card available. This makes peripherals, like I/O boards with large amounts of memory, much more complex and ex-

continued

DMA CYCLE TYPES

Table 1: *Most ISA-compatible DMA devices can transfer data faster if the EISA controller is set up to use Type A and Type B transfers instead of ISA-compatible timing. Enhanced arbitration shortens the time between the DMA device's request and grant events.*

DMA cycle type	Size of transfer	Transfer rate (MBps)	Compatibility
Compatible	8-bit	1.0	All ISA
	16-bit	2.0	All ISA
Type A	8-bit	1.3	Mostly ISA
	16-bit	2.6	Mostly ISA
	32-bit	5.3	EISA only
Type B	8-bit	2.0	Some ISA
	16-bit	4.0	Some ISA
	32-bit	8.0	EISA only
Burst DMA (Type C)	8-bit	8.2	EISA only
	16-bit	16.5	EISA only
	32-bit	33.0	EISA only

pensive to design and build for Micro Channel systems.

EISA Takes Its Stand

Intel has already introduced EISA chip sets, including three chips for the motherboard and one chip for an add-in card. The first motherboard chip has been designated the integrated system peripheral and provides 32-bit DMA control, timer/counter control, interrupt control, bus arbitration, and DRAM refresh functions on a single chip.

The EISA bus controller, the second chip in the set, interfaces with the 8- and 16-bit ISA bus, the 32-bit EISA bus, and the CPU by performing the timing and control functions. The last motherboard chip, which is called the EISA bus buffer, contains buffering logic for any one of the data, address, and parity-control modes.

The intelligent add-on cards chip, which is called the bus-mastering interface controller, serves as the interface between a plug-in card and the 32-bit EISA bus and provides interface logic, drivers, and a DMA controller that is capable of becoming a bus master. EISA chip sets work with the 386 and i486 CPUs at speeds of up to 33 MBps.

The members of the original Gang of Nine are starting to introduce EISA systems, but not all of them are ready yet. Only a few currently have EISA systems. Hewlett-Packard was the first to produce an EISA microcomputer system, the Vectra 486PC. It transfers data at a rate of 20 MBps with a 16-bit ISA ESDI controller.

Right before Fall Comdex 1989, Compaq revealed its EISA system, the Systempro. The Systempro can decrease the time required to transfer a file to or from the disk by distributing a single file among multiple bus-master controllers, called an Intelligent Drive Array (IDA). Compaq also claims that its system will transfer data at 33 MBps.

Zenith Data Systems' 386/33E is the latest EISA PC system. The bus-master controller, which uses 1 MB of memory and is expandable to 4 MB, will support up to four ESDI devices, seven SCSI devices, and two floppy disk drives. The Zenith 386/33E is also supposed to be able to support a data transfer rate of about 33 MBps.

Some companies outside the original Gang of Nine are also working on EISA products. By the end of June, Arche Technologies will expand its current 486 AT system (up to 64 MB of memory, 256K bytes of external cache, and enhancements for write posting, page memory cycle, and prefetch cycles) to support the EISA standard. The Arche 486 EISA system will be able to use 32-bit VGA, 32-bit Ethernet, and 32-bit SCSI host adapters.

Although EISA systems are downward-compatible with ISA expansion boards, a number of EISA-specific products are expected to appear by the end of this year. These include

- Adaptec's 32-bit SCSI controller,
- Distributed Processing Technology's 32-bit hard disk controller,
- Proteon's 32-bit EISA version of a token-ring adapter,
- Standard Microsystem's 32-bit EISA version of an Ethernet board,
- SunRiver's 32-bit fiber-optic board,
- 3Com's network card,
- Arcnet's 16-bit multiuser board, and
- Western Digital's 16-bit ESDI controller.

EISA systems will thrive on the availability of EISA-specific products and the already existing stock of ISA products from current PC machines.

Make New Friends but Keep the Old

EISA will save you money, time, and paperwork because it will allow you to make better use of the hardware and software resources you already have. Like its predecessor, ISA, EISA is an evolutionary approach to the need to improve system performance. It offloads I/O processing from the microprocessor's list of things to do.

Unlike the Micro Channel, however, EISA does not require new peripheral cards to support its I/O bus. It uses standard AT cards. While adapting to the current AT bus architecture and using the more powerful 32-bit processors, EISA preserves compatibility with the existing world of AT-compatible devices. EISA has it all. ■

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We would like to express our appreciation to our colleagues Derek Cheng and Michael Bruzzone for their tremendous help, and to Lawrence Jair for many stimulating discussions about this article.

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A Calculating RISC

Coprocessors based on RISC engines will soon deliver supercomputing performance to your desktop

Trevor Marshall

Many personal computers can already deliver the same computational performance as mainframes, if you add in their coprocessing capabilities. With the advent of RISC coprocessors, these systems will approach speeds that you now associate with supercomputers. This next leap in performance will bring some unique advantages to the coprocessing environment.

Who Needs It?

When you think of a supercomputer user, you probably conjure up an image of a scientist in a research laboratory laboring over a massive problem in nuclear physics. While it's true that this type of user tends to have a virtually insatiable desire for compute power, the bulk of high-performance computing is devoted to three-dimensional graphics, mathematical simulations (e.g., aircraft flight simulators), and routine data analysis (e.g., in geophysics). Even apparently mundane applications in the printing industry, such as optical character recognition, color prepress, and typographic output, make up a significant sector of high-performance computing.

The applications that benefit most from coprocessing technology are those that are "compute-intensive"—where most of the processing is actual number crunching or manipulating data in memory. Because the host computer is used for disk I/O and operator interaction, a coprocessor is not very effective in situations where its CPU spends a significant amount of its time waiting for I/O tasks to complete. Thus, applications involving considerable file manipulation, for example, will benefit least from using a coprocessor.

Host Machines

Coprocessors are generally designed to boost the performance of workstations and high-end personal computers. Workstations are usually the most expensive desktop computers, and they often feature a multiuser capability. High-end personal computers are typically DOS-based systems using 386 or i486 CPUs with 80387 or Weitek floating-point chips. The Mac II family has also become a popular high-end platform, due to its intuitive user interface.

Both workstations and personal computers are mass-produced as general-purpose machines. Coprocessors are complete computing systems that plug into the expansion bus on these machines and work with their 386, 68020, or RISC CPUs, offloading those tasks that the general-purpose machines don't do well. This allows the host to concentrate on the I/O, file system, and operator interface while the coprocessor does the number crunching.

continued

ILLUSTRATION: CARY HENRIE © 1990

Photo 1: *This frame from the He-Man animation, created by Mr. Film using software from Digital Arts, shows how the power of a coprocessing system translates into tangible graphics. (Image copyright 1989 by Mattel Corp.; used by permission.)*

Coprocessing Through the Ages

Like desktop computers, high-performance coprocessors are a relatively recent phenomenon. The first was Steve Ciarcia's Trump Card, described in the May and June 1984 BYTE. The Trump Card featured a Zilog Z8000 16-bit CPU and plugged into an IBM PC. Although the available software was limited to a BASIC interpreter, the Trump Card nonetheless defined many of the features of today's high-powered coprocessing systems.

In the August and September 1985 BYTE, I described the Definicon Systems 32032-based coprocessor, which improved on the Trump Card in two ways: It used a true 32-bit microprocessor and came with a fully defined MS-DOS software interface. With multiple languages (C, Pascal, and FORTRAN) available that had been ported from the 32000 Unix environment, the Definicon DSI-32 coprocessor offered a high degree of software portability between Unix and DOS systems. The interaction between the compilers and the DOS operating system had evolved to where the coprocessor could execute even 80x86 software interrupts, and thus access all the features of the PC.

The following year, a 68020-based coprocessor system (the DSI-020) finally achieved a performance level exceeding that of minicomputers. This system ensured the success of the coprocessor concept, and it still forms the basis of software systems as complex as nuclear-reactor simulations.

A Stellar Performance

Coprocessors have several advantages over their workstation and personal-computer hosts that explain the performance differential between them. First, the CPU on the coprocessor usually doesn't run a complete operating system (like DOS or Mac OS), but operates in a shell of the host operating system.

You usually invoke an application running on a coprocessor with commands or mouse activity, the same as you would to execute a native application. Consequently, when a new CPU is released, coprocessor companies need only rewrite the shell code to take advantage of it—a task that usually takes just a few months.

Thus, new CPUs normally appear in coprocessor form as much as a year before they appear in a complete system implementation. Given the rate of performance increases in microprocessors over the last decade, this edge frequently translates into a 300 percent advantage in performance for coprocessors versus complete systems at any particular point in time.

Also, you can usually mount multiple coprocessors on one host and give each a different task to perform. This is especially useful with 3-D graphics software.

Finally, a coprocessor rarely has more than a rudimentary expansion bus. Unlike a conventional desktop system, all the memory and I/O subsystems on a coprocessor are closely coupled and optimized for better performance rather than compatibility with an existing expansion structure.

Boards of Distinction

Many people make no distinction between array processors and true coprocessors. Array processors, however, are generally designed for specialized tasks, such as computing fast Fourier transforms (FFTs), and come with libraries of subroutines that are linked with the main code running on the host. Most programs have to be rewritten to take advantage of an array processor.

A computing coprocessor, on the other hand, has extensive software support (including compilers) to minimize or eliminate the need to rewrite applications software. Generally, all you need to do to complete a port to a coprocessor is recompile the source code, using the software tools supplied with the coprocessor.

Array processors have advantages in two primary areas. First, if the computing task is quite small but repetitive (such as an FFT), an array processor can usually compute it faster than a general-purpose CPU.

Second, where a large proportion of the application is interaction with the operator via a complex operating environment (as in the Macintosh), it may be easier to let much of the code run untouched on the host and link in a few key subroutines running on the array processor. Several coprocessor manufacturers have designed linkable interfaces to their boards to allow them to be used this way as well.

The Soft Sell

Little third-party software is available for most coprocessors. One exception is transputer-based systems, which have a proliferating base of applications software that generally runs on any PC-based transputer board. Most of the available third-party software comes from specialized developers whose applications require a lot of computing power. Otherwise, much coprocessor software development remains in the hands of end users.

If you're writing coprocessor software rather than using third-party products, the software supplied to compile and run your application will be the most important part of your system. Be aware that the quality of compiler support varies greatly from system to system and even between identical CPUs on different platforms.

Although software for coprocessors is not nearly as abundant as it is for desktop computers, the programs available perform tasks beyond the scope of standard personal computers and workstations.

One natural application for coprocessing is graphics rendering. Recognize the image from the He-Man animation in photo 1? It was computed with coprocessors. In fact, coprocessors compute the animation for many of the title sequences you see on TV.

The DGS system that was used to create the He-Man image was created by Digital Arts. During product design, Digital Arts quickly realized that the PC itself did not have the power or the architecture to run complex rendering code at commercially viable frame rates. Each image in such an animation sequence takes about 45 minutes to compute, even on a coprocessor-equipped system.

The total computing time needed to produce the 2-minute video (at 15 frames per second) was about eight weeks. If you consider that the DGS system uses two coprocessors—a 68030 to set up the images and edit the sequence, and a transputer to perform the actual rendering—you can appreciate that graphics rendering is computationally intensive indeed. Without coprocessors, the time required would escalate dramatically.

The fact is, coprocessors compute the animation for many of the title sequences you see on TV.

The graphics card and video interface that the DGS system uses are standard PC devices. The DGS software allows the results of computation on the coprocessor to be sent to the video interface.

Another point is worth noting here. There is a certain amount of standardization in coprocessor technology. Coprocessors not specialized to perform array processing or graphics rendering are designed to take standard source code (usually from a Unix system) and then compile it with minimal changes to run on a personal computer. Therefore, once you have started using coprocessor technology, it becomes a relatively straightforward task to switch to a new processor when it becomes available. This tends to keep competition strong and prices reasonable.

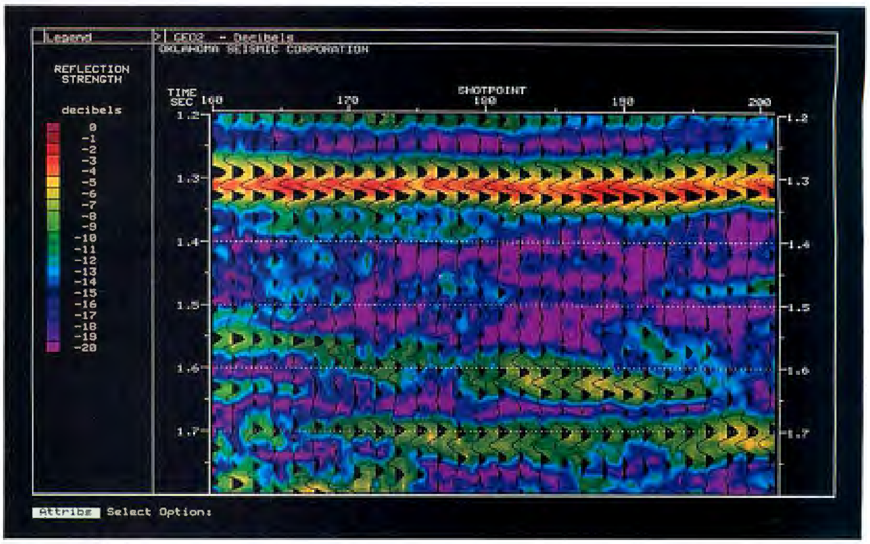


Photo 2: *Although written for 680x0 machines, the Oklahoma Seismic MIRA program runs on DOS machines, thanks to coprocessor technology. The program gives geologists and petroleum engineers a view of the structural geology of a region.*

The DGS software, for example, uses a 68030 coprocessor from either Definicon or YARC Systems, and transputer cards from CSA, Microway, or YARC.

Powerful Pluses

There are many reasons to use coprocessors besides raw power. One is to ensure object code compatibility. A coprocessor is probably the only way to market an application that uses, for example, 68020 assembly language in the Intel-dominated PC world, short of a total rewrite of the code.

This is why Oklahoma Seismic used a 68020 coprocessor for its MIRA geophysical data-analysis programs. MIRA analyzes the echo returns from sound blasts set off at regular intervals along the earth's surface that estimate a probable reconstruction of the underground geophysical-layer structures. A typical reconstruction is shown in photo 2. No compromises need to be made in a program's graphical or operator interface because it is running on a coprocessor.

Another attraction of coprocessors is the ability to increment your computing power just by adding more boards. For example, Visual Information (VIDI) produces an animation package for the Mac II that is similar to the Digital Arts DGS software. The VIDI software running on a single 29000 RISC coprocessor runs about 10 times faster than on a standard Mac II, and about 5 times faster than on the Mac IIci.

VIDI has written some software that allows up to five RISC boards to simultaneously render the images from an animation sequence. This gives an effective system speed 50 times greater than that of the Mac II host itself. This architectural flexibility, which is common in a mainframe environment, is only available on the desktop by using computing coprocessors.

State of the Market

The table lists the manufacturers that are currently shipping a coprocessor product. In order to exclude nonprogrammable systems (such as VGA video cards), table entries are restricted to systems that have a high-speed CPU, will execute user-written programs, and are targeted at desktop platforms.

Some of these systems are intended for specific applications, such as graphics. Boards from Apple, Hewlett-Packard, IBM, and NEC fall in this category. Others are intended as array processors. They don't usually allow direct and easy porting of applications software, as the array processor interacts with the host via a series of subroutines that are linked with main software running on the host. Array processors used to be very popular, but most AP manufacturers now offer alternative, more comprehensive, software-support packages.

continued

COMPUTING COPROCESSORS

The coprocessors listed here fall into three categories. The ones marked "AP" are devoted to array processing. The entries from Apple, IBM, Hewlett-Packard, and NEC are graphics coprocessors. The remainder are general-purpose coprocessing systems.

Company	CPU	Platform	Operating system	Max. RAM (MB per CPU)
Apple	RISC 29000	Mac	QuickDraw	N/A
Avalon	RISC 88000	VAX	VMS	80
CSA	Transputer	PC	DOS	8
Definicon	CISC 68030	PC	DOS	8
	RISC SPARC	PC	DOS	8
	Transputer	PC	DOS	4
HP	Graphics engine	PC	AP	N/A
IDT	RISC MIPS R3000	Mac	Special	64K bytes
IMS	Custom	Mac	Smalltalk	64
	Custom	PC	Smalltalk	64
IBM	RISC i860	PC	AP	N/A
	RISC RT	PC	Unix	N/A
Levco	Transputer	Mac	Mac OS	N/A
Meiko	Transputer	Sun	SunOS	N/A
Mercury	RISC Weitek	PC	DOS	N/A
	RISC Weitek	Sun	SunOS	N/A
Microway	Transputer	PC	DOS	16
NEC	Graphics engine	PC	AP	N/A
Opus	RISC 88000	PC	Unix	16
	CISC 32532	PC	Unix	N/A
Tektronix	RISC 88000	Mac	AP	8
Parsytec	Transputer	PC	DOS	N/A
	Transputer	Mac	Mac OS	N/A
	Transputer	PS/2	DOS	N/A
YARC	CISC 68030	PC	DOS	8
	CISC 68020	PS/2	DOS	4
	Transputer	PC	DOS	16
	RISC 29000	PC	DOS or AP	16
	RISC 29000	Mac	Mac OS or AP	8

The IMS product is also a little unusual. It lets you define the instruction set of the custom processor chip. IMS calls its technology WISC, for writable-instruction-set computer. In addition, IMS offers conventional language-development environments, such as Smalltalk and C++.

The Movement to RISC

One of the startling points visible from even a cursory glance at the table is the number of RISC CPUs that are used in coprocessing systems. The main reason for this is the current higher performance of RISC engines compared to that of conventional complex-instruction-set-computer (CISC) processors. There are several reasons why RISC CPUs are well suited to a coprocessor environment.

First, a coprocessor is a small computing system featuring a tightly coupled RAM subsystem. This happens to be the ideal topology for a RISC computing system. At the high frequencies that RISC processors use, it is very difficult to propagate signals around a circuit board. The bigger the board, the more features it has and the lower its performance. Conversely, the small, tightly coupled coprocessor can often extract peak performance out of a RISC CPU.

Second, RISC carries no requirement for object-level compatibility. Almost all compatibility between coprocessor platforms is achieved at the source code level. Thus, the lack of an applications software base for RISC engines is no particular disadvantage.

In addition, a RISC engine is often less expensive than a CISC CPU of comparable performance. This is especially true for the Advanced Micro Devices (AMD) 29000 and SPARC-based products. Since the cost/performance ratio is often the major selection criterion for a coprocessor engine, the RISC machines usually excel.

RISC vs. CISC

RISC technology has other advantages over CISC that are not specific to coprocessing systems. These days, processors based on RISC define the standards of high-end computing. Although RISC technology itself is not necessarily superior to CISC, a number of factors have combined to position RISC systems at higher performance levels than their CISC counterparts.

First of all, architects of RISC microprocessors began with a clean slate. There were no previous generations of software with which they had to maintain compatibility, and no preconceived notions of how they had to achieve hardware interfacing. This factor is very important.

Designers of computers based on a particular family of processors—the Motorola family, for example—are prepared to accept only minor changes in system architecture from one generation to the next. If, for instance, the designers of the 68040 had implemented an external Harvard architecture, with separate external instruction and data memories, they would be in a considerable amount of trouble right now.

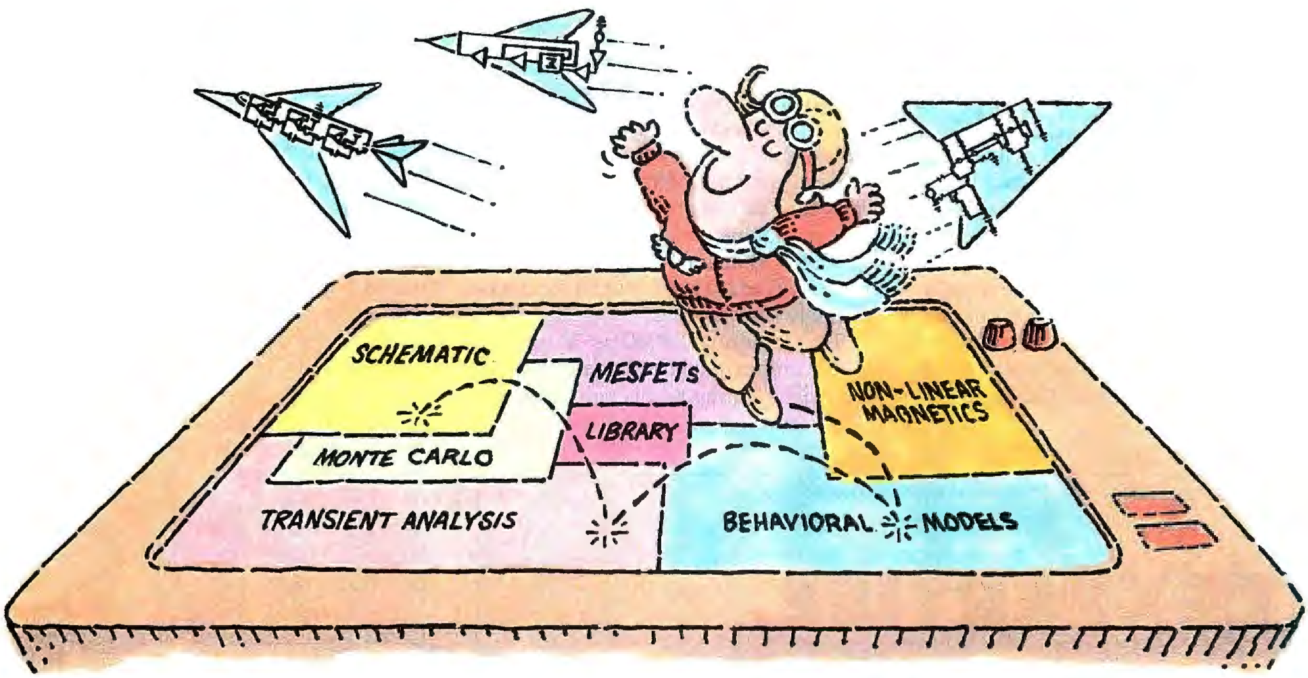
Both hardware designers and software engineers would have trouble dealing with such a radical change in 680x0 architecture. Hardware designers would have to redesign system boards, and software developers would have to relink all current 680x0 binaries, for instance, to separate the source code and data address spaces. This would complicate the smooth upward migration path provided by the 680x0 family.

Thus, Motorola implemented an internal Harvard architecture with separate data and instruction buses on the 68040. The data and instruction paths pass through separate memory management units and caches within the chip, but the signals are combined before they are brought out of the chip.

On the other hand, the AMD 29000 RISC designers had no qualms about implementing an external Harvard architecture. Separated external buses seemed clearly superior (and, ultimately, cheaper), so they were used. The designers were not faced with any overriding compatibility issues.

Second, it's easier to design a fast memory system for a modern RISC chip, because the software can maintain closer control of the internal pipeline status

continued



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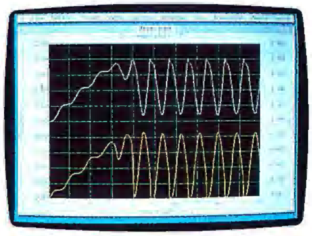
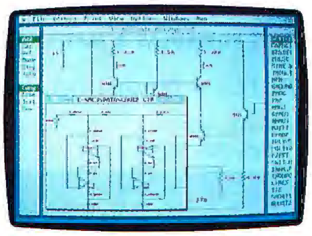
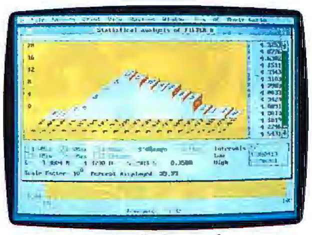


Transient analysis



Schematic editor



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than it can with the CISC chip. This allows the use of "load scheduling" and other optimization techniques to hide the wait states that are introduced when interfacing to real-world memory systems.

Which RISC?

In terms of overall system speed (as defined by the actual speed of operation when running application code), the leading RISC families are currently the MIPS R3000, the AMD 29000, and the Motorola 88000. The R3000 requires too many peripheral and cache chips to be really suitable as a coprocessor engine. Indeed, the only offering is from IDT. This card should probably be used solely as a development platform, as it has only cache RAM and has to go across the NuBus for access to main memory, an unacceptably slow process.

The Motorola 88000 is a very fast CPU, with arguably the fastest single-precision floating-point engine available. It produces its best results on small programs, such as benchmarks, that easily fit within its small 16K-byte data cache. It doesn't perform as well with larger problems primarily because of a minor design flaw in the 88200 cache controller. When there is a cache miss, the whole 4-word cache line must be refilled before execution can continue.

Thus, for programs whose data has good locality of reference, the 88100/88200 chip set turns in a superlative performance (its Whetstone figures are essentially equivalent to those of the Cray-1S). But when it is manipulating sparse matrices, at least 2 words of each cache line are usually never used. The overhead associated with waiting for them to be filled on each cache miss is crippling.

For example, when the 88000 runs a Gauss-Jordan elimination of a 200-by-200 matrix (from the Argonne Labs LINPACK benchmark suite), its Cray-relative performance drops to only 10 percent of what it achieves on Whetstone tests. In fact, if you use enough 88200 cache-controller chips, you can perform the whole LINPACK reduction in the caches and double the performance of the 88000 system.

The AMD 29000 offers a compromise between performance and hardware cost. It uses two totally separated buses for the instruction and data streams, which allows standard DRAM to achieve almost the same performance as static RAM (see "Real-World RISCs," May 1988 BYTE). Although a 29000 system won't outperform an R3000 or an 88000 system on small benchmarks, it will frequently emerge the winner on larger tests or applications code.

Coprocessing Comes of Age

Coprocessor systems have truly come of age. In 1984, when Dave Rand, George Scolaro, and I were defining what we thought could be done with coprocessors and how to do it, we could only dream that one day manufacturers such as IBM, Apple, and Tektronix would offer products using this technology.

Today's coprocessor systems give PCs the computing power of a mainframe. Over the next two years, you will see coprocessors achieve a level of performance currently reserved for supercomputers. Why dream about a Cray? Coprocessor technology will soon put that kind of power into your desktop computer. ■

Trevor Marshall is a BYTE consulting editor and is president of YARC Systems Corp. (Agoura, CA). You can contact him on BIX as "tmarshall."

Super Sources

Desktop supercomputers rely on a mix of technologies to deliver Cray-like performance in personal computer-size packages. For more information on the developing technologies discussed in this section, contact these companies:

Arche 486 EISA
Arche Technologies, Inc.
48835 Kato Rd.
Fremont, CA 94539
(800) 422-4674
Inquiry 1053.

C-Linda
Hypercomputer Linda
Scientific Computing Associates, Inc.
246 Church St.
New Haven, CT 06510
(203) 777-7442
Inquiry 1054.

ComputeServer
Torque Computers, Inc.
100 Varick St.
New York, NY 10013
(212) 925-1715
Inquiry 1055.

Connection Machine
Thinking Machines Corp.
245 First St.
Cambridge, MA 02142
(617) 876-1111
Inquiry 1056.

Cray Y-MP
Cray Research, Inc.
608 Second Ave. S
Minneapolis, MN 55402
(612) 333-5889
Inquiry 1057.

i486
i860
EISA chip set
Intel Corp.
3065 Bowers Ave.
Santa Clara, CA 95051
(408) 765-8080
Inquiry 1058.

Intelligent Drive Array
Systempro
Compaq Computer Corp.
20555 FM 149
P.O. Box 692000
Houston, TX 77269
(713) 370-0670
Inquiry 1059.

isPC/860
Intel Scientific Computers
15201 Northwest Greenbrier Pkwy.
Beaverton, OR 97006
(503) 629-7629
Inquiry 1060.

MC486
Apricot Computer plc
Apricot House
111 Hagley Rd.
Edgbaston
Birmingham B16 8LB
UK
44-012-456-1234
Inquiry 1061.

Micro Channel
IBM Corp.
Old Orchard Rd.
Armonk, NY 10504
(914) 765-1900
Inquiry 1062.

MPX
Unix System V/386
Xenix
The Santa Cruz Operation
P.O. Box 1900
Santa Cruz, CA 95061
(408) 425-7222
Inquiry 1063.

Parallel Programming
Support Environment (PPSE)
Oregon Advanced Computing Institute
19500 Northwest Gibbs Dr., Suite 110
Beaverton, OR 97006
(503) 690-1220
Inquiry 1064.

68040
88000
Motorola, Inc.
6501 William Cannon Dr. W
Austin, TX 78735
(512) 891-2000
Inquiry 1052.

SX-X Series
HNSX Supercomputers, Inc.
77 South Bedford St.
Burlington, MA 01803
(617) 270-7600
Inquiry 1065.

386/smp
486/smp
Corollary, Inc.
17881 Cartwright Rd.
Irvine, CA 92714
(714) 250-4040
Inquiry 1051.

Vectra 486 PC
Hewlett-Packard
19091 Pruneridge Ave.
Cupertino, CA 95014
(408) 725-8900
Inquiry 1066.

Z-1000
Z-386/33E
Zenith Data Systems
1000 Milwaukee Ave.
Glenview, IL 60025
(312) 391-8860
Inquiry 1067.

This resource guide lists information sources for the major concepts and products listed in this State of the Art section. Inclusion in the resource guide should not be taken as a BYTE endorsement or recommendation. Likewise, omission from the guide should not be taken negatively. The information here was believed to be accurate at the time of writing, but BYTE cannot be responsible for omissions, errors, or changes that occur after compilation of the guide.

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AROUND THE WORLD IN TEXT DISPLAYS

You think your computer is complicated? Try typing with 8000 different characters.

Ben Smith

According to the Bible, all the people in the world once spoke a common language. Then, when men of a great city tried to build a tower to the sky, the Lord came down and confused the language and scattered the people. The city came to be known as Babel, after the Hebrew word for "confused."

"Confused" aptly describes today's world, where the existence of thousands of distinct languages creates problems for commerce, politics, and technology—including computers.

Those of us in the English-speaking computer community tend to forget that computing is done all over the world, where functions that we take for granted are not quite so simple. The characters *A* to *Z* are easy to use in computers when compared with Cyrillic, Hebrew, Greek, Arabic, Chinese, and Japanese. Fortunately, today's faster and cheaper processors, memory, and high-resolution screens are providing affordable solutions to the problems of worldwide computing.

