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BYTE

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Lotus 1-2-3 Release 2.3 runs smoothly and quickly no matter what hardware you're running it on.

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WHAT'S NEW IN LOTUS 1-2-3 RELEASE 2.3.

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- Dialog Boxes for an easier, more interactive way of working
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- The Auditor for documenting or highlighting your spreadsheet logic
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us 1-2-3 Release 2.3

that simplifies the job of documenting and analyzing worksheet logic.

Of course, you won't just like what Release 2.3 does. You'll like how it feels. It's quick and smooth. With a WYSIWYG (what-you-see-is-what-you-get) graphical environment that lets you format text, data, and graphics "live" on screen. With the mouse, you can execute commands, highlight cells or ranges, open dialog boxes, place and size graphs, change type styles, fonts and point sizes. All with unparalleled speed and ease.

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Along with 96 type style combinations, drop shadows, new 3D-effect graphs, drawing and annotation tools, and the most font support, choices of colors and shading available.

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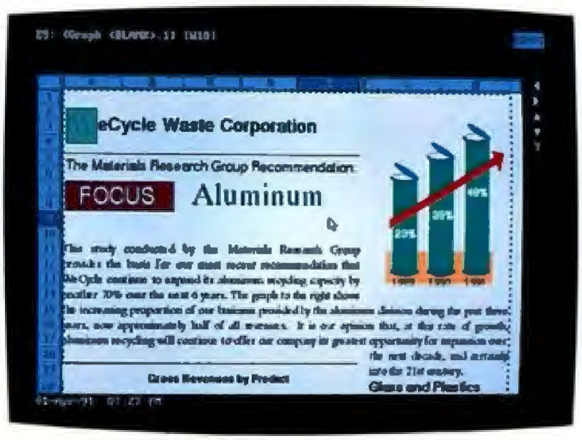
To order your upgrade direct from Lotus* call **1-800-TRADE-UP, EXT. 1231.** Or see your Lotus Authorized Reseller.



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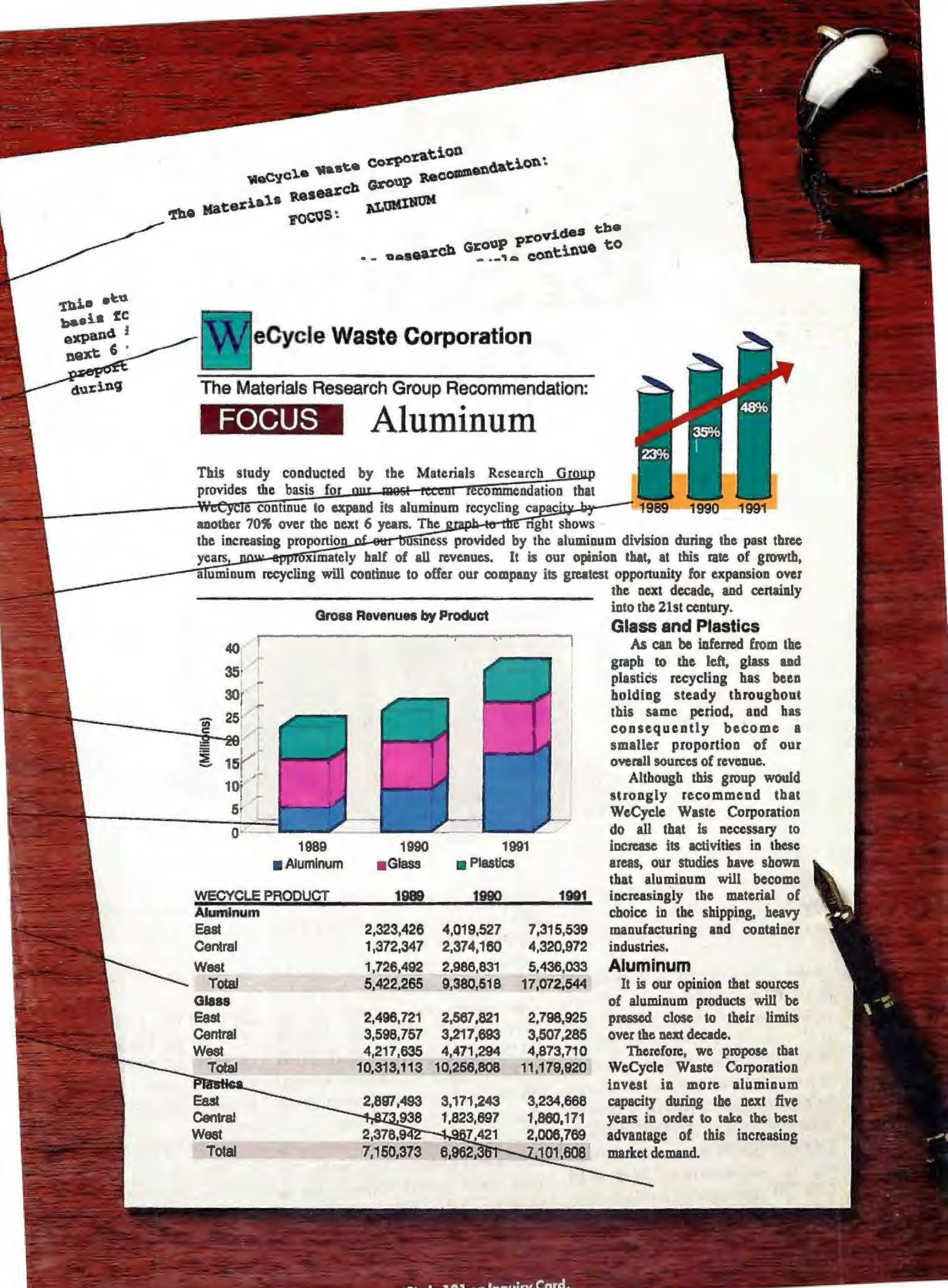

W eCycle Waste Corporation

The Materials Research Group Recommendation:

FOCUS Aluminum

This study conducted by the Materials Research Group provides the basis for our most recent recommendation that WeCycle continue to expand its aluminum recycling capacity by another 70% over the next 6 years. The graph to the right shows the increasing proportion of our business provided by the aluminum division during the past three years, now approximately half of all revenues. It is our opinion that, at this rate of growth, aluminum recycling will continue to offer our company its greatest opportunity for expansion over the next decade, and certainly into the 21st century.

WECYCLE PRODUCT	1989	1990	1991
Aluminum			
East	2,323,426	4,019,527	7,315,539
Central	1,372,347	2,374,160	4,320,972
West	1,726,492	2,986,831	5,436,033
Total	5,422,265	9,380,518	17,072,544
Glass			
East	2,496,721	2,567,821	2,798,925
Central	3,598,757	3,217,693	3,507,285
West	4,217,635	4,471,294	4,873,710
Total	10,313,113	10,256,808	11,179,920
Plastics			
East	2,897,493	3,171,243	3,234,668
Central	1,873,938	1,823,697	1,860,171
West	2,378,942	1,967,421	2,006,769
Total	7,150,373	6,962,361	7,101,608

Glass and Plastics

As can be inferred from the graph to the left, glass and plastics recycling has been holding steady throughout this same period, and has consequently become a smaller proportion of our overall sources of revenue.

Although this group would strongly recommend that WeCycle Waste Corporation do all that is necessary to increase its activities in these areas, our studies have shown that aluminum will become increasingly the material of choice in the shipping, heavy manufacturing and container industries.

Aluminum

It is our opinion that sources of aluminum products will be pressed close to their limits over the next decade.

Therefore, we propose that WeCycle Waste Corporation invest in more aluminum capacity during the next five years in order to take the best advantage of this increasing market demand.

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Computer Reseller News Editors' Choice

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Model	POWERPRO VM 386/33	SYSTEMPRO™ 386/33	Premium™ 386/33TE
CPU	33-MHz i386	33-MHz i386	33-MHz i386
BUS Architecture	EISA	EISA	EISA
RAM Standard	5-MB	4-MB	4-MB
Floppy Standard	1.2-MB	1.44-MB	1.2-MB
Total Slots	12	11	10
Starting List Price	$4995	$11,999*	$6495
Upgrade Path	20-MHz i486SX 25-MHz i486 33-MHz i486 Dual Processing 33-MHz i486	Dual Processing 33-MHz i486 *includes 240-MB Hard Drive and VGA controller	25-MHz i486 33-MHz i486

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BYTE

August 1991 *Volume 16, Number 8*

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INSIDE BYTE

REGIONAL SECTION begins after page 72

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INSIDE BYTE

BYTE Topic Index and Author Guide

This index helps you find articles that contain information on each of the listed topics. (The topic list changes each month.) Combined with the table of contents (page 4) and the Editorial Index by Company (page 322), you can identify articles by type, subject, title, author, or product discussed.

THE RIGHT DECISION
February 18, 1991
PC WEEK \ REVIEWS
Page 92
PC WEEK LABS
PRODUCT REVIEW
Tri-Star Leads 33MHz 486 PC Pack
Eight Low-Cost Systems Perform Well; Video and Hard-Disk Components Va
By David Claiborne
"Tri-Star is king of the 33MHz 486 Mountain."
PC WEEK
Analyst's Choice, February 18,1991
Tri-Star Computer continues to outdistance the pack as America's prefered supplier of high-end 486 Workstations. Read the reviews and you will understand why Tri-Star is the undisputed 486 champ.
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PC Magazine
Editor's Choice Honorable Mention, September 11, 1990
"Tri-Star's edge is its good documentation and excellent service policy."
PC Sources
486/33 Lead Review, February 1991
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DOS computer Macintosh.

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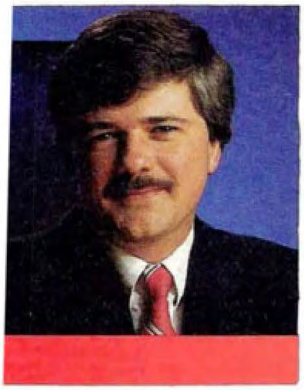

FRED LANGA

EDITORIAL

Moscow's Second Annual Computer Forum

The Soviet computer industry has matured enormously in the last 12 months

I am writing this on a laptop in the terminal at Frankfurt, Germany. I've just gotten off a flight from Moscow, and I have several hours before my flight to Boston departs. I was in Moscow to attend and speak at the second annual International Computer Forum, one of a growing number of computer trade shows in the Soviet Union.

Last year's trip to Moscow—my first—was an eye-opening experience (see my October 1990 Editorial). I came away convinced that the Soviet Union has enough superlative programming talent and training to be a world leader. The impediments to the computer industry's success in the world market have nothing to do with intrinsic abilities or interests, but have everything to do with the now-well-known economic and political problems of the Soviet Union.

Despite these problems, positive changes are afoot: Soviet citizens can now tune in commercial TV and radio channels, and they can read any of a large and rapidly growing number of privately owned, independent magazines and newspapers. Private shops have sprung up around Moscow, selling American cigarettes, Asian tape recorders, and Western clothing.

The Soviet computer industry has made remarkable progress in the past year. Last year, the most impressive Soviet-made hardware included a few XT clones and several 8-bit data acquisition boards. This year, the show's most impressive hardware was the 68030 based Besta workstation, made by Oversun. Oversun (get it?) is a joint venture of the Soviet Academy of Sciences and the company that makes Zil limousines.

Made in Moscow using surface-mount technology, the Besta is a credible, affordable Unix System V release 4.0 box: a 68030 or (68020) operating at 33 MHz (or 25 MHz), with an FPU, up to 128 megabytes of RAM, up to a 1.6-gigabyte hard disk drive, nine I/O ports, Ethernet and SCSI controllers, a VME-standard bus, 1280- by 1024-pixel noninterlaced graphics with 2 MB of video RAM—the specs go on for pages, and they are world-class. What a difference a year makes.

On the software front, Stepan Pachikov, the peripatetic CEO of Paragraph—quite possibly the premier software company in the Soviet Union—briefed me on Paragraph's recent advances. It has made a name for itself with "Cyrillization" programs that convert Western software into Russian; Paragraph now sells Russian Word, a Cyrillic version of Microsoft Word, under license from Microsoft. Several laser printer manufacturers and word processor vendors are also interested in Paragraph's extensive library of Cyrillic fonts.

The company has also made a name for itself in script recognition—reading normal, unbroken, fluid handwriting—and in advanced applications of more standard character recognition. For example, it's likely that Paragraph's pen-input software will be incorporated into one or possibly two new laptops within the next year. And one of the world's leading makers of fax boards is negotiating to acquire Paragraph's proven technology for converting even muddy, low-quality fax messages into clean, correct ASCII.

Other interesting items at the Forum included an "intelligent spelling and grammar checker for Russian"; a sound card and speech-synthesis software that can teach you to speak Russian; expert-system development tools; a way of producing color scanned images with a black-and-white scanner using color filters and "color synthesizing software"; myriad data acquisition products; specialized and general text editors; tutorial generators/software demonstrators; antiviral/data integrity software; E-mail gateways (to the West); and more. Some of these products are available outside the Soviet Union (we'll have more information in the future); other vendors need distributors.