First, the Easy Ones

The task of developing systems and software that use non-English characters and words ranges from fairly easy to nearly impossible. Languages that use the same Latin alphabet as English, such as German and French, are the easiest to develop software for. Only a few special characters are required, and you can use these on many word processors by loading international keyboard and printer drivers, or by pressing special key combinations to insert them into documents.

IBM—very much an international company—provides its AIX version of Unix with a set of routines, called *message services*, to help display messages from a program. Developers of programs for the international market can use these facilities to internationalize their applications by externalizing all their messages and help screens. Different message and help tables are built for each language. Modern character-generator tables include extensions to the standard Latin characters for German, French, Portuguese, Spanish, the Scandinavian tongues (including Icelandic), and other European languages.

But if the characters are nonroman, say Cyrillic, you need more than just a language-specific message table. You also need to have the characters represented on the keyboard, the screen, and any other output device. Admittedly, the computer knows the characters as only bits and bytes, but the user needs to be able to interact with the computer. There are Cyrillic fonts for screens and printers, as well as Cyrillic key caps. Russian and Slavic writers need to learn only their version of the keyboard and to run versions of software that use their language.

Solutions to Classic Problems

The next major problem of representing foreign languages is how to deal with diacritical marks. This problem stems from the standard way of putting a character on the screen. Each character is stored as an array of bits within a character cell (see figure 1). In IBM PC compatibles and computer terminals, the cell size is dependent on the display hardware. (On bit-mapped systems like the Macintosh, the cell size varies from character to character and from font to font. See the text box "The International Macintosh" on page 266.) When a character is copied from memory to the screen, the entire cell is rewritten, replacing any bits that may have previously been mapped to that area. Thus, there is no way to display diacritics in the same character cell as the base character.

This is an exclusive-OR logic: One or the other character can occupy the space on the screen, but not both at the same time. In order that diacritics be added to the display, there must be a separate character defined for each diacritic and base character (radical) combination. One design that uses this method, IBM's High Function Terminal, has 10-bit characters, which extends the table to 1024 (2^{10}) characters.

A better solution is found by breaking from the standard way of generating characters on the screen, the OR logic, and using AND logic instead; one character *and* another can occupy the same space on the screen at the same time. David Packard Jr. did just this with his design for the Ibycus Scholarly Computer.

continued

ILLUSTRATION: GREG RAGLAND © 1990

You won't find an Ibycus in your local computer store, but you may find one in a college humanities department. It's a special-purpose computer, made to order for classical scholars. It's a word processor and text-searching machine for Latin, Greek, Hebrew, and Coptic writing, including all breathing and diacritical marks and Western European vowels and symbols. Contrasted with the PC's Monochrome Display Adapter 9- by 14-pixel character matrix, the Ibycus uses a matrix 18 pixels wide by 16 pixels high. (The characters are 16 pixels wide; the other 2 pixels separate characters.) The display shows 24 rows of 80 columns.

The Ibycus is usually combined with a CD-ROM device for research and study of the Western classics. The search utilities can quickly find text in any of the supported languages—not a trivial accomplishment.

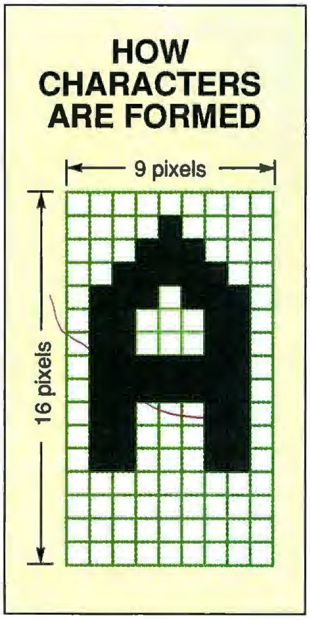

Figure 1: *On a typical IBM PC-compatible system, characters are constrained to a 9- by 16-pixel cell, making it difficult or impossible to display many international characters. When such a system copies a character from memory to the screen, it completely replaces the previous character, which prevents the addition of diacritical marks, such as those needed for Hebrew and Greek. This means that every possible form of a character must be stored in a separate memory location.*

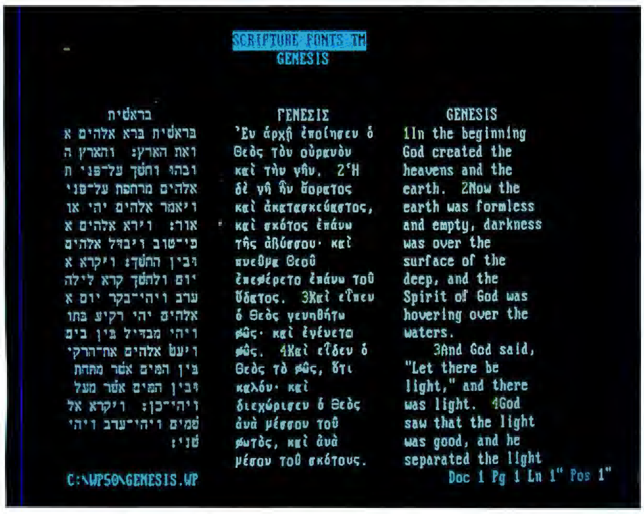

Photo 1: *ScriptureFonts, a package for students of Western classics and the Bible, lets users enter Greek, Hebrew, and Latin on a single line, display the proper characters on the screen, and print them on a printer. All the characters in the alphabets are mapped to the standard keyboard and displayed using standard character-generation hardware.*

Closer to personal computer home, Zondervan Electronic Publishing makes a package for biblical and classical scholars. ScriptureFonts lets you enter Greek, Hebrew, and Latin on the same line, display the proper characters on the screen, and print them on your printer. All the characters in the alphabets are mapped to the standard keyboard and displayed using standard character-generation hardware (see photo 1).

Such software must deal with a further complication to internationalization: Not all written texts run left to right and top to bottom. Hebrew text, for example, runs from right to left. Display software must place the cursor on the leftmost column after a carriage return and move the cursor to the right after displaying each character in a stream.

Zondervan has solved many of the cursor-direction and line-wrap problems by using absolute cursor positioning after every key press. (Normally, the system's BIOS automatically moves the cursor to the right after each key press; ScriptureFonts, however, bypasses the BIOS and sends an escape code to the screen after each key press, telling it where to place the cursor.) While this solution works, it adds to the program's overhead and can cause problems; for example, inserting text after the fact confuses the line-wrap macros. For a total solution to all the right-to-left writing differences, the control needs to be at the level of the display device. The Ibycus handles this well because its display is designed to work in any direction.

The Challenges of Arabic

Arabic writing is right-to-left for text and left-to-right for numbers. This complexity is further exacerbated by the number of cases in Arabic. While printed Hebrew has only one case, and Roman and Cyrillic have two, Arabic has four. Arabic also uses stretch character forms, which add emphasis and aesthetics to the written word. So much of the Arabic writing that we are familiar with is actually calligraphic. And while standard typewriter and printing Arabic fonts have existed for decades, the list of characters that are acceptable, even required, varies from region to region. This is not just a minor disagreement—this is a religious issue.

As with roman computing, a standard must be well established for Arabic writing to become common for computing. As yet, no convention exists for Arabic-character computing codes. NCR has a half dozen different character maps for its Arabic terminals and printers. IBM has at least 10.

The problem lies with the displays and printing devices on which Arabic is implemented. First, Arabic characters within a word must be physically connected. An EGA or better display handles this reasonably well, and bit-mapped displays and graphics workstations have no trouble with it.

When it comes to printing, the vertical range of Arabic characters and their diacritical marks is beyond the range of single-pass nine-pin dot-matrix printers. However, 24-pin printers have no difficulty with either the resolution or the management of the Arabic fonts. Laser printers are even more flexible because of their capability for very large character bit maps and the ease with which they build compound characters from basic elements.

Putting aside the religious issues of which characters to codify, the industrial issues of standardizing the codes, and the technical issues of printing and displaying them, you still have the problems of four cases and writing in both directions. You can use standard keyboards with Arabic key caps for text entry if you (or the application you're using) have a way to select the correct form of the letter based on the context. To understand how to do that, you need to know some details of Arabic script.

Stretching a Point

The Arabic alphabet consists of 28 basic characters and the stretch character (used for aesthetics and emphasis). With the exception of the letters *alif*, *waw*, and *ya*, all characters are consonants. These three exceptions are actually consonants with attached vowel sounds. The vowel sounds are usually added to Arabic by diacritical marks.

When a character stands alone or is at the end of a word, it is written with a bold stroke. When it occurs in the middle of a word, it is usually joined to the next letter by an upward curved stroke. And when it occurs at the beginning of a word, it is often an abbreviated stroke unless it is capitalized. There are six letters in the Arabic alphabet that can be connected only to the preceding letters. These are cast as delimiters in the scheme described below.

The Arabic characters can be divided into four classes: radical, delimiter, space, and numeric. The radical and delimiter characters can each have four forms (cases): capitalized, end-connective, midword, and word-beginning. Once the characters and forms have been defined in this way, it's not difficult to build contextual-analysis tables and rules. Then the only characters forms that need to be mapped to the keyboard are the base forms (usually word-beginning) of the radicals and their accented versions.

When you enter text on a system that can handle Arabic characters, it's a little surprising to watch the form of surrounding characters change as the computer resolves which form to display—not to mention watching the cursor move to the left (see figure 2). Then, when you enter numerals, the cursor stays in one place and the *numerals* stream off to the left, since numerals run left-to-right.

The Great Frontier: Chinese

Chinese is traditionally written in columns, top-to-bottom, with columns running right-to-left. This problem can be overcome, however, because modern Chinese people have learned to read in Western style, by rows left-to-right. The greatest challenge of computerized Chinese, then, comes from the fact that Chinese characters are not phonetic but rather pictographic and ideographic—that is, they represent images and concepts rather than sounds. The entire Chinese language includes more than 40,000 characters, 8000 of which are commonly used. Try putting all those on your standard keyboard.

Many Chinese characters were developed by combining other characters. For example, the character for *dream* is derived from the character forms for *flower*, *evening*, *roof*, and *eyes-while-lying-down*. However, as the base forms are combined, they are often abbreviated to simplify writing or modified to improve the character's readability, writability, or aesthetic value (see figure 3).

Modern Chinese writing was developed with brush and ink. The strokes from a brush naturally have different thicknesses at various places. Uniform lines and curves make reading the characters more difficult, and, in some strokes, impossible. Even though the height of the characters can be kept relatively uniform while using the Western writing direction, character width will vary. Reading Chinese characters with fixed width and height is like trying to understand someone who's speaking in an absolute monotone. Again, the Chinese have learned to cope, this time with the limitations of computer displays.

Chinese computing involves many of the same issues as computing in Arabic: the politics of which characters to include in the basic set, the necessity for high-resolution screens and bit-mapped character displays, printer limitations, and so on. Even if you solve those, you're left with the problem of how to enter the thousands of Chinese characters from a keyboard—a challenge much more complex than that of Arabic.

The first attempts to solve this problem have involved huge, specially designed keyboards with hundreds of keys. Some early designs came from Multitech, a multinational high-tech company headquartered in West Germany. In 1987, Multitech changed its name to Acer and moved its headquarters to Taipei, Taiwan. Suddenly, finding ways to make Chinese computing easier became a necessity.

Besides being a major force in the development of Chinese MS-DOS, Acer has also implemented methods for entering Chinese characters with a standard AT-style keyboard—though "selecting" may be a better word than "entering." Acer provides two ways of selecting a character from the expandable character database in its Chinese system. The first selection method, involving phonetics, migrated from Japan along with many Japanese phonetic characters on the keyboard.

Using 42 key combinations, the user enters the consonants,

continued

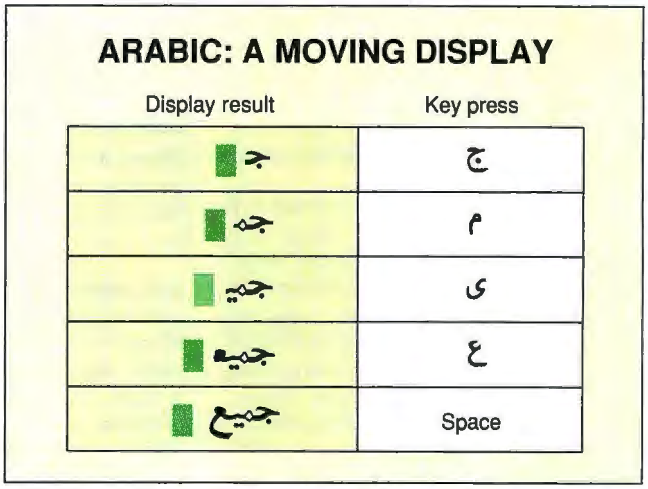

Figure 2: *Using NCR's Decision Mate V system, a user might type an Arabic word by pressing the characters shown above. After each key press, the cursor moves to the left. When the user presses a space as the last character, the system adds a bold stroke to denote the end of a word.*

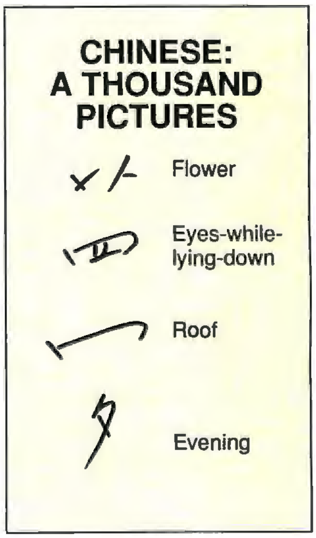

Figure 3: *Chinese characters are based on images and concepts instead of phonetics. Often, these images are combined to form new characters. The Chinese character for* dream *comes from the character forms for* flower, evening, roof, *and* eyes-while-lying-down.

The International Macintosh

Many systems specifications for internationalization are currently little more than just words on paper. But the Macintosh has everything in place and working. The key lies in the Script Manager, a set of general text-manipulation routines for Latin-based alphabets and nonroman writing systems such as Japanese and Arabic. By merely redefining a few resources, an application can take on the appearance of a different language.

Resources underlie Mac applications and system operations. They can be added, subtracted, or modified without any concern by the application, yet their encapsulated information determines the attributes of operations and events (e.g., fonts, menus, and cursor type and motion). Resources in the system file are globally available; resources in the application file are only available while that application is running.

To create an international version of a program, an application developer needs to define messages in the target language. He or she may also have to provide the fonts, although fonts are available for nearly every writing method. Due to the bit-mapped nature of the Macintosh display, the size of characters may vary from character to character and from font to font—a necessity for displaying many international characters (see photo A).

Use of the Script Manager and associated resources greatly facilitates the development of multilingual applications. The Macintosh resources take care of all the details of selecting the correct font, displaying it, and controlling the direction of the writing—left-to-right, right-to-left, even up-and-down. Meanwhile, the keyboard is mapped appropriately. The Script Manager defines 32 different scripts, including Japanese, Chinese, Korean, six other Eastern scripts, 10 different East Indian scripts, and even Ethiopian. Different scripts can be combined on the same line, usually a simple problem when the direction of writing differs between scripts.

The Macintosh International Utilities Package works in conjunction with the Script Manager to complete the task of internationalization: date, time, monetary, and decimal format, as well as sorting where characters may be equal at one level of sorting but unequal at another.

The tragic flaw is that the Macintosh is proprietary and limited in scope. The operating system doesn't fill the needs of non-Mac users. Nonetheless, despite Apple's attempt to limit the use of its ideas, its solutions to human-interface problems have influenced MS-DOS, OS/2, and Unix.

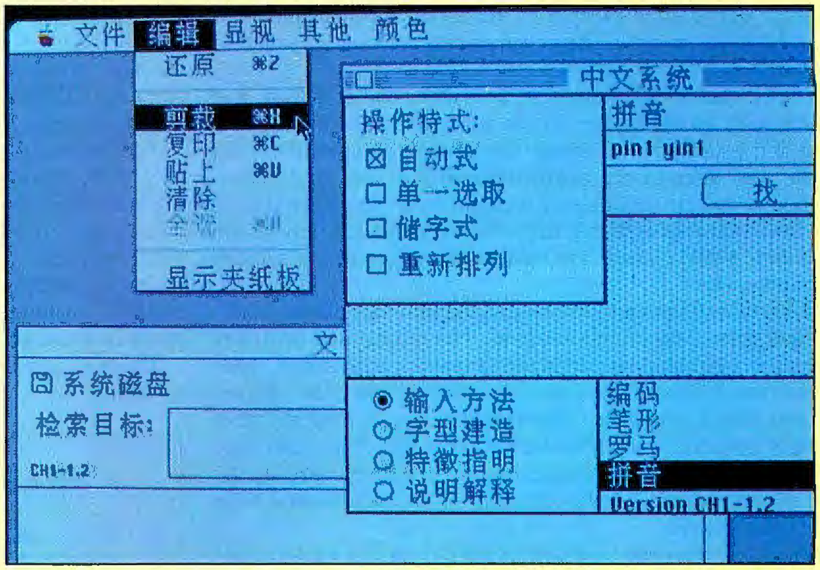

Photo A: *Due to the bit-mapped nature of the Macintosh display, the size of characters may vary from character to character and from font to font—a necessity for displaying many international characters.*

vowels, and pitches to describe the sound of the character. Since many different characters can sound the same, the user might have to select the correct character from a list of homonyms. For example, Chinese has three "ying" characters; they look considerably different, but one is for an eagle, another is for a parrot, and the third is for a greenfinch.

Although the process of entering Chinese characters phonetically sounds slow and complex, it actually isn't far removed from entering text in roman-based computing, since the Latin alphabet is phonetic. The difficulty for Chinese computer users is in learning a totally foreign way of thinking about their writing.

The other method of Chinese character selection uses a combination of one to five character elements (out of 25 different elements) to build the character. This is similar in concept to actually drawing the character. Acer's name for the method is Changjei, literally translated "characters of Chang, originator of writing."

While this method of building characters may seem simple, it took a tremendous amount of work to distill Chinese writing to this structure. Mathematically, more than 10 million characters can be described in this way, although not all possible combinations of the 25 Changjei elements generate valid Chinese characters—just as all combinations of five Roman characters do not necessarily form valid English words.

No Western font or character table is designed to hold even a few thousand characters, let alone the many thousands of Chinese characters. Acer uses TCA Code (Taipei Computer Association Recommended Internal Code) and extended memory to address a 2-byte (16-bit) character-generation code. Once the system has determined which character to use (using one of the two methods described above), it copies the character-generation operations from a table entry to the character generator. There are actually three tables: the first holds the data for the 5402 most commonly used characters; the second holds data for 7650 less frequently used characters; and the third table holds data for 5640 user-defined characters.

continued

Figure 4: *Japanese text, while using a much smaller set of characters than Chinese, can contain three different kinds of writing: the formal kanji, the phonetic katakana, and the informal hiragana—not to mention roman characters for words and phrases that are untranslatable. The English translation is given below the Japanese text.*

JAPANESE: THREE IN ONE

かなり以前のことだが，CP/M上のデータベース・プログラムであるVulcanというソフトを批評したことがある。そのとき"頭にくるが傑作"という評価を下した。その意味は，強く希望していたことを実現してくれるプログラムであるが，その操作のやり方が嫌になるほど面倒ということだ。アルゴリズムはとっても優れているが，それに比べユーザ・インタフェースがかなり見劣りしている。余談ではあるが，これはその後dBASE IIとなった。George Tateは私の批評を読んでVulcanを買収した。

Long ago, I reviewed a CP/M database program called Vulcan that caused me to invent the rating "infuriatingly excellent"; meaning that the program did something I very much wanted done, but I had to fight it every step of the way. The algorithms were far better than the user interface. Incidentally, that was the first review of the program that became dBASE II. George Tate once told me he bought Vulcan (and renamed it) as a result of my review.

Kanji　Katakana　Hiragana

Japanese High Technology

Japanese writing uses a much smaller set of characters than Chinese, but it is more complex because it includes three different *kinds* of writing (see figure 4). The first writing style is kanji (writing of the Kan dynasty of China). This is the traditional and formal style of writing. The second kind of writing is katakana, a phonetic alphabet used to spell out words that are foreign to Japanese. The third kind of writing is hiragana, an informal, abbreviated style. Japanese computers have to display a mixture of kanji, katakana, hiragana, and ASCII roman.

Japanese characters are usually entered phonetically, often spelled out using the anglicized version of the character. For example, to enter the character for *sushi*, the user enters S-U-S-H-I. Simple for us, but not intuitive for Japanese. Another degree of sophistication hides behind all of this: The pronunciation of a word or character depends on where and how it is used in a statement. As with Arabic, characters change on either side of the cursor as the user enters text. If the word isn't resolved to kanji or hiragana, it will end up either katakana or roman.

Because of the computational power and sophisticated programming required to select and generate Japanese characters, computerization of the average Japanese office didn't take off until 1980. Prior to that, all office work was done by hand. There has never been a successful Japanese typewriter.

The Japanese interest in AI grew out of the work on solving the data-entry problems of their writing, likely the most complex of all. Now Japan has become a great resource for innovative programming as well as computer hardware. Although the Japanese started computerizing much later than the Western world, the lessons they learned on the way have made them leaders in sophisticated systems.

A Unified World Theory

Each writing method carries some special problems for application programs. For example, how do you sort textual data when an alphabet has more than one sorting order? How do you edit Chinese writing? Do you remove the entire character and start again, or can you edit the character? Sorting Chinese names is simplified by the fact that there are only about 200 Chinese surnames. The Japanese use a great deal of Chinese writing, and there are far more surnames in Japan. So Japanese names are sorted phonetically.

If you think Japanese computing has problems, consider India, which has nearly 20 different methods of writing, besides classical Sanskrit, Devanagari, and Arabic. Countless other writing methods exist in Asia and Africa. Africa alone has nearly a thousand languages—many with no written form.

Still, there are now affordable solutions to the technical problems of computing for the most widely used forms of nonroman writing: Eastern European (Cyrillic), Hebrew, Arabic, Chinese, and Japanese. But great challenges still remain. Perhaps the greatest challenge involves the issue of standards. Some promising signs exist: Many modern standards require programs to have an international version before they can be certified. ANSII Standard C defines a multibyte character type and specifies that all string functions operate on the structure in a sensible manner. The IEEE Posix standards for Unix include specifications for internationalization.

These are steps in the right direction. Structures that allow for more information per character position must exist below the application program, at the level of the compiler and operating system. Unfortunately, very few operating system and language implementers have done more that acknowledge the problem and agree to work on it "very soon now."

Until the problem is attacked at that level, international users will be forced to make do with ad hoc solutions. Not that we need more standards; the existence of YAT (Yet Another Standard) would only make the problem worse. We just need to change our mind-set from "I can do it better" to "We can do it together." ■

Ben Smith, a technical editor for BYTE, formerly helped to develop a computerized form of Arabic. He can be reached on BIX as "bensmith."

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Photographs: Harry Langdon

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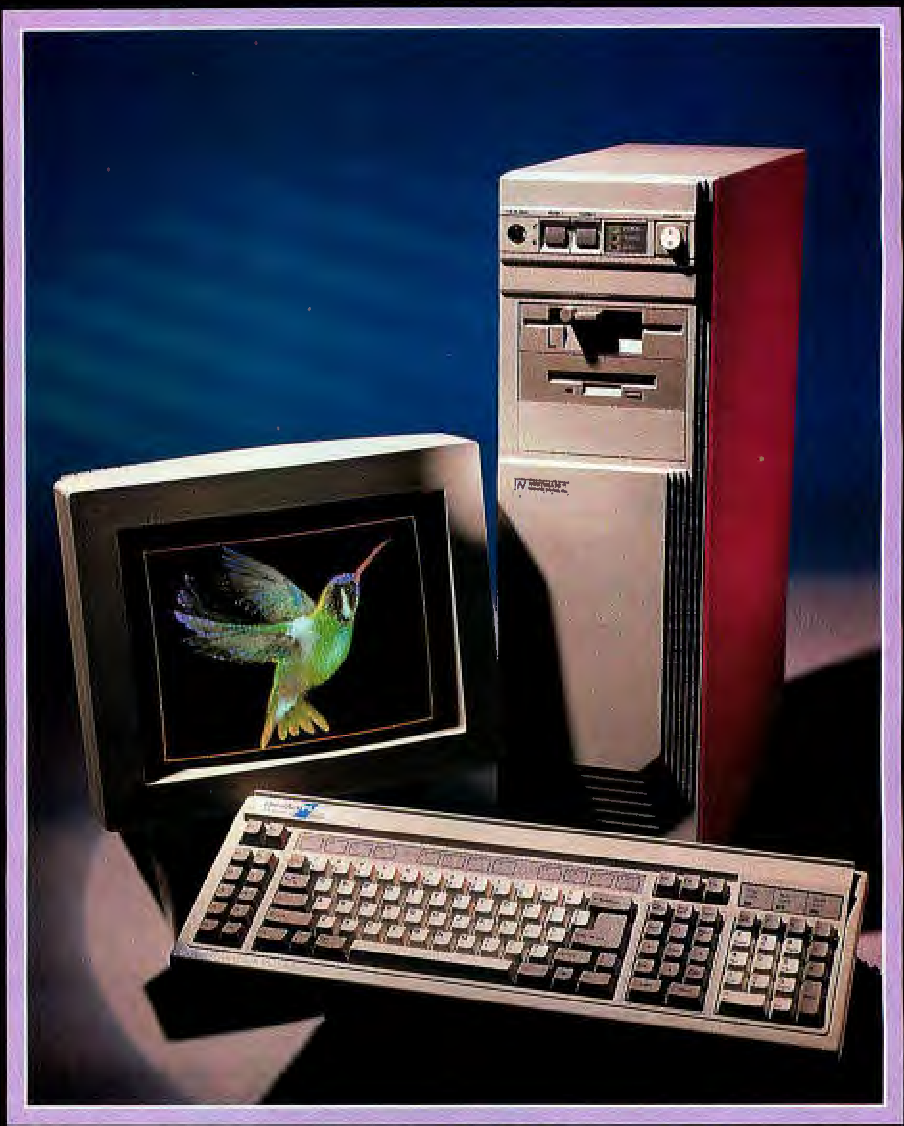

PHOTO: HARRY LANGDON

THE NORTHGATE 386 33 MHz ELEGANCE SYSTEM

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b. Tasteful opulence in form, decoration or presentation.

2. Something that is elegant." (American Heritage Dictionary)

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☐ **INDIVIDUAL CREDIT** but rely on income or assets of another person as a basis for repaying the credit requested. Complete entire application.
☐ **INDIVIDUAL CREDIT.** Complete sections "a" and "b" only.

Please complete all appropriate sections, providing at least two year's residence and employment history. This will enable your application to be processed as quickly as possible. If you are self-employed, please be sure to complete section "D" on back.

Applicants must be 18 years of age or older.

a. Your Personal Information

Requested Line of Credit $_____

Your Name: First Initial Last **Date of Birth:** Mo. Day Yr. **Social Security Number:**

Present Address Street Apt. # City State Zip **Home Phone** ( ) —

Date of Residence: Month Year **Monthly Payment: $** Buy ☐ Rent ☐ Other ☐

Previous Address: **Dates of Residence:** From To

Your Employer: (If self-employed, see rear panel) **Date of Employment:** Mo. Yr. **Position:** **Monthly Income:** Gross $ Net $

Employer's Address: Street City State **Business Phone:** ( ) —

Previous Employer: **Address:** **Dates of Employment:** From To

Income from alimony, child support or separate maintenance payments need not be disclosed if you do not wish to have it considered as a basis for repaying this obligation. **Other Income:**

I have received since: (Date) Monthly Income: Gross $ Net $

Name and Address of Nearest Relative Not Living With You: Relationship:

b. Credit Information

Include joint applicant's information, if joint account requested.

Bank Account: Bank Name Address ☐ Checking ☐ Savings

Bank Account: ☐ Checking ☐ Savings

	Payment	Balance
Bank Loan Reference:		
Bank Card Reference: ☐ VISA ☐ MasterCard		
Other Credit Card Reference		
Other Credit References: Account No: Expires:		

Driver's License No. State: Expires:

c. Joint Applicant's Personal Information

*If you are a married Wisconsin applicant, you must provide your spouse's information below, even though your spouse may not be signing this contract.

Joint Applicant's Name: First Initial Last **Date of Birth:** Mo. Day Yr. **Social Security Number:**

Address Street Apt. # City State Zip **Date of Residence:** Mo. Yr. **Home Phone** ( ) —

Employer: **Date of Employment:** Mo. Yr. **Position:** **Monthly Income:** Gross $ Net $

Employer's Address: Street City State **Business Phone:** ( ) —

d. Self-Employed Information

Complete this section only if you are self-employed.

Business Name: ☐ Proprietorship ☐ Corporation ☐ Partnership

Business Address: Business Telephone: ( ) —

Description of Business: Your Position: In Business Since:

Your annual Income from business: Business' annual income: (gross) (net)

You must provide at least one of the following:

1. Business Bank: Name Telephone ( ) — Personal Banker's Name:
2. Accountant's Name Telephone ( ) —
3. **Financial statement on business attached.**

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Circle 179 on Reader Service Card

POWER TO THE PORTABLES

New batteries will store more power and allow laptops to run longer

Andy Reinhardt

In 1981, Adam Osborne introduced not only a new computer, but a new *kind* of computer: the portable. The original Osborne I, like its early offspring, was the size of a suitcase and was meant to be ported from home to office. It was definitely not a laptop machine—unless you had a lap like the Incredible Hulk—and its AC power cord meant that you had to tether it to a wall outlet when in use.

When Tandy introduced the AC/battery-operated Model 100 in 1983, the portable family tree split into two branches: the luggables and the laptops. The trade-offs between these two types of portable computers involved power, in one form or another. If you needed a small machine that you could take on the road and run off batteries, then you bought a laptop and settled for limited features. If you needed a high-powered CPU, memory, disk drives, screen, and software, you were stuck with a suitcase-size portable.

Since those days, the two types of portables have converged, thanks, in part, to smaller, low-power components. Still, a major limiting factor in laptop design has been the humble battery, which has often dictated what you could do with your laptop and how long you could do it.