As companies come on-line and begin to succeed, a number of individuals are succeeding, too. Despite some major handicaps—a chief programmer for a state agency who only last year got a desktop PC for his own use at work; a librarian in the Academy of Sciences whose eyeglasses are broken and who cannot get them repaired; a general director of a software company (he'd be called a CEO in the West), well paid by Soviet standards but earning the equivalent of US$27 a month; and so on—the Soviet people I have had the privilege of knowing are getting by with a grace under pressure that makes me admire and respect them enormously.

I can't say if the people associated with the Soviet computer industry are typical of Soviet society as a whole. But for everyone's sake, I hope they are: With talented people like this working to make things better, the future of the Soviet computer industry—and indeed all of Soviet society—looks more hopeful than ever.

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

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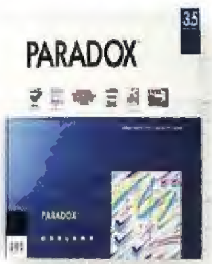

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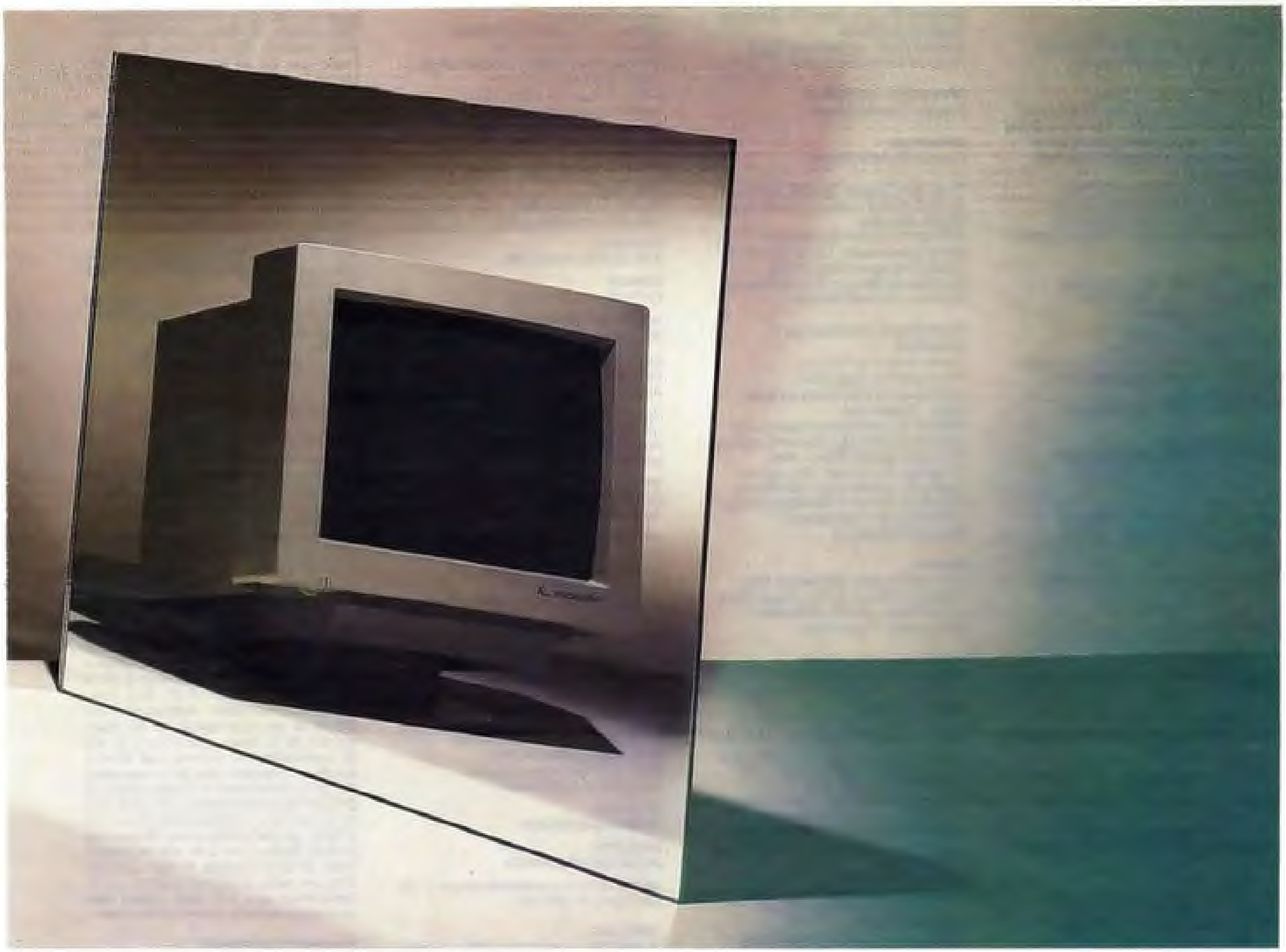

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SPARCserver™ 470	$77,800	3.8	19.4
DECsystem™ 5500	$74,700	4	21.5

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

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LETTERS

Back in the U.S.S.R.

Your April article "Computing in the U.S.S.R." was interesting and comprehensive. I would like to share some information with others working with the Soviets.

In the main article, the statement that the Soviet Union produces an IBM PC–compatible computer, the ES-1840, is an oversimplification. On my visit to the U.S.S.R. in 1990, I found that the ES-1840 is functionally compatible with an IBM PC but not mechanically or electrically compatible. Specifically, it utilizes a male pin connector for plug-in cards. This is entirely incompatible with the Western female-card edge connector. Thus, the ES-1840 will not accept a Western clock, modem, hard disk drive, or other internal add-ons. I was told that the ES-1841 would be fully compatible, but I suggest applying President Reagan's maxim: "Trust but verify."

On a separate subject, I discovered that most Soviets use modems set up for the Bell 212A standard, not the European CCITT standard. You can now direct-dial modems into the Moscow region from the U.S. for about $2 per minute. However, Moscow lines are extremely noisy because they still use pulse dialing exclusively. Many Soviets employ error-correction techniques routinely on calls across town.

James T. Fulton
Corona Del Mar, CA

The April article on Soviet computing was fascinating. Having been to the U.S.S.R. twice, I think that the only way the U.S.S.R. can ever catch up technologically is if there is private interaction between citizens of the U.S. and the Soviet Union. "Official" governmental actions always result in bureaucratic barriers.

John Draper
Alameda, CA

NewWave Misquote?

I was very disappointed to read a quote attributed to me (Nanobytes, April) regarding my opinion of Hewlett-Packard's NewWave. My remark came during a conversation in which someone who apparently had never used NewWave commented on a certain aspect of NewWave's capability in the versioning and object-sharing area. The reporter was not part of the conversation but apparently overheard it. I said specifically that NewWave does not do anything to protect users who might open multiple versions of a single document across a network. The reporter quoted me instead as saying that NewWave does not do anything, period.

By abridging my remark, you completely misrepresent my opinion of NewWave. With NewWave, HP has done a very nice job of extending the Windows environment. NewWave does indeed do many good things that are helping customers get more value out of the Windows environment today.

Microsoft and HP might have a difference of opinion on how object-oriented technology should ultimately be incorporated into systems software, but Microsoft gives a great deal of credit to HP for its pioneering work in this area.

Bill Gates, Chairman
Microsoft Corp.
Redmond, WA

We apologize if we misrepresented Mr. Gates's opinion of NewWave. However, our reporter's notes do not agree with Mr. Gates's recollection.

Program Tune-Up

The April article "A Fast, Easy Sort" intrigued me so much that I had to try it out. I coded it in FORTRAN 77, ran it, and was well pleased with the performance. There was one line of code in the program that I took exception to:

```
gap=(int) (float)gap/1.3);
```

This equation requires that the integer gap be converted to floating point and divided by 1.3 in floating point, and the result converted back to an integer. In removing the floating-point operations, I was able to see a 15 percent improvement in CPU performance. The equivalent "integer" operation is as follows:

```
gap=gap*8/11
```

This has the same effect as dividing by 1.375, but all operations are done in integer arithmetic. This equation will shift the value of gap by 3 bits to the left (the same as multiplying by 8), and then it will do an integer divide by 11.

This may seem like a trivial matter, but, like saving gas in the family car, if you want the saving, you have to keep the car tuned up.

Rodney Hills
Gresham, OR

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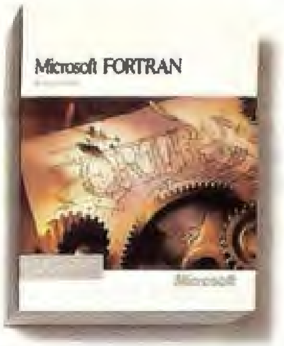

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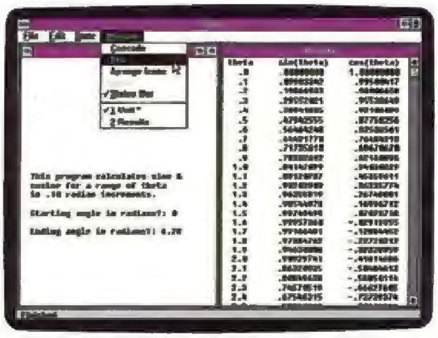
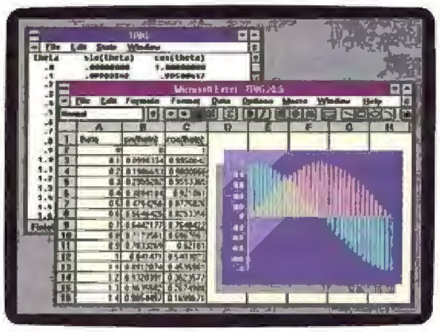


The Microsoft Windows graphical environment lets you have multiple windows in your FORTRAN applications. This means that you can resize and scroll input and output displays to view data...



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PROGRAMMER'S TIPS

- *Use the new /MW option with the FL command to invoke the QuickWin library. For example: "FL/MW MYAPP.FOR" is all it takes to make MYAPP a Windows-based program.*
- *Use the ALLOCATE statement to dynamically size arrays and to access more than 16MB of memory on a 386.™*

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A Bright Spot

In reference to April's "Beyond DOS: A Smaller, Faster OS/2," Douglas A. Hamilton's sense of humor completely cleared up a cloudy March day here in central New York. Thanks!

Tom Lawlor
Syracuse, NY

Redesign Yeas and Nays

Regarding BYTE's redesign beginning in March, I particularly like the new department groupings and especially the decision to keep Jerry Pournelle up front. The photos of columnists are a nice touch, too.

Edwin C. Harler Jr.
Levittown, PA

Please drop the fancy graphics. You are producing a hands-on magazine to be read and then kept as a reference to be reread again and again. BYTE is a fine magazine, one that will be around far into the future as long as you remember where your roots are.

Robert Meegan
Pittsburgh, PA

When Things Don't Work

Jerry Pournelle seems to be encouraging a certain impatience with recalcitrant software. His attitude seems to be that if a program doesn't do his instant bidding, he'll stuff it into the nearest waste can. Software should, of course, be as user-friendly as human ingenuity can make it. Life is too short to spend a lot of time thrashing around helplessly with some perverse command structure.

On the other hand, approaching software with a chip on your shoulder can be distinctly counterproductive. I speak not only of mainstream user programs, but also of operating systems and compilers. Jerry's battles with Unix and C are premier examples. He dutifully installed Unix on one of his 386s, and when he couldn't get it to run satisfactorily in two weeks, he consigned it to limbo because it was "unfriendly."

Neither Unix nor C is for the faint of heart or the prematurely geriatric. This is software that requires a lifetime commitment. Expect to work hard for several months before you gain even minimal control over a system and a language as powerful as Unix. Once you have made this initial investment of energy, the rewards are big-time.

William B. Fankboner
La Quinta, CA

My attitude is that if I have to work too hard at software, what it does had better be worth the work. If it doesn't accomplish much, why should I spend a great deal of time learning it?

Some software is obviously important, and one simply takes the trouble to learn it. But often there is another program as good as the complicated one and much easier to learn. And I certainly decline to make a lifetime study of an operating system.—Jerry Pournelle

I read in Jerry Pournelle's December 1990 column about his experiences trying to get QEMM-386 to work by the trial-and-error method.

The last "prime axiom of fun and fiddly computerish things to do" is, Read the manual.

You will find a neat little utility called QEMM.COM ANALYSIS. No more trial and error! QEMM.COM ANALYSIS accurately tells you which areas of memory to include and exclude, and it really works!

Hugh A. Roberts
Snowmass, CO

Oddly enough, not only had I read that section, but I had a QEMM expert on the phone while we tried it, and that didn't do it either.

I have recently found a way to crash a 486 with QEMM when the exact same thing with another memory manager runs fine. No one can figure out why.

I agree that the QEMM manual is a great introduction to memory management, and we still use QEMM on the main systems here. It would be even better if the manuals had good indexes and analytical tables of contents, though. Computer manuals are not most people's notion of light reading.—Jerry Pournelle

Comparing UPSes

Your recent article " 'Smart' UPSes Alert LANs to Power Problems" (May) unjustly puts our product, Unison's UniPower PS8.0, at a disadvantage relative to the Elgar and American Power Conversion UPS systems. Several important points were omitted from the story.

First, the Elgar and APC units are standby battery-backup systems, not true uninterruptible power supplies. A true UPS has zero transfer time, which the Elgar and APC units do not have. The Unison unit is on-line and does indeed have zero transfer time and pure sine-wave output, the definition of a true UPS.

Generally, a standby unit costs a fraction of what an on-line system does, due to the sophisticated electronics required for the on-line system. Unison models, including the PS8.0, are very reasonably priced for on-line units. However, when you compare one to a standby UPS, the on-line unit cost will appear disproportionately high.

In the closing paragraph of your review, the APC gets the nod because of its "SmartBoost" feature, a step-up transformer that makes one "voltage bump" of up to 12 percent to correct brownouts without switching to battery power. The PS8.0, being on-line, provides continuous, volt-by-volt voltage correction without using battery power. Thus, instead of letting line voltage fall below 183 V before providing a single voltage boost (as SmartBoost does), the Unison unit corrects for every fluctuation in incoming voltage down to 98 VAC without using batteries.

In short, if your reviewer liked SmartBoost, he would love the Unison voltage-correction solution—if he understood that this feature is inherent in our on-line UPS design.

Keelin Wyman, Director of Marketing
Tripp Lite/Unison
Chicago, IL

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LETTERS

Your points about the differences between on-line and standby UPSes are well taken. However, we found that the transfer times of standby UPSes are so brief that the switching power supplies in use on microcomputers today would not even be aware of the transfer from "outlet" power to battery power. It becomes a question of whether or not the "sophisticated electronics" you speak of justifies the cost. In some severe cases where a user faces extremely poor utility power, perhaps it does.

Instead, we focused on the intelligence of the UPSes because we thought our readers would be most interested in the associated benefits. Also, given the difficult economic times, we had to keep an eye on each UPS's cost, since we know our readers are doing the same. We hope that, all in all, we arrived at the proper conclusions.

Finally, thank you for pointing out the Unison's voltage-correction system.—Rick Grehan

GOSIP Clarification

In "The Missing Link" (May), Wayne Rash Jr. states that "GOSIP . . . includes TCP/IP. The GOSIP standard used to exclude TCP/IP, but users refused to give in, so the standard was changed." This statement is incorrect. TCP/IP is not in GOSIP. TCP/IP has never been considered for inclusion in GOSIP. There have never been any federal agency requests to incorporate TCP/IP into GOSIP.

GOSIP is and will continue to be a Federal Information Processing Standard that mandates that federal agencies acquire computer networking products that conform to the Open Systems Interconnection international standards.

Jerry Mulvenna, Chairman
GOSIP Advanced Requirements Group

Recycling 486s

While I do not know the details of Intel's behind-the-scenes workings, I agree that the company gives the appearance of what Fred Langa describes in his June editorial: It obviously wants to eliminate all would-be competitors.

Langa makes a statement that some readers may question. I refer to his contention that Intel takes a "fully functional i486" and then cripples it. Langa's conclusion that Intel could "sell you the fully functional i486 at that same price—or less" may be faulty.

In the chip-making operations I have known, many chips (sometimes 50 percent or more) must be junked after testing. I believe Intel's operation has similar problems. Intel is undoubtedly doing what floppy disk and tape manufacturers have done for years: It probably first tests the 486 chips to its highest standards. Chips that fail at full clock speed may be retested. If they function at a speed high enough for the 486SX, they can be remanufactured as such. Likewise, if testing reveals any flaw in the FPU section of the 486, the FPU can be disabled. What would have doomed that chip as a 486 is no problem for the 486SX. In this way, Intel sells "factory seconds" at reduced prices.

Phil Bond
Castro Valley, CA

Hope for the Disabled

Things aren't quite as bleak as they seem for Joseph Lazzaro (Stop Bit. "Windows of Vulnerability," June). The three most prominent "*GUI-from-the-factory*" computers (Amiga, Macintosh, and Next) all contain built-in audio I/O. The Amiga's may be the most extensive—the "narrator device" provides text-to-speech capabilities at the lowest system level. This device is supported at the file-system level via a file-system device named Speak. You can read a file aloud as simply as saving text to Speak. Several commercial modem and spreadsheet programs allow a read-aloud option using this device.

While speech-input support is less advanced, audio-input hardware for the Mac and Amiga can cost less than a good modem. The problem is that speech-recognition systems require much of the work to be done in RAM by the CPU, requiring large amounts of both resources, and the recognition rate is not as high as it needs to be.

Actually, most GUI-based systems are better suited to nontraditional I/O techniques than text-based ones because they work with event streams and at the application level don't actually care whether those events were generated from a mouse, trackball, touchscreen, or whatever. While I find it difficult to envision a CAD program for the blind, a 3-D modeling program would not be unthinkable.

GUIs even provide better support for the vision-impaired: Large fonts are commonplace. Frequently, even the system default fonts can be specified as large fonts, which are then inherited by all cooperating applications.

As you can see, modern-day GUI systems give users much more than just graphics, mice, and menus.

Tim Holloway
Jacksonville, FL

Information Etiquette

Ken Sheldon's Stop Bit "Human Filters?" (May) did a good job of summing up the State of the Art's theme: managing gigabytes. We live in an age when information expands in direct proportion to the ease with which it can be created and distributed. As information producers, we need to take personal responsibility for the management of information pollution. The answer is an "information etiquette" to control the spread of distribution for distribution's sake.

John R. Woodward
Tallahassee, FL

FIX

• Time-outs can be set on the Lasernet PSU-82SP (see "Extend Your Printer's Reach Without a LAN," May) at intervals of between 20 and 90 seconds (not 20 or 90 seconds). Also, users can configure hardware handshaking parameters through software on a port-by-port basis, and all programmed parameters are saved in battery-backed memory. ■


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NEWS

MICROBYTES

New Algorithm Could Eventually Speed Up Database Sorts

A new algorithm for sorting and searching data could eventually revolutionize the way computers sort and retrieve information. Dr. Michael Fredman of the University of California at San Diego and Dr. Dan Willard of the State University of New York at Albany have devised a sorting method that breaks the sort speed barrier of conventional comparison-based sorting algorithms. This barrier, called the information-theoretic lower bound, is the mathematical limit on the number of computational operations or comparisons required to sort a given number of records by comparing two items at a time. The mathematical limit is $N(\log N)$, where N is the number of items to be sorted.

The Fredman/Willard algorithm compares one item with many others in a single computational step, using a new data structure called a *fusion tree*. Fredman says, "What we managed to do is exploit the information in all the bits of each word rather than working with 1 bit of information." The research is aimed at solving a different problem—namely, coming up with a faster method for traversing a so-called spanning tree, which is "a network of nodes or vertices connected by edges." Their algorithm makes it possible to devise a "minimum spanning tree," in which the number of computational steps required to traverse the spanning tree is proportional to the number of vertices and edges. Fredman emphasizes that the algorithm is currently "totally impractical. It's a theoretical advance."

—Nick Baran

Playing Soon on a Mac Near You: QuickTime, the Media Mixer

When it delivers its QuickTime system-software extensions later this year, Apple will tighten the synchronicity between the Macintosh and mixed forms of digital media. Described variously as a media integration technology, a multimedia coordinator, and "an architecture for dynamic media," QuickTime is essentially an underlying technology for handling time-variant data of all kinds. Since time is a unifying element in synchronized data, an accepted widespread means for controlling time will make multimedia easier to implement.

One of QuickTime's main components is a movie editor for assembling source materials that go into a presentation or mixed-media document; a *movie* is a new file format that consists of synchronized data such as sound, video, and animation. Movies can become part of other files; for example, a PageMaker document can contain little windows of video on each page, illustrating the material

QuickTime's movie player runs video clips in a window.

NANOBYTES

Sports artist **Joni Carter** used **digital tools** to create a new series of stamps commemorating the 1992 Olympic Games. Carter manipulated video clips, her source material, with a PS/2 equipped with an IBM M-Motion board. She painted with a PS/2, Time Arts' Lumena software, a Truevision Targa+ board, and a Wacom tablet and pen. She printed proofs with a Kodak thermal printer. A Scitex printing system produced the stamps forthe U.S. Postal Service. □

Software Publishing plans to release its Windows version of Harvard Graphics sometime around November. The new product will have a feature set similar to that of Harvard Graphics 3.0, but one big difference will be the ability to hold all charts or slides for a presentation in a single file rather than in multiple files as in 3.0. The new package will cost $595, company representatives said; users of existing Harvard Graphics products can upgrade for $125. □

Intel (Santa Clara, CA) has revamped its **860 RISC chip** to better handle multiprocessing and three-dimensional graphics. The **new 860 XP**, available in speeds of 40, 50, or 60 MHz, consists of 2.55 million transistors in a package about the size of a 486. The internal cache has been beefed up from 16 to 32 KB. New parts include a cache controller tailored to multiprocessing, a special interrupt controller that can work with multiple CPUs, and a 50-MHz static RAM chip that lets the XP run at true zero wait states, Intel officials said. □

with moving pictures. Apple says that it will publish the full specifications for the movie file format, providing developers of cross-platform applications with a standard way of exchanging dynamic data from one computing environment to the next.

Apple Computer supplies with QuickTime a basic set of software-based compression and decompression schemes for still images, animations, and video. The Joint Photographic Experts Group compression scheme is used for still pictures. The animation compressor, which is based on run-length-encoding principles, can squeeze sequences of 1 to 32 bits in depth. The video compressor can squeeze moving pictures from a ratio of 5 to 1 to one of 25 to 1 and lets you play back digitized video sequences from a hard disk or CD-ROM in real time, with no additional hardware, on any Mac with a 68020 or higher processor. Another module controls peripheral devices such as digitizers and monitors.

QuickTime differs from what has previously been available through special function boards in that it reads information from disk and decompresses/compresses it on the fly. QuickTime also doesn't require lots of RAM as a buffer.

Apple has also specified what it calls the Human Interface Standards, which is meant to provide consistency across applications for doing things such as turning sound on and off or starting and stopping a movie. These operations will be controlled using on-screen buttons and sliders from within applications.

QuickTime's design is broad enough to handle multiple audio tracks with a single video track. This means that a "content provider" could, for example, distribute a movie on a CD with user-selectable voice tracks in different languages.

Version 1.0 requires a 68020 CPU and Color QuickDraw. Apple says that it will extend QuickTime to 68000-based machines, but several developers said that they think the older Macs will choke on the video. Some also pointed out a need for products that sharpen the video in QuickTime windows.

Apple will provide QuickTime as system-software extensions. Other developers will have to provide the programs and toolkits for making movies and editing sound. Most of the major Mac developers working in video graphics and multimedia software have pledged to implement hooks into QuickTime. The company will eventually sell QuickTime system extensions to users for a nominal fee.

As one Apple executive put it, QuickTime "increases the bandwidth of what can be presented on a personal computer." It also sets goals for personal computing in the nineties.

—Larry Loeb

Laser Light Sharpens Liquid Crystals

A new technique being developed at Hercules Aerospace (Wilmington, DE) could result in portable computer displays with much better resolution than is possible now. The current methods of aligning liquid crystals in a typical LCD involve a mechanical "rubbing" process, in which a cloth is used to mechanically rub a polymer surface. When the liquid-crystal molecules come in contact with the polymer surface, they tend to line up in the direction of the rubbing.

This method works fine, except that the rubbing can produce scratches or grooves on a surface. But Hercules researchers have discovered a new "noncontact" method of aligning liquid crystals that uses laser light rather than mechanical rubbing.

The new method starts with a polymer-dye mixture developed by Hercules researchers. "It's just like any standard polymer layer that's been used in displays before, but we've incorporated an absorbing dye molecule," says research physicist Wayne Gibbons.

The researchers put the polymer-dye mixture on a glass substrate and shine polarized laser light onto the surface. The laser light alters the polymer surface, causing the liquid crystals to orient perpendicularly to the laser-light polarization, Gibbons says.

"When you remove the laser light, the liquid-crystal molecules maintain a memory," Gibbons says. "They stay in the position that was created by the laser light." The advantage, he says, "is that we don't introduce scratches or grooves that you normally get with a standard mechanical buffing." But, he adds, "there's still research and development that needs to be done to demonstrate that this is better than current methods."

Could this discovery lead to better resolution for flat-panel displays? "We're not discounting that possibility, but it's a little early to say how much of an impact it would have," Gibbons says.