Experts have long predicted that better batteries for laptop computers were just around the corner. The time is right. Despite big improvements in power management, neither customers nor manufacturers are entirely happy with the current options, especially finicky nickel-cadmium (NiCd) batteries. Actually, every type of portable battery now in use has drawbacks.

Poised to arrive are new batteries that promise to solve many of the current crop's problems. Nickel-hydride (NiH_2) batteries, for instance, offer higher power capacity and thus longer operating life. Air-breathing zinc alloy batteries, similar to those used in hearing aids, offer longer life, lower weight, and fewer hazards. And a new technology that was announced recently will someday provide solid-state lithium batteries with long life and a high number of recharges without the safety risks of liquid lithium cells.

The Trouble with Nickel Cadmium

Rechargeable NiCd batteries are widely used in today's laptops, including models from Compaq, Toshiba, Zenith, and NEC, yet their reputation is not very favorable. Aside from environmental concerns regarding their disposal (cadmium is highly toxic), NiCd batteries are a hassle. Even with sophisticated power management, they typically last only 3 to 4 hours before they need to be recharged, and they can only be

continued

ILLUSTRATION: RICHARD STEADMAN © 1990

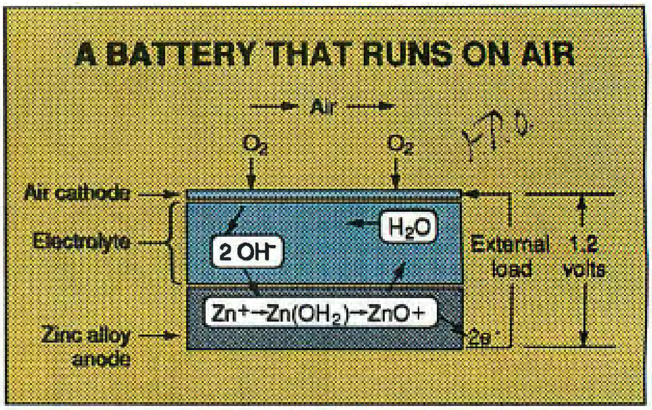

Figure 1: *At one end, the Aerobic Power battery has a fairly typical zinc alloy anode. The cathode, however, features an air-breathing carbon membrane that extracts oxygen from the atmosphere. Oxygen and water are broken down into negatively charged hydroxide ions (OH^-), which bond with positively charged zinc atoms, releasing water and electricity.*

recharged a few hundred times before they must be replaced.

The greatest controversy about NiCd batteries concerns the recharging process. The energy output of NiCds is relatively stable, dropping off only as they near depletion. But if improperly recharged, NiCds suffer a well-known memory effect known as *voltage depression*. This means that the battery "remembers" how much power was left when you recharged it. When you use your machine and the battery's power falls below that level, the voltage drops 10 percent. This situation can fool the computer's power management circuitry into thinking the battery is spent.

To avoid this problem, vendors counsel users to fully discharge the batteries before recharging them and not to charge batteries in mid-cycle. However, many designers now discount the memory effect, saying that good power management design eliminates it completely. Richard Stickel of Gates Energy Products blames most of the problems associated with NiCd voltage depression on poor power engineering. For example, he says, rather than using 10 1.2-volt NiCds for a 12-V system, designers should use 11.

In the last year, many manufacturers have reworked older technologies in innovative ways to avoid the problems of NiCds. Dynabook Technologies used a dry lead-acid battery for its portable, while Apple chose a lead-acid gel battery for the Macintosh Portable. A growing number of pocket-size personal computers, including the Poqet, Psion MC series, and Atari Portfolio, use off-the-shelf AA alkalines.

But none of these alternatives to NiCd is an ideal solution. Lead acids are as heavy and expensive as NiCds, and their power decays at a more linear rate, putting big demands on the power management system. AA cells are relatively cheap, but they can't be recharged. And, under some circumstances, all these batteries can explode or leak.

Nickel Hydride

Last summer, when personal computer pioneer George Morrow announced his intention to market a laptop sometime in the future, he said that the machine would use NiH_2 batteries, an emerging alternative to NiCds. Morrow said that his nickel hydrides are twice as efficient as traditional NiCds.

Now, battery maker Gates Energy Products is commercializing rechargeable nickel hydrides. Gates says that it intends to produce samples this year and volume quantities in 1991. According to the company, NiH_2 batteries able to replace the NiCds in existing portables will have 50 percent higher capacity, which could boost operating time by as much as 50 percent.

The only problem with nickel hydrides is that they have a higher internal impedance than NiCds. Laptop makers won't be able to count on them to run computers that both consume more power *and* last longer between charges. To best exploit the higher capacity of nickel hydrides—that is, to enjoy longer operating times—laptop designers will have to make computers that use the same amount of or less power.

Stickel says that NiH_2 batteries will suffer less from voltage depression than today's best NiCds and that you should be able to recharge them nearly as many times. Current prototypes, however, do not perform this well. NiH_2 batteries will cost somewhat more than NiCds, although exact pricing hasn't been established. They are, however, environmentally preferable to NiCds because they don't contain cadmium.

The "Aerobic" Battery

One new development has come from an unexpected source: A small company called Dreisbach ElectroMotive, Inc., or DEMI, recently demonstrated a zinc battery that breathes airborne oxygen for use in its internal chemical reaction. This rechargeable battery, dubbed Aerobic Power, offers lighter weight and greatly improved run time over NiCds and will cost about the same in dollars per hour of operation, DEMI says.

The Aerobic Power battery has a zinc alloy anode and an air-breathing cathode—a carbon membrane that extracts oxygen from the atmosphere (see figure 1). In operation, the Aerobic Power requires a ducted air supply and some sort of airtight shield to shut it down when not in use.

The battery reaction draws oxygen through the gas-permeable membrane into an alkaline gel electrolyte. Oxygen and water molecules in the electrolyte break down into oxygen and hydrogen atoms that pair to form negatively charged hydroxide ions. These ions, in turn, bond at the anode with positively charged zinc ions to form harmless zinc oxide. Water and electricity are released in the process, and each cell produces about 1.2 V of potential. The excess water is absorbed back into the electrolyte.

One of the major breakthroughs of the Aerobic Power battery is its rechargeability. Other companies have attempted without success to design rechargeable zinc-air batteries, says DEMI's Len Danczyk. DEMI's process is proprietary, but basically it involves reversing the reaction. Water from the electrolyte and electricity supplied by a power source are applied at the anode, producing zinc atoms and free hydroxide ions that escape through the cathode membrane as oxygen.

Among this battery's other breakthroughs are its high power output—up to 1000 times that of a typical hearing aid battery—and its low weight-to-power ratio. Zinc-air batteries are lighter than others because the oxygen is obtained from the air, rather than from metal compounds such as the nickel hydroxide or

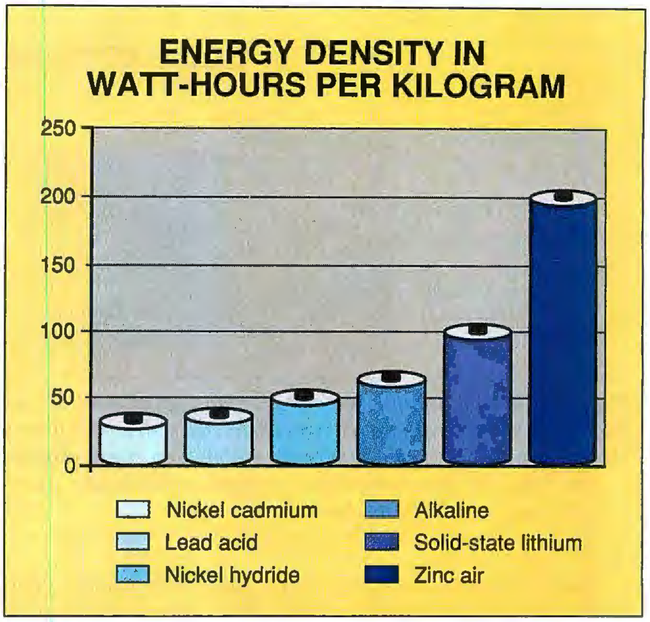

Figure 2: *As this graph of power output shows, rechargeable nickel-cadmium batteries (currently favored for portables) and good old alkaline batteries may face stiff competition from zinc-air, nickel-hydride, and solid-state lithium batteries, which offer combinations of rechargeability, higher power, and longer operating life.*

manganese dioxide typically found in other batteries. A single cell weighing only half as much as a NiCd cell can produce power four to five times longer, DEMI says. This feature gives the Aerobic Power a rating of 200 watt-hours per kilogram, versus roughly 30 Wh/kg for NiCd and lead acid (see figure 2). Thus, a laptop battery could last for an entire 8-hour workday.

A key problem with zinc-air batteries has been that dendrites of zinc oxide (tree-like marks made by one mineral crystallizing in another) grew on the anode and could eventually short-circuit the battery. DEMI says that its process combats this zinc oxide buildup but won't disclose details on the technology.

A drawback of this battery is that the maximum number of recharge cycles is less than that for NiCds. DEMI currently rates the battery for 25 to 30 cycles; it expects 40 to 60 when the technology matures. But because its raw materials cost less, the Aerobic Power battery will sell for roughly $50, as opposed to from $80 to several hundred dollars for NiCds and lead-acid cells. In the end, the cost per hour of operation is equal, DEMI says. Another potential problem, according to Bill Jergens of Texas Instruments, is that once they are exposed to oxygen, zinc-air batteries tend to degrade no matter how carefully they're sealed.

continued

COMPANY INFORMATION

Aerobic Power Systems 120 Interstate North Pkwy. E, Suite 160 Atlanta, GA 30339 (805) 965-0829 **Inquiry 1105.**	**Gates Energy Systems** P.O. Box 114 Gainesville, FL 32602 (904) 462-3911 **Inquiry 1106.**	**Lawrence Berkeley Laboratory** Public Information Dept. 1 Cyclotron Rd. Berkeley, CA 94720 (415) 486-5771 **Inquiry 1107.**

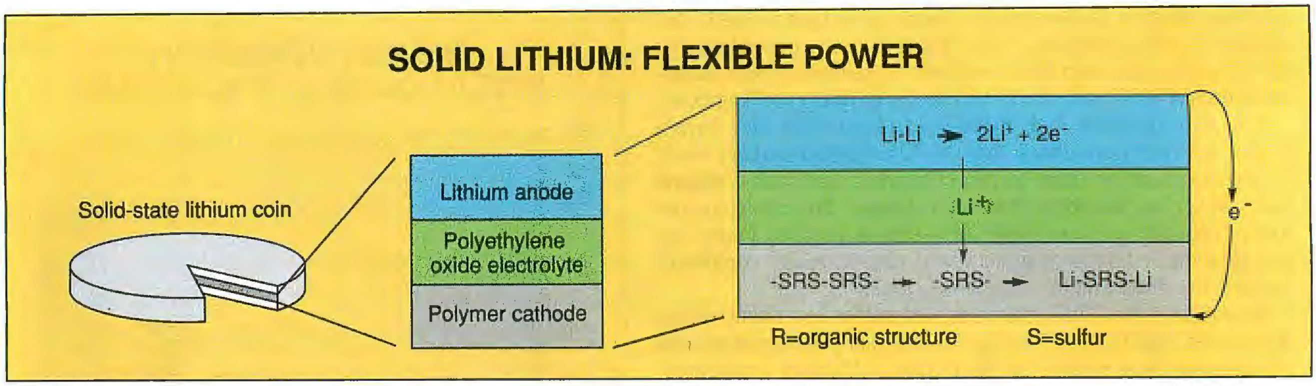

Figure 3: *In solid lithium batteries, a thin film of disulfide polymers (acting as a cathode) is layered between films of lithium (the anode). When the lithium oxidizes, it releases electrons that cause the sulfur compound to depolymerize, giving off electrochemical energy. Much more stable than conventional lithium batteries, this lithium "sandwich" could be made into "coins" (for use in cameras and watches) or flat bricks (such as the batteries used in today's laptops), or rolled up to create various sizes of cylindrical batteries.*

Pilot production is expected this year, with volume laptop battery production slated for early 1991. Incorporation of the Aerobic Power battery into commercial laptops will require higher-power recharge circuitry, changes to power management schemes, and packaging modifications, including the addition of air ducts and airtight access doors.

Laboratory Lithium

Although George Morrow was enthusiastic about nickel hydride, he noted that rechargeable lithium batteries would be even better. Unfortunately, such batteries aren't manufactured because of their potential explosiveness. Currently, the only available commercial lithium cells are nonrechargeable "coin" batteries used in some cameras, watches, and calculators.

But there's hope on the horizon. Scientists at the University of California's Lawrence Berkeley Laboratory recently announced that they have developed a new lithium battery that uses advanced thin-film technology and is based entirely on solid materials. This battery should deliver higher power, more recharge cycles, and a longer shelf life (at a lower price and weight) than any of the commercial batteries that are now available. And, say its developers, unlike lithium batteries with a liquid electrolyte, the new batteries won't leak or explode when exposed to heat.

This solid-state, thin-film lithium cell exploits the organic sulfur-sulfur bond that is essential in chaining together amino acids into proteins. To use this bond innovatively, the scientists developed a breakthrough cathode material—a thin film of disulfide polymers that contains long chains of molecules joined by these sulfur-sulfur bonds (see figure 3).

The cathode is layered between thin films of a lithium anode. When the lithium oxidizes, it releases electrons that cause the sulfur compound to depolymerize, giving off electrochemical energy. Electricity reverses the process, causing the sulfur bonds to rejoin into polymers. According to the developers, no battery has ever before used the energy of sulfur-sulfur chemical bonds.

Solid-state lithium batteries should be able to operate in both room-temperature and high-temperature applications (80°C to 100°C). Room-temperature versions for uses such as laptops could be available in three to four years. High-temperature versions may someday have applications in electric automobiles.

This new technology should result in many ways to configure lithium batteries. Manufacturers could start with sandwiches of thin films and cut them into coins similar to the current lithium batteries. They could layer them into flat bricks such as the batteries used in today's laptops. Or they could roll them up to create the various common sizes of cylindrical batteries. The solid-state lithium coins could deliver about seven times the watt-hours per kilogram of today's liquid lithium cells. Room-temperature cylindrical batteries could deliver about four times the watt-hours per kilogram of a NiCd.

According to its developers, this new type of lithium battery can be recharged 100 times with minimal loss of energy capacity. Some prototypes have been successfully recharged as many as 350 times. In addition, developers believe that the raw materials for the new battery will cost less than those required for current batteries, which would result in less expensive replacements. That this type of battery contains no toxic materials should minimize disposal problems. And one benefit of these new devices that should greatly interest laptop toters (with one arm longer than the other) is that because the polymer in lithium batteries is lighter than a metal cathode, the batteries will weigh less than NiCds.

Power Management

Even with the pending arrival of new battery technologies, most observers say that improved battery performance—especially in the immediate future—will depend on the same criteria that are valid today: lower power consumption and better power management.

NiCd technology has matured. Users probably won't see additional capacity improvements of more than 10 percent to 15 percent. To boost laptop operating time, manufacturers will need to use lower-power disk drives and displays, active power management (CPU sleep mode and system suspend/resume), and "passive" advances such as static CMOS ICs and slow refresh DRAM.

Furthermore, some of the high-storage-capacity batteries of the future will achieve their longer operating times in part by doling out power at a lower rate. Since both NiH_2 and zinc-air batteries perform best when the consumption of current is very low, vendors must provide systems that are even less power-hungry than today's models to take full advantage of the new power technologies. ■

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SMOOTH VIEWS

Antialiasing lets programs squeeze higher resolution out of VGA displays

Michael A. Covington

Remember the first, crude computer graphics? With screen resolutions of about 320 by 200 pixels, and a limited number of colors (in numerous cases, exactly two), early microcomputer graphics forced users and programmers to get creative, both in drawing graphics and in imagining that the image on the screen really looked like what it was supposed to.

That has all changed, thanks to high-resolution screens and technology that allows for millions of colors. Of course, not everyone can afford the latest state-of-the-art video display. But there are ways to get more out of your current display.

One way is a technique known as *antialiasing*, which can give any video display the smoothness—though not the full sharpness—of a display with twice the resolution. Diagonal lines lose their stair-step appearance, and small type becomes more readable. There are trade-offs; a 16-color display is reduced to only two colors, and the displayed image is slightly blurred. But since the human brain is good at compensating for blur, the overall effect is remarkably pleasant and effective. (See photo 1.)

As an example, I'll show how antialiasing doubles the effective resolution of a 640- by 480-pixel VGA display.

How It's Done

The key idea of antialiasing is that a line on the screen cuts a swath across a grid of pixels (see figure 1). It fills some pixels completely and others only partly. To produce an antialiased image, the partly filled pixels are only partly illuminated. For instance, a half-full pixel is displayed at half brightness. This smooths out the jagged appearance of lines and other shapes.

To keep track of how much of a pixel is filled, you divide it into 4 subpixels (see figure 2) and assign 1 bit to each. As it happens, the VGA already assigns 4 bits to each pixel to distinguish 16 colors.

To achieve antialiasing, all you have to do is treat the color bits as subpixels and then translate the colors into appropriate percentages of illumination. The colors corresponding to binary 0001, 0010, 0100, and 1000 will be 25 percent illuminated; those corresponding to 0011, 0101, 0110, 1001, 1010, and 1100, half illuminated; and so on. The color of each pixel will then show how many of its subpixels are illuminated, but not which ones.

Setting Up the VGA

Procedure `SetUpAntialiasing` (see listing 1) does all the work. First, it uses `SetGraphicsMode` to invoke 640 by 480 16-color mode (denoted by hexadecimal 12). `SetGraphicsMode` also sets the Pascal global variable `DirectVideo` to false so that all `write` and `writeln` statements will use the BIOS; otherwise, the Pascal run-time I/O package would run into problems because it doesn't know the screen is in graphics mode.

Then, `SetUpAntialiasing` maps VGA colors 0 to 15 onto VGA color registers 0 to 15. At any given time, 64 colors can be defined, but only 16 can be used, so you just use the first 16.

continued

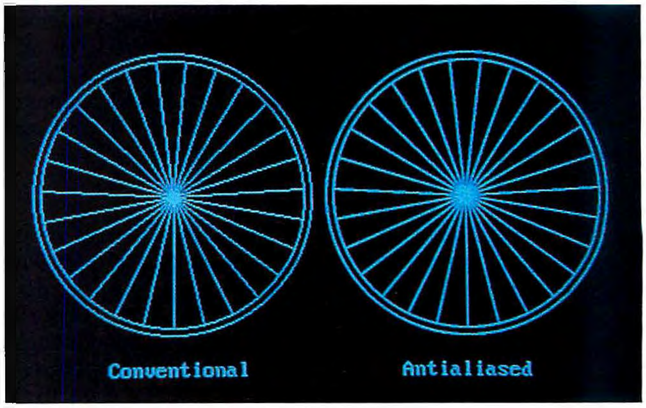

Photo 1: *By smoothing the transitions, antialiasing removes the stair-step appearance of lines and curves.*

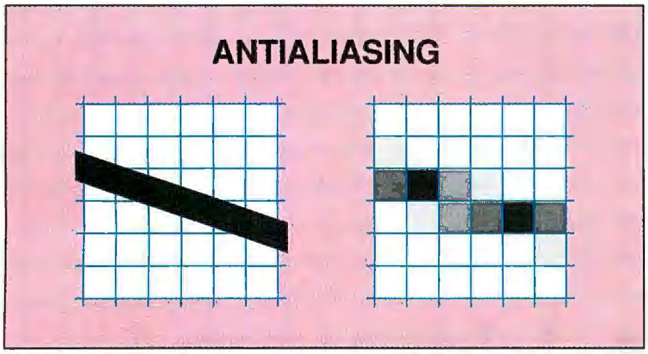

Figure 1: *As a line cuts a swath across a grid of pixels (left), partly filled pixels are partly illuminated (right).*

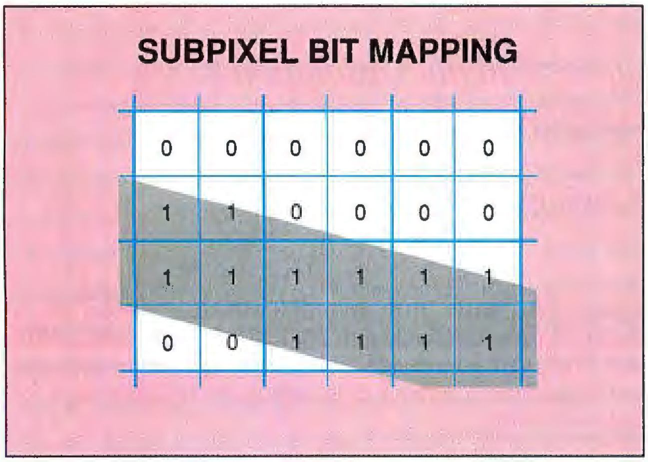

Figure 2: *To keep track of partial filling, each pixel is divided into 4 subpixels. By mapping subpixel bit patterns onto color registers, the display produces the appropriate brightness.*

The next step is to define these 16 colors. Recall that each color number, 0 to 15, is actually a 4-bit binary number, and you are treating the 4 bits as subpixels. So the brightness percentage assigned to each color depends on the number of 1s in its binary representation.

The five constants `c0`, `c1`, `c2`, `c3`, and `c4` give the brightness values for 0 percent, 25 percent, 50 percent, 75 percent, and full illumination. To produce different shades of cyan (black to full bright), you assign the values in the appropriate `c` variables to both green and blue phosphors, leaving red at 0. You may prefer a yellow-brown (red plus green) or gray-white display instead. You could even get other hues by assigning fractions of the total brightness to red, green, or blue in ways of your own choosing.

Plotting Antialiased Displays

There are two basic operations for plotting a point: `PlotSubpixel`, which illuminates a single subpixel, and `PlotDot`, which illuminates 4 adjacent subpixels (see listing 2). A "dot" thus plotted is the size of a full pixel but does not necessarily coincide with one. Plotting with dots results in smooth-edged figures; plotting with individual subpixels does not, because the smoothing effect applies only to the edge of a relatively large area of subpixels.

As you might guess, `PlotSubpixel` sets a single bit in the

continued

Listing 1: *Basic video routines for antialiasing.*

```
program Antialiasing;
uses CRT, DOS;

procedure SetGraphicsMode(mode:integer);
var regs: Registers;
begin
 regs.ax := (mode mod 256);
 intr($10,regs);
 DirectVideo := false;
end;

procedure SetPaletteRegister
                 (register,value:integer);
var regs: Registers;
begin
 regs.ax := $1000;
 regs.bx := ((value mod 64) shl 8)
                      + (register mod 16);
 intr($10,regs)
end;

procedure SetColorRegister
         (register,red,green,blue:integer);
var regs: Registers;
begin
 regs.ax := $1010;
 regs.bx := register;
 regs.dx := ((red mod 64) shl 8) + lo(regs.dx);
 regs.cx := ((green mod 64) shl 8) + blue;
 intr($10,regs)
end;

procedure SetUpAntialiasing;
const
 c4 = 63;  { Full brightness }
 c3 = 55;  { 3/4  brightness }
 c2 = 48;  { Half brightness }
 c1 = 40;  { 1/4  brightness }
.c0 =  0;  { No   brightness }
var i: integer;
begin
  SetGraphicsMode($12);
  for i:=0 to 15 do SetPaletteRegister(i,i);
  SetColorRegister( 0,0,c0,c0); { for 0000 }
  SetColorRegister( 1,0,c1,c1); { for 0001 }
  ...likewise for all other 4-bit patterns...
  SetColorRegister(15,0,c4,c4); { for 1111 }
end;
```

Listing 2: *Subpixel plotting routines.*

```
procedure PlotSubpixel(x,y:integer);
 { Illuminate a subpixel. }
 { Coordinates are 0..1279, 0..959. }
var
  offset: word;
  plane, planemask, oldval: byte;
begin
 { Select appropriate memory plane }
  plane := (y and 1)+(y and 1)+(x and 1);
  planemask := 1 shl plane;
  port[$3CE] := 4;
  port[$3CF] := plane;     { for reading }
  port[$3C4] := 2;
  port[$3C5] := planemask; { for writing }
 { Set value in memory }
  x := x div 2;
  y := y div 2;
  offset := word(y) * 80 + x div 8;
  oldval := mem[$A000:offset];
  mem[$A000:offset] := oldval or
                      ($80 shr (x mod 8));
end;

procedure PlotDot(x,y:integer);
   { A dot is the size of a full pixel }
   { but need not coincide with one. }
begin
 PlotSubpixel(x,y);
 PlotSubpixel(x,y+1);
 PlotSubpixel(x+1,y);
 PlotSubpixel(x+1,y+1)
end;
```

Bresenham's Line and Circle Algorithms

In 1965, J. E. Bresenham devised the standard way to plot lines on a computer. Bresenham's line-drawing algorithm applies to lines that are within 45 degrees of horizontal. You can bring steeper lines into this range by reversing the roles of x and y.

For the purpose of this explanation, assume that lines slope up to the right (you can deal with negative slopes by reversing a sign). The algorithm starts at one end of the line and moves horizontally to the other end, plotting a pixel in each column. At times the plotted line stays on the same row of pixels, but if the line has any slope that can be represented on the screen, it eventually moves up to the next row in order to follow the slope (see figure A). The problem is how to determine when to move up to the next row.

You have to keep track of the true height of the line. Every time you increment x (move 1 pixel column), y should increase by $(y_2-y_1)/(x_2-x_1)$. Actually, since a pixel row is an incremental element, the row number either stays the same or increases by an integer. If you store the discrepancy in the variable e and add $(y_2-y_1)/(x_2-x_1)$ to it with each new column, then you can advance to the next row when e reaches 0.5. Whenever you move to the next row, you subtract 1 from e.

Bresenham eliminates the slow floating-point operations in the following way: If you start e at 0.5 and test for 1, you can use only integers by multiplying the variables and tests by $2(x_2-x_1)$. The sign of e doesn't change, so the comparisons still work the same way. Eliminating the floating-point calculations and tests speeds up the operation.

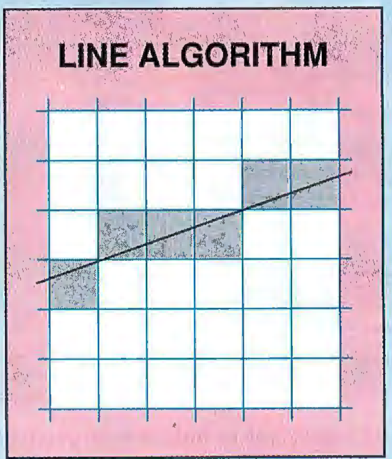

Figure A: *Bresenham's line algorithm displays a line by determining which pixels are appropriate. The math is done with integers, thus avoiding the overhead of floating-point operations.*

Bresenham also devised an efficient way to plot circles. Again, the key is to move incrementally and choose pixels one at a time. The center of the circle is treated as the origin, and plotting starts at $x=0$, $y=r$. The question is then whether to get to the next pixel by moving vertically, horizontally, or diagonally (see figure B).

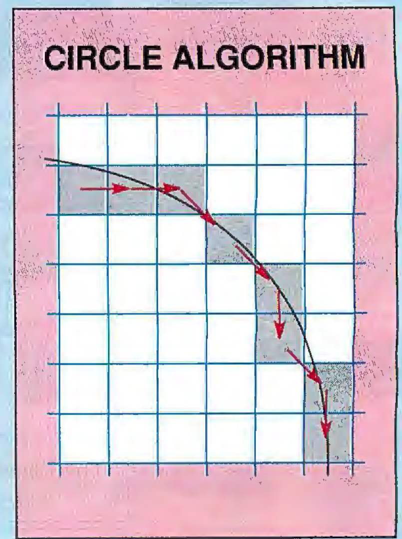

Figure B: *Following a circle requires vertical, diagonal, and horizontal moves.*

In making its decision, the algorithm thinks about moving diagonally to $(x+1, y-1)$ and asks how close to the circle it would end up. There are three possibilities. If it would land very close to the circle, it goes ahead and moves di-

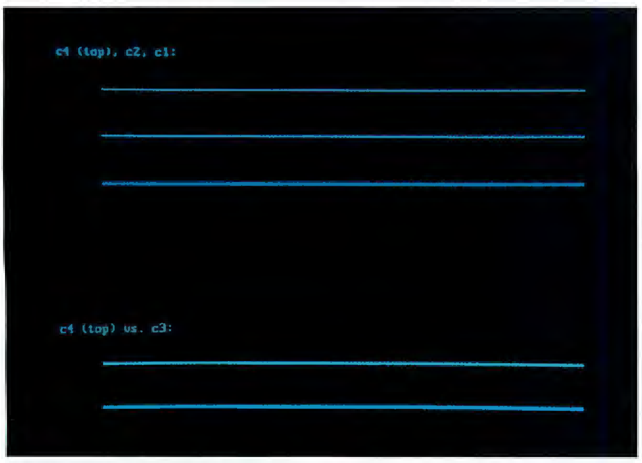

Photo 2: *When you display the test pattern, the width of lines is inversely proportional to the desired brightness; if the lines look alike from a moderate distance, then the balance between width and brightness is correct.*

VGA's video memory. This is a surprisingly complex task. First, VGA memory is divided into four planes that share the same address space; the 4 bits of each pixel are on different planes. So the first task is to tell the VGA which plane to use.

This is the purpose of several port I/O statements. Perversely, the VGA selects planes in different ways for reading and writing. To select the plane to be written, it uses a bit mask (0001, 0010, 0100, or 1000); to choose the plane to be read, it uses binary numbers (00, 01, 10, 11). This done, `PlotSubpixel` reads a byte from memory, toggles 1 bit, and writes it back. `PlotDot` simply calls `PlotSubpixel` on four neighboring points.

Given `PlotDot`, it's easy to construct line- and circle-drawing routines (see the text box "Bresenham's Line and Circle Algorithms" above).

Gamma Correction

One technical problem remains: How do you get a pixel to be half, or 25 percent, or 75 percent of full brightness? Brightnesses are numbered from 0 to 63, and it's naive to assume that halfway up the scale is really half brightness.