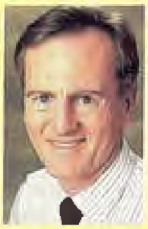
—Jeffrey Bertolucci

NANOBYTES

IBM's "vision" of that nebulous term *multimedia* goes beyond cramming current computers with graphics and audio capabilities, judging by comments from IBM vice president **Michael Braun**.

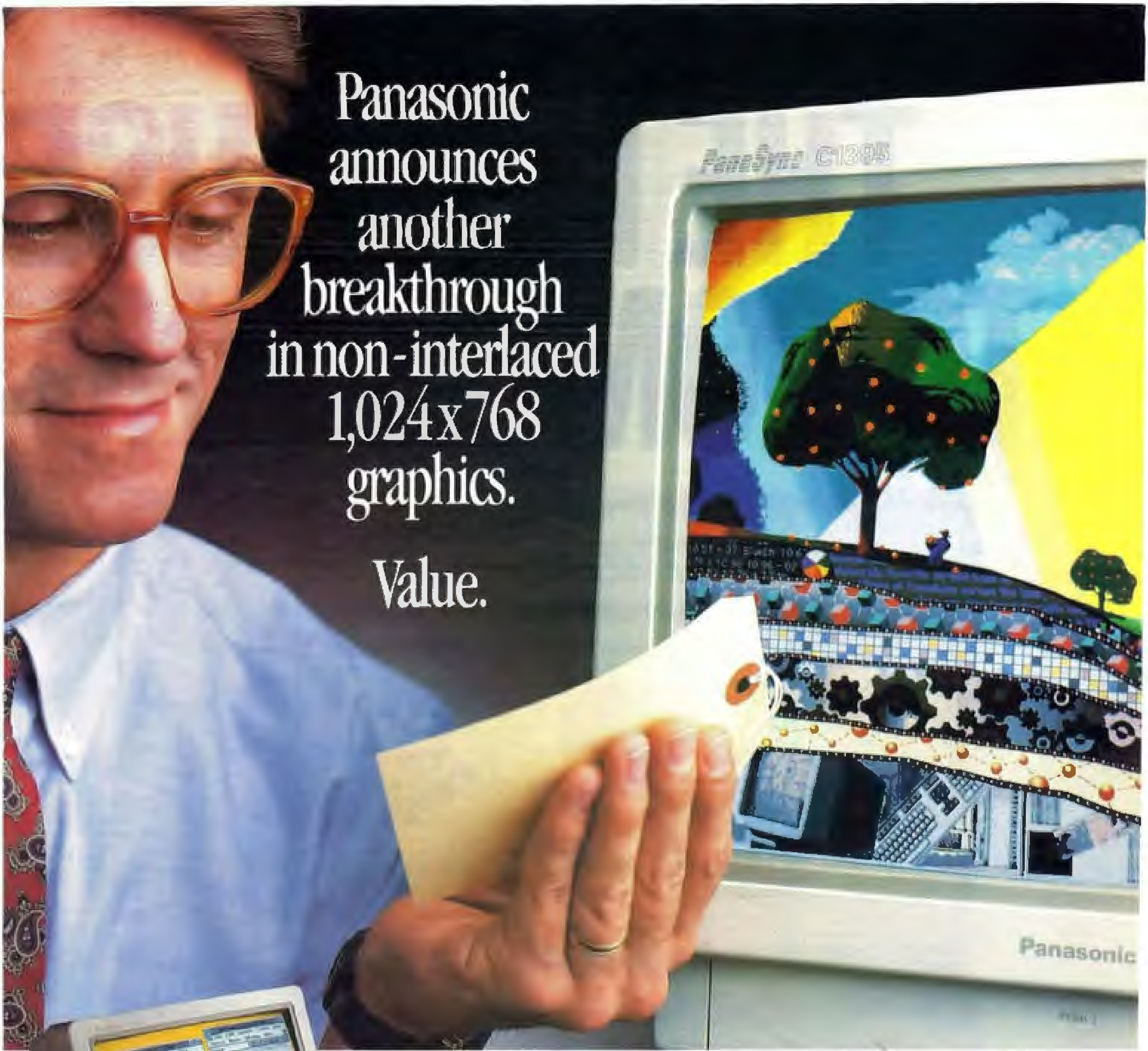
At the spring Comdex, he described a future of **"personalized information"** piped into homes and offices by computerized TVs, "intelligent information selectors," and vast sources of hyperconnected data and sensory stimuli. One example: an "interactive smart TV" that can monitor various newsfeeds all day and also tape any programs you want to see and then assemble a package of material according to your profile. Not only do people want personalized information presented with sound and graphics, "they're willing to pay for it," Braun said. □

System 7.0 will be Apple's "most important strategic advantage" in the 1990s, company CEO **John Sculley** said at the launch of the new Mac operating system.



Sculley said that Publish & Subscribe, System 7.0's mechanism for letting applications share updated data, will have the same importance as copy and paste. □

Although Sculley was able to report that **Apple is shipping more Macs** this year than last, thanks to those new low-cost models, the smaller profit margins on those machines are taking a toll on the bottom line. And the vogue way to fix that is by **cutting personnel**. Apple announced that it will "restructure" parts of the company over the next 12 months to reduce operating expenses. The plan involves a work force reduction of approximately 10 percent. □



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Proposed "Soldier's Computer" Holds Commercial Promise

Along with weapons and supplies, foot soldiers of the future could be packing a 1-pound portable computer with wireless voice/data communications, a heads-up display, a joystick, and a microphone for voice input. The Army's Communications Electronics Command has hired Texas Microsystems (Houston) to study the feasibility of a "soldier's computer," which, if successfully built, could eventually be used in the civilian sector by mechanics, firefighters, or police.

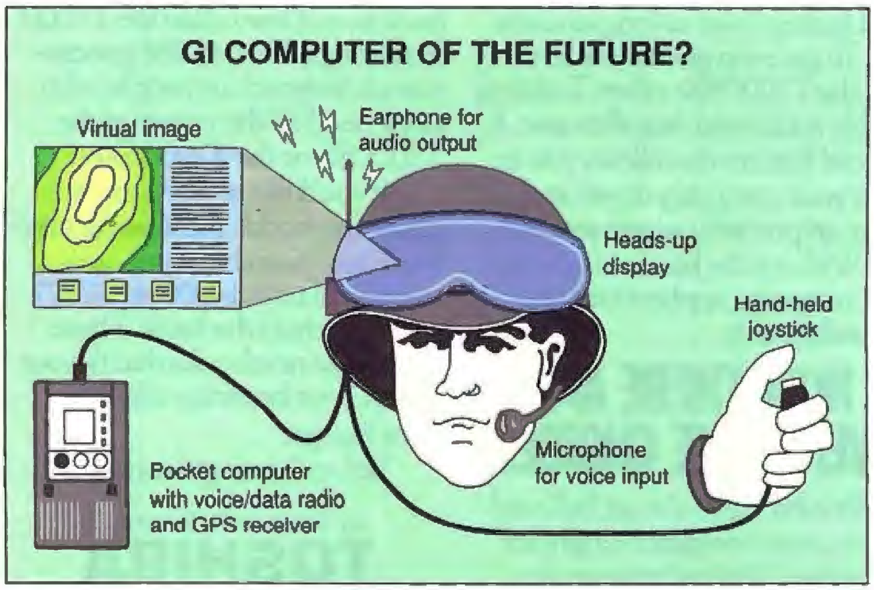
Slated for deployment by as early as 1995, the portable may give soldiers an edge in the battlefield by letting them download graphical images of battlefields from satellites or reconnaissance aircraft showing enemy troop locations. Soldiers could also use the computer for real-time communication with supporting artillery, aircraft, and other units to avoid death by friendly fire. Mechanics in the field could possibly send images back to the base to illustrate problems with machinery and get the help needed to make repairs quickly.

According to Michael Stewart, president of Texas Microsystems, the company won the feasibility study contract when it bought the assets and inventory of Agilis, which had planned to use military radio technology for wireless networking using notebook and modular hand-held PCs. Texas Microsystems acquired Agilis's spread-spectrum radio technology. Stewart says that the working prototype of the machine will initially use Intel's 386. Although still in the speculation stage, the computer could have a pocket-size processing unit, a radio for transmitting voice and data, a heads-up display that soldiers can attach to a helmet or wear like glasses to project a virtual image, a microphone for voice messaging, a joystick-like device, and an integrated link to a global positioning system that lets soldiers pinpoint their location. (The GPS is a series of navigation satellites that enable those with suitable equipment to locate where they are within about 30 feet in terms of latitude, longitude, and altitude.)

Stewart said that the company is looking at cutting-edge technology, such as memory cards, voice input, modularity, and tiny displays. Reflection Technology is on the right track with its Private Eye display, but the display "doesn't do graphics or handle full color," he said. The company is investigating "ruggedized LCDs that you'd put on your arm" as an alternative to the heads-up display, but those, too, suffer from limitations—namely, poor performance in extreme temperatures. Stewart said that in extreme cold, heaters could be used to warm the LCD, "but then you run into the power problem with batteries."

"We're trying to find out what we can do two years from now," Stewart said. "We think that we can build something that will survive in the battlefield."

—**David Andrews**



NANOBYTES

Apple's Advanced Technology Group, during the recent developer's conference, gave developers a peek at some of their work, including a **hand-held machine** with a notebook-like interface and stylus control. ATG members also showed projects under way to extend the data reach of Macs. They linked Cray supercomputers in Cupertino and Illinois using a simple icon-wiring diagram on the Mac screen to do image processing—fast. In this diagram, the icons were cubic; they had sides, tops, and bottoms labeled as to data direction. Other portents: The so-called **Tower Mac**, to be based on Motorola's 68040, will have built-in support for **24-bit color** and Ethernet, Apple vice president **Randy Battat** told developers. A **new Mac Classic** based on the 68030 processor can be expected, he said. □

IBM has finally anointed the **higher-density floppy disk drives** that have been waiting in the wings. The 2.88-MB floppy disk drive was rumored to be appearing in IBM machines a year ago; it has now just arrived. Currently, it is available as a standard part only in the PS/2 Model 57 SX, but IBM says that it will become common in new configurations of higher-end systems as well. The drives that IBM uses are manufactured by **Toshiba** and **Sony**, and the higher-quality barium-ferrite medium is available now from various sources, including Verbatim, Toshiba, and Sony. Toshiba predicts that the market for 4-MB floppy disk drives (when formatted, they hold 2.88 MB) will soar from 5 million units this year to 200 million units in 1994. Gene Dougherty, Toshiba's vice president of sales and marketing, says that virtually every system maker will follow IBM's lead and introduce 2.88-MB floppy disk drives by early 1992. □

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NEWS

MICROBYTES

New BIOS Spells Less FUD for Pen Computing

Go Corp. (Foster City, CA) and Phoenix Technologies (Norwood, MA) are jointly developing a dual-mode BIOS for pen-based computers that will support both Go's PenPoint and Microsoft's PenWindows environments. The partnership should speed delivery of the next generation of pen-based machines. Greg Slyngstad, Microsoft's general manager of the PenWindows unit, said Phoenix's work is "good for both Go and PenWindows. More available technology makes everything happen a little faster."

This new BIOS could lead to standards that simplify matters for computer buyers. But the greatest beneficiary of this alliance is likely to be pen-based computing itself. "This should enable manufacturers to begin work without being retarded by FUD [fear, uncertainty, and doubt] in the marketplace," stated Go chairman S. Jerrold Kaplan.

Under the agreement, IBM-compatible-BIOS maker Phoenix has licensed the right to sell and enhance Go's design of its next-generation prototype machine. The new prototype uses Intel's power-miserly 386SL microprocessor SuperSet and the new Phoenix PenBIOS. PenBIOS will incorporate Go's Machine Interface Layer, for compatibility with the PenPoint operating system, and a system BIOS for the 386SL, for compatibility with Microsoft's PenWindows (which is a set of extensions that will make Windows able to understand input from a stylus). The BIOS will also include the power management capabilities Phoenix has designed into its 386SL notebook BIOS.

The Go/Phoenix agreement means that machines based on Go's prototype will be able to work with Microsoft's pen extensions to Windows. This may represent Go's capitulation to the inevitable—the market appeal of PenWindows. But the agreement should also give the Go hardware design some independence from the success or failure of its PenPoint operating system.

Phoenix will produce a reference design for the new Go machine prototype, making it available to those manufacturers that wish to produce pen-based machines. Phoenix expects to announce a formal reference program within the next month or so.

The market will determine which operating system to use, according to George Adams, vice president of operations at Phoenix. Using PenBIOS, a manufacturer could choose to use either PenPoint or PenWindows, or go with a dual-boot design. Adams doubts, however, that users would want to "switch back and forth" between the two systems.

With the help of the Phoenix reference design and dual-mode PenBIOS, manufacturers are likely to start showing prototypes of the next generation of pen-based machines by fall Comdex, Phoenix officials said, and by spring Comdex 1992, there should be a significant number of new pen-based machines. However, one big question manufacturers would not answer yet is how soon they might implement schemes that will run both PenPoint and PenWindows.

—Ellen Ullman

The Future of X Looks Like Mac, Windows

"Cut and paste, drag and drop are not enough. The applications environment vendor will have to simplify the process of interoperability.". Edward Zander, president of Sunsoft, Sun Microsystems' software subsidiary, was criticizing the Open Look user interface for not offering real interoperability between applications. Open Look, like the Open Software Foundation's Motif, is a graphical Unix interface based on the X Window System.

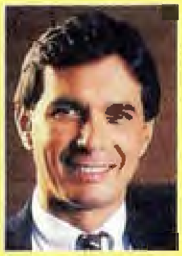
Zander's comments at the recent Xhibition conference, like those of Microsoft's Bill Gates and Apple's John Sculley, underscore how the major operating environments are beginning to agree on their role. Microsoft Windows, the Macintosh, and Unix by way of X/Open Look and X/Motif are all addressing a similar set of functionality: GUIs, protocols between windows, data exchange between applications, linked objects, multimedia, and distributed processing across heterogeneous networks.

It will be interesting to see how the major platforms go about implementing their tasks. The Mac and Windows are currently ahead of the X world in some respects, already delivering or promising object linking and interapplications communication. But X/Open and X/Motif were built on the idea of a networked system, giving the Unix world a major head start. ■

—Ellen Ullman

NANOBYTES

While IBM vice president Michael Braun was talking primarily about home delivery of multimedia, another IBM official apparently sees **corporations** as the main target. "There is a clear trend toward the home market," **Peter Blakeney**, IBM's manager of market programs for multimedia, acknowledged, "because computers and television are coming together."



But the immediate potential for mixed digital media is in large, enterprise-wide systems, using image databases, video and voice mail, and document management systems, he said. □

Hewlett-Packard's NewWave environment, which sits on top of Microsoft Windows, will now **support Microsoft's Object Linking and Embedding** technology. This means that every Windows application that supports OLE will automatically be a NewWave application, too, HP says. Since NewWave is based on objects and application links as well as the concept of software agents, OLE represented a possibly competitive technology that could have split Windows applications into two camps: those supporting NewWave and those supporting OLE. The upshot of this announcement is that developers of applications for Windows can include OLE and gain the extra benefits of NewWave when operating in that environment. □

Lotus (Cambridge, MA) will bundle copies of **Adobe Type Manager** and 13 Adobe typefaces with all its Windows applications, including the "real soon now" 1-2-3 for Windows and Freelance Graphics for Windows. The font technology, which generates smooth, scalable text characters, will also show up in future releases of Ami Pro and Notes, Lotus said. ■

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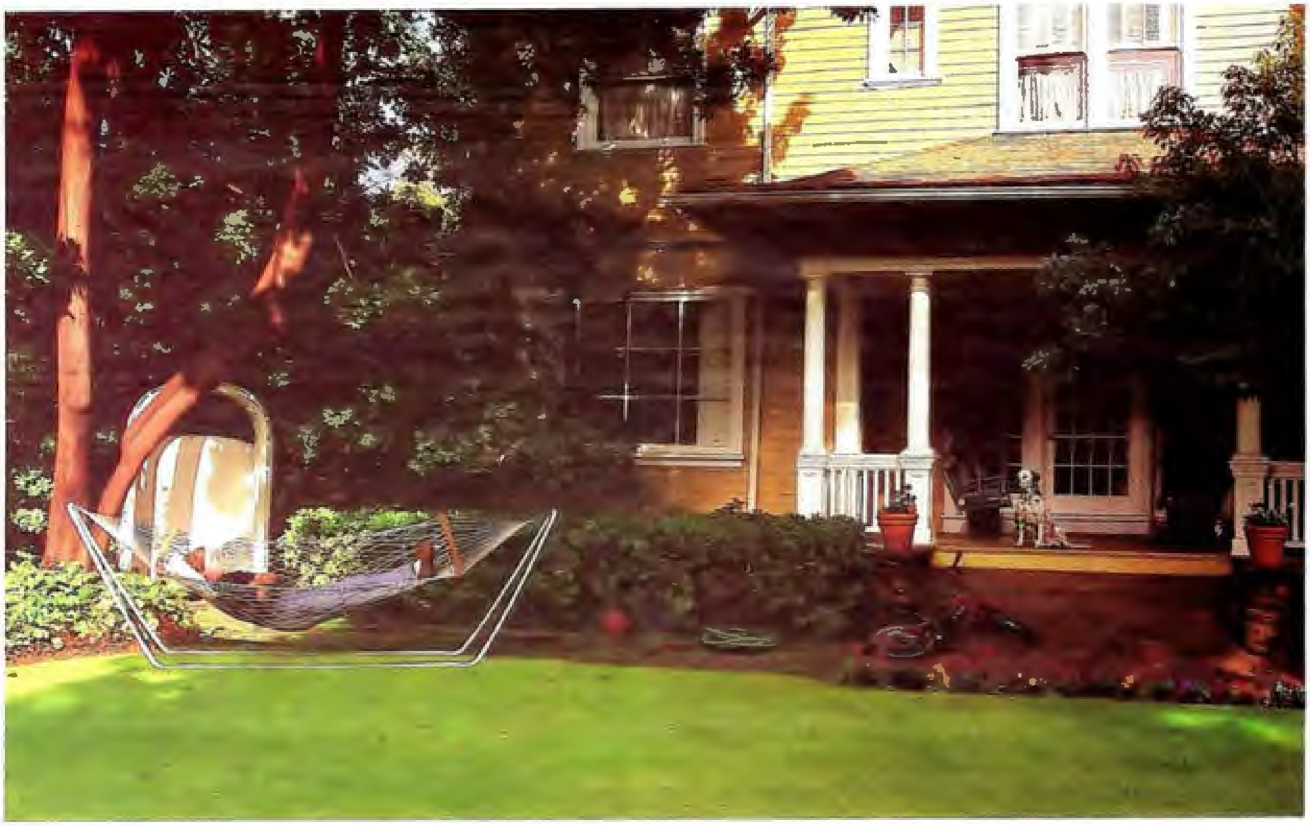

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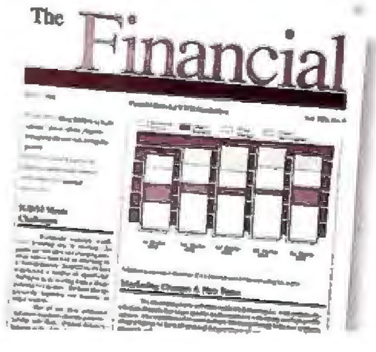

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NCR Knows Notepads

ANDREW REINHARDT

You can't decide between PenPoint and PenWindows? The NCR System 3125 runs both.

Ever since February's unveiling of PenPoint from Go Corp., the world has waited impatiently for a tablet computer that would run the innovative proprietary operating system. In the meantime, Microsoft has demonstrated its answer to PenPoint, an environment called PenWindows, which is pen-aware yet supports existing Windows applications.

Now, the wait for hardware is over. The surprise leadoff player is NCR, with a 386 pen-based portable that weighs less than 4 pounds and will run either PenPoint or PenWindows. The NCR System 3125, expected to ship this month and list for $4400, will set a standard to meet or beat among the new wave of pen-input PCs.

The System 3125 looks remarkably like a spiral notebook. It measures 8½ by 11 inches and is 1 inch thick, except for a cylindrical battery pack that attaches along the top edge of the machine and measures 1¼ inches in diameter. There's no keyboard, of course, because the system is intended for pen-input applications. Whether you're seated at a desk or walking around with the tablet cradled in one arm, you interact with it by writing on the screen with a cordless stylus.

NCR plans to ship the System 3125 with PenPoint or PenWindows preinstalled, but the system's BIOS will run either operating system—or plain old DOS—without modification. You can't have both operating systems installed at the same time, however, because each needs to control the boot process. Since neither package is expected to ship before fall, NCR will initially provide beta versions and upgrade them for free.

Although PenPoint and PenWindows have built-in handwriting-recognition algorithms, they also permit third-party routines to be swapped in. NCR is using an algorithm codeveloped with Computer Intelligence. The software recognizes uppercase and lowercase block printing, and it's faster and more accurate than the standard algorithms, NCR says. The system even recognizes handwriting when running DOS: The ROM-resident algorithm intercepts pen input and passes it to the system through the keyboard buffer.

The tablet can be used in either portrait or landscape orientation, depending on what software you're running. PenPoint now works in portrait mode and PenWindows in landscape mode, but in the future, both will support either orientation.

Power on the Move

The brain of the System 3125 is Intel's power-saving 386SL running at 20 MHz. The CPU is backed up with 16 kilobytes of cache memory, 2 megabytes of RAM (expandable to 8 MB), and 2 MB of flash EPROM (expandable to 8 MB), used as a sort of nonvolatile RAM disk. For more permanent storage, the tablet comes with either a 20-MB hard disk drive or an industry-standard IC memory card slot.

The hard disk drive version weighs just under 4 pounds, and it uses a 2½-inch PrairieTek drive with a 19-millisecond average access time. But if you want to save weight and prolong battery life—or if you want a removable storage medium—you can substitute a JEIDA/PCMCIA-compatible memory card reader for the hard disk drive. Configured with the card slot, the system weighs a bit more than 3½ pounds. NCR will sell 2- and 4-MB flash memory cards now, and larger sizes when the technology permits.

The design of the System 3125 is sleek and simple. Aside from the battery pack and mass-storage bay, it has only three external features: an option slot, a bus extension connector, and a pen garage for the stylus. The option slot on the left side of the system, for which NCR will publish an open specification, can hold a 9600-bps fax/2400-bps data modem (available from NCR for $695) or third-party devices, such as an external floppy disk drive. NCR is working with Motorola to develop an RF modem for the option slot.

The 180-pin universal bus extension connector on the right side of the system serves two roles. An included plug-in connector module offers four I/O ports: serial, parallel, keyboard, and external VGA display. These ports let you quickly convert the tablet into a desktop system, or attach it to a LAN or a printer. The internal and external displays are visible at the same time.

If you need even more desktop functionality, NCR will introduce, before the end of the year, a docking station that attaches via the universal connector. This chassis will include floppy and hard disk drives, two full-size expansion slots, and a power supply that recharges the system's battery. Its price hasn't yet been set. One possible use for the docking station is as a repository for an alternative operating system: If you want to convert the tablet from PenPoint to PenWindows, for example, you could load the new operating system off the hard disk.

The pen garage is a little cavity on the front of the system with a hinged door. Typical of the thoughtful design of the 3125, the system beeps at you if you turn it off and don't return the pen to the garage. At $100 a pop for the special stylus, it's an accessory you don't want to misplace.

Dual-Purpose Display

The most important element of the System 3125 is its display, because, after all, it's used for both input and output of information. The LCD, which measures 8½ inches diagonally, dominates the front of the system. It offers 640- by 480-pixel VGA resolution with 16 levels of gray and is unusually fast, NCR says, to avoid the ghosting typical of other LCDs. The display is reflective, not backlit, partly to save power and weight, and partly because the 3125 is expected to be used outside often, where a reflective screen offers better contrast. Even indoors, the display is sharp and easy to read.

The technology for making the screen an input device was codeveloped by NCR and Wacom, a company known for digitizing pads and stylus pointers. The panel uses an innovative electromagnetic design that doesn't require a screen overlay and doesn't interfere with the LCD, a problem that has plagued earlier electromagnetic digitizers, NCR says.

In the NCR/Wacom design, a capacitive grid is sandwiched behind the LCD panel, and the magnetic tip of the stylus "breaks" the grid to indicate its position. The magnetic field of the stylus is strong enough for you to drag around the cursor without having to touch pen to screen. The pen's action is only binary, not sensitive to varying levels of pressure, so you can't achieve effects like variable line widths when using certain drawing packages.

THE FACTS

NCR System 3125
without a hard disk drive, $4400

NCR Corp.
Workstation Products Division
1601 South Main St.
Dayton, OH 45479
(800) 225-5627
(513) 445-6160
Circle 1170 on Inquiry Card.

Power Play

Power usage is a critical issue for mobile computers, and the System 3125 offers mixed results. Even though it uses the power-saving 386SL and doesn't have a backlit screen or floppy disk drive, the system's rated battery life of 4 to 6 hours isn't much more than some notebook PCs. And it's shorter than the 8 hours promised by the Zenith Mastersport 386SL notebook computer.

NCR responds that, based on typical usage patterns, the rated operating time is enough to last for a full day of work. If you have a longer shift, the removable battery pack makes it easy to swap in some new power during the middle of the day, although that means you have to buy an extra $90 battery. The battery pack uses five cylindrical nickel-cadmium cells and features a fast recharge time of 1½ hours. The system can also run on AC power.