This is the familiar problem of video gamma correction. In

Listing A: *Bresenham's line and circle algorithms.*

```
{ Sign(x) is -1 if x<0, otherwise
     1 }
{ Swap(a,b) swaps values of a and
     b }

procedure Line(x,y,x2,y2:integer);
 { Note: If line is steep,
     meanings of x and y are
     swapped throughout. }
var
 i, steps, sx, sy, dx, dy, e:
     integer;
 steep: Boolean;
begin
  dx := abs(x2-x);  sx :=
     Sign(x2-x);
  dy := abs(y2-y);  sy :=
     Sign(y2-y);
  steep := (dy > dx);
  if steep then begin
    swap(x,y); swap(dy,dx);
        swap(sx,sy)
  end;
  e := 2*dy - dx;
  for i:=1 to dx do begin
    if steep then PlotDot(y,x)
        else PlotDot(x,y);
    while e >= 0 do begin
      y := y + sy;
      e := e - 2*dx
    end;
    x := x + sx;
      e := e + 2*dy
    end;
    PlotDot(x2,y2)
  end;

procedure Circle(xc,yc,radius:
     integer);
var
  x,y,d: integer;
begin
  x := 0;
  y := radius;
  d := 2*(1-radius);
  while y > x do begin
    PlotDot(xc+x,yc+y);
     { also (xc-x,yc-y), etc., to
          reflect each point into
          all eight octants }
    if d + y > 0 then begin
      y := y - 1;
      d := d - 2*y + 1
    end;
    if x > d then begin
      x := x + 1;
      d := d + 2*x + 1
    end;
  end;
end;
```

agonally. If a diagonal move would land it outside the circle, it moves vertically, to get closer in. If a diagonal move would land it too close to the center, it moves horizontally to get further out.

Bresenham's key insight was how to compare these distances without doing any floating-point arithmetic. Since the equation of a circle is $y = \sqrt{(r^2 - x^2)}$, the job seems far from trivial.

But recall that to get to any point (x, y), you go through all intervening values of x and y starting at $(0, r)$. It's easy to sum a series involving x and/or y along the way. In particular, the sum of $(1 + 2x)$ for all x and $(1-2y)$ for all y turns out to be $(x+1)^2 + (y-1)^2 - r^2$.

That's ideal, since $(x+1)^2 + (y-1)^2$ is the square of the distance from $(x+1, y-1)$—the contemplated diagonal point—to the center of the circle, and r^2 is of course the radius. The difference between them tells you whether you're on the circle, inside it, or outside it. Because it's a difference of squares (not the same thing as a squared difference), it needs to be compared to x and y rather than to 0 or 1.

The circle algorithm in listing A is more concise than the versions usually given in the literature. It divides the circle into eight octets with a common algorithm. Studying it, I began to suspect that no one had ever hunted down all the redundancies in the arithmetic—or if they had, they kept the results strictly proprietary. There doesn't need to be even a single floating-point operation.

As shown, the algorithm computes only an eighth of a circle and obtains the rest by reflecting about the axes. To adapt the routine to devices with different horizontal and vertical pixel spacing or to draw ellipses, modify it to loop while $y>0$ rather than $y>x$, use only the first four `PlotDot` calls, and multiply the term $2*y$ by the appropriate constant when updating d.

photography, gamma is the slope of the function relating original brightness to reproduced brightness. High gamma equals high contrast. But the function is actually nonlinear, and therein lies the problem: How do you straighten it out?

Fortunately, all that's needed for the present purpose is a simple experiment. Plot a line 1 pixel wide at full brightness, a line 2 pixels wide at half brightness, and a line 4 pixels wide at one-quarter brightness. Then step back until you can't see the difference in width. If the lines look equally bright, their brightnesses are correct. Similarly, a 75 percent-bright line 4 pixels wide can be compared with a conventional line 3 pixels wide (see photo 2). That's how the values of `c0`, `c1`, `c2`, `c3`, and `c4` were obtained for this program.

Gamma correction changes whenever you move to another monitor or adjust your brightness or contrast control. It also changes when images are photographed or reproduced in other ways. Fortunately, gamma correction doesn't have to be perfect for antialiasing to be effective.

What You See Is. . .

The best-looking two-color display from a VGA is available only through antialiasing. It is easy to implement antialiasing on the VGA because of its design. Even though antialiased displays take longer to plot, the result contains four times as much information.

If high resolution is more important than the number of colors available, you might want to consider this approach for your application programs. ■

Editor's note: *The actual code is in Pascal and is available in a variety of formats. See page 5 for details. The code includes routines for implementing all the concepts in this article, including the antialiasing test programs for Bresenham's line and circle algorithms. It runs in Quick Pascal or Turbo Pascal but does not use Microsoft's or Borland's graphics units. Instead, it performs BIOS calls directly, so it will be easy to translate into other languages.*

Michael A. Covington does research on logic programming and natural-language processing at the University of Georgia. He is coauthor of Prolog Programming in Depth *(Scott, Foresman, 1987) and* Dictionary of Computer Terms *(Barron's, 1986) and former contributing editor of* PC Tech Journal. *He can be reached on BIX as "mcovington."*

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Object-Oriented Programming for Windows

Using OOP to develop applications for Microsoft Windows

Zack Urlocker

Applications developed for standard graphical user interfaces are becoming more and more popular, since these programs offer a consistent, easy-to-use interface, a reduced learning curve, and better integration of programs. Despite the advantages for end users, programming for a GUI with a traditional language can be overwhelmingly difficult. Object-oriented programming (OOP) reduces the complexity of GUI programming by encapsulating standard windowing behavior into predefined objects.

I'll review the basic principles of windowing environments and OOP, and then I'll walk through the design and implementation of a simple business graphics program called Chart.

GUIs: Good News for End Users and Programmers

In an increasingly competitive software market, programmers developing for GUIs have an edge over those creating traditional character-based systems. Not only is there the advantage of easy-to-use applications, but GUIs provide the programmer with a rich application programming interface (API) and, in many cases, a device-independent graphics system.

For example, programs developed for Microsoft Windows support CGA, EGA, VGA, and Hercules graphics modes, as well as hundreds of displays and printers. Since the device drivers are part of Windows, you can distribute one application that will run on any system. Writing configuration programs and device drivers, thankfully, are the GUI's responsibility, not the application's. There's also the ability to cut and paste between programs and create automatic hot links with Windows' Dynamic Data Exchange protocol. This makes it possible to integrate your application with other Windows programs you might create or with commercial applications such as Microsoft Excel.

Nevertheless, as in the laws of physics, every force has an equal and opposite force when it comes to programming for a GUI. The ease of use you supply to the end user comes at the expense of mastering the complexity of the API. Microsoft Windows and the Macintosh Toolbox each have over 400 function calls, about 10 times as many as there are in MS-DOS. Even for the simplest of programs, you need to be acquainted with the details of standard windowing behavior, dialog boxes, menus, memory management, and event-driven programming.

Programming for a GUI with a traditional language is a little like running the Boston Marathon wearing hiking boots and a three-piece suit. Even if you're used to regular jaunts and occasional sprints, be prepared to hit the wall after about 20 miles. In programming terms, that's about 3000 lines of code, or what it might take you to create a half-decent text editor for a GUI. Even a "Hello, world!" program is about 300 lines of code when all is said and done. Of course, if you regularly undertake programming marathons, you may prefer to investigate OS/2 Presentation Manager, the triathlon of programming with over 1000 function calls.

You might be wondering if there is a way to build a higher layer on a GUI so that you don't have to know all the details of the API. OOP offers the ability to do just that, and more.

GUI Programming for the Rest of Us

OOP has always enjoyed a close relationship with graphical systems and GUIs. Smalltalk, the first completely object-oriented environment, was developed hand-in-hand with the pop-up menus, windows, and mouse that have become associated with systems like the Mac and Microsoft Windows.

Of course, the association between OOP and GUIs is by no means a historical accident. Graphical environments have an inherent complexity that makes them good candidates for the benefits of OOP. As a result, OOP has caught on widely on platforms such as the Mac, Microsoft Windows, and the NeXT machine.

Objects in a Graphical Environment

Many elements of a GUI can be conceived of as objects made up of both data and functionality. For example, a generic window

continued

Graphical environments have an inherent complexity that makes them good candidates for OOP.

includes private data to maintain its location, size, and built-in functionality so that it can be scrolled, moved, and resized. Application windows that you create should automatically include the characteristics and functionality of generic window objects.

More formally, this process is known as *inheritance*. In effect, you can create subclasses or descendants of existing kinds of objects. For example, if the `Window` class defines the data and functionality of generic windows, then you can create a descendant class, `ChartWindow`, which adds to this the ability to create and display charts. There is no need to duplicate or even understand the implementation of the generic behavior in the `Window` class.

MICROSOFT WINDOWS MESSAGES

Table 1: Windows messages and their associated events and parameters.

Message	Event	wParam	lParam
WM_KEYDOWN	Key press	Key code	Repeat count
WM_LBUTTONDOWN	Left mouse button	State	Location point
WM_SIZE	Window resize	Type	Width/height
WM_ACTIVATE	Window selected	Type	Handle
WM_HSCROLL	Window scrolls	Code	Position
WM_CLOSE	Window closed	—	—
WM_PAINT	Repaint the window	—	Paint struct
WM_COMMAND	Menu command	Item	Type

Unlike traditional function libraries, where you are locked into the limitations imposed by the original programmer, in an object-oriented system you're free to override any of the inherited functionality. This gives you the ability to further customize objects for more specialized behavior. For example, if your application requires that the main window cannot be resized or closed, you can simply override these capabilities.

Many object-oriented languages have numerous predefined classes of objects that give the programmer a head start in developing applications for GUIs. Actor, for example, includes classes of windows, dialog boxes, and graphics, as well as data management. The standard classes provide the generic capabilities common to all Windows applications, thereby eliminating the need to become involved in the details of memory management, pointers, handles, and most of the API.

Beyond Windows and Dialog Boxes

If OOP only allowed you to simplify the development of user interfaces for GUIs, it would still provide a dramatic increase in programming productivity. However, OOP goes beyond windows and dialog boxes. In an OOP system, all the logical entities that make up your application can be created as objects. Since objects are both data and functionality, they more closely resemble the real-world entities you're dealing with, giving you a solution that is easier to understand.

For example, an accounting program would be made up of objects that correspond closely to the real world, such as ledgers, transactions, and accounts. In the Chart program, you will create pie chart and bar chart objects, as well as a chart window and chart dialog box. These objects embody all the functionality that you expect of a chart, window, and dialog box, respectively.

Objects can be made up of other objects declared as instance variables. Instance variables correspond to fields in a data structure. For example, a `Chart` object has instance variables called `data` and `labels` that are arrays of `integer` objects and `string` objects, respectively.

Handling Window Events and Messages

Most graphical environments are event-driven systems. For example, when the user presses a key or clicks the mouse, this is an event that is trapped by the GUI and handled by the application. On the Macintosh, for example, applications contain a main loop that polls for events and determines how to handle them.

In Microsoft Windows, events are more generalized and are

USER EVENTS IN MICROSOFT WINDOWS

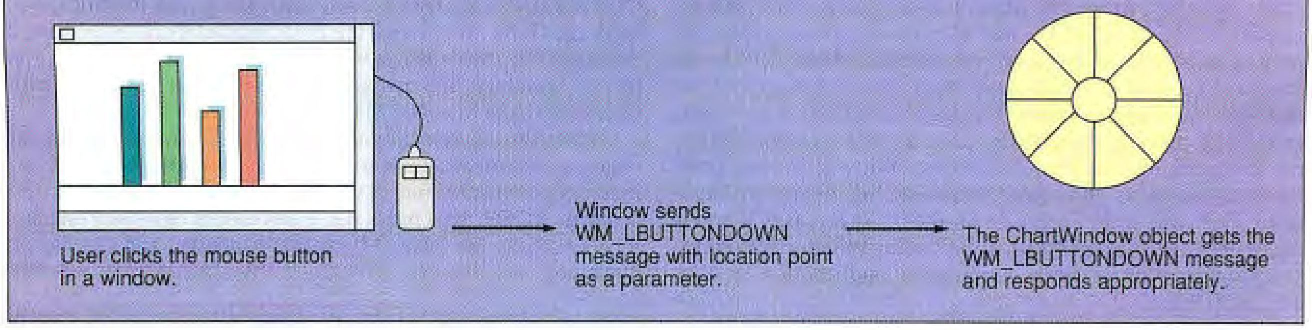

Figure 1: *Most events are initiated by the user. In the example, the user presses the mouse button, causing a* `WM_LBUTTONDOWN` *message to be sent to the Window in which the user clicked.*

treated as messages. When an event occurs, Microsoft Windows sends a message to the appropriate window. Figure 1 shows how events are processed in Microsoft Windows.

Microsoft's window messages are sent with two parameters to supply additional information. These are known as the word parameter or wParam, a 2-byte number, and the long parameter or lParam, a 4-byte pointer. For example, when you press a key, a WM_KEYDOWN message is sent to the window, with the wParam giving the value of the character. Table 1 shows examples of other Windows messages and the meaning of the parameters.

When developing a Windows application in C, you process the messages by writing a function known as the WndProc, which contains a switch statement to determine what the message is and how it should be handled. An example of the WndProc function is shown in listing 1.

Messages and Methods

In an object-oriented system, all computation is done by sending messages to objects. Like messages in a windowing environment, a message is simply a request to an object to perform some action. To draw a chart, for example, you send a draw message to a Chart object:

```
draw(myChart, context); /* Actor code */
```

In this example, myChart is the receiver of the draw message, and context is an argument indicating the display context where the drawing is to take place. To respond to the draw message, the Chart object must define a draw method. Thus, a message corresponds to a function call, and a method corresponds to a function definition in a procedural programming language.

One major distinction between a message and a function call in a procedural language is that the different objects can respond to the same message in different ways. For example, all graphical objects, including rectangles, ellipses, points, and charts, can respond to the same general-purpose draw message. In a procedural language such as C, you would have to know what type of data you are dealing with and then call the appropriate function. In an object-oriented language, the system handles this task for you.

The ability of objects to respond to general-purpose messages in different ways is known as *polymorphism*, meaning "many behaviors." Polymorphism lets you write more generic, reusable code, since the objects themselves will handle the details.

Since object-oriented languages already handle messages, Windows messages can be handled easily. In Actor, Windows messages are automatically trapped and sent as Actor messages to the appropriate window object, with no code required by the programmer. Higher-level Actor methods hide many details of processing the Windows messages.

For example, the Window class defines a WM_PAINT method to trap the message requesting the window to repaint itself. The WM_PAINT method will allocate memory for repainting, and then it will send an Actor paint message with a display context in which to draw. Code for the WM_PAINT method is shown in listing 2.

Since this code is already built into the system, descendant classes merely have to respond to an Actor paint message. They do not have to directly allocate or deallocate memory for the display context.

In order to redraw the chart contained in a ChartWindow, the paint method is written as shown in listing 3. Of course, this code simply sends a draw message to the Chart object, which must in turn handle the details of drawing.

Listing 1: WndProc *for Microsoft Windows in C. This code shows the logic of how Windows messages are processed in C. Processing details are in the user-defined functions* newfile(), openfile(), savefile(), help(), hittest(), *and* keypress().

```
long FAR PASCAL WndProc(hWnd, message, wParam, lParam)
HWND hWnd;                        /* window handle   */
unsigned message;                 /* type of message */
WORD wParam;                      /* word parameter  */
LONG lParam;                      /* long parameter  */
short x, y;                       /* mouse location  */

{
  FARPROC lpProcAbout;            /* ptr to About function */
  HMENU hMenu;                    /* handle to system menu */

  switch(message)                 /* what event has occurred? */
  {
    case WM_SYSCOMMAND:           /* system menu commands   */
       if (wParam == IDABOUT)     /* About... menu command */
       {                          /* display a dialog box   */
         lpProcAbout = MakeProcInstance(About, hInst);
         DialogBox(hInst, "AboutBox", hWnd, lpProcAbout);
         freeProcInstance(lpProcAbout);
         break;
       }
       else                       /* do default processing */
        return(DefWindowProc(hWnd, message, wParam, lParam));

    case WM_COMMAND:              /* menu commands */
           switch(wParam)         /* what menu item? */
      {
        case CW_FILE_NEW:         /* various menu commands */
          newfile();
        break;
        case CW_FILE_OPEN:
          openfile();
        break;
        case CW_FILE_SAVE:
          savefile();
        break;
        case CW_HELP:
          help();
        break;
      }
    break;

    case WM_LBUTTONDOWN:          /* left mouse button */
       x = LOWORD(lParam);        /* x coordinate      */
       y = HIWORD(lParam);        /* y coordinate      */
       hittest(hWnd, x, y);       /* hit test logic    */
    break;

    case WM_KEYDOWN:              /* key press         */
       keypress(hWnd, wParam);    /* key press logic   */
    break;

/*
 *  other messages go here...
 */
   case WM_DESTROY:               /* quit the application */
      PostQuitMessage(0);
      break();

   default:                       /* default processing */
     return(DefWindowProc(hWnd, message, wParam, lParam));
  }
  return(NULL);
}
```

Objects as Abstract Data Types

By defining a complete set of messages that objects understand, you can shield the physical representation from users. This makes it possible to treat objects as abstract data types that can be manipulated without regard for their physical implementation.

continued

Listing 2: *Trapping Windows messages in Actor. This method defines default processing of the* `WM_PAINT` *message in the* `Window` *class. It allocates memory for the paint structure, creates a display context, and sends an Actor paint message to the window. When finished, the memory used for painting is deallocated. The* `self` *parameter refers to the window that was clicked in;* `dc`, `hPS`, *and* `lpPS` *are local variables referring to the display context, handle to the paint struct, and long pointer to the paint struct, respectively. If you define any descendant classes, they should define a paint method to handle redrawing in the display context.*

```
Def  WM_PAINT(self, wParam, lParam | dc, hPS, lpPS)
{
  hPS := asHandle(paintStruct);       /* get a paint struct  */
  lpPS := globalLock(hPS);            /* lock down memory    */
  dc := Call BeginPaint(hWnd, lpPS); /* get display context */
  paint(self, dc);                    /* send Actor message  */
  Call EndPaint(hWnd, lpPS);          /* finish painting     */
  globalUnlock(hPS);                  /* unlock memory       */
}
```

Listing 3: *The paint message for* `ChartWindow`, *which is used to redraw the chart when necessary.*

```
Def paint(self, context)
{
    if chart then
      draw(chart, context);    /* tell the chart to draw */
  endif;
}
```

Listing 4: *The* `init()` *function initializes a new* `Chart` *object and its instance variables. The data and labels collections have an initial size of 10 but will automatically grow to accommodate additional data. The variables are used as follows:* `data` *refers to a collection of data values;* `labels` *is a collection of text labels;* `space` *is an integer indicating the spacing between items;* `scale` *is a point indicating the scale to be used; and* `lead` *is a point indicating the lead spacing to be used. The* `resetScale()` *function sets the scale instance variable to a point. Descendant classes may override this method. The* `resetLead()` *function sets the lead instance variable to a point. Descendant classes may override this method.*

```
Def init(self)
{
  data := new(OrderedCollection, 10);
  labels := new(OrderedCollection, 10);
  space := 10;
  resetScale(self);
  resetLead(self);
}

Def resetScale(self)
{
  scale := 10@10;
}

Def resetLead(self)
{
  lead := 10@10;
}
```

Listing 5: *Code for* `reScale` *and* `draw` *methods of* `Charts`. *The first function,* `reScale()`, *rescales the chart based on data and area. Descendant classes will define the* `adjustScale` *method. The second function,* `draw()`, *is used to draw a chart in the given display context by drawing the data and the labels.*

```
Def reScale(self | max)
{
  max := 0;                      /* find the maximum */
  do(data,
   {using(item)
    if item > max
          then max := item;
    endif;
  });
  if max > 0 then                /* rescale according to max */
    resetLead(self);
    adjustScale(self, max);
  endif;
}

Def draw(self, context)
{
  if area then
    drawData(self, context);
    drawLabels(self, context);
  else
    error(self, stackTop(), #areaNilError);
  endif;
}
```

Listing 6: *In the* `HBarChart` *class: This* `resetLead()` *overrides the inherited* `resetLead` *method to allow more room for the labels on the left edge of the chart. The* `adjustScale()` *function adjusts the scale based on the data and area. The* `drawLabel()` *function draws the labels, computes the positions, and converts the label into a string. The* `drawData()` *function draws the data elements in the given display context. It computes the positions based on scale and lead (*`x`, `y`, *and* `dRect` *are temporary variables).*

```
Def resetLead(self)
{
  lead := 90@20;
}

Def adjustScale(self, max)
{
  scale := point((x(area) - 2 * x(lead)) / max, 15);
}

Def drawLabel(self, context | str, x, y)
{
  x := 1;                                 /* left edge */
  do(size(labels),                        /* for each label */
  {using(i)
    y := y(lead) + i * (y(scale)+space); /* vert. location */
    str := asString(labels[i]);           /* convert it */
    drawText(self, x, y, str, context);   /* draw it */
  });
}

Def drawData(self, context | x, y, dRect)
{
  x := x(lead);                           /* left edge of bar  */
  do(size(data),                          /* for each item     */
  {using(i)
    y := y(lead) + i * (y(scale)+space); /* vert. location  */
    dRect := rect(x, y,                  /* create a rect     */
              x + data[i]*x(scale),
              y + y(scale));
    fill(dRect, stock(GRAY_BRUSH), context); /* draw it */
  });
}
```

For example, the physical representation of Chart objects is considered private. Users of Chart objects do not need to know how Charts are implemented or what their instance variables are. Instead, they send messages to Chart objects to perform certain actions, set their private data, or return a value. These messages define the "public protocol." In the case of Chart objects, the protocol might include messages such as draw, size, and reScale. You can then send messages to objects telling them what to do without getting caught up in the details of how they do it. Figure 2 shows a diagram of a Chart as an abstract data type.

The advantage of separating the public protocol from the private implementation is that it reduces the dependencies in the system to a well-defined interface. You can easily change the internal implementation of Chart objects knowing that users of Charts will not be affected.

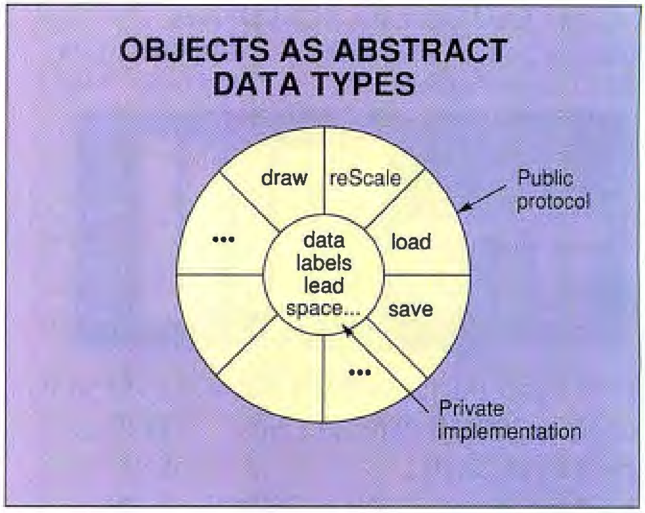

Figure 2: *The* Chart *object has a private internal implementation and a public protocol layer.*

Designing the Chart Application

Since the Chart application is quite simple, it has only a few different classes, including ChartWindow, ChartDialog, and several kinds of charts that descend from the Chart class.

Figure 3 shows a class tree for the Chart application. Table 2 describes the classes. The Chart class is used to define all the common data and functionality among the various kinds of charts. For example, all charts should respond to the same messages: draw, reScale, print, load, save, and so on.

Similarly, all charts contain the same instance variables: data and labels maintain the numeric data and the string labels that will be plotted; area and scale are point objects; and lead and space are integer objects.

The only real difference between the different kinds of charts is how they implement the details of drawing the data and labels. All the common code is stored in the Chart class and automatically inherited by the descendant classes. Since there is nothing chart-like already in the system, the Chart class descends directly from the Object class, inheriting only minimal object functionality.

The code to initialize new Chart objects is shown in listing 4. Initialization is broken down into three methods to allow descendant classes to override parts of the initialization as necessary. For example, horizontal bar charts may have a need for different lead spacing to accommodate text labels. Thus, they can override the resetLead method inherited from the Chart class with their own methods. Note that the inherited code of class Chart exists only once in the application; it is not copied into the other classes. Inheritance lets you reduce the size of the application by factoring common parts into ancestor classes.

A chart will receive messages to draw or reScale from the ChartWindow in which it is contained. For example, if the user resizes the ChartWindow, the ChartWindow will send a reScale message to the chart. Listing 5 shows the code for the draw and reScale methods using two interesting messages, do and error.

The do message lets you loop over a collection's items and perform a block of code without having to keep a count. For example, the code

```
do(aCollection, /* iterate over a collection */
{using(item) /* item is the loop variable */
printLine(item) /* print each item */
});
```

iterates through all items in a collection, printing each. The do message is understood by all the system's collections—Arrays,

continued

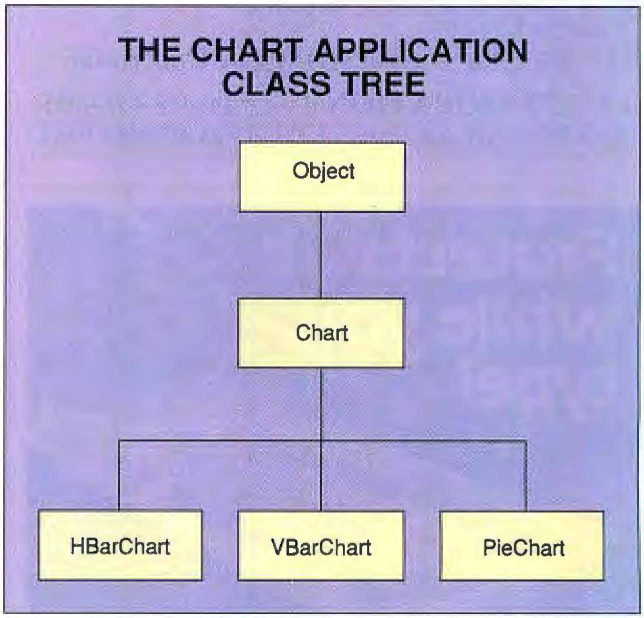

Figure 3: *The* Chart *class defines common data and functionality among the descendant classes.*

CLASSES IN THE CHART APPLICATION

Table 2: A description of each class used in Chart, the sample application.

Class	Purpose
ChartWindow	Display the chart, handle user interaction.
ChartDialog	Allow the user to edit the chart data points.
Chart	Formal class to define common chart functions.
HBarChart	Horizontal bar chart.
VBarChart	Vertical bar chart.
PieChart	Pie chart.

Listing 7: *The Chart application header file,* `chart.h`, *contains the constants for the charting program.*

```
#define TWO_PI          6.283185307    /* for pie charts */

#define CW_FILE_NEW     501            /* menu item IDs */
#define CW_FILE_OPEN    502
#define CW_FILE_SAVE    503
#define CW_HELP         600

#define CW_HELP_BOX     801            /* dialog box IDs */
```

Listing 8: *Menu handling in the* `ChartWindow` *class. This* `init( )` *automatically initializes new* `ChartWindow` *objects by setting up the menus and their logic. The menu definitions are loaded from resources. The actions dictionary provides the menu logic. Keys in the dictionary give the menu item ID. Values in the dictionary give the message to be performed. The* `command( )` *function handles menu commands using a data-driven approach. The first argument,* `menuItem`, *indicates the menu item ID. It looks up* `menuItem` *in the actions table, and if it is found, performs the appropriate action. It ignores* `lParam`.

```
Def init(self)
{
  chart := new(VBarChart);          /* default chart type */
  addAbout(self);                   /* add an "about box" */
  loadMenu(self, "CWMenus");        /* load menu resources */
  setMenu(self, hMenu);

  actions := new(Dictionary, 4); /* add menu item logic */
  add(actions, CW_FILE_NEW, #newChart);
  add(actions, CW_FILE_OPEN, #restoreFile);
  add(actions, CW_FILE_SAVE, #saveFile);
  add(actions, CW_HELP, #help);
}

Def command(self, menuItem, lParam)
{
     if actions[menuItem] then
          perform(self, actions[menuItem]);
   else
        beep();
        errorBox("Error", "Undefined command: "
             + asString(menuItem)));
     endif;
}
```

`OrderedCollections`, `SortedCollections`, and others. The `error` message lets you define your own error conditions. You can flag different error conditions and easily define your own error handlers for different kinds of objects.

Chart's Descendant Classes

To fully implement the charts, each descendant class must define the `drawData`, `drawLabels`, and `adjustScale` methods as shown in listing 6 for the `HBarChart` class. These methods implement the rest of the protocol for `Chart` descendant classes. The `drawData` method calculates the location of each bar in the chart as a rectangle from the left edge. Then the rectangle is drawn in gray by sending it a `fill` message.