One of the benefits of the 386SL is that sophisticated power management features (e.g., slowing down the CPU speed and even shutting it off completely) are built into the chip. NCR has added some system-level tricks. For example, instead of shutting the system off, you can put it into a "deep sleep." When the system is turned back on, it resumes exactly where it left off. But if it is left asleep for more than three to five days, depending on the amount of available battery power, the contents of RAM are automatically saved into flash memory.

Chic and Sleek

The System 3125 is targeted at service and blue-collar workers, a huge potential market that has not made wide use of microcomputers. PCs haven't penetrated these professions, despite their obvious utility, because they were too complex to use and because people who work standing up cannot use a keyboard. With its groundbreaking GridPad, Grid Systems identified and helped build a market for pen-based systems in field automation.

The NCR tablet represents a new generation of machines that use more powerful processors than the GridPad and that employ operating environments designed for pen computing. Grid and other companies are expected to follow suit with 386 machines. But it's still not clear exactly who will buy them. The market may be segmented by operating system: PenPoint, with its easy-to-use "notebook" interface and applications developed for mobile computing, could dominate the "field workers" segment, while PenWindows, with its support for existing desktop-oriented Windows applications, could become trendy with executives.

By being first out of the gate, NCR could take an early lead in the market for second-generation pen-based systems, especially considering its established strength in the retail market. But the 3125 is not without its drawbacks. Although it is smaller, lighter, and more powerful than the GridPad, it is not necessarily more responsive, because much of its additional horsepower is used to drive the more demanding operating environments it supports.

In tests with a prototype system, I found the handwriting recognition at times quite accurate and at other times maddeningly, inexplicably incorrect. Learning to use a pen-based system requires some training and practice. It's also unfortunate that you have to choose between a hard disk drive and an IC card reader, because some people may want both. And I was a little disappointed in the battery-life specification, if only because I think that to be successful, a pen-based computer must be able to be used and left on for a full 8-hour shift without running out of juice.

Overall, however, I was impressed by the sleek design, innovative technology, and durable construction of the NCR System 3125. As usual, I was also struck by NCR's ability to partner with companies that can help it deliver state-of-the-art solutions before companies that try to do it all by themselves. The System 3125 won't be the last pen-based computer to hit the market, but for now, it has established the standard to beat. ■

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

A Whale of a System

Still small, still light, the latest Brick sports a full-power 486 heart

Last year, I took an early look at Ergo Computing's Brick, a full-fledged 386SX system packed into a compact and technologically advanced package (see Short Takes, June 1990). While 386SX-based systems are still popular, Ergo president Tom Spaulding told me that customers have been asking for cutting-edge computing power. Enter Moby Brick.

Despite its terminally cute moniker, Moby is quite a system. Ergo has taken its unique technology and packed a full-fledged 486-based system into the identical 3⅓- by 8- by 11⅓-inch black granite-finish case. (If granite offends your sensibilities, the case is also available in beige.) The total weight is just 8¾ pounds.

Alternative Portability

Ergo has taken a different tack on portable computing. Many of today's "information workers" take work home with them at night. Regardless of the sociological implications, it's a reality of the 1990s. Why have a full PC in both your office and your home? You can have a keyboard and monitor in each location and carry Moby Brick between locations. It's light enough and small enough to fit in a regulation corporate briefcase, and you're assured of having all your applications and crucial files with you. (If you insist on a "genuine" portable computer, a small keyboard and LCD should be available about the time you read this. But you'll still need an AC outlet. Batteries aren't included—or available.)

To eliminate the admittedly small task of plugging and unplugging keyboard, monitor, and AC connections, Ergo offers a $395 Docking Terminal. With a 180-pin edge connector hidden behind a door on the bottom of the system, Moby Brick brings all internal signals (including parallel and serial ports) to the Docking Terminal and hooks up in seconds. You just drop it in. The Docking Terminal also handles another add-in card, which is perfect for a network card at Moby Brick's office location.

Moby Brick is available in several configurations. You can get it with a full-power 486/33 or opt for Intel's new 20-MHz 486SX. You can pack in up to 32 megabytes of RAM and round out the system with hard disk drives that store up to 510 MB. The prerelease system I tested was a 486/33 with 32 MB of RAM and a 212-MB hard disk drive. And it was fast. The preliminary BYTE Lab benchmarks show that it equals or bests the fastest 486/33 systems we've tested.

Impressive Technology

When I looked at the first Brick, I marveled at how Ergo packed everything into such a small case. That goes in spades for Moby Brick; a 486/33, large amounts of RAM, and a large hard disk drive generate large amounts of heat. But the integrated design of Moby Brick takes care of all that heat.

This isn't just a pieced-together clone. The heat-producing components of Moby Brick lay against a plastic pouch filled with an inert and nonconductive heat-sink liquid. The liquid wicks away the heat to the carefully designed extruded-aluminum case. The entire case acts as a heat sink, and it gets only lukewarm to the touch.

A thermostatically controlled tiny fan turns on only when needed—which isn't often. If you're used to the comparative roar of the fans in most desktop systems, working with Moby Brick is disconcerting. It's almost too quiet.

There's lots more technology to Moby

Brick than the case. This is a loaded machine. An internal 2400-bps modem, dual serial ports, and a parallel port are standard. Also standard is extended VGA circuitry that gives noninterlaced resolutions of up to 1024 by 768 pixels and includes the Edsun Continuous Edge Graphics chip, which increases the apparent resolution of fonts and graphics through antialiasing. Ergo has included Edsun drivers for all popular applications and environments (including Windows 3.0, of course) in Moby Brick.

You would think that there wouldn't be any more room left in the packed Moby Brick case. But surprise: A 16-bit AT add-in slot will take a three-quarter-length add-in card. If you're willing to forgo the standard 3½-inch 1.44-MB floppy disk drive, that frees up an additional 8-bit slot.

A Surprising BIOS

One of the least apparent and most interesting parts of Moby Brick is its heavily customized BIOS. A large part of Ergo's business is DOS extenders, and the company has used an array of programming tricks to wring every bit of performance from the Chips & Technologies BIOS that runs Moby Brick.

First of all, the BIOS is stored in flash ROM, which is easily reprogrammable remotely. When a new version of the BIOS becomes available, just call Ergo's BBS and download the new BIOS directly to your Brick.

There's more. The BIOS includes an integrated disk cache. My preliminary tests showed it to be considerably faster than most add-on software caches (e.g., Microsoft's ubiquitous SmartDrive). Even better, it works entirely in the high-memory area (HMA) between 640 and 1024 kilobytes.

And speaking of that mysterious HMA, Ergo has also tweaked the BIOS to give you a contiguous 192-KB block in the HMA. (With most BIOSes, the HMA is filled with fragmented free areas.) With Quarterdeck's QEMM (which is available with Moby Brick), you can easily load TSR programs and device drivers into the HMA without the programming gymnastics usually required with most high-memory managers.

Moby Brick's BIOS has more surprises. You can make adjustments on all sorts of system parameters, including changing the speed of the system bus to match it to an add-in board. (Not recommended for beginners.)

On the software side, Ergo does not leave you high and dry. The company's philosophy is to deliver a system that's ready to run straight from the box. You can purchase it loaded with Windows 3.0 and Adobe Type Manager or with Quarterdeck's Desqview 386 with QEMM. Ergo also sells most popular applications and will install them onto your personal Moby Brick.

A Sensible Concept

I've liked the concept of the Brick from the first. While portable computer manufacturers are always touting the advantages of on-the-go computing, I find that most of my computing is done at fixed locations. Even with a lightweight notebook computer, typing away on an airplane is just too much of a hassle. The Brick's concept makes a great deal of sense. And with the evolution of this concept to Moby Brick, taking a loaded 486 system in my briefcase is the perfect way to travel. It's also a natural for folks who need to travel with cutting-edge computing power for presentations or the like.

But even if you never need to move your computer, Moby Brick is a classy system for a fixed location. Its technological sophistication aside, it's an elegant system that's so quiet that you won't even know it's working. And it looks great. You can easily hide it under your desk, but I'd rather have it out in the open. ■

Stan Miastkowski is BYTE's senior editor for new products. He can be reached on BIX as "stanm."

THE FACTS

Moby Brick
486/33 version, $4995 (with 14-inch 1024- by 768-pixel noninterlaced monitor, $5595); 486SX version, $3995 (with monitor, $4595)

Ergo Computing, Inc.
1 Intercontinental Way
Peabody, MA 01960
(800) 633-1925
(508) 535-7510
fax: (508) 535-7512
Circle 1169 on Inquiry Card.

NEWS

FIRST IMPRESSIONS

A RISCy Add-On for the LaserJet III

Even though the Hewlett-Packard LaserJet III is rated at eight pages per minute, it's easy to slow it down to 8 minutes per page when you start working with multiple fonts or heavy graphics. But the **PacificPage XL** can restore the printer's performance to the level you expected when you bought it, and it can upgrade you to PostScript along the way.

The PacificPage XL combines Pacific Data Products' venerable PacificPage PE PostScript-emulation cartridge with an accelerator card that incorporates 2 megabytes of additional memory and a 32-bit RISC-based Intel 960 microprocessor. This captures the tasks of PostScript interpretation and page building from the printer's native 16-bit 68000 processor. The LaserJet's brain is freed to deal with all its other chores (e.g., I/O handling and engine interfacing). The bottom line is a substantial speed increase: I found an improvement of two to eight times over HP's own PostScript cartridge.

A simple front page of a newsletter produced with Ventura Publisher 3.0 for Windows took 2 minutes to print using the PacificPage XL card/cartridge combination; it took 4 minutes using HP's stand-alone cartridge. The page, which incorporated a 1¼- by 2¼-inch TIFF image and three PostScript fonts, took 8 minutes to print in standard HP Printer Command Language (non-PostScript) mode. Interestingly, because the PostScript screen fonts provided with the PacificPage XL are modified Bitstream FaceLift fonts, it was possible to print in PCL mode. They are converted to bit-mapped fonts by the PC and downloaded to the printer.

As intelligent as the PacificPage XL is, however, it is not all-knowing. It cannot, for instance, detect another memory board in the printer's second slot, so adding one will not make the printer any faster. (Using the PacificPage XL bundled with the 2 Plus 2 board, for example, had no effect on print speed with the sample page.) And because the accelerator card has special interface circuitry, it will not work as such with any PostScript cartridge except the PacificPage PE. (When I used it with other cartridges, the board behaved as an ordinary 2-MB memory board, though. When I used it with the HP cartridge instead of the 2 Plus 2 board, I got the same 4-minute print time with the sample page.)

I had a problem when running under Windows 3.0: Large or complex PostScript files (e.g., those that incorporate four or more PostScript fonts) can stall the PacificPage XL. But a solution was at hand. I traced the problem back to Windows' infamous WIN.INI file. I modified the printer time-out and device retry parameters, and the problem was gone.

For all that it delivers, the PacificPage XL's $999 price tag is a bargain. HP's stand-alone PostScript cartridge retails for $695. Toss in a 2-MB memory card (required for PostScript), and the price jumps past $999. And that's not counting the speed advantage of the PacificPage XL's accelerator board or the utility of the supplied screen fonts.

—Robert E. Calem

THE FACTS

PacificPage XL
$999

System requirements:
Hewlett-Packard LaserJet III, IIID, IIIP, or IIIsi.

Pacific Data Products
9125 Rehco Rd.
San Diego, CA 92121
(619) 552-0880
fax: (619) 552-0889
Circle 1165 on Inquiry Card.

Sprint Through Windows Development with Visual Basic

Even before I got the chance to try Microsoft's **Visual Basic**, rumors of the product were intriguing—a version of BASIC to program in Windows, a new visually oriented programming method, or an object-oriented BASIC. Two of the three rumors turned out to be true, and the name "Visual Basic" is an apt description of this new programming language. Microsoft's code name for the product, Thunder, is also a good metaphor for the impact the language will have on programming for Windows.

Visual Basic is Microsoft's first attempt to make Windows programming easy. Underlying it is a structured version of BASIC that is similar to QuickBASIC for DOS. It has a great many commands

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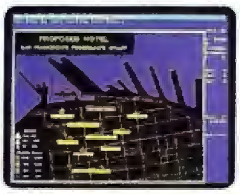

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San Jose, CA 95117

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THE FACTS

Visual Basic
$199

System requirements:
DOS system running Windows 3.0.

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
fax: (206) 883-8101
Circle 1164 on Inquiry Card.

and functions, and it makes consistent and continual use of procedures, as well as including the familiar idiosyncrasies of BASIC. Any competent BASIC programmer will rapidly be at home with it.

The big change comes about in how Visual Basic deals with the user interface and, more specifically, with programming for Windows. Unlike regular languages—in which you design the program, write the code, and run the program—Visual Basic combines interface design and coding into one step. You create the interface interactively, dropping in text boxes, command buttons, radio buttons, check boxes, and other interface elements. You then define lists of properties for them (e.g., position, fonts, and colors). You plug in menus and carefully position all the elements of the interface so that it looks right on-screen.