The code for `VBarChart` is similar to that for `HBarChart`. For the `PieChart` class, the implementations of `drawLabels` and `drawData` are different, since drawing a pie chart can be done by calling a Microsoft Windows function directly. The `drawData` method for `PieChart` encapsulates the direct call to the Windows `Pie` function as shown below.

continued

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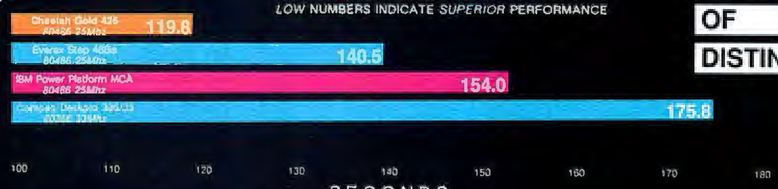

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```
/* call the Windows Pie function directly */

Call Pie(context, xLeft, yTop, xRight, yBottom
     xStart, yStart, xEnd, yEnd);
```

The ChartWindow Class

The `ChartWindow`, of course, inherits most of its functionality from the `Window` class. In addition, it responds to the `paint` message, as shown previously in listing 3.

The `ChartWindow` provides the user interface to the Chart application. This includes menu selection, resizing the window, and clicking the mouse to edit data points. Whenever a menu event occurs, Windows will send a `WM_COMMAND` message, with the `wParam` indicating the menu item that was selected. In C programs, normally a case statement is used to test the value of the `wParam` and take the appropriate action.

In Actor, a more object-oriented approach can be used. Typically, a table is used to look up the method to be performed based on the menu item selected. If the user selects, say, the `File New` command, the `wParam` will have the value defined by the constant `CW_FILE_NEW`, and the `newChart` method should be performed. The menu item constants are defined in a header file, shown in listing 7, which uses C-style `#define` statements. The numbers identified with the menu items are arbitrary, but they must be unique.

Listing 8 shows the code used to initialize the `ChartWindow`'s instance variables, including the `chart` and the `actions` lookup table. It also loads the resources that define the look of the menu. The `command` method looks up the `wParam` in the actions table and, if it finds it, performs the method.

The Main Program

Since the `ChartWindow` is really the centerpoint of the application, all the main program really has to do is create a new `ChartWindow` object and show it on the screen. This requires only two lines of code:

```
CW := defaultNew(ChartWindow, "Chart)";
show(CW, 1);
```

Although I haven't shown all the Chart code, I've highlighted the most interesting aspects of an object-oriented approach to GUI programming—encapsulation, inheritance, message sending, and polymorphism.

An object-oriented approach can help reduce the complexity of GUI programming and can help give you a competitive edge in the marketplace. OOP increases your productivity by providing predefined classes that encapsulate the API. By using inheritance, you can customize the existing classes and extend them for your own applications. In addition, since GUIs are event-driven, they map well to the message basis of object-oriented systems. ■

Editor's note: *The Chart source code is available in a variety of formats for those who would like to explore it further (see page 5 for details). Chart is written in Actor, which is an OOP language for Microsoft Windows. The* `Chart` *classes can be used as they are, or descendant classes can be created for your particular needs.*

Zack Urlocker is manager of developer relations at the Whitewater Group, the creators of Actor. He holds a master's degree in computer science from the University of Waterloo, where his research was in the area of programming environments. He can be contacted on BIX c/o "editors."

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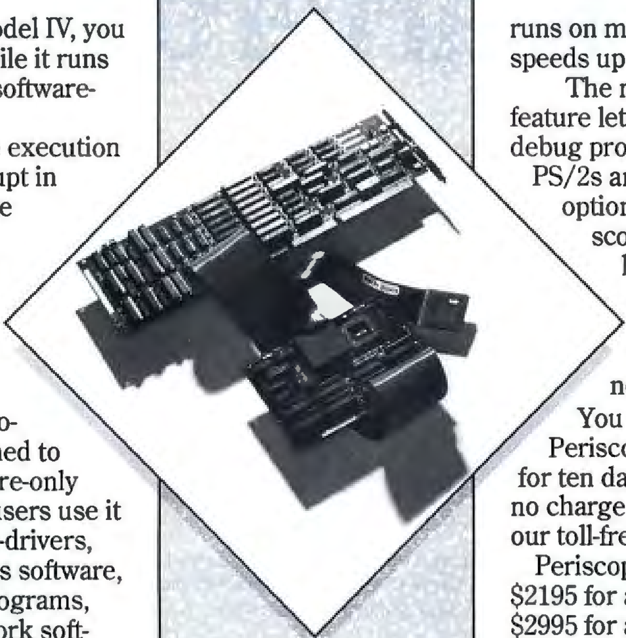

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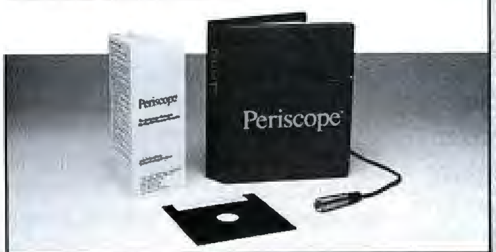

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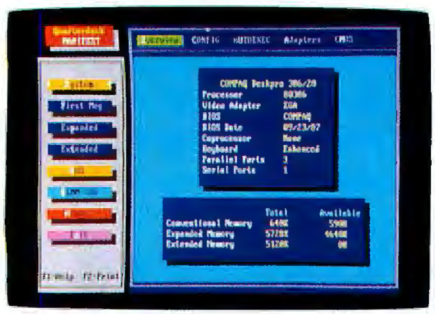

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QEMM also works with Microsoft's XMS spec to extend memory for Windows users.

QEMM gives you maximum control over your memory between 640K-1024K. It can find unused memory nuggets as small as 4K and use them to free up room for programs to use.

QEMM 386 even monitors how your programs use memory while they're running. Then it shows you where there's additional memory you can use. It even measures which parts of your memory are fastest and 'decides' how to use them for better performance. In action, it's easy and fun—almost like having an *artificial intelligence* program to help tune up your PC.

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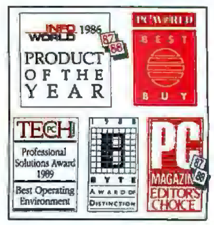

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REELING IN THE DATA

Tape backup systems are no longer just for the wealthy or the overanxious

One day it will surely happen: Your system's hard disk drive will die of old age, mysteriously lose data, or succumb to power glitches or (worse yet) a fire. And, if you're like the majority of microcomputer users, you'll lose precious data because you didn't make a recent backup.

This situation is, of course, preventable if you're willing to spend a few minutes each day backing up your data, either to floppy disks (using a high-speed floppy disk backup utility) or to tape. In this installment of Under the Hood, I'll focus on the latter medium and describe how the most popular types of tape backup units work.

Why Tape?

Magnetic tape is ideal for situations in which you need to store large amounts of data without changing the medium—typically, unattended backup or the distribution of large programs or databases. The lowest-capacity tape drive you're likely to find will store 40 megabytes of data on a single cartridge. High-end helical-scan units from Exabyte store 5 gigabytes per cartridge and will probably increase to 8 gigabytes before the end of the year.

By contrast, a standard AT-type 5¼-inch floppy disk can hold only 1.2 MB of data; its 3½-inch counterpart can hold only 1.44 MB. Backing up a large hard disk drive with a utility like Fastback from Fifth Generation Systems can be a true test of one's disk-swapping patience.

Extra-high-density floppy disks—like those from Insite Peripherals and Brier Technology—are available, and you may find them useful as a backup medium. However, these disks will hold at most 40 MB, the same as the least capacious tape, and aren't widely available yet. Tape drives, on the other hand, are available from numerous manufacturers, and media for them are available at virtually all computer stores. And tape is generally less expensive, megabyte for megabyte, than floppy disks.

One area where tape is *not* superior to floppy disks is durability. Floppy disks, which have both a thicker substrate and a heavier magnetic coating, have a better chance of coming through extremes of temperature (e.g., fire) intact.

What about WORM (write once, read many times) drives and read/write optical disk drives? So far, the main disadvantage of these drives is cost: $4000 to $8000 per unit, plus $50 or more per disk. The advantage of such drives is that they're useful for other kinds of storage between backups.

Disks of any kind—magnetic or optical—will always be far superior to tape when random access is required. It's much easier and faster to step from track to track on a disk than to fast-forward and rewind a tape drive. But in backup applications, which primarily involve the transfer of long, continuous streams of data, tape truly comes into its own.

Varieties of Tape Formats

The four tape formats most often used for data storage are half-inch reel-to-reel (most often used on minicomputers and mainframes), quarter-inch cartridge, 8-mm cartridge, and 4-mm DAT (digital audio tape).

Of these four, half-inch reel-to-reel (often called nine-track) is the most mature technology. As the name suggests, data is laid down in nine parallel tracks at 800, 1600, 3200, or 6250 bits per inch. The tracks are read in parallel using a head with nine distinct elements, making data transfers extremely fast, even at relatively low tape speeds. A full

continued

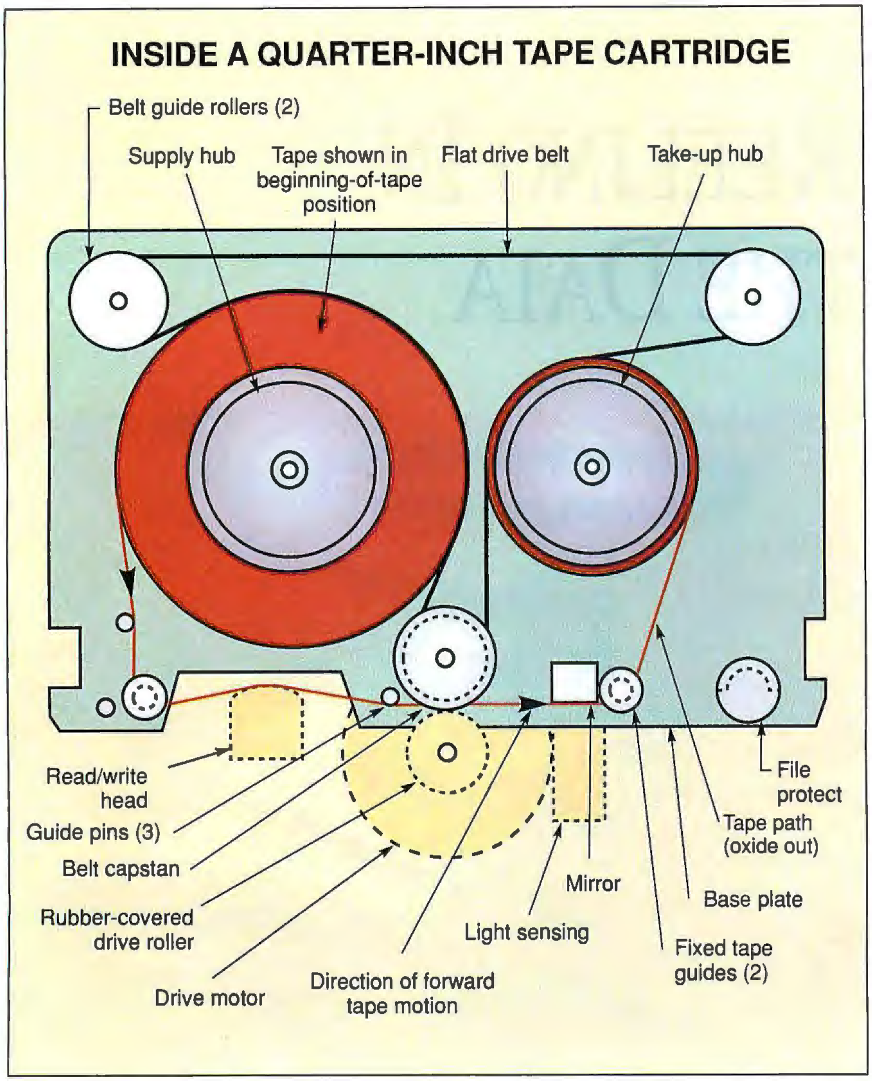

Figure 1: *Quarter-inch tape cartridges use a clever drive mechanism that moves the tape directly, eliminating the need for separate drives and clutches for the hubs.*

reel of tape recorded at the highest density typically holds about 145 MB.

Nine-track tape is time-tested and almost 100 percent interchangeable between virtually all the drives that handle it. It's frequently used to transport data between machines as well as to back up disks. But nine-track drives—especially good ones—aren't cheap, and the big reels of tape are awkward and not likely to be available at your local computer store. Also, while they offered more capacity than cartridge units until a few years ago, they're now falling behind. Perhaps this is the reason you don't see nine-track tape on many personal computers nowadays.

Clever Cartridges

The most common medium used by tape backup units is quarter-inch tape, which is enclosed in one of two sizes of cartridges: a DC2000-class minicartridge, which is about 2½ by 3 inches, or a DC600-class cartridge, which is the same shape but about 30 percent bigger in each dimension. (A new class of cartridge, DC9135, will look like a DC600 but will have 900-oersted tape, which can handle denser recording schemes, inside.) The exact specifications for the cartridges, originally defined by 3M, are now embodied in ANSI standards.

Each cartridge (see figure 1) contains two tape hubs, a flexible drive belt that passes partway around each hub, tape guides, and a small mirror assembly (used by the drive to detect holes at the beginning and end of each tape). A small door (not shown) protects the cavity where the read/write head enters the cartridge from dust and debris.

The mechanism inside a quarter-inch cartridge is clever and unique. Even though it's been around for more than a decade, you won't see anything like it in an audiocassette or a videocassette, probably for patent reasons. Note that the drive belt actually contacts the tape and moves with it partway around each hub, ensuring that the linear velocity of the tape is equal to that of the belt no matter how much tape is on each hub. The angular velocities of the hubs, which aren't directly driven, vary as necessary. This makes the drive extremely simple at the expense of a small amount of additional hardware in the cartridge.

All the drive needs to do to position the tape is rotate a pulley called the *belt capstan*; the pulley moves the belt, which in turn moves the tape. There's no need for a tape capstan, a pinch roller, or independent drive mechanisms and clutches for the hubs. (An ordinary Philips-type audiocassette deck, by contrast, must have all these things.)

Cartridges within a class may have different lengths. Many users have been pleasantly surprised to find extra-long tapes appearing on computer store shelves, letting them increase the capacity of an existing drive by up to 50 percent without buying new hardware. A QIC-40 drive (nominal capacity of 40 MB) can often record 60 MB on such tapes, and a QIC-80 drive (80 MB) can get 120 MB on one tape.

QIC and Easy

Standards that describe how to record on quarter-inch cartridges are published by the organization Quarter Inch Cartridge Drive Standards (311 East Cabrillo St., Santa Barbara, CA 93101). So far, the organization (QIC for short) has adopted 36 standards, specifying such things as interfaces between computers and tape drives, tape formats, recording-head properties, error-correction codes, data-compression algorithms (see the text box "Data Compression Doubles Tape Capacity" at right), and SCSI command sets for tape drives (see the table for a partial list; if you'd like a complete list, contact QIC).

Some of these standards have become pervasive enough that makers of drives for other tape formats have adopted them. For instance, most 4-mm DAT drives used for tape backup implement the set of SCSI commands specified in the QIC-104 standard and will probably move to QIC-121 (a SCSI-2 command set) in the future.

As a result of this standardization

continued

Data Compression Doubles Tape Capacity

Data compression is a highly effective way of increasing the capacity of a tape drive. Unfortunately, most software algorithms with good compression ratios can process at most 64K bytes per second—and would therefore constitute a major bottleneck in a tape backup system.

To solve this problem, a company called Stac Electronics (Pasadena, CA) has developed a data-compression/decompression chip with an average throughput of 750K bytes per second and an average compression ratio of 2-to-1. The chip, which uses a modified Ziv-Lempel algorithm, achieves this ratio using only 16K bytes of RAM, only 2K bytes of which is used to hold the string table for the compression algorithm.

Even though the company refuses to divulge exactly how the proprietary algorithm works, the organization Quarter Inch Cartridge Drive Standards (Santa Barbara, CA) has adopted it as the QIC-122 standard. Should vendors wish to implement the algorithm in software only, rather than buying a $50 chip to put in every drive, Stac Electronics will license object code for the cool sum of $25,000.

Because other manufacturers may wish to go their own way rather than embrace one manufacturer's proprietary solution, the QIC committee has established a registry of "data algorithm identifiers" that can be written on a tape to show how the data is encoded. A tape backup system can use this code to apply the correct algorithm—if it knows it—to the data on the tape while reading it.

SOME KEY QIC STANDARDS

A partial list of the 36 standards adopted by Quarter Inch Cartridge Drive Standards.

Interfaces

QIC-02	Quarter-inch cartridge tape drive intelligent interface
QIC-36	Quarter-inch cartridge tape drive basic interface
QIC-104	Implementation of SCSI for QIC-compatible sequential storage devices
QIC-121	Implementation of SCSI-2 for QIC-compatible sequential storage devices

Commonly used tape formats

QIC-24	Serial-recorded magnetic tape cartridge for information interchange (60 MB)
QIC-40	Flexible-disk-drive-controller-compatible recording format for information interchange (40 MB)
QIC-80	Flexible-disk-drive-controller-compatible recording format for information interchange (80 MB)
QIC-120	Serial-recorded magnetic tape cartridge for information interchange (125 MB)
QIC-150	Serial-recorded magnetic tape cartridge for information interchange (150 MB)
QIC-525	Serial-recorded magnetic tape cartridge for information interchange (525 MB)
QIC-1350	Serial-recorded magnetic tape cartridge for information interchange (1.35 GB)

Data compression

QIC-122	Data-compression format for quarter-inch data cartridge tape drives
QIC-123	Registry of data algorithm identifiers for quarter-inch cartridge tape drives

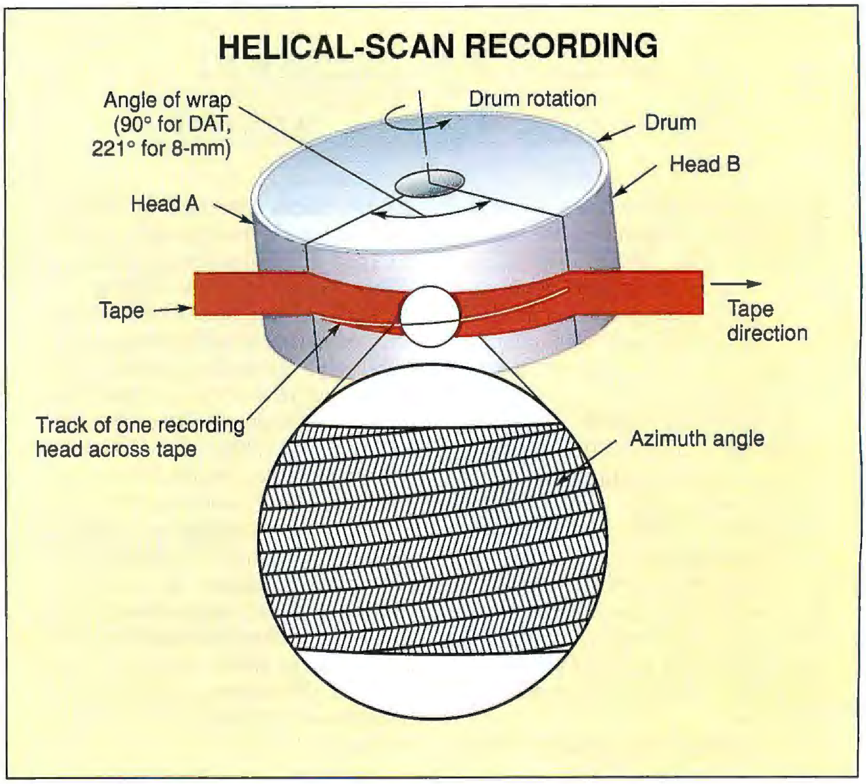

Figure 2: *Slanted tracks maximize use of the tape's surface area; alternate azimuth angles minimize cross talk.*

effort, tapes recorded on one manufacturer's drive can be read in another, provided that the industry-standard format is used. (Almost all manufacturers have their own enhanced, proprietary, and incompatible formats in addition to the standard ones.) In December 1989, an independent laboratory called Pericomp (Natick, MA) certified QIC-40 cartridge drives from three manufacturers—Archive, Mountain Computer, and Colorado Memory Systems—as fully compatible. Other manufacturers (such as Alloy Computer Products and Everex Systems) are expected to follow, and Pericomp has begun to certify QIC-80 drives as well.

"Floppy Tape"

The QIC-40 and QIC-80 standards are sometimes called the "floppy tape" standards, because they're designed to use the computer's existing floppy disk drive controller to read and write tapes. This is less expensive than providing a custom controller and may save backplane slots, which is especially important for users with "baby" motherboards. However, this approach has some drawbacks.

First, since the maximum bit clock rate of many floppy disk drive controllers is either 250,000 bps (as on the IBM XT) or 500,000 bps (as on the IBM AT), there's an upper bound on how fast data can be stored and retrieved without a special controller.

Second, since many computers (e.g., the AT) were designed to have at most two floppy disk drives, they don't provide select lines for any more devices. So, in systems that have two floppy disk drives, clever software and hardware tricks are required to let the tape drive share the interface. One commonly used technique is to tell the floppy disk drive controller to select *no* drive; circuitry on the drive or an interface card detects this condition and activates the tape. Pulses on the floppy disk drive controller's step line are often used to send commands to the tape drive; the drive counts the pulses to determine the command.

If, like me, you have an IBM AT compatible that has high- and low-density floppy disk drives and no more cutouts in the chassis, you may suffer from another problem when buying one of these normally inexpensive tape backup units: sticker shock. An external drive can cost as much as $400 more than an internal drive due to the costs of a case, power supply, and FCC-certified cable.

continued

Still, if you find yourself in this situation, resist the temptation to write (and potentially ruin) 360K-byte floppy disks in the high-density drive. Instead, spend the extra money or consider moving to a high-density 3½-inch drive, which will not have compatibility problems with low-density 3½-inch disks.

In the QIC-40 and QIC-80 standards, the floppy disk drive controller sees blocks of data on the tape as if they were disk sectors 1K byte in length. The standards specify how the tracks of the tape are mapped to the sectors, tracks, and sides of the imaginary floppy disk. The tracks of the tape are read and written sequentially in a serpentine fashion. The cyclic redundancy checks that are generated by the floppy disk drive controller are used for error detection, and a Reed-Solomon code is used to correct errors where possible.

Higher-numbered QIC formats move away from using the floppy disk drive controller to read and write and are usually implemented within SCSI-based tape drives. This results in full SCSI speed and greater interchangeability of drives—but not necessarily tapes—among vendors.

Triple Helix

At this writing, the only available backup systems that can store more than a gigabyte per cartridge use helical-scan technology (i.e., the same kind that is used in VCRs and DAT recorders) to achieve this and higher capacities.

Figure 2 shows how a helical-scan drive reads and writes data. The tape wraps around a spinning drum whose axis is tilted at a small angle (typically 5 to 6 degrees) to the tape. The heads, which are mounted on the drum, traverse the tape in long, diagonal stripes (actually, sections of a helix). Each section is about nine times the width of the tape in length.

This is the point where the 8-mm and 4-mm designs diverge, however. Exabyte's 8-mm helical-scan technology, which is based on an 8-mm analog VCR mechanism supplied by Sony, uses three heads (a servo head, a read head, and a read-after-write head) on the drum, plus a separate erase head that erases the full width of the tape at once.

Tracks are written individually, and they contain 8K bytes of data each. The tape wraps more than halfway around the head—211 degrees, to be exact. The current storage capacity of the Exabyte drive is 2.3 gigabytes per cartridge, with an increase to 5 gigabytes expected sometime this year.

The DDS (Digital Data Storage) format, developed and licensed by Hewlett-Packard and Sony, currently appears to be the dominant data format for 4-mm DAT. DDS uses the innards of a DAT deck, with four heads on the drum: two write and two read-after-write. Tracks are written in pairs (called *frames*) that actually overlap slightly.

The heads can distinguish the tracks, however, because they are recorded at different *azimuth angles* (i.e, with heads that are tilted at different angles relative to the direction of the track). Each frame contains 8K bytes, and the tape wraps only 90 degrees around the drum, which the designers claim helps to reduce tape wear. DDS tapes currently hold 1.3 gigabytes each.

Another format for DAT, called Data/DAT, is now under development by another consortium. While it is similar to DDS in many ways, it adds one important

continued

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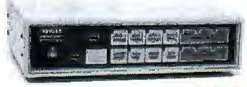
feature: the ability to update data in place. Since this allows partial updates of a backup tape, it could potentially save a lot of time. It also lets the system use a tape drive as a block-oriented, random-access medium, which is an especially useful feature in systems where inexpensive but not superfast mass storage is required.

However, proponents of DDS argue that using a tape as a random-access device—starting and stopping it rather than streaming data smoothly—may promote tape wear. They also claim that writing a driver for such a device is likely to be more difficult than for a streaming device. Is it worth it? The answer is unclear today, but it may make a difference to some applications in the long run.

All the helical-scan drives offer read-after-write data verification and error correction, and they can correct an error detected during a write without breaking stride.



Can QIC Catch Up?

Makers of helical-scan drives claim that they can pack data more densely than on any equivalent "linear" drive because a helical-scan drive doesn't need a multi-track head, or a single one that must shift its position from track to track, to cover almost the entire surface area of the tape. (Doing either, they claim, would introduce mechanical tolerances that limit data density.)

They also claim that the combined motion of the tape and head, which generates an effective head-to-tape velocity of roughly 150 inches per second, provides higher data transfer rates than can be achieved with a linear drive. A linear drive couldn't move the tape at that speed without generating enough friction to melt it!

Meanwhile, QIC adherents are claiming that QIC-1350, a new development standard based on special heads, 900-oersted tape, and data compression, will soon let quarter-inch cartridges store 1.35 gigabytes at data transfer rates of 600K bytes per second. However, the point may soon be moot. Nearly all the major manufacturers of QIC drives have licensed the DDS technology, and many are expected to release DDS drives in the near future.

If they do so, the cost advantages of a mass-market mechanism and the expense of supporting yet another standard may cause them to abandon quarter-inch cartridges for their high-end products. But even if this occurs, quarter-inch cartridges are likely to remain dominant in lower-capacity applications for a long time to come.

The good news for all of us, however, is that mass production and standardization are forcing down prices—at least on the low end of the tape backup spectrum. It's now possible to purchase an internal QIC-40 tape backup unit for around $300 from any of several mail-order dealers. Hopefully, this will be enough to convince most users that there's no sense leaving one's data in danger. ■

ACKNOWLEDGMENT
Special thanks to Dan Stromska of Mountain Computer and Mike Barton of HP Ltd. for help in preparing this article.

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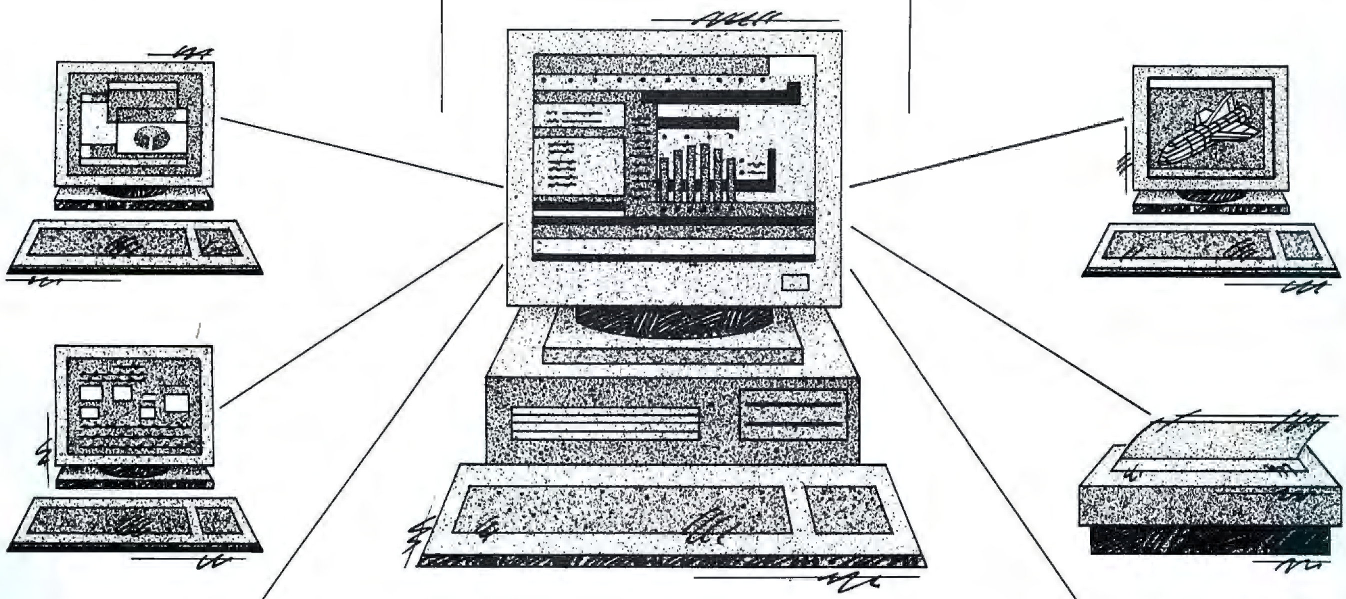

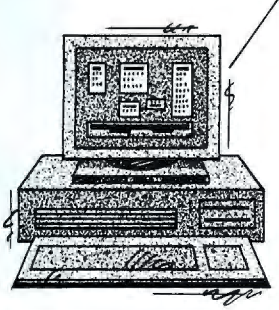

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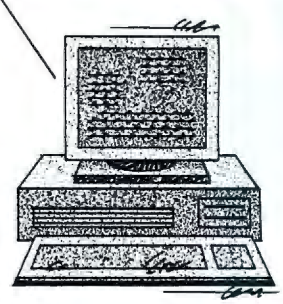

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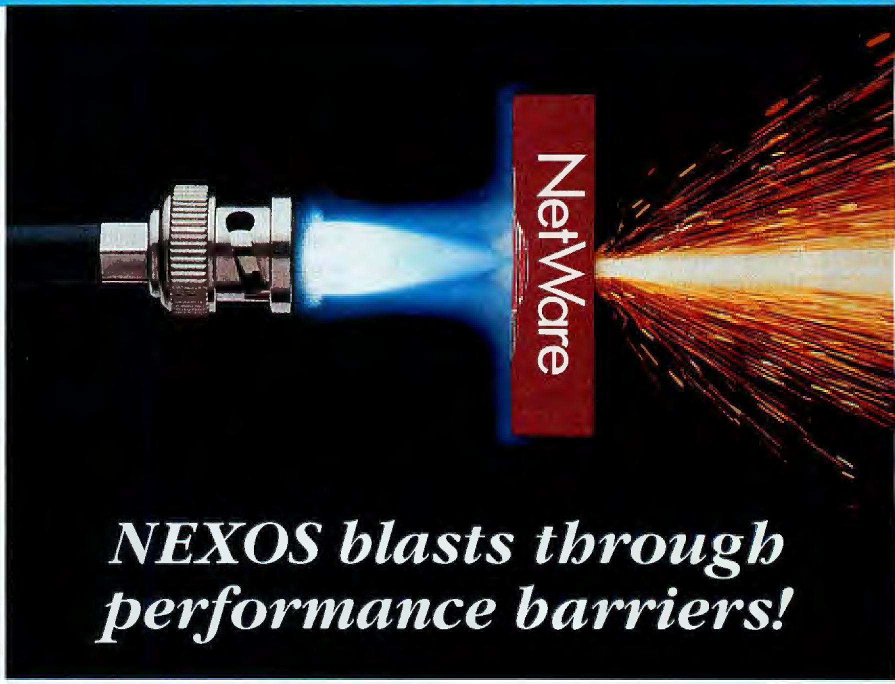

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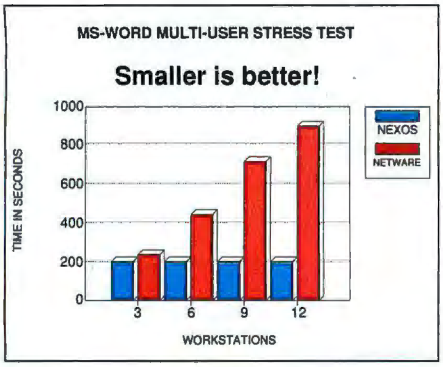

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IN ANY EVENT

Pressing a button on a mouse may seem trivial, but in the world of windows, it's a major event

Not so long ago, the gauge of a programmer's capabilities was how many boxes of punched cards he or she could carry unassisted. Writing a program was straightforward. Programs possessed a simple, linear overall structure: Your program read its input from the cards, did its calculations, and printed the output.

I suppose the genesis of this was the old batch station—the card reader and line printer combo that you found in the corner of the computer room. Not much user interaction there beyond pressing the "formfeed" button on the printer when your job was done. The teletypewriter was a rare (and noisy) addition to the computer room and seldom used for more than an alternate portal for input when the batch station was too crowded.

The world has changed. Although I'm sure there are still some card readers around here and there, you don't find many hooked to the latest 386 clones or Mac IIs. Teletypewriters have become little more than sound-effects devices placed offstage during news programs.

The input-process-output structure has also given way to more-complex designs. The avenues by which a program must be able to receive data have multiplied. Now, instead of a card reader, applications use keyboards, mice, serial ports, and—in multitasking systems—messages from other tasks. And nowhere is this diversity of input devices more evident than in the realm of graphical user interfaces (GUIs).

In an effort to relieve the snarl of source code that would surely result from a program's having to loop and poll every conceivable point of input, many GUI systems channel input into a single pipeline—the event queue. With this design, the most active code in a program is the looping procedure that retrieves events from the event queue and responds appropriately.

Line 'Em Up

User input occurs asynchronously. That is a fancy way of saying "unpredictably." Of course it's unpredictable—there's a human on the other end of the mouse. Operating-system designers might cope with this situation by providing a library of interrupt service routines—one routine for each device or source of input. Application builders could then hook into the appropriate ISRs and take things as

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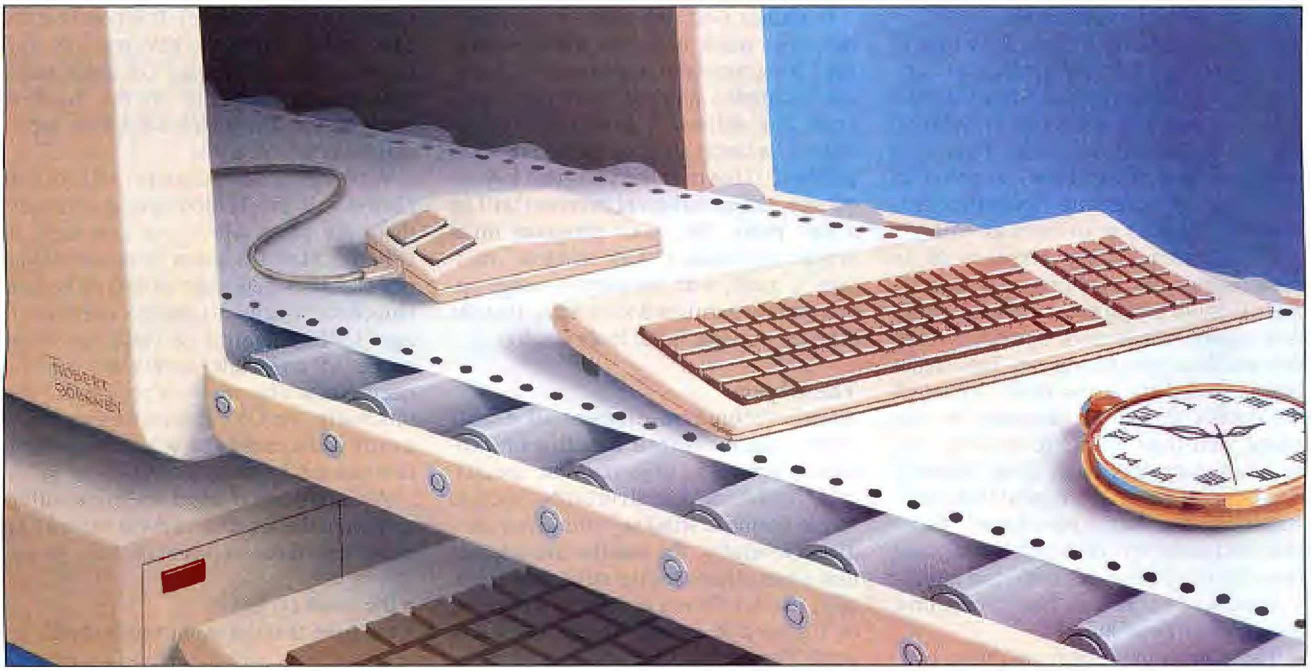

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Listing 1: *C pseudocode for a simple event loop. Messages carrying event information come in through the* `GetNextEvent()` *routine. The* `switch` *selects the appropriate handling routine. In this case, the program manipulates a single window.*