To enter in the real code of the program, you click on the items that issue the commands for each part of the program, such as menu selections. Visual Basic brings up a code window for that item, into which you enter the appropriate BASIC code.

Since Windows is an event-driven environment and many events can occur at any time, each item you place into the user interface can have many associated code subroutines, one for each possible event (e.g., key presses or mouse-clicks). The connecting code is automatically created by Visual Basic, which also tracks syntax and flags errors as you type them in. One subtle but impressive feature of Visual Basic is that it automatically corrects capitalization typos as you enter code into the code window. This saves a lot of frustrating time making a program look right and automatically formats the program to look good when printed.

Once you have entered the user interface and put in any necessary extra code, you can run the program from within the Visual Basic environment or create an .EXE file for use as a standard Windows application. Visual Basic includes some simple debugging tools within the environment to trace and step through a program and to set breakpoints. It also includes many icons that you can use in your own programs. The on-line tutorial and help system are both invaluable—one when getting started, and the other when you're programming in Visual Basic.

Programs you create with Visual Basic can run on any system under Windows, but they require a run-time dynamic-link-library file to be present on all systems where the program is running. This file is included with Visual Basic.

Already, there has been a great deal of hype about Visual Basic, with people saying that it will let anyone program easily for Windows. This is not strictly true. It will let any programmer create programs for Windows quickly and easily. But Visual Basic will not help an ordinary computer user produce a real Windows program. Somewhere underneath, you still have to write some BASIC code, and without some programming knowledge, you won't get very far.

What Visual Basic does is raise to a new level the quality of tools a programmer can use to design an application. Creating the user interface of a program, particularly one in a complex GUI environment like Windows, is a lengthy, arduous, complex, and often boring task for a programmer. It is so easy to create the user interface for a Windows program using Visual Basic that it is likely to be used for the creation of any Windows application where speed and power aren't issues.

—Owen Linderholm

Business and Pleasure Mix in a Notebook

As the first notebook computer from Philips Consumer Electronics, the **Magnavox Metalis/286** does a good job of mixing business with pleasure. It's sophisticated, yet reasonably priced and easy to become friends with.

Setting up the Metalis was straightforward. Setup, Working, and Utilities disks are provided, and the instructions are clear. GeoWorks Ensemble—a collection of icon- and menu-driven programs that work together to give you graphical multitasking applications—and a two-button mouse pen are bundled with the computer, adding to its versatility.

In addition to the mouse port, the com-

THE FACTS

Magnavox Metalis/286
$2699

Philips Consumer Electronics Co.
One Philips Dr.
P.O. Box 14810
Knoxville, TN 37914
(800) 882-1888
(615) 521-4499
fax: (615) 521-4330
Circle 1166 on Inquiry Card.

puter has the usual serial and parallel ports, as well as ports for a keyboard and a VGA monitor. I used the Metalis with an external modem, but you have the option of installing a 2400-bps internal modem for $399. When fully charged, the nickel-cadmium battery powers the Metalis for up to 3 hours; an auxiliary battery, which Magnavox says will run for 20 minutes, lets you replace the nickel-cadmium battery without turning off the computer. A standby mode lets you conserve battery power.

Measuring the normal notebook size of 8½ by 11 by 2 inches, the Metalis naturally has a compact keyboard, but one that I found easy to use. The keys have just the right feedback for my touch, although they were reminiscent of typewriter keys, clicking lightly along as I typed. Placement of the cursor and editing keys is more intuitive than on some small keyboards I've dealt with, and it didn't take me long to feel at home using them.

The Metalis/286's paper-white backlit VGA LCD screen is clearly a plus, in spite of an uneven, spotty appearance. While I was indoors writing this piece next to the glass wall overlooking my deck, the sun was doing some serious disappearing behind clouds and then popping out again with a determined brightness. At no time, whether the day was cloudy or bright, did I have difficulty seeing the display.

My major complaint about the Metalis has to do with the back port cover. While the left- and right-side port covers flip out and down, you have to remove the back cover—a frightening demand if you're absentminded, since its smallness and gray color camouflage it beautifully.

My second major complaint abruptly disappeared. When I first used the Metalis, it ran with a continous and annoyingly loud sound, as if it were constantly grinding away at saving a file. The noise stopped quite suddenly the day I sat down to write this critique, however, giving me a machine that ran silently. As Magnavox advertises: Smart. Very smart.

—Carol J. Swartz

Tape Backup Handles up to 700 Miserly Megabytes

High-capacity hard disk drives aren't unusual anymore: 330-MB, 512-MB, or even bigger drives are commonly found in LAN file servers—or even in the systems of those ever-elusive power users. Losing hundreds of megabytes of applications and data to drive failure can be an unmitigated disaster, so having a reliable backup system (and, of course, using it) is an absolute necessity.

Low-priced tape backup drives that handle up to 250 MB or so of data are common these days, but once you venture into a higher range, the choices get more limited and much more expensive.

Colorado Memory Systems, the company largely responsible for developing the first low-capacity tape backup systems, has entered the high-capacity fray

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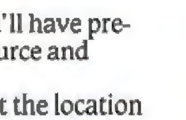

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* March 1991 study published by ISoft Decision, Inc., including CA-SuperProject 2.0, Microsoft Project For Windows, Symantec's Timeline 4.0, ABT Project Workbench and Scitor's Project Scheduler-5.

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with the **QFA-700** drive. While it doesn't have a clever name like the company's low-end Peanut drive, it's a unique hybrid of proven technology coupled with cutting-edge compression technology—at a comparatively low price. Using the latest long-length versions of the venerable DC-600-series tapes that have been available for years, along with hardware compression, the QFA-700 can store up to 700 MB on a single tape.

I've used Colorado Memory Systems drives for years and have never had any problems with them. They are solidly built, with a minimum of moving parts for high reliability. The same can be said for the QFA-700. Although it's larger than drives that use the small DC-2000 tapes, it still fits nicely in a standard half-height drive bay. It's also available as an external system if you don't have a free drive bay or if you want intermachine portability.

The secret of the drive's capacity is the full-length add-in controller card that uses the STAC compression chip. The STAC chip has been proven in a number of applications, including other Colorado Memory Systems drives. It's also responsible for some respectable speed. The QFA-700 backs up about 10 MB per minute. That's competitive with many other drives (often faster), including the high-end digital audiotape drives. And you can set up automatic backups for system-idle times.

As you might expect, the actual degree of compression you get varies by the type of file. I found that it ranged from a high of about 3.5 to 1 (for spreadsheet files) to a low of 1.5 to 1 (for .EXE files). And, naturally, my already-compressed archive files didn't compress any further.

If you've ever used a Colorado Memory Systems drive, the software interface will be familiar. Numerous partial and full backup options are available; just follow the directions on-screen. The only problem I had was software installation, but that was a function of my loaded system.

The hardware compression board requires dual interrupts and DMA channels, and the automatic installation was not able to detect that my caching hard disk drive controller was using one of the DMA channels that the QFA-700 wanted to use. I had to experiment a bit with the manual installation, but I was finally able to find a free DMA channel. (A word to the wise: If your system is loaded with add-in boards and peripherals, a system diagnostic program like CheckIt or System Sleuth can ease installation.)

A tape backup system like the QFA-700 will be used in a variety of machines, and the folks at Colorado Memory Systems provide lots of options. The DOS software that comes standard with the unit is compatible with Novell, 3Com, and PC Net LAN software. And they have not forgotten Unix aficionados; backup software for Unix and Xenix is available.

The QFA-700 drive is a logical middle ground between the ubiquitous low-end, low-capacity tape backup systems and the high-capacity, high-cost systems. It's a proven technology, and on a cost-per-megabyte basis, it simply can't be beat.

—Stan Miastkowski

THE FACTS

QFA-700
$1199; external version, $1498;
TC-02 controller, $399.95;
TC-02M controller (for Micro Channel), $499.95; Unix/Xenix backup software, $199.95

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

Colorado Memory Systems, Inc.
800 South Taft Ave.
Loveland, CO 80537
(303) 669-8000
fax: (303) 667-0921
Circle 1167 on Inquiry Card.

Multimedia Window Dressing

One of the reasons the Mac took an early lead over the PC in the promised land of multimedia was that it had graphics and audio capabilities built in. This was not so with the PC. You couldn't use devices without device drivers, and writing them is not for the faint-of-heart beginning programmer. The emergence of Windows 3.0 helped the situation, but it didn't go far enough.

Enter multimedia extensions to Windows, laughing. Software developers who have the **Microsoft Multimedia Development Kit** (MDK) can write to the generalized Media Control Interface using ordinary ASCII command strings or Windows messages. For more detailed control, you can use lower-level services for applications involving MIDI, CD audio, Autodesk Animator movies, joysticks, and videodisks. Conversely, multimedia presentation authors can work at a higher level. New versions of authoring packages like ToolBook handle the media interfaces internally, although you still need to learn about MCI control strings.

Along with the extra device support of multimedia extensions come additional hardware requirements. And, naturally, the requirements for developing multimedia applications are even greater. You must consider subtleties as well. Not every CD-ROM drive is up to the throughput requirements of multimedia applications. Only newer drives with internal look-ahead buffers (e.g., the Tandy CDR-1000, Hitachi CDR-3650, Sony CDU-541, or Toshiba XM-3201B) will do. In the beta version of the MDK, the only waveform audio card supported is the Sound Blaster, and the only 256-color graphics card supported is the Video Seven card with 512 kilobytes of RAM.

Multimedia extensions support high-quality MIDI equipment (e.g., the Roland LAPC-1d), as well as the low-quality MIDI music you can eke out of the Ad Lib–compatible part of a Sound Blaster card. You can add and use a videodisk player (e.g., the Pioneer LD-V4200). You can also add video-frame-capture hardware, but it isn't yet supported by multimedia extensions. You'd use it outside of Windows to create bit maps and movie files to be played within Windows.

The MDK comes with a few simple but serviceable data-preparation tools. The Convert tool reads a wide variety of waveform audio, bit-mapped graphics, graphics palette, and MIDI formats, and it writes to the rather smaller variety of formats useful in multimedia Windows. The FileWalk utility helps you sort out the various chunks in a RIFF file.

A Mac-based movie converter prepares Director files for use under Windows. The BitEdit and PalEdit tools offer primitive color bit-map editing facilities. For serious editing, you'd use a more powerful program, like Adobe Photoshop on the Mac or PhotoStyler under Windows.

WaveEdit provides you with simple

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NEWS

waveform recording, playback, and editing—enough to use the 12-kHz monaural capabilities of the Sound Blaster board. For higher-quality waveform preparation, you'd want a digital audiotape drive and something like a Turtle Beach 56-KB card and Turtle Beach SoundStage software. Alternatively, you could use Digi-Design AudioMedia on a Mac. Of course, if you want professional-quality sound, you may wind up hiring a professional sound studio. There's no substitute for good equipment operated by experts.

A glaring omission in the MDK is its lack of a MIDI editor. It also doesn't have much of a MIDI player. To prepare MIDI music, you'll need a MIDI controller (a MIDI keyboard or other instrument), a sound module (for synthesized or sampled sounds), a MIDI compatible with the Roland MPU-401, and sequencing software.

If things go as expected, multimedia PCs in the $2000 range and multimedia upgrade kits for under $700 will be available soon from Tandy and other vendors. Multimedia Windows is the first step toward a standard way to write applications that work properly on every vendor's multimedia PC. ■

—Martin Heller

THE FACTS

Microsoft Multimedia Development Kit
$500

System requirements:
A 10-MHz 286 with 2 MB of RAM; a VGA adapter and monitor; a 3½-inch 1.44-MB floppy disk drive; a 30-MB hard disk drive; a mouse; a CD-ROM player with audio outputs; 8-bit, 11-kHz waveform audio inputs and outputs; a music synthesizer chip and MIDI ports; an on-board analog audio mixer; and serial, parallel, and joystick ports.

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
fax: (206) 883-8101
Circle 1168 on Inquiry Card.

NEWS

WHAT'S NEW • SYSTEMS

Slimline Sophistication

A slimline unit with a small footprint, the 16-MHz Sensor SP-386SX is a complete system that includes Windows 3.0 and a number of software packages loaded on the hard disk drive. It also has an interactive on-screen tutorial.

The Sensor SP-386SX features a 40-MB hard disk drive, a 3½-inch floppy disk drive, 2 MB of RAM (expandable to 8 MB on the motherboard), and a 2400-bps internal modem. The system includes Super VGA with 512 KB of video RAM, 1024- by 768-pixel resolution, and a 14-inch EVGA monitor. The monitor supports all popular VGA modes, according to the manufacturer. Other features include a mouse; serial, parallel, and analog ports; two 16-bit expansion slots; and a 101-key keyboard.
Price: $1995.
Contact: Samsung Information Systems America, Inc., 3655 North First St., San Jose, CA 95134, (800) 446-7002 or (408) 434-5400; fax (408) 434-5653.
Circle 1271 on Inquiry Card.

The Sensor SP-386SX's slimness hides a system packed with features.