```
for(;;)
{
       GetNextEvent(&message);
       switch(message.type)
       {
              case MOUSE:
                     DoMouseMsg(message);
                     break;
              case KEYBOARD:
                     DoKeyboardMsg(message);
                     break;

              <...other message types...>

              case QUIT:
                     DoExit();
       }
}
```

they came. Coping with interrupts at that level, however, would leave problems such as buffer management in the laps of the application developers.

Instead, the designers of Windows, Presentation Manager (PM), and others have built systems that funnel the asynchronous events into a queue. The system kernel captures the interrupts, packages the information, and places it on a kind of software conveyer belt: the event queue. The application program pulls the event message off the queue, examines it, and then executes the appropriate routine. Voilà: Asynchronous interrupts become an ordered list of events.

(I'm simplifying things. I do that at the beginning a lot. The application program doesn't always just remove events from the queue; it often places them on the queue. Also, more than interrupts triggered by user input will summon an event. Messages coming from other processes can appear as an event as well.)

Programming in the presence of an event queue has encouraged programmers to mold a distinctive process structure around whatever statement fetches the next item from the queue. This structure is called the *event loop*. Although the details vary from language to language (and from system to system), you build an event loop with three primary components: a big "repeat forever" statement, the "fetch next event" function, and some sort of dispatch statement (usually a `switch` statement). Listing 1 is a pseudocode fragment that shows how the whole thing is built.

The queue is nothing more than a two-ended stack: The system is busy pushing events onto the far end while your program is busy pulling them off the near end. The event queue handling function—`next_event()`—pulls the next event off the queue and then returns the event's information in a data structure whose contents describe the associated event. For example, if the event is a mouse-click, the data structure would carry pointer coordinate information.

The `switch` statement simply passes the event data to the appropriate routine. Hence, the `do_mouse()` routine takes care of mouse functions, the `do_keypress()` function handles keyboard input, and so on.

As you might guess, things are certainly more complicated than I have shown. A program built around an event queue must keep track of its current state. In a paint program, for example, a mouse-click at coordinates *x,y* would produce one result if a drawing-tools window is open, and a completely different result if a fonts window is open. Applications typically manage such situations by keeping track of which windows are currently active, where those windows are on the screen, and other such status information.

Multitasking systems allow tasks to operate independently of one another. The event manager maintains a separate event queue for each task. This makes its job more difficult than in a single-tasking system, since now the event manager must know which windows are attached to which task so that events in a given window will go to the proper parent task.

It sounds odd, but there are actually instances when it makes sense to have your program send a message to itself. For example, suppose your paint program has defined a particular key sequence as being a signal to hide its tools window. If the user activates that key sequence, the actual event received will be a key press. So, your program turns around and sends a "hide window" message to itself, with the event message appropriately garnished to indicate that the targeted window is the tools window.

The Object

Another common element of event-driven systems is their handling of complex structures as objects. More specifically, elaborate data structures—such as might define a window—are given handles. Generally, the handles are integers that act as aliases for the structure. (Usually, the handle is a pointer to a pointer, as I described in my August 1989 column. This permits the object referenced by the handle to be relocatable, a critical asset in graphical systems where windows are always coming and going.)

The use of handles is particularly important with the X Window System, since it is designed to operate across a network. For example, given that a program must manipulate a window—whose defining data structure occupies hundreds of bytes of storage—a single operation could require substantial network traffic if the window's entire data must be exchanged between the client process and the server process. Associating the window with a 32-bit handle means that a request across the network needs only a long integer to identify the window.

In DESQview, the use of objects reduces the complexity of coding the event loop. The object queue structure lets a program treat all sources of input identically and channel their events through a single event queue. The specific event-handling subroutine must resolve the handle into its associated object. The result is a kind of information-hiding: Only the routines that manipulate the object have any idea of the object's internals. DESQview carries this even further; it isn't even necessary for a program to know the details of an object's data structures. A program operates on an object through DESQview calls, never by directly reading or writing data fields within the object's definition.

Macintosh

The Macintosh's event-handling software is divided into two parts. The Mac OS event manager is the lowest (i.e., closest to the hardware). It is here that the Macintosh captures key presses and mouse-clicks. The Mac OS event manager passes events up to the Toolbox event manager, which is what most applications converse with.

Although your program will almost always call the Toolbox event manager, there are cases where you may need to call the Mac OS event manager. Most important, when your program is first launched, it can call the OS event manager's `FlushEvents` to clear the event queue of any stale events left on the queue from any previous programs. Additionally, the OS event manager's `PostEvent` is the means by which an application can send events to itself.

An application receives event information in the form of an event record. An event record is composed of

- the event type;
- the time that the event was posted

continued

into the event queue;

- the location of the mouse when the event took place;
- the state of the mouse button and the modifier keys (the Shift, Option, and clover keys) when the event occurred; and
- information that is dependent on the type of the event.

The last entry is referred to in Macintosh documentation as the *message field*. It's a long integer whose contents differ from event type to event type. For example, if the event is a key press, the lowest byte of the message field contains the ASCII code corresponding to the key. The next-higher byte (bits 8–15) carries the scan code of the key pressed. As you continue reading, you'll discover that most of the other systems I'll mention use an event record (sometimes called a message) structure that's a variation on the Macintosh theme.

The Mac provides a filter for incoming events called the *event mask*. Each bit of the event mask corresponds to a particular type of event. Setting a bit in the event mask lets the corresponding event type "pass through" to the application; clearing a bit blocks the associated event type. Therefore, if your application is—heaven forfend!—command-line driven and thus has no need of the mouse, you can filter out mouse events so that your program needn't bother with them.

The Mac's core event-handling routine is `GetNextEvent`. It takes two arguments: the event mask word and a pointer to a memory buffer where the next event record will be stored. `GetNextEvent` returns a Boolean value indicating whether there's an event waiting for your application to handle. It also performs some background work that your application doesn't explicitly see. For example, `GetNextEvent` checks whether an alarm that you've set on the alarm clock should be triggered; it also activates any routines that have been attached to command-shift-number keys (FKEY functions).

The Mac's event queue can handle up to 20 events. If the queue fills up, the system pushes old events into oblivion to make room for incoming new events. The `GetNextEvent` routine actually pulls events off the queue. Sometimes, however, your program may wish to only examine events on the queue without removing them. In this case, you call the `EventAvail` routine, which operates just like `GetNextEvent` without extracting events from the queue.

Keep in mind that the event manager is an application's sole source of user input. The Mac provides a journaling feature: Items passing through the event queue can be fed to an audit file while on their way to the application. Then, at some later time, you can put the program into "playback mode," in which the contents of the audit file are fed directly to the event queue. This lets you create quite complex demonstration programs that include mouse movements and button clicking, as well as keyboard input.

Microsoft Windows

The Microsoft Windows world is a little different from that of the Mac—an understatement if ever there was one. But if you look beyond the obvious differences in host processors and parent companies, Windows distinguishes itself by virtue of its multitasking capabilities.

Windows actually maintains two event

continued

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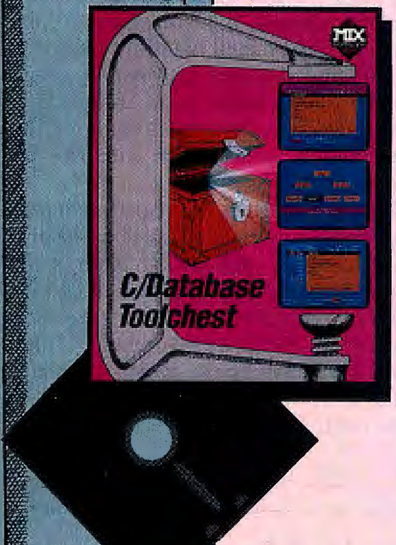

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queues. Your program is really never aware of one, the system queue. As its name implies, the system queue is maintained by Windows and is the system-wide clearinghouse for all events. Your application program actually accesses the other event queue. Since each application gets its own queue, it's up to Windows to determine the recipient of a given event message. Now that I think about it, I suppose that means that a Windows session actually supports multiple event queues; the number is dependent on how many tasks are simultaneously active.

Windows event messages are compact (as on the Mac), and they are all built using the same four fields:

- a 16-bit handle to a window,
- a 16-bit message type,
- a 16-bit parameter, and
- a 32-bit parameter.

The last two fields are the Windows counterparts to the Mac's message field. (Don't get confused by my usage of the word *message*. Windows, and everyone else following, refers to event records as messages.) They carry data specific to the event. For example, if the event indicated a movement of the mouse (defined by Windows as a `WM_MOUSEMOVE` event message), the 32-bit parameter carries the concatenated *x* and *y* coordinates of the mouse.

Windows has its own meaning for *synchronous* and *asynchronous*: A synchronous event message pops out of the queue in the same order (relative to everyone else in the queue) that it went in. However, as soon as an asynchronous event enters the queue, it moves immediately to the front. Agreed, an asynchronous event sounds dangerous, but its raison d'être is to alert a task to some situation that must be handled immediately.

A Windows event loop revolves around three functions: `GetMessage()` receives an event message from the Windows kernel. The message is passed to `TranslateMessage()`, where any key-down messages are translated to their appropriate ASCII equivalents. Finally, the message is handed to `DispatchMessage()`, which delivers it to the proper window.

Of course, I'm oversimplifying. How does a window accept delivery of a message? The answer lies in what occurs in the initialization code that every Windows program executes just after start-up. Specifically, the program must register with the operating system the *kinds* of windows that it intends to use. (This is referred to in Windows and OS/2 as registering the window *class*.)

During the registration process, the program provides each window class with a pointer to a routine that will handle all messages delivered to windows of that class. So when I say that the window accepts delivery, that translates to "the window's associated handling routine is called, and detailed information about the message is passed in as arguments." The `switch`-statement portion of the event loop is within each window-handling routine.

Listing 2 outlines the registration process. In its initialization portion, the program hands Windows a template of the classes `Window1` and `Window2`. When the program creates instances of those windows (with the `CreateWindow()` function), Windows knows which templates to use to draw the windows on-screen, as `CreateWindow()` specifies the class.

continued

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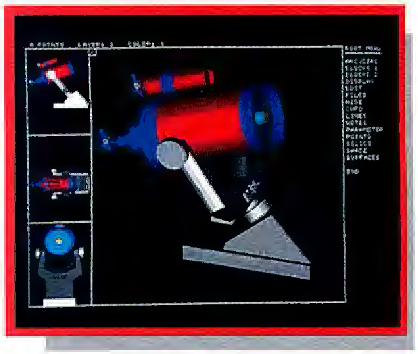

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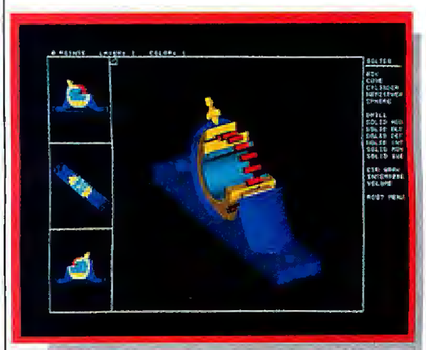

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Listing 2: *Event handling in a multiwindow environment—in this case, Windows. Notice that the* `switch` *statement has been decoupled from the* `while` *statement. The* `DispatchMessage()` *routine sends the message to the proper window-handling routine—*`Wind1Proc()` *or* `Wind2Proc()`*—where message filtering takes place.*

```
/*
** Initialization routine to register
** a window with the operating system.
*/
BOOL FAR PASCAL Initialize(myhandle)
HANDLE myhandle;        /* Handle to myself */
{
WNDCLASS mywind1;
WNDCLASS mywind2;
/*
** Name mywind1's class and associate a
** window-handling routine.
*/
mywind1.lpszClassName="Window1";
mywind1.lpfnWndProc=Wind1Proc;
/*
** Do same with mywind2.
*/
mywind2.lpszClassName="Window2";
mywind2.lpfnWndProc=Wind2Proc;
/* Register with Windows. */
RegisterClass(&mywind1);
RegisterClass(&mywind2);
return;
}
/*
** Create two windows of class mywind1
** and mywind2.
*/
BOOL FAR PASCAL Createwinds(myhandle);
HANDLE myhandle;        /* Handle to myself */
{
HWND hWind1, hWind2;    /* Handles to windows */
/* Create two windows */
hWind1=CreateWindow((LPSTR)"Window1",(LPSTR)"MyW1",...
                myhandle,(LPSTR)0);

hWindw=CreateWindow((LPSTR)"Window2",(LPSTR)"MyW2",...
                myhandle,(LPSTR)0);

<..code to display the windows goes here...>
}

long FAR PASCAL Wind1Proc(whandle,msgtype,wp,lp)
HWND whandle;           /* Window handle */
unsigned msgtype;       /* Message type */
WORD wp;                /* Word parameter */
LONG lp;                /* Long parameter */
{
switch(msgtype)
{
        case WM_ONETHING:
                <code to handle one thing>
                break;
        case WM_ANOTHER:
                <code to handle another>
        default:
                return(DEfWindowProc(whandle,msgtype,wp,lp));
                break;
}
return(OL);
}

long FAR PASCAL Wind2Proc(whandle,msgtype,wp,lp)
HWND whandle;           /* Window handle */
unsigned msgtype;       /* Message type */
WORD wp;                /* Word parameter */
LONG lp;                /* Long parameter */
{
< code virtually identical to Wind1Proc above >
}
int Pascal WinMain(myhandle,...)
HANDLE myhandle;
{
MSG mymsg;

        Initialize(myhandle);
        CreateWinds(myhandle);
        while(GetMessage(&mymsg,NULL,0,0))
        {       TranslateMessage(&mymsg);
                DispatchMessage(&mymsg);
        }

        <...termination code goes here...>
}
```

Listing 2 solves another riddle. How does Windows know which program owns a particular window? When you launch an application under Windows, the system assigns the application a unique identifier—`myhandle` in listing 1. The `CreateWindow()` function takes `myhandle` as an argument when a particular instance of a window is created. The argument is the key to how the operating system knows which application is a given window's keeper.

Presentation Manager

The user interface supported by OS/2's PM is the same as that employed by Windows; in fact, PM's application programming interface is based on the Windows API. Consequently, it's no surprise that the two systems share many traits.

As in Windows, applications running under PM respond to event messages passed in from PM itself. Also, PM carries on with the use of handles—16- or 32-bit aliases to complex structures such as windows, message queues, and so on.

Unlike Windows programs, PM applications must explicitly create their own event message queue. (My guess is that this is because OS/2 might be running PM and non-PM applications simultaneously. A non-PM application may not need an event message queue, so programs create their own queues only when necessary.) A program does this with a call of the form

```
msgqhand=
  WinCreateMsgQueue(hab,0)
```

where `msgqhand` is a handle to the created queue. The variable `hab` is a handle to what is referred to as an *anchor block* and is used more or less as a program's means for uniquely identifying itself in the PM environment.

PM provides the program with this unique identifier via the `WinInitialize()` routine, which you must call prior to calling `WinCreateMsgQueue()`. This anchor block handle is the counterpart to the handle passed into a Windows application when it is launched.

The format of a PM event message looks like a Windows event message with some finery added:

- the handle of the window to which the message is directed;
- a 16-bit message type field;
- two 32-bit parameter fields;
- the time the message entered the queue; and
- the position of the mouse when the message entered the queue.

As you can see, a PM message has a special field for the mouse coordinates. In Windows, whenever the application receives a mouse message, the rodent's coordinates are kept in the 32-bit parameter (see above).

(Aside: PM further deviates from Windows in the nomenclature it applies to event messages. In PM, synchronous messages are referred to as *queued*, asynchronous messages as *nonqueued*.)

A PM event-loop kernel takes up about two lines of source code. It looks something like this:

continued

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Listing 3: *A DESQview event loop. This section of event handling identifies which object requires servicing. Each object-handling routine would first read the event from the appropriate source (e.g., keyboard object and mouse object) and then execute yet another* `switch` *statement for dispatching the event to the proper code.*

```
/*
** A DESQview-style event loop. The
** variable 'finished' is global, and
** is set by one or more of the object
** handlers to signal that the user
** has elected to close the
** application.
*/
while(finished!=0)
{
        /* Read objectq */
    object=obq_read();

    switch(object)
    {
        /* Keyboard event */
        case key_handle:
                do_keyboard();
                break;

        /* Mouse event */
        case mouse_handle:
                do_mouse();
                break;

        /* Something in our mailbox */
        case mail_handle:
                do_mailbox();
                break;

        <...other case statements...>
    }
}  /* End of while loop */

<...following code would free.......>
<...all objects this program........>
<...had allocated...................>
```

```
while(WinGetMsg(...))
  WinDispatchMsg(...);
```

I've removed the functions' arguments. The `WinGetMsg()` function retrieves a message from the message queue, while `WinDispatchMsg()` sends that message off to the appropriate destination. Since `WinGetMsg()` is the argument to the `while` loop, apparently this loop exits only when `WinGetMsg()` returns a value of 0. That's exactly what happens when your program receives a `WM_QUIT` message (sent whenever the user selects Close from the menu).

As in Windows, the `switch`-statement portion of the event-handling loop is carried in a window's window-handling procedure. Oddly, the time of posting and the mouse-coordinates portion of the event structure are not passed to the window-handling routine—only the handle, message type, and parameter fields are. I suppose this is done to keep memory use trim; only messages generated by the mouse demand that the application know where the pointer was at the time of the event. Your program can retrieve the mouse location with a call to the `WinQueryMsgPos()` function.

X Window System

The X Window System (referred to as X Window hereafter) is a network-based windowing system released by MIT (with significant contributions by DEC and other companies). Since it works across a network, its structure is client-server. User programs run as clients, passing requests to the server, which does most of the grunt work of managing a bit-mapped display. User programs talk to the server through a set of C routines gathered into the Xlib library.

Since X Window can operate over a network, the transformation of interrupts (from key presses, mouse-clicks, and so on) into event messages is mandatory. The hardware that generates user-input interrupts may be several meters' worth of coaxial cable away from the hardware executing the application program.

X Window carries on the theme of using handles to manipulate complex entities. However, a handle is referred to as a *resource identifier*, since abstract objects are called *resources*.

The fulcrum routine of the X Window event loop is `XNextEvent`, which takes two arguments. Its first argument is a pointer to a display structure, which carries information about the current screen and the X Window server. (This display structure is X Window's way of uniquely identifying a given user. It is the counterpart of OS/2's anchor block and the `myhandle` variable in Windows.)

The second argument is a pointer to an `XEvent` structure. This is a union of structures, each member structure of which defines a type of event. The first integer in the `XEvent` acts as a selector and lets you pick which member of the union to use for a particular event. (If you find this confusing, consider `XEvent` a data structure whose architecture differs from event type to event type.)

The `XNextEvent` routine doesn't do any event filtering; you set that with the `XSelectInput` routine prior to calling `XNextEvent`. As with the other event-driven systems I've mentioned, the filtering is handled by a mask. In this case, the mask is a 32-bit word.

DESQview

DESQview is another multitasking operating system. Most of the programs that you execute under it are "DESQview unaware"; they're simply programs written for MS-DOS that don't know any better. But you can create "DESQview aware" programs that use the multitasking capabilities. (See my February column.)

In DESQview, items that a program communicates with (screens, keyboards, and so on) appear in the form of objects. So your program manipulates window objects (display output), panel objects (dialog boxes, menus, and help screens), keyboard objects (self-explanatory), pointer objects (mice), mailbox objects (semaphores and interprocess communication), and objectq objects (the event queue). I pronounce "objectq" as "object queue" to help remind me of its use. As in the other systems I've mentioned, objects are referenced by handles (32-bit identifiers in DESQview).

The objectq is the foundation for the event loop in a DESQview application. You might reasonably imagine that your program would accept keyboard input by creating a keyboard object and attaching that keyboard object to the current task. Whenever the task expects input, it sends a READ message to the keyboard object. This scenario would apply as well to a task requiring mouse input: The task creates and then opens a pointer object.

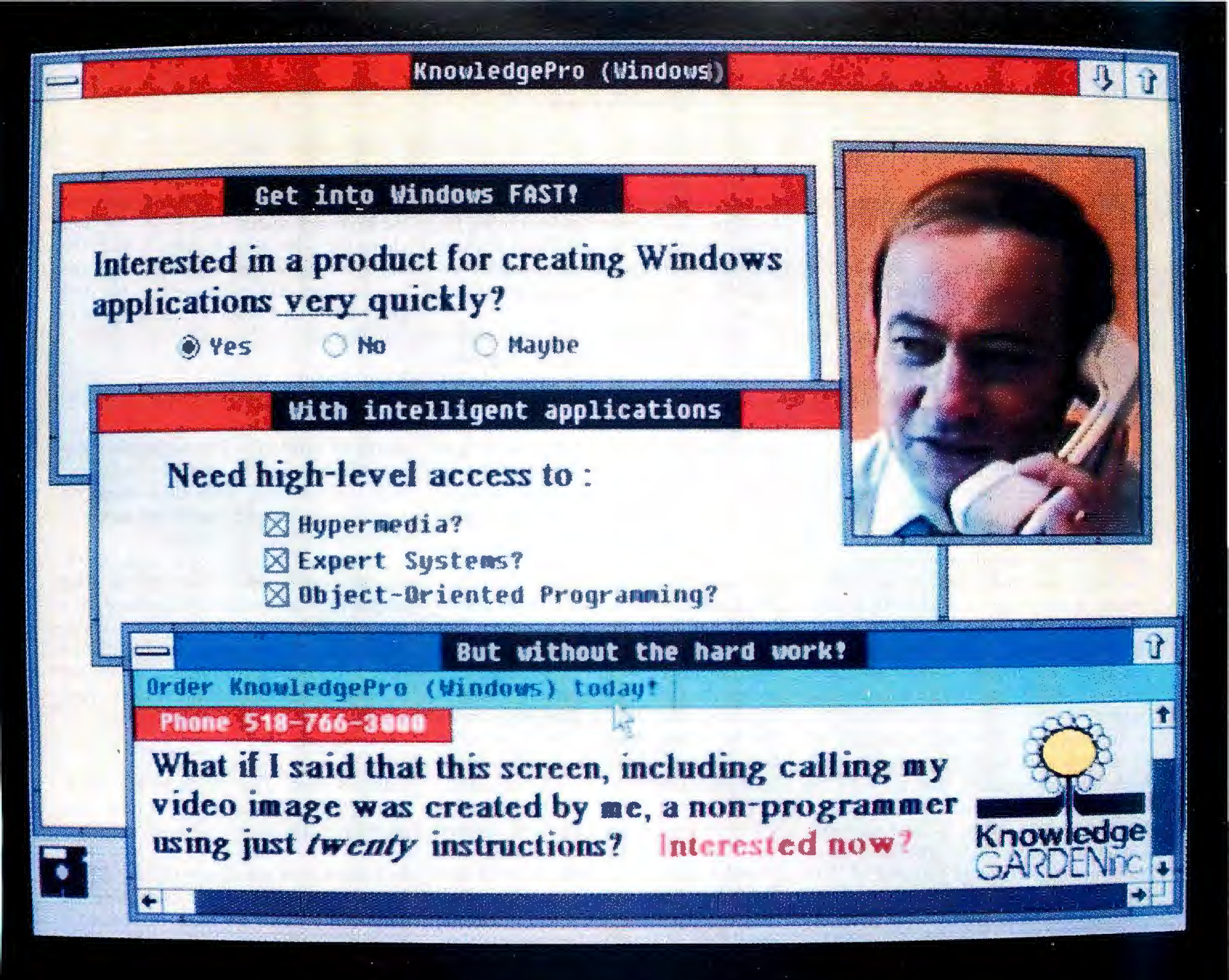
That's not precisely true, and here's where the objectq comes in: Each item on the objectq is a handle to an object for which an event is pending. So, if your program reads the objectq and receives the handle to the keyboard object, your program knows that the keyboard holds the next pending event. This saves your program from having to issue passels of READ messages helter-skelter to all the objects it is manipulating. A DESQview event loop ends up looking something like what I've shown in listing 3.

In addition, the objectq sidesteps the potential for a task's falling asleep at the wheel. Specifically, if a task issues a READ call to a keyboard object when no keyboard input is available, that task is suspended until a key is pressed. So if the user is using the mouse while the task is waiting on the keyboard, mouse input may get lost. (Or worse, the system can simply freeze up.)

For Example

To illustrate event-loop programming, I put together a small calculator program for DESQview. It's simply a hexadecimal-to-decimal conversion calculator. But it gives me the opportunity to showcase some of the special features DESQview provides for user input.

continued



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The calculator's front panel consists of 19 keys: the digits 0 through 9, the characters *A* through *F*, and the special keys *, 10, and 16. You can guess the use of many of the number and letter keys. The 10 key sets the display to base 10, 16 sets the display to base 16, and * clears the display. Keys can be activated by pointing and clicking with the mouse, as well as typing their counterparts on the keyboard. (You access 10 and 16 through the F1 and F2 function keys.)

This calculator program takes input from the mouse as well as from the keyboard. You'd therefore expect that the event loop would require some means of distinguishing between messages from the keyboard and messages from the mouse. This is not so, thanks to a component of DESQview referred to as the *field manager*. The field manager lets you make a window "aware" of those parts of itself that make up user input and output.

You activate the field manager by building a data structure called a *field table* and transmitting that table to the window as part of what is referred to as a *window stream*. This is data that you send to a window to alter the behavior of the window's contents (instead of data for display). In this case, the field table's elements describe all the input and output fields within that window—where those fields are and how they act. So the input fields are the calculator's keys; the output field is the display.

Of course, the calculator's keys are really more or less buttons. DESQview calls fields of this sort *select* fields; you can select them by pressing an associated key from the keyboard or by moving the mouse pointer to the field and clicking the button. Fields that can actually accept arbitrary strings of input are simply called *input* fields.

Once you've defined the floor plan of your window (i.e., where all the fields are located and what their attributes are), assembled that into a field table, and sent that to the window, your work is largely done. Your program can capture all user input by opening a keyboard object attached to the window. The field manager consolidates mouse and keyboard input and sends it to the keyboard object.

Furthermore, information that your program receives from the keyboard object has had considerable intelligence injected into it by the field manager. For example, since the field manager knows where fields are within the window, it attaches the field number to any received input and sends that to your program via the keyboard object. Your application doesn't have to determine which field has been input based on mouse coordinates.

This is true for input fields as well as select fields. In my calculator, I need only know which key was selected. In a complex data-entry screen, I could have fields for clients' names, dates, and addresses. The user could select a field and enter data, and the field manager will report to my program what the user typed, as well as what field he or she was in when it was typed.

Detailed information—mouse buttons and such—can be had from a variable called the *keyboard status*. DESQview returns this variable whenever you read the keyboard object. This is how the user closes the calculator: A specific bit in the keyboard status field indicates when the user has pressed the Escape key. My program reads an Escape key as a signal to shut down.

Final Event

It's relieving to see that, with all the diversity in computers today, there's still plenty of similarity. I suppose Mac programmers have a leg up on the rest of us; they were dealing with event loops on microcomputers before there was any mention of PM or X Window.

Perhaps, if you look at it right, event-driven systems have been around a lot longer than you may have guessed. It's just that their early forms were subtle. Why, I clearly remember feeling like an object in a queue, waiting for my chance at the card reader and line printer. And when the program worked...what an event *that* was. ■

Editor's note: *The full source code is available in a variety of formats.* *See page 5 for details.*

Rick Grehan is the director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in computer science/mathematics from Memphis State University. He can be reached on BIX as "rick_g."

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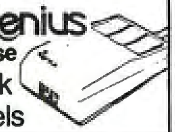

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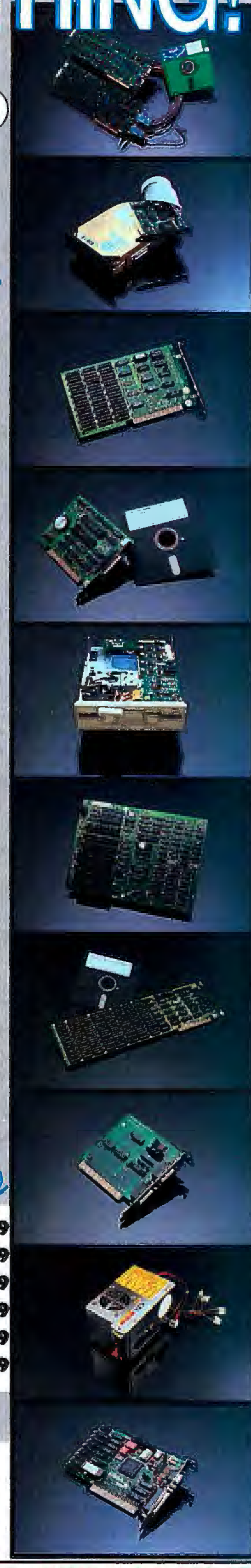

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10Mhz 286XT Motherboard 1MB,Shadow,Diskcache,0K	$129
286-12Mhz Motherboard Upto 4MB, EMS 4.0	$199
286-16Mhz Motherboard Upto 4MB on system board	$295
286-20Mhz Motherboard Upto 4MB, C & T Chipset	$345
386-SX 16Mhz Motherboard Upto 8MB, C & T Chipset	$395
386-20/25Mhz Motherboard Upto 8MB, C & T Chipset	$729
386-25C 25Mhz 32K Cache Upto 16MB on motherboard	$1309
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1200 BAUD INTERNAL 5 Yr Warranty, 1200/300 Baud	$49
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MODEL/DESCRIPTION		BASE	MONO	CGA	EGA	MONO VGA	COLOR VGA	VGA SYNC
88-12	1 / (1) 360K Floppy Drive	$399	$499	$619	$808	$577	$899	$998
640K	2 / (2) 360K Floppy Drives	$469	$569	$689	$878	$689	$969	$1,068
12 MHZ	20 / 22MB,45MILS,MFM,3.5"	$649	$749	$869	$1,058	$869	$1,149	$1,248
	30 / 33MB, 45MILS, RLL, 3.5"	$679	$779	$899	$1,088	$899	$1,179	$1,278
286-XT	1 / (1) 360K Floppy Drive	$499	$599	$719	$908	$719	$999	$1,098
1 MB RAM	2 / (2) 360K Floppy Drives	$569	$669	$789	$978	$789	$1,069	$1,168
10 MHZ	20 / 22MB,45MILS,MFM,3.5"	$749	$849	$969	$1,158	$969	$1,249	$1,348
	30 / 33MB, 45MILS, RLL, 3.5"	$779	$879	$999	$1,188	$999	$1,279	$1,378
286-12	1 / (1) 1.2MB Floppy Drive	$699	$799	$919	$1,131	$985	$1,199	$1,325
1 MB RAM	20 / 45MILS,MFM,2-1,KL320	$899	$999	$1,119	$1,331	$1,085	$1,399	$1,525
12.5 MHZ	20 / 38MILS,MFM,2-1,ST125	$979	$1,079	$1,199	$1,411	$1,165	$1,479	$1,605
0-WAIT	30 / 38MILS,MFM,2-1,ST138	$1,039	$1,139	$1,259	$1,471	$1,225	$1,539	$1,665
Norton SI-14	40 / 60MILS,IDE,1-1,WD	$1,029	$1,129	$1,249	$1,461	$1,215	$1,529	$1,655
Speed-16Mhz	40 / 38MILS,RLL,1-1,MS8045	$1,079	$1,179	$1,299	$1,511	$1,265	$1,579	$1,705
Exp. to 4MB	40 / 20MILS,IDE,1-1,CONNERS	$1,099	$1,199	$1,319	$1,531	$1,285	$1,599	$1,725
AWARD BIOS	65 / 38MILS,RLL,1-1,PTI	$1,119	$1,219	$1,339	$1,551	$1,305	$1,619	$1,745
DIP DRAM	85 / 20MILS,IDE,1-1,CONNERS	$1,269	$1,369	$1,489	$1,701	$1,455	$1,769	$1,895
EMS 4.0	120 / 20MILS,IDE,1-1,CONNER	$1,509	$1,609	$1,729	$1,941	$1,695	$2,009	$2,135
	200 / 16MILS,IDE,1-1,CONNER	$2,179	$2,279	$2,399	$2,611	$2,365	$2,679	$2,805
	320 / 16MILS,ESDI,1-1,MS9380	$2,979	$3,079	$3,199	$3,411	$3,165	$3,479	$3,605
286-16	1 / (1) 1.2MB Floppy Drive	$799	$899	$1,019	$1,231	$985	$1,299	$1,425
1 MB RAM	20 / 45MILS,MFM,2-1,KL320	$1,019	$1,119	$1,239	$1,451	$1,205	$1,519	$1,645
16 MHZ	20 / 38MILS,MFM,2-1,ST125	$1,069	$1,169	$1,289	$1,501	$1,255	$1,569	$1,695
0-WAIT	30 / 38MILS,MFM,2-1,ST138	$1,139	$1,239	$1,359	$1,571	$1,325	$1,639	$1,765
Norton SI-18	40 / 60MILS,IDE,1-1,WD	$1,129	$1,229	$1,349	$1,561	$1,315	$1,629	$1,755
Speed-22Mhz	40 / 38MILS,RLL,1-1,MS8045	$1,169	$1,269	$1,389	$1,601	$1,355	$1,669	$1,795
Exp. to 4MB	40 / 20MILS,IDE,1-1,CONNERS	$1,189	$1,289	$1,409	$1,621	$1,375	$1,689	$1,815
AMI BIOS	65 / 38MILS,RLL,1-1,PTI	$1,209	$1,309	$1,429	$1,641	$1,395	$1,709	$1,835
SIM Modules	85 / 20MILS,IDE,1-1,CONNERS	$1,359	$1,459	$1,579	$1,791	$1,545	$1,859	$1,985
	120 / 20MILS,IDE,1-1,CONNER	$1,599	$1,699	$1,819	$2,031	$1,785	$2,099	$2,225
	200 / 16MILS,IDE,1-1,CONNER	$2,269	$2,369	$2,489	$2,701	$2,455	$2,769	$2,895
	320 / 16MILS,ESDI,1-1,MS9380	$3,079	$3,179	$3,299	$3,511	$3,265	$3,579	$3,705
286-20	1 / (1) 1.2MB Floppy Drive	$899	$999	$1,119	$1,331	$1,085	$1,399	$1,525
1 MB RAM	20 / 45MILS,MFM,2-1,KL320	$1,119	$1,219	$1,339	$1,551	$1,305	$1,619	$1,745
20 MHZ	20 / 38MILS,MFM,2-1,ST125	$1,169	$1,269	$1,389	$1,601	$1,355	$1,669	$1,795
0-WAIT	30 / 38MILS,MFM,2-1,ST138	$1,239	$1,339	$1,459	$1,671	$1,425	$1,739	$1,865
Norton SI-22.5	40 / 60MILS,IDE,1-1,WD	$1,229	$1,329	$1,449	$1,661	$1,415	$1,729	$1,855
Speed-24 Mhz	40 / 38MILS,RLL,1-1,MS8045	$1,269	$1,369	$1,489	$1,701	$1,455	$1,769	$1,895
Exp. to 4MB	40 / 20MILS,IDE,1-1,CONNERS	$1,289	$1,389	$1,509	$1,721	$1,475	$1,789	$1,915
AMI BIOS	65 / 38MILS,RLL,1-1,PTI	$1,309	$1,409	$1,529	$1,741	$1,495	$1,809	$1,935
DIP DRAM	85 / 20MILS,IDE,1-1,CONNERS	$1,459	$1,559	$1,679	$1,891	$1,645	$1,959	$2,085
EMS 4.0	120 / 20MILS,IDE,1-1,CONNER	$1,699	$1,799	$1,919	$2,131	$1,885	$2,199	$2,325
Shadow RAM	200 / 16MILS,IDE,1-1,CONNER	$2,369	$2,469	$2,589	$2,801	$2,555	$2,869	$2,995
	320 / 16MILS,ESDI,1-1,MS9380	$3,179	$3,279	$3,399	$3,611	$3,365	$3,679	$3,805
386SX	1 / (1) 1.2MB Floppy Drive	$999	$1,099	$1,219	$1,431	$1,185	$1,499	$1,625
1 MB RAM	20 / 45MILS,MFM,2-1,KL320	$1,219	$1,319	$1,439	$1,651	$1,405	$1,719	$1,845
20 MHZ	20 / 38MILS,MFM,2-1,ST125	$1,269	$1,369	$1,489	$1,701	$1,455	$1,769	$1,895
0-WAIT	30 / 38MILS,MFM,2-1,ST138	$1,339	$1,439	$1,559	$1,771	$1,525	$1,839	$1,965
Norton SI-22.5	40 / 60MILS,IDE,1-1,WD	$1,329	$1,429	$1,549	$1,761	$1,515	$1,829	$1,955
Speed-25 Mhz	40 / 38MILS,RLL,1-1,MS8045	$1,369	$1,469	$1,589	$1,801	$1,555	$1,869	$1,995
Exp. to 8MB	40 / 20MILS,IDE,1-1,CONNERS	$1,389	$1,489	$1,609	$1,821	$1,575	$1,889	$2,015
AMI BIOS	65 / 38MILS,RLL,1-1,PTI	$1,409	$1,509	$1,629	$1,841	$1,595	$1,909	$2,035
SIPP Modules	85 / 20MILS,IDE,1-1,CONNERS	$1,559	$1,659	$1,779	$1,991	$1,745	$2,059	$2,185
EMS 4.0	120 / 20MILS,IDE,1-1,CONNER	$1,799	$1,899	$2,019	$2,231	$1,985	$2,299	$2,425
Shadow RAM	200 / 16MILS,IDE,1-1,CONNER	$2,469	$2,569	$2,689	$2,901	$2,655	$2,969	$3,095
	320 / 16MILS,ESDI,1-1,MS9380	$3,279	$3,379	$3,499	$3,711	$3,465	$3,779	$3,905

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MODEL/DESCRIPTION		BASE	MONO	CGA	EGA	MONO VGA	COLOR VGA	VGA SYNC
386-20	1 / (1) 1.2MB Floppy Drive	$1,299	$1,399	$1,519	$1,731	$1,485	$1,799	$1,925
1 MB RAM	20 / 45MILS,MFM,2-1,KL320	$1,529	$1,629	$1,749	$1,961	$1,715	$2,029	$2,155
20 MHZ	20 / 38MILS,MFM,2-1,ST125	$1,579	$1,679	$1,799	$2,011	$1,765	$2,079	$2,205
0-WAIT	30 / 38MILS,MFM,2-1,ST138	$1,649	$1,749	$1,869	$2,081	$1,835	$2,149	$2,275
Norton SI-22.5	40 / 60MILS,IDE,1-1,WD	$1,639	$1,739	$1,859	$2,071	$1,825	$2,139	$2,265
Speed-24 Mhz	40 / 38MILS,RLL,1-1,MS8045	$1,689	$1,789	$1,909	$2,121	$1,875	$2,189	$2,315
Exp. to 8MB	40 / 20MILS,IDE,1-1,CONNERS	$1,709	$1,809	$1,929	$2,141	$1,895	$2,209	$2,335
AMI BIOS	65 / 38MILS,RLL,1-1,PTI	$1,719	$1,819	$1,939	$2,151	$1,905	$2,219	$2,345
SIPP Modules	85 / 20MILS,IDE,1-1,CONNERS	$1,869	$1,969	$2,089	$2,301	$2,055	$2,369	$2,495
EMS 4.0	120 / 20MILS,IDE,1-1,CONNER	$2,109	$2,209	$2,329	$2,541	$2,295	$2,609	$2,735
Shadow RAM	200 / 16MILS,IDE,1-1,CONNER	$2,779	$2,879	$2,999	$3,211	$2,965	$3,279	$3,405
	320 / 16MILS,ESDI,1-1,MS9380	$3,589	$3,689	$3,809	$4,021	$3,775	$4,089	$4,215
386-25	1 / (1) 1.2MB Floppy Drive	$1,499	$1,599	$1,719	$1,931	$1,685	$1,999	$2,125
2 MB RAM	20 / 38MILS,MFM,2-1,ST125	$1,779	$1,879	$1,999	$2,211	$1,965	$2,279	$2,405
25 MHZ	30 / 38MILS,MFM,2-1,ST138	$1,849	$1,949	$2,069	$2,281	$2,035	$2,349	$2,475
0-WAIT	40 / 60MILS,IDE,1-1,WD	$1,839	$1,939	$2,059	$2,271	$2,025	$2,339	$2,465
Norton SI-27	40 / 38MILS,RLL,1-1,MS8045	$1,889	$1,989	$2,109	$2,321	$2,075	$2,389	$2,515
Speed-36 Mhz	40 / 20MILS,IDE,1-1,CONNERS	$1,909	$2,009	$2,129	$2,341	$2,095	$2,409	$2,535
Exp. to 8MB	65 / 38MILS,RLL,1-1,PTI	$1,919	$2,019	$2,139	$2,351	$2,105	$2,419	$2,545
AMI BIOS	85 / 20MILS,IDE,1-1,CONNERS	$2,069	$2,169	$2,289	$2,501	$2,255	$2,569	$2,695
SIPP Modules	120 / 20MILS,IDE,1-1,CONNER	$2,309	$2,409	$2,529	$2,741	$2,495	$2,809	$2,935
EMS 4.0	200 / 16MILS,IDE,1-1,CONNER	$2,979	$3,079	$3,199	$3,411	$3,165	$3,479	$3,605
Shadow RAM	320 / 16MILS,ESDI,1-1,MS9380	$3,789	$3,889	$4,009	$4,221	$3,975	$4,289	$4,415
386-25	1 / (1) 1.2MB Floppy Drive	$1,769	$1,869	$1,989	$2,201	$1,955	$2,269	$2,395
4 MB RAM	20 / 38MILS,MFM,2-1,ST125	$2,039	$2,139	$2,259	$2,471	$2,225	$2,539	$2,665
25 MHZ	30 / 38MILS,MFM,2-1,ST138	$2,099	$2,199	$2,319	$2,531	$2,285	$2,599	$2,725
0-WAIT	40 / 60MILS,IDE,1-1,WD	$2,089	$2,189	$2,309	$2,521	$2,275	$2,589	$2,715
Norton SI-36	40 / 38MILS,RLL,1-1,MS8045	$2,139	$2,239	$2,359	$2,571	$2,325	$2,639	$2,765
Speed-44 Mhz	40 / 20MILS,IDE,1-1,CONNERS	$2,159	$2,259	$2,379	$2,591	$2,345	$2,659	$2,785
Exp. to 16MB	65 / 38MILS,RLL,1-1,PTI-	$2,179	$2,279	$2,399	$2,611	$2,365	$2,679	$2,805
AMI BIOS	85 / 20MILS,IDE,1-1,CONNERS	$2,319	$2,419	$2,539	$2,751	$2,505	$2,819	$2,945
SIMM	120 / 20MILS,IDE,1-1,CONNER	$2,569	$2,669	$2,789	$3,001	$2,755	$3,069	$3,195
EMS 4.0	200 / 16MILS,IDE,1-1,CONNER	$3,229	$3,329	$3,449	$3,661	$3,415	$3,729	$3,855
32K CACHE	320 / 16MILS,ESDI,1-1,MS9380	$4,039	$4,139	$4,259	$4,471	$4,225	$4,539	$4,665
386-33	1 / (1) 1.2MB Floppy Drive	$2,719	$2,819	$2,939	$3,151	$2,905	$3,219	$3,345
4 MB RAM	20 / 38MILS,MFM,2-1,ST125	$2,989	$3,089	$3,209	$3,421	$3,175	$3,489	$3,615
33 MHZ	30 / 38MILS,MFM,2-1,ST138	$3,049	$3,149	$3,269	$3,481	$3,235	$3,549	$3,675
0-WAIT	40 / 60MILS,IDE,1-1,WD	$3,039	$3,139	$3,259	$3,471	$3,225	$3,539	$3,665
Norton SI-44	40 / 38MILS,RLL,1-1,MS8045	$3,089	$3,189	$3,309	$3,521	$3,275	$3,589	$3,715
Speed-58 Mhz	40 / 20MILS,IDE,1-1,CONNERS	$3,109	$3,209	$3,329	$3,541	$3,295	$3,609	$3,735
Exp. to 8MB	65 / 38MILS,RLL,1-1,PTI	$3,129	$3,229	$3,349	$3,561	$3,315	$3,629	$3,755
AMI BIOS	85 / 20MILS,IDE,1-1,CONNERS	$3,269	$3,369	$3,489	$3,701	$3,455	$3,769	$3,895
SIMM	120 / 20MILS,IDE,1-1,CONNER	$3,519	$3,619	$3,739	$3,951	$3,705	$4,019	$4,145
EMS 4.0	200 / 16MILS,IDE,1-1,CONNER	$4,179	$4,279	$4,399	$4,611	$4,365	$4,679	$4,805
64K CACHE	320 / 16MILS,ESDI,1-1,MS9380	$4,989	$5,089	$5,209	$5,421	$5,175	$5,489	$5,615
486-25	1 / (1) 1.2MB Floppy Drive	$4,619	$4,719	$4,839	$5,051	$4,805	$5,119	$5,245
8 MB RAM	20 / 38MILS,MFM,2-1,ST125	$4,889	$4,989	$5,109	$5,321	$5,075	$5,389	$5,515
25 MHZ	30 / 38MILS,MFM,2-1,ST138	$4,949	$5,049	$5,169	$5,381	$5,135	$5,449	$5,575
0-WAIT	40 / 60MILS,IDE,1-1,WD	$4,939	$5,039	$5,159	$5,371	$5,125	$5,439	$5,565
Norton SI-44	40 / 38MILS,RLL,1-1,MS8045	$4,989	$5,089	$5,209	$5,421	$5,175	$5,489	$5,615
Speed-117 Mhz	40 / 20MILS,IDE,1-1,CONNERS	$5,009	$5,109	$5,229	$5,441	$5,195	$5,509	$5,635
Exp. to 16MB	65 / 38MILS,RLL,1-1,PTI	$5,029	$5,129	$5,249	$5,461	$5,215	$5,529	$5,655
AWARD BIOS	85 / 20MILS,IDE,1-1,CONNERS	$5,169	$5,269	$5,389	$5,601	$5,355	$5,669	$5,795
DIP	120 / 20MILS,IDE,1-1,CONNER	$5,419	$5,519	$5,639	$5,851	$5,605	$5,919	$6,045
EMS 4.0	200 / 16MILS,IDE,1-1,CONNER	$6,079	$6,179	$6,299	$6,511	$6,265	$6,579	$6,705
	320 / 16MILS,ESDI,1-1,MS9380	$6,889	$6,989	$7,109	$7,321	$7,075	$7,389	$7,515

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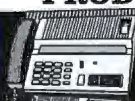

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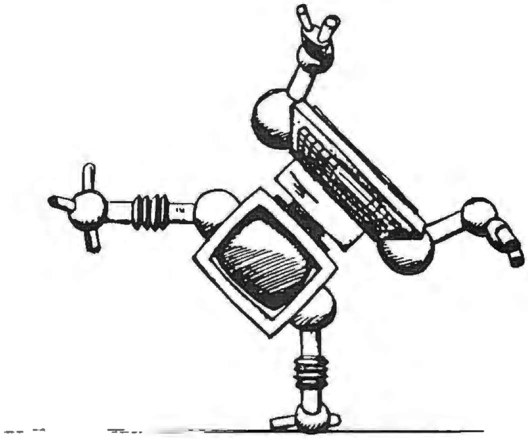

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4MB Memory Exp. Bd	113634-001	Deskpro 386S	1149.00
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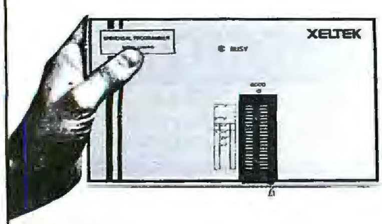

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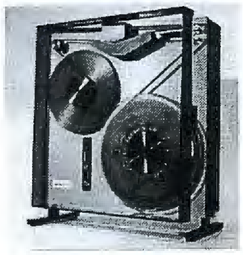

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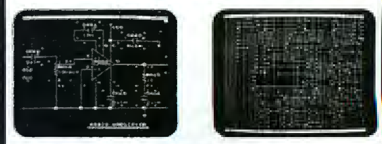

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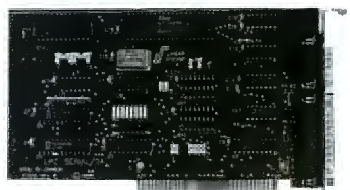

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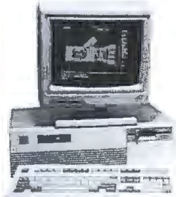

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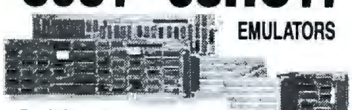

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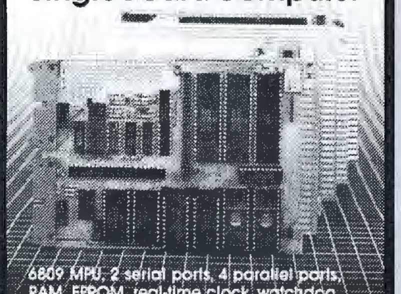

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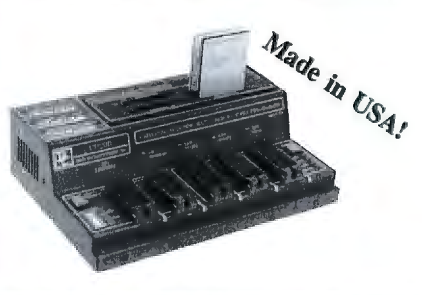

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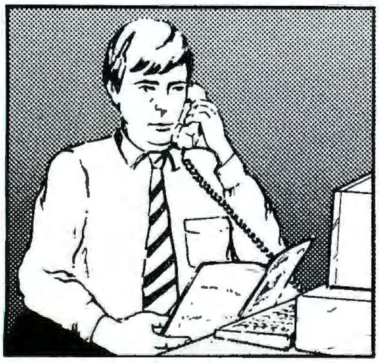

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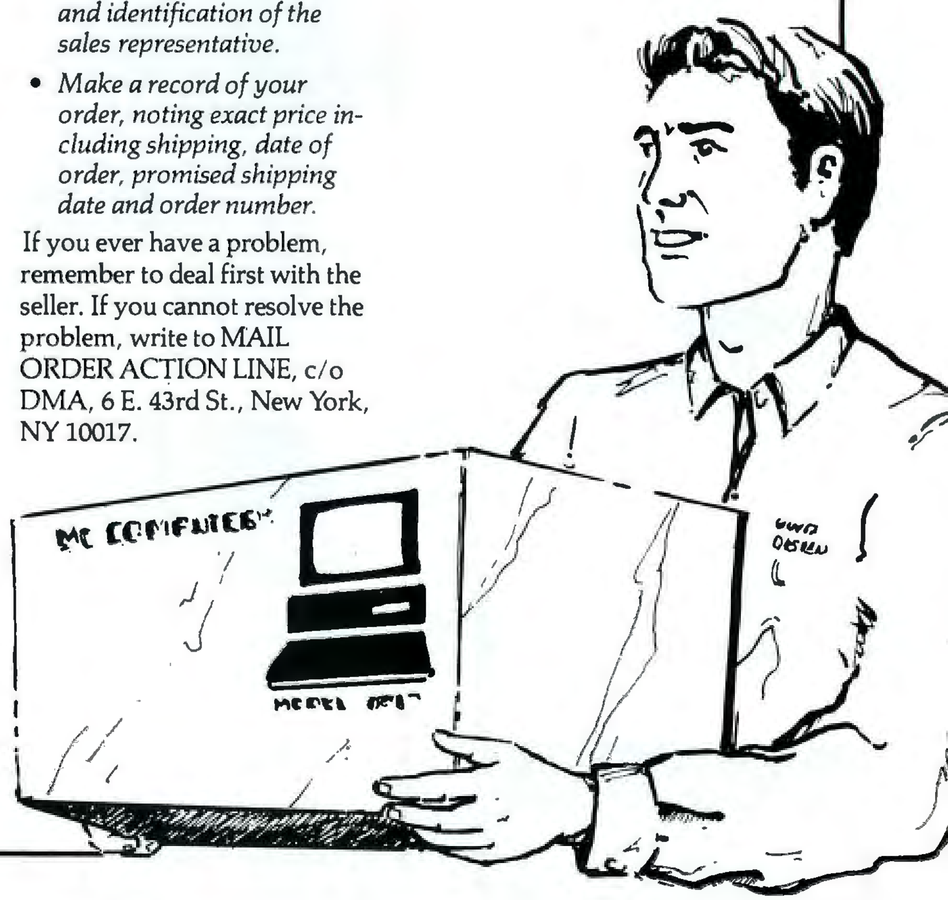

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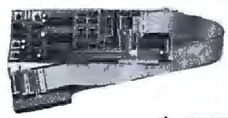

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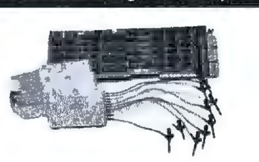

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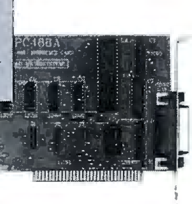

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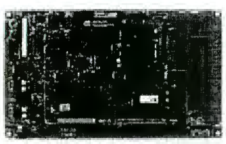

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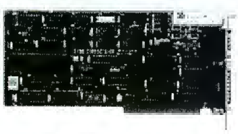

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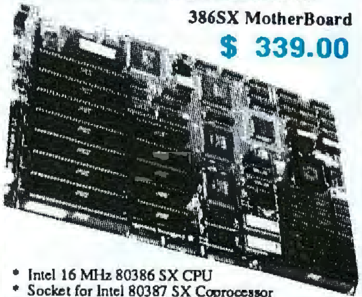

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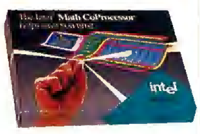

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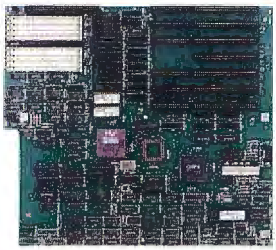

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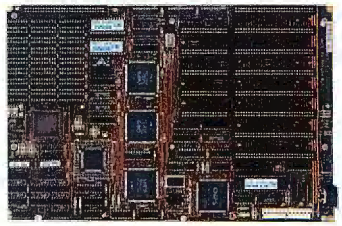

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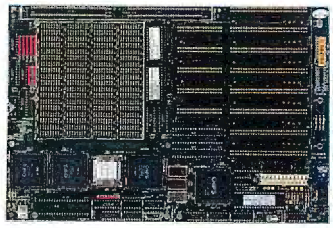

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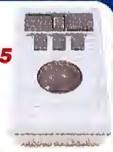

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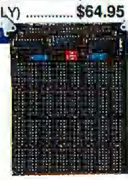

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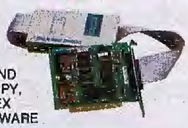

• PROGRAMS 27XX AND 27XXX EPROMS UP TO 27512 • SPLIT OR COMBINE CONTENTS OF SEVERAL DIFFERENT SIZED EPROMS (VARIOUS FORMATS AND VOLTAGES) • READ, WRITE, COPY, BLANK CHECK AND VERIFY • HEX AND INTEL HEX FORMATS SOFTWARE

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DATARASE II EPROM ERASER $39.95

• SMALL SIZE! • ERASES ALL SIZE EPROMS UP TO 4 AT A TIME-- MOST IN 3 MINUTES
• WALL PLUG POWER SUPPLY

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MODULAR PROGRAMMING SYSTEM

EACH MODULE IN THIS SYSTEM USES A COMMON HOST ADAPTOR CARD, SO YOU CAN USE JUST ONE SLOT TO PROGRAM EPROMS, PROMS, PALS & MORE!

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• SELECTABLE ADDRESSES PREVENTS CONFLICTS
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• PROGRAMS EPROMS, EEPROMS, PALS, BI-POLAR PROMS, 8748 & 8751 SERIES DEVICES: 16V8 AND 20V8 GALS (GENER-IC ARRAY LOGIC) FROM LATTICE, NS, SGS • TESTS TTL, CMOS, DYNAMIC & STATIC RAMS
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MOD-MEP-8 8-EPROM PROGRAMMER $259.95
MOD-MEP-16 16-EPROM PROGRAMMER $499.95

PAL MODULE $249.95

• PROGRAMS MMI, NS, TI 20 & TI 24 PIN DEVICES • BLANK CHECK, PROGRAM, AUTO, READ MASTER, VERIFTY & SECUR-ITY FUSE BLOW

MOD-MPL

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Index of companies covered in articles, columns, or news stories in this issue
Each reference is to the first page of the article or section in which the company name appears

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Overseas Corp.
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Kasumigaseki Bldg.
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Chiyoda-Ku
Tokyo 100, Japan
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503 Wilson House
19-27 Wyndham St.
Central, Hong Kong
Tel: 5-260149
Telex: 60904 SEVEX HX
FAX: 852 810 1283

SINGAPORE
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400 Orchard Road, #10-01
Singapore 0923
Republic of Singapore
Tel: 734-9790
Telex: RS35539 SEAVEX
FAX: 65 732 5129

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Empresa Internacional de
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Rua da Consolacao, 222
Conjunto 103
01302 Sao Paulo, S.P., Brasil

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Index to Advertisers by Product Category

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REQUEST FREE INFORMATION BY FAX

Attention BYTE Readers!! Now you can fax your requests for free product and advertiser information featured in this issue.

Just fax this page to 1-413-637-4343. You'll save time because your request for information will be processed as soon as your fax is received.

1 Circle the numbers below which correspond to the numbers assigned to advertisers and products that interest you.

2 Check off the answers to questions "A" through "C".

3 Print your name, address, and fax number clearly on the form.

4 Remove this page or copy this page clearly and fax it to the number above.

Fill out this coupon carefully. PLEASE PRINT.

Name ______________________

Title ______________________

Company ______________________

Address ______________________

City ______________________

State/Province ______________ Zip ______

Country ______________________

(_____)______________ Phone Number (_____)______________ Fax Number

A. What is your level of management responsibility?

1 ☐ Senior-level Management
2 ☐ Other Management
3 ☐ Non-Management

B. What is your primary job function/principal area of responsibility? (Check one.)

4 ☐ Administration
5 ☐ Accounting/Finance
6 ☐ MIS/DP/Information Center
7 ☐ Product Design and Development
8 ☐ Research and Development
9 ☐ Manufacturing
10 ☐ Sales/Marketing
11 ☐ Purchasing
12 ☐ Personnel
13 ☐ Education/Training
14 ☐ Other: ______________

C. Please indicate your organization's primary business activity: (Check one.)

Computer-Related Businesses:

15 ☐ Manufacturer (Hardware, Software)
16 ☐ Computer Retail Stores
17 ☐ Consultants
18 ☐ Service Bureau/Planning
19 ☐ Distributor/Wholesaler
20 ☐ Systems House/Integrator/VAR
21 ☐ Other: ______________

Non-Computer-Related Businesses:

22 ☐ Manufacturing
23 ☐ Finance, Insurance, Real Estate
24 ☐ Retail/Wholesale
25 ☐ Education
26 ☐ Government
27 ☐ Military
28 ☐ Professions (Law, Medicine, Engineering, Architecture)
29 ☐ Consulting
30 ☐ Other Business Services
31 ☐ Transportation, Communications, Utilities
32 ☐ Other: ______________

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☐ *Please send me one year of BYTE Magazine for $24.95 and bill me. Offer valid in U.S. and possessions only.*

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2 Check all the appropriate answers to questions "A" through "C".

3 Print your name and address and mail.

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Title ______________ Phone (____) ______________

Company ______________________________

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City ______________ State ______ Zip ______

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1 ☐ Senior-level Management
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3 ☐ Non-Management

B. What is your primary job function/principal area of responsibility? (Check one.)
4 ☐ Administration
5 ☐ Accounting/Finance
6 ☐ MIS/DP/Information Center
7 ☐ Product Design and Development
8 ☐ Research and Development
9 ☐ Manufacturing
10 ☐ Sales/Marketing
11 ☐ Purchasing
12 ☐ Personnel
13 ☐ Education/Training
14 ☐ Other: ______________

C. Please indicate your organization's primary business activity: (Check one.)

Computer-Related Businesses:
15 ☐ Manufacturer (Hardware, Software)
16 ☐ Computer Retail Stores
17 ☐ Consultants
18 ☐ Service Bureau/Planning
19 ☐ Distributor/Wholesaler
20 ☐ Systems House/ Integrator/VAR
21 ☐ Other: ______________

Non-Computer-Related Businesses:
22 ☐ Manufacturing
23 ☐ Finance, Insurance, Real Estate
24 ☐ Retail/Wholesale
25 ☐ Education
26 ☐ Government
27 ☐ Military
28 ☐ Professions (Law, Medicine, Engineering, Architecture)
29 ☐ Consulting
30 ☐ Other Business Services
31 ☐ Transportation, Communications, Utilities
32 ☐ Other: ______________

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Jerry Pournelle answers questions about his column and related computer topics

High-Priced Floppy Disks

Dear Jerry,

As a user of 3½-inch high-density disks, I am frustrated by the monumental prices charged for them. I fail to understand how these disks can cost two to three times as much as the 3½-inch standard-density disks when the only apparent difference is the magnetic media.

To make matters even worse, recent ads for a glorified hole punch—which converts standard disks to high-density disks—seem to indicate that there is no difference in the two media at all. What gives? Are we being bilked?

I used to shake my finger at people who lost data because they didn't back up their data frequently. At $100 per backup, all I can say is, "I know how you feel."

Roy Anderson

I get conflicting stories about those disks, but I have concluded the following:

At least with all the major media makers (e.g., Sony and Dysan), all the disk media is made by the same process and in the same factories. The product is then tested. Some disks fail when tested as high-density, although most don't. The ones that don't fail are marked high-density and put in containers with the high-density hole punched in them. This process continues until there are sufficient high-density disks to fill the marketing demand for them.

The rest of the disks are then subjected to less stringent tests—as double-sided double-density disks, for example—and those that pass are packaged accordingly until the market demand for them is met. This goes on until all the demands, including those for single-sided single-density disks, have been met.

Note what has happened: It may be that no disk ever failed any test. On the other hand, some have not been tested at any data density higher than that marked on the package. Moreover, depending on yields and demands, some disks may in fact have failed a higher-density test, and some disks sold as single-sided may have failed a double-sided test.

I have no data on what defects can cause a disk to fail in one mode but not in another (other than the obvious: one side may be flawed). If there are statistics on this, the disk companies are not publishing them.

Conclusion: You take a chance when you buy one of those hole punches and make a high-density disk out of a standard double-sided double-density disk. I cannot calculate how dangerous that is. I don't do it, and I don't recommend that you do. The best I can accomplish in buying cheap disks is to save a couple of hundred dollars. The worst that can happen is to lose data worth—in my case, at least—a lot more than that.

A last warning: Some disks have not been very highly burnished, and thus they have rougher media than others. It's certainly true that such disks can cause extra head wear or deposit bits of the media on the disk head, thus requiring more frequent head cleaning. For all those reasons, I buy quality premium disks; the brand I prefer is Dysan, largely because I've been using their disks since 1976 and I've had no reason to change. I don't doubt that there are other premium disks as good.—Jerry

Nota Bene, Pro and Con

Dear Jerry,

In your reply to Joseph M. Prospero's letter (February 1989), you mentioned having recommended Nota Bene to "a young person writing a dissertation."

I believe I am that person. I'm writing to let you know that the dissertation is finished and that Nota Bene worked like a dream. In fact, I wouldn't have finished without it. The program requires too much memory (which is in short supply because I wrote chapters that were as long as 275K bytes), but it's worth every byte. I used Nota Bene's Special Language Supplement to enter diacritical marks for romanized Japanese and Sanskrit (e.g., Ōkubo Dōshū, Ākāśagarbha, and maṇḍala). Can you imagine trying to write these in by hand (accurately!) in a 500-page manuscript?

The most wonderful thing about Nota Bene, however, is its speed and ease of use. It really is a dream marriage of simplicity and versatility. This is one program whose advanced features get used because they are easy to use.

William Bodiford
Tarzana, CA

I think 275K-byte chapters are self-defeating, but then I'm not on your degree committee. I am glad that everything worked out well for you.—Jerry

Dear Jerry,

I read with interest the letter from Joseph M. Prospero, recommending that you move up to Nota Bene instead of considering XyWrite III Plus. I think Nota Bene may well be the software marketing bomb of the decade.

As Prospero says, Nota Bene is a customized version of XyWrite. Unfortunately, it has been "customized" in such a way that, from the user's point of view, it functions as a totally different word processor. I work in a university, and my job is to edit academic texts. For this we use XyWrite, which is compatible with the Atex system used to publish the texts. Some academic departments bought Nota Bene because they need its additional features, such as Hebrew and Greek. That's how I got to try Nota Bene and compare it to XyWrite. I thought it would be easy—because the programs are fundamentally the same, it should be possible to use both, XyWrite for the straightforward jobs and Nota Bene for the specialized ones. But to use Nota Bene would require almost as much retraining as changing to Microsoft Word, WordPerfect, or one of the other word processing programs.

Both XyWrite and Nota Bene have far more logical command structures than WordPerfect, but XyWrite uses the Alt key for word functions, while Nota Bene uses the Control key for word functions and the Alt key for paragraph functions. In XyWrite, F9 is the Execute key, while in Nota Bene it is F10, and so it goes on.

Why did the companies do this? The

continued

only reason I can think of is that either XyQuest insisted on it, or Dragonfly got the idea of doing it so it wouldn't be competing for the same territory. Whatever the reason, it is a great pity that they did it. XyQuest and Dragonfly had a winning combination, and with it they could have swept the academic and publishing worlds at least. Instead, they've painted themselves into a corner. People will continue to buy WordPerfect, with its difficult user interface, because one difficult interface is probably easier to learn than two easy but incompatible ones.

Steve Hayes
Pretoria, South Africa

Well, people tend either to love or hate Nota Bene, which, now that you remind me, is the case with XyWrite, too.—Jerry

Update Syndrome

Dear Jerry,

I just finished reading your column in the July 1989 BYTE, and it led me to the following thoughts about the relationship between software updates and those people who are afflicted by them.

There are very few updates that I look forward to. The only one that comes immediately to my mind is my annual notice from SoftView that the new version of MacInTax is ready. Of course, SoftView knows that updates are at the heart of its business, so they do them right.

Some update notices appear determined to make me feel technically archaic. I've received update notices for MacDraw and MacProject telling me that I need a Mac Plus to run them. I called Claris and told them that I have a 512KE with a memory upgrade. "Sorry," they said, "you need to have the Plus." Well, the demo packages that my clients let me try work fine on my old system. Maybe Claris just wants to hold down the number of upgrades.

Upgrades can provide wonderful hardware restrictions to accompany wonderful software features. When I received an upgrade to FileMaker, it refused to run on my Mac. I called the company, and the person I spoke with told me that the problem was that I didn't have a SCSI port on my system. "But your announcement said that it would run on a floppy disk drive-only system," I said. A few days later, a special version of the program arrived that didn't check for the SCSI.

Update announcements don't tell you what you need to know. Last week I got a notice that I could upgrade to Borland's Reflex 2.0 at a very attractive price. As a registered user of Reflex for the Mac, I thought it was strange that the order card offered the choice of a 3½-inch or 5¼-inch disk. There was nothing in six pages of update advertising that described the hardware needed to run it.

I can't figure out who these updates are for. In only one case (a little utility called KiwiEnvelopes) has a company written to me asking about how I use its software and what sorts of things I might like to see in an improved version. Do other companies try to find out what their users are actually doing, or do they just check the features in their competitor's press releases?

I'm being held hostage by my software. I've just moved up to version 4 of Microsoft Word for the Mac. It doesn't give me any major benefit over version 3.02 for the things I do, but I can't shake the feeling that if I call up next January with a problem I'm having with 3.02, I'll find out that support is available for version 4 only.

Most updates don't make the good stuff better. Where are the improvements to the things that made me buy the program in the first place? There's always plenty of "new" stuff, and I'm sure that there are people to whom it's very important. I'm not one of them. The new "table" feature in Word looks neat, but an improved spelling checker would be more useful.

On another subject, I've looked at the announcements and reviews for the Sinclair, and I'm still having difficulty seeing the degree to which it's an improvement over my old Tandy 102, particularly with the Traveling Software ROM. Does it all come down to the quieter keyboard?

John Boddie
Newark, DE

I agree completely with your update blues. As for the Sinclair, it runs a long time on not much power, and it's a lot lighter than the Tandy. And quieter keys really do make a difference.—Jerry ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. He can be reached c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "jerryp."

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PRINT QUEUE

Hugh Kenner

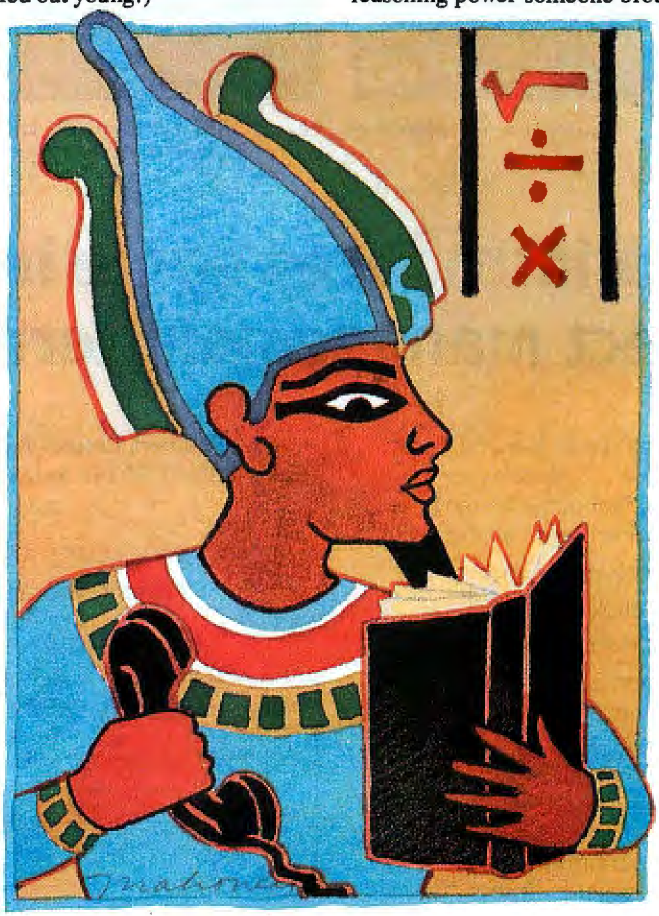
Does the Walking Do the Fingers?

How the great mathematicians did it, and how the telephone does it to us

Over and over, in the 53 years since Lancelot Hogben's book *Mathematics for the Million* made a stir by selling and selling for months on end, the expositor's formula of choice has been historical. Start way back when it all began, with the Egyptians and their knotted ropes. Then tell lots of stories. That's all fine until the stories start obstructing the foreground.

In his *Men of Mathematics* (1937), E. T. Bell solicits our tears over Évariste Galois, age 20, scribbling by candlelight all night before a fatal duel, but he never does try to make us see why the scribblings matter. (Worse, it now turns out that the famous last night is almost all fiction. Galois didn't invent group theory against the clock. He did write a few letters. The story had gotten romanticized before Bell; then Bell's inability to read the French sources abetted his ideologized desire to create a tormented radical snuffed out young.)

William Dunham's *Journey Through Genius: The Great Theorems of Mathematics* (1990, John Wiley, New York, $19.95) is a different kind of book entirely, and it's heartening in these days when the paradigmatic oracle is Dan Rather to find it an alternate selection of the Book of the Month Club, the Quality Paperback Book Club, the Macmillan Library of Science, the Reader's Subscription Book Club, and the NEA Professional Library. Not that Dunham eschews stories; but he also assumes that we may want to understand something: that we'll not be put off, even, by a page or two of x's and square brackets and superscripts.



It's, yes, a book about people, 10 great mathematicians, ordered in sequence: Hippocrates, Euclid, Archimedes, Heron, Cardano, Newton, two Bernoullis, Euler, Cantor. But. . . well, if you wanted us to understand why Alexandre Dumaine was the greatest French chef of the twentieth century, then you'd serve us a meal of Dumaine's, which is now impossible; whereas Dunham can serve us a theorem of Heron's (aka "Hero of Alexandria"), who achieved the general formula for a triangle's area although fettered by impossibly primitive notation. Heron called on five prior propositions, three of them Euclid's, and achieved "one of the best surprise endings in mathematics." For, "as with a good Agatha Christie novel, we can be within a few lines of the end and still have no idea how the matter will be resolved. Yet we need not fear, for he ultimately brings the strands together in a wonderful climax."

A man who sets an exposition up like that may possibly be setting himself up for a pratfall. Dunham, though, doesn't falter. Again and again, on that pattern, he leads us through the preliminaries to a proof, through the proof itself, and then—rightly—invites us to marvel. Always, his attention is on the reasoning power someone brought to bear with the then-available tools.

With the then-available tools. That means, there's an unwavering historical focus. So we're shown Euclid working toward a proof of the Pythagorean theorem—which is the climax of book I of the *Elements*—via necessarily sequenced propositions. The result—square on the hypotenuse, you know it—"was well known before Euclid's day." But Euclid wanted a proof he could make with "a rather lean tool-kit"—his postulates, "common notions," and a mere 46 already-proven propositions.

"It is surely possible to devise short proofs of the Pythagorean theorem by using similar triangles," but those won't come up till book VI, and Euclid clearly wanted to get to it "as early and directly as possible." Also, having no algebra—$a^2 + b^2 = c^2$—he had to work with plain drawings. His great proof, out of context, has been made to seem clumsy. But by the time Dunham has put in place all

continued

ILLUSTRATION: KATHERINE MAHONEY © 1990

those easily forgotten restrictions, the only response that fits his climactic exposition is awe.

He's equally good on Newton, at age 23, inventing the binomial theorem, in free time he had while Cambridge was shut down by plague; then five years later using it to evaluate pi. From a mere nine-term series, he got seven correct decimal digits; later, from 20 terms, he got 16. ("I am ashamed to tell you," he added, "to how many places of figures I carried these computations, having no other business at the time.")

What Avital Ronell would have us understand is the world a century with the telephone has lodged us in.

The anecdotal details have been reported often. What I can't display in this space is something else, the way William Dunham illuminates the inner workings of the pi theorem itself. That's a rare compliment he's paying his lay readers.

Lay readers will (I hope) also open Avital Ronell's *The Telephone Book*, if only to go "Arrrrgh!" before sticking around to be hooked. (*The Telephone Book: Technology, Schizophrenia, Electric Speech*, 1990, University of Nebraska Press, Lincoln, $35.) An ongoing, if tacit, theme of *Journey Through Genius* is the difference a mental environment can make; base-10 numbers with zero for placeholder created a mind-set unimaginable to Euclid and Archimedes. Euler, writing *x*'s and *y*'s, extracting roots, may never have reflected on the extent to which he and his greatest predecessors lived in utterly different worlds.

What Avital Ronell would have us understand is the world a century with the telephone has lodged us in. The blurb says she worked with "an advanced form of optical fiber," and it takes a moment to realize the meaning of that: She just *looked*, mostly at texts.

From the primal soup on her first pages, we can pick out one-liners like "The telephone...presupposes the existence of another telephone, somewhere" and "America operates according to the logic of interruption and emergency calling." Also, when you answer the phone, you accept the role of "automatic answering machine." (Dammit, the phone just rang, and my hand reached. Is Ms. Ronell on to something? What? Well, nothing ever prodded Newton's hand to just reach, his mind to regress into answer mode.)

A son of mine helps edit a magazine in New York. As a frequent contributor, I've frequent need to call him. With every call, I'm aware of interrupting something. I've grown aware, too, how that's become the rhythm of his psyche: mental work between random interruptions. His next caller may be a lawyer in Newark, a flack in Soho. In the interstices, he crafts his resourceful prose. The phone is simply part of his environment, like his desk lamp. I myself, having never reached a truce with it, am happiest when my wife screens the calls.

For let me declare two biases. Having lost much of my hearing at age 5, I'm more estranged from the telephone than are most of you. Also, for a number of years, from age 26, I was intimate with Marshall McLuhan, later (after I'd lost touch with him) the media guru. So I came at *The Telephone Book* from a special angle.

It has black covers, it's twice as tall (10 inches) as it's wide, and it sports real Yellow Pages, devoted to Notes and Index. Here and there, type on a line gets bigger and smaller, even gets illegible (simulating line noise?), and folk that Marshall would have called "linear thinkers" will run away screaming. Moreover, its target reader will be up on Heidegger, Derrida, Freud, deconstruction, and arguments that pivot on puns; also deft at fielding German and French citations.

Just paging through the first half tried my patience. Then at page 227 my attention locked. For Mr. Thomas J. Watson—no, not IBM's fabled Old Man, but the "Come here! I want you!" Watson of the Bell story—left us a nearly unknown autobiography, where we learn of a queer time (1875) when the world contained but two telephones and no telephone system.

The Thing had begun life as a pure idea: "speech-shaped electric current," something any competent electrician (unlike A. G. Bell) knew was impossible. And once they'd made it, what *was* it? So little did it meet a felt need, it stirred up fear, contempt, blushes. "When a prominent lawyer tried it," and "heard my voice on the telephone making some simple remark, he could only answer after a long embarrassed pause, 'Rig a jig, and away we go.'"

Bell and Watson thought of it as an obstreperous child with a will of its own. Disadvantaged Thing, "it talked better nights and Sundays," when "the diminution of city sounds gave the telephone a much better chance to be heard." Notice that trope: Like E.T., the wee newcomer is trying to make itself heard. Tom Watson was a dabbler in the occult, and getting the child to talk sense could resemble a séance. (One time, without Bell's knowledge, he even consulted a medium. No dice.)

Word of it attracted people who "heard voices"—schizophrenics. One visitor knew how to talk at *any* distance without a wire. He did it all the time; even offered (for 15 dollars a week) to let Watson take off the top of his skull and check circuitry.

And the first long-distance call, Boston to East Cambridge, amounted to "Ahoy! Ahoy!" "Are you there?" "Do you hear me?" "What's the matter?" Watson found random noise more interesting: "I used to spend hours at night in the laboratory listening to the many strange noises in the telephone and speculating as to their cause." There were snaps and chirps that he attributed to "explosions on the sun" or "signals from another planet." He may have been, as Ms. Ronell remarks, "the first convinced person ever actually *to listen to noise*."

Gone days. Now we casually pick up The Thing, or move binary data with its aid, or dial to order matinee tickets on a charge card. What I'm recommending of *The Telephone Book* is just (in samplings) the second half. I know I'll be going through that second half again, to seek more nuances in The Thing's initial strangeness. For ponder, "Are you there?" Where's there? There's nobody there. That voice isn't in the room, it's in your head: a statement that, prior to 1875, was never applicable to a voice, unless you were a schizophrenic. ■

Hugh Kenner is a professor of English at Johns Hopkins University. His reviews have appeared in publications like the New York Times *and* Harper's. *His recent books include* A Sinking Island *and* Mazes. *He can be contacted on BIX as "hkenner."*

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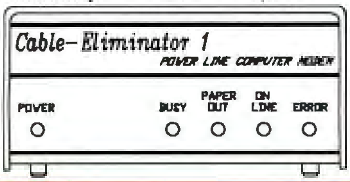

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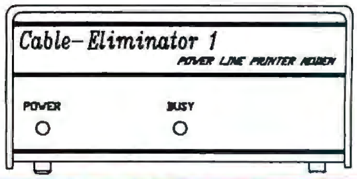

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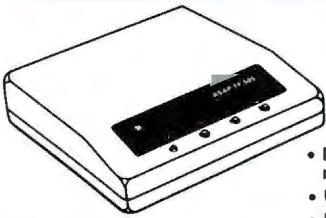

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- Programmable security codes for auxiliary device and fax
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- Use with or without answering machine
- Prohibits line access, with busy signal to extensions, while fax or PC is in use
- Normal phone use is not inhibited
- No switches to turn on or off
- Automatic ring through to phones if power fails
- Memory retention if power fails
- Automatic reset after power surges
- Always on line to accept switching commands

How The ASAP TF 505 Works

When the TF 505 is connected to your telephone line, it will answer each incoming call on the first ring listening for an incoming fax signal (beep tones) transmitted by most fax machines. If the "beep tones" are heard, the call is immediately transferred to your fax without ringing your phone. All other calls, including fax calls without "beep tones" will ring through to your phone(s). These calls can also be transferred to your fax from any extension phone.

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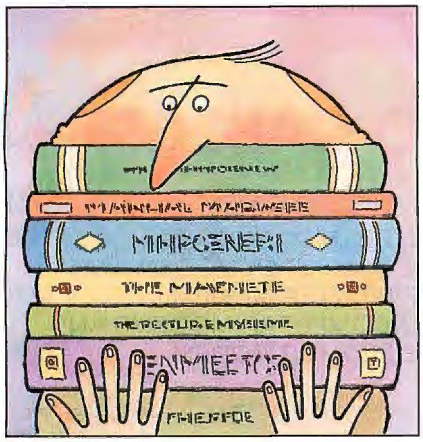

SETTING THE STANDARDS 15 YEARS

RETURN OF THE COLOSSAL CODE

Sherman, set the wayback machine for 1975

Back in my old data-processing days—just as the flame was being held to the fuse of the microcomputer explosion—I worked for a Memphis company that specialized in accounting and record-keeping packages for radio and TV stations. I was tucked into a two-man office with a fellow named Chuck, who had already been working there for some months. The nameplate on Chuck's desk didn't carry his name; instead, it read: "I'm so confused." At first, I thought this was just a joke.

Then I began trying to do some programming for the company. These people used walls of Data General minicomputers and big, washing-machine-size hard disk drives. I discovered that all work was done in assembly language buttressed by gigantic macro routines, each of which carried on for several lines—sometimes pages. Deciphering each routine's function was often impossible. Worse, as I dug deeper into what source code I could find, the number of routines proliferated exponentially. It took me days just to get a program to say "Hello, world" on my terminal.

Chuck came to my rescue. He had gone through the same learning shock that I was in the middle of, and he had put together a catalog of all the macro routines and what they did. "Don't worry," he said, "I've already made a dictionary of all that. Here." My desk thundered as he dropped the foot-thick homemade manual in front of me. Don't worry? Geez, I thought, is there a concordance for this thing? I'll be buried for weeks just looking for the table of contents!

Years later, I'm in my office at BYTE when one of the editors walks in carrying his proud new bundle: a back-cracking box of disks and manuals. My desk thunders as he drops it in front of me. It is a C compiler. Not a whole operating system or an illustrated encyclopedia, just a C compiler. Remember C—the language that Kernighan and Ritchie described in that thin white book with the pale blue capital *C* on the front cover? This monster on my desk is so big that the software company can't ship it on 360K-byte floppy disks anymore; they'd need about 30 disks if they tried. They use 1.2-megabyte floppy disks.

The sight of such a huge box for a C compiler makes me dizzy. I still have my old copy of the first CP/M manual that I ever purchased. Some issues of BYTE are thicker. Yet I got plenty done with CP/M: I wrote programs, edited files, deleted files, and did some word processing. I could cope with it.

Two shelves up from that old CP/M manual is a whole shelf of red AT&T Unix manuals. I have two Unix machines that I use frequently: I write programs and edit and delete files, and I even once tried to do some word processing. The kinds of things that I do in Unix are not substantially different from the kinds of things I did in CP/M. Yet there's all this extra *stuff* I have to figure out—starting friction, I suppose—just to get some work done.

Before it begins to look like I've singled out Unix, I'll mention the time when a representative from Microsoft demonstrated the benefits of OS/2 Presentation Manager's on-line manual. It was a ride through screenfuls of functions, functions, and more functions, and it left me feeling like I'd just had my turn on Space Mountain. What amazed me the most wasn't just the amount of source code you needed to print "Hello, world" in a window; it was everything you had to know *before* you could even begin to write a "Hello, world" program.

Don't get me wrong; I understand that complex jobs require complex tools. A CP/M machine certainly wouldn't do well as a network server. But I wonder sometimes if we're not injecting complexity where it isn't needed. Manipulating the computer becomes more involved than the actual work we need to do to complete whatever job we're tackling. Remember those early programs of the cassette-driven Apples, VICs, and TRS-80s? Remember how you were going to throw out your index cards and keep your family's dinner recipes on the computer?

I see similar things happening today. I see people using pop-up TSR programs for phone lists and appointment logs—spending hours tweaking this and that to get the format just right for the morning printout—when a Rolodex and a desk calendar would probably do just as well. I once spent three days with a project system, printing out Gantt charts and flow diagrams for every staff member in the BYTE Lab for the next two months. A week later I sat down with some notebook paper and a pen and did much the same thing in about 10 minutes. (I'll admit that I messed up a few times and had to cross stuff out, but I'll redraw everything when I get a free moment.)

I have this nightmare. We're all up on the crest, riding the wave of new microcomputer technology. But then the wave washes us up on a beach. And there stand all the minicomputer and mainframe guys with thick COBOL manuals and piles of source code listings. They look down at us and say: "Where've you been? We've been waiting for you." ■

Stop Bit is an open forum for informed opinion on topics related to personal computing. The opinions expressed are those of the author and not necessarily those of BYTE or its staff. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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