Security in a Notebook

The password-protected NBS-386S notebook computer from Fora comes with 1 MB of RAM (expandable to 5 MB), 64 KB of ROM, a 3½-inch floppy disk drive, an optional 20- or 40-MB hard disk drive, ports for an external VGA display and a keyboard, and parallel and serial ports.

The NBS-386S has a paper-white backlit LCD screen and a BIOS-controlled sleep mode. It supports OS/2, Unix, Xenix, and NetWare, as well as Windows 3.0.
Price: $2995.
Contact: Fora, Inc., 3081 North First St., San Jose, CA 95134, (800) 367-3672 or (408) 944-0393; fax (408) 944-0392.
Circle 1272 on Inquiry Card.

Fora's first notebook computer, the NBS-386S has password protection and an offer for SafeLink software.

Take the Office in a Briefcase

The Office, a portable system for those on the go, is based on the Tangent Model 320N notebook computer. A 20-MHz 386SX unit with 2 MB of RAM and a 387SX math coprocessor, the Office includes a Motorola 8000 portable phone, a 2400-bps pocket fax/modem, and a briefcase that has room for the optional Canon BJ10E printer, as well.

The computer features a backlit supertwist LCD with 640- by 480-pixel resolution and an external VGA monitor connector. The unit also has an internal 3½-inch floppy disk drive, a Conner Peripherals 20-MB hard disk drive, an external keyboard connector, and one parallel and two serial ports.
Price: $3995.
Contact: Tangent Computer, Inc., 197 Airport Blvd., Burlingame, CA 94010, (800) 223-6677 or (415) 342-9388; fax (415) 342-9380.
Circle 1273 on Inquiry Card.

A 286 with Growth in Mind

Leading Technology's 5500AT 12-MHz 286 system offers performance to grow with your needs. Outfitted with HyperDOS and DOS 4.1, the system also has Lotus Works installed on the hard disk.

The 5500AT comes with 1 MB of RAM, a 40-MB hard disk drive, 5¼- and 3½-inch floppy disk drives, a VGA monitor on a tilt-and-swivel base, a Microsoft-compatible mouse, and a 101-key keyboard. You set the system to run at 8 or 12 MHz using the turbo button on the front of the case.

Growth to 4 MB of memory is simple via easy-to-install SIMMs. Four expansion slots and a socket for a math coprocessor are present. Ports include two serial and one parallel.
Price: $1199.
Contact: Leading Technology, Inc., 10430 Southwest Fifth St., Beaverton, OR 97005, (800) 999-5323 or (503) 646-3424; fax (503) 626-7845.
Circle 1274 on Inquiry Card.

A Platform for a Workstation

A small-footprint desktop system from Astrix, the Platform is a 33-MHz 486 PC/workstation. The unit includes 128 KB of cache memory, 1 MB of RAM, an Intelligent Drive Electronics controller card, and a 3½- or 5¼-inch floppy disk drive. Additionally, the Platform has one parallel port and two serial ports.
Price: $1991.
Contact: Astrix Computer Corp., 1546 Centre Pointe Dr., Milpitas, CA 95035, (800) 445-5486 or (408) 946-2883; fax (408) 946-1610.
Circle 1275 on Inquiry Card.

A Board to Remember

The OS/RAM32plus memory card automatically configures itself for 16- or 32-bit operation. Compatible with all operating systems and programs, the card provides from 2 to 128 MB of extended and expanded memory in one slot.

OS/RAM32plus uses 1-, 4-, and 16-MB SIMMs for various memory combinations. Its single-chip interface handles 128 MB at the highest data rate supported by Micro Channel architecture.

Price: $349 without memory.

Contact: Capital Equipment Corp., 76 Blanchard Rd., Burlington, MA 01803, (800) 234-4232 or (617) 273-1818; fax (617) 273-9057.

Circle 1276 on Inquiry Card.

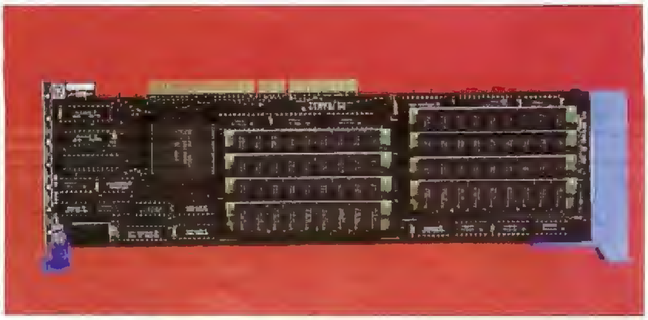
Apex for Mac Math

Second Wave's Apex, a plug-in math coprocessor board for the Mac LC, performs at 16 MHz. Based on Motorola's 68882 math coprocessor chip, the triangular Apex plugs into the Processor Direct Slot of the LC. The board accelerates math-intensive tasks such as CAD, graphics, and spreadsheets by five to 10 times, the company says.

Price: $249.

Contact: Second Wave, Inc., 9430 Research Blvd., Echelon II, Suite 260, Austin, TX 78759, (512) 343-9661; fax (512) 343-9663.

Circle 1277 on Inquiry Card.



The self-configuring OS/RAM32plus provides up to 128 MB of extended and expanded memory in one slot.

Memory on a Motherboard

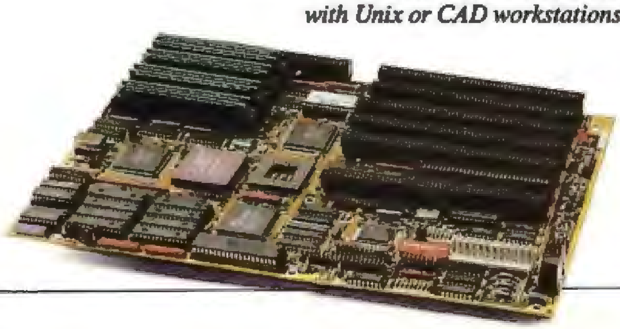
One of many features on Cache Computers' Cache386-40 motherboard is AMD's 386 processor. The board has up to 256 KB of write-back cache memory, up to 32 MB of on-board memory via 4-MB SIMMs, and up to 64 MB of memory with an optional expansion card. It also has a floppy disk drive controller, interfaces for one parallel and two serial ports, and a 32-bit expansion slot.

Price: $900.

Contact: Cache Computers, Inc., 46714 Fremont Blvd., Fremont, CA 94538, (415) 226-9922; fax (415) 226-9911.

Circle 1278 on Inquiry Card.

Based on the AMD 386 processor, the Cache386-40 works with Unix or CAD workstations.



Refreshing Color Control

A graphics controller capable of multiple resolutions, the Cobra Elite 16 performs well in CAD and Windows 3.0. Add VMI's RenderReady technology in support of true color, and you have the Cobra Elite Spectrum.

The Cobra Elite is capable of 1024- by 768-pixel resolution with 70-Hz and 60-Hz refresh rates and 800- by 600-pixel resolution with a 56-Hz refresh rate. You choose the refresh rate you need for your application. The board includes 1 MB of DRAM, upgradable to 2.5 MB with an optional DRAM kit. An optional snap-on VGA daughtercard provides VGA pass-through capability.

Price: Cobra Elite 16, $1395; Cobra Elite Spectrum, $1795.

Contact: Vermont Microsystems, Inc., 11 Tigan St., Winooski, VT 05404, (800) 354-0055 or (802) 655-2860; fax (802) 655-9058.

Circle 1279 on Inquiry Card.

One Board, Multiple Personalities

The Volante Multi-Personality Series of graphics coprocessor boards lets you tailor the graphics capability of your AT. With snap-on modules, the AT1100 can conform to your changing requirements. Graphics software compatibility includes X Window System, Super VGA, TIGA, 8514/A, and Windows.

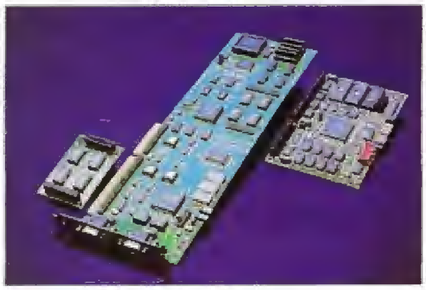
The basic board—the AT1100—uses the true-color module for a 1024- by 768-pixel resolution. For 1280- by 1024-pixel resolution, you remove the AT1100 module and snap on the 3- by 2-inch AT1300 daughterboard. If you need still higher resolution, you can get it with the AT1600 daughterboard.

A snap-on VGA daughterboard featuring the Tseng Labs VGA chip is an option, as are an upgrade in refresh rate from 60 Hz to 72 Hz and the TMS34082 floating-point coprocessor.

Price: AT1100, $2995; AT1300 or AT1600, $3995; AT1300 or AT1600 module only, $900.

Contact: National Design, Inc., Houston Building, Suite 203, 9171 Capital of Texas Hwy., Austin, TX 78759, (512) 343-5055; fax (512) 343-5053.

Circle 1280 on Inquiry Card.



CAD, Windows 3.0, and true color applications are all possible with the Cobra graphics controller.

New Fonts for Your Apple Printer

Apple LaserWriter IINTX users now have access to an additional 25 PostScript fonts. FontCard NTX, which plugs directly into a font-expansion connector on the LaserWriter IINTX's controller board, stores its collection of headline and other typefaces in ROM. Bundled with each card are Adobe Type Manager software and Mac versions of the PostScript fonts.

FontCard NTX includes bit-mapped versions of the 25 fonts, which you can install on each Mac attached to the network. Once the fonts are installed, you can print them as scalable outline characters. The fonts include 14 headline fonts from different type families, five Helvetica fonts, four Adobe Garamond fonts, and two Tekton fonts that simulate hand lettering for drawings.
Price: $595.
Contact: Sonnet Technologies, Inc., 18004 Sky Park Cir., Suite 260, Irvine, CA 92714, (714) 261-2800; fax (714) 261-2461.
Circle 1285 on Inquiry Card.

Sonnet's FontCard NTX increases the LaserWriter IINTX's capabilities.

Add Sound to Your PC

SoundByte, an audio recording and playback unit, captures and digitizes sound for the PC. The unit lets you attach high-quality sound files to multimedia and educational programs, business applications such as spreadsheets, and gameware. Compatible with DOS and Windows, SoundByte can take audio input from a microphone or hi-fi equipment, compress files in real time, and store them on your computer's hard disk or on a network server. The unit plugs into the parallel port.
Price: $249.95.
Contact: Meridian Data, Inc., 5615 Scotts Valley Dr., Scotts Valley, CA 95066, (408) 438-3100; fax (408) 438-6816.
Circle 1286 on Inquiry Card.

Network Security Personalized

An add-in controller board and card reader provide security for PC workstations and networks. The Securecard Network Security System provides multiple levels of protection against viruses, data theft, and unauthorized access.

The Personal Securecard reader configures and activates the system when you insert your programmed credit-card-size Securecard into it. Both the reader and the card can be programmed to limit access to a local disk, peripherals, and the network.

The system features the Run Time Security Subsystem; Intermission Lockout; and built-in memory, which lets the system run without consuming any PC memory. Personal Securecard requires a full-size expansion slot and an internal storage drive bay.
Price: $995.
Contact: Datamedia Corp., 20 Trafalgar Sq., Nashua, NH 03063, (603) 886-1570; fax (603) 886-1782.
Circle 1287 on Inquiry Card.

SpeedScan Offers Flexibility as Well as Speed

A new keyboard-scanning option is available for people who are physically disabled. For use with one or two switches, SpeedScan lets you scan a keyboard image on your screen at your own speed; you can scan from the top or from the bottom in the opposite direction.

The layout of the keyboard is based on how often you use a particular letter or symbol. The keys for spacing, shifting, and erasing are readily available, and keyboards are designed for linear or row/column scanning. The screen displays both the keyboard image and what you are typing.
Price: $695.
Contact: Pointer Systems, Inc., 1 Mill St., Burlington, VT 05401, (800) 537-1562 or (802) 658-3260; fax (802) 658-3714.
Circle 1288 on Inquiry Card.

Pocket Protection for Your Mouse

The space-saving Mouse Pocket protects your mouse when you're not using it. Secured with double-faced tape to the side of your computer or other flat surface, the Mouse Pocket helps organize your work space. Any size mouse pops into the pocket.
Price: $5.95.
Contact: Computer Cover-up, Inc., 2230 South Calumet St., Chicago, IL 60616, (800) 282-2541 or (312) 326-3000.
Circle 1289 on Inquiry Card.

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Mission Critical Rackmount 3014 & 8014 *(above) each has 14 option slots, 3 drive bays. For computing where desktops die. A complete 386SX 3014 system from $4395. A complete 386SX 8014 system from $4675 Without monitors.*

You won't find them torturing their systems like we torture ours either. Not only do we perform extensive "shake, rattle and roll" tests on each new design, we pretest all our systems before they leave our dock. We burn them in at 55C/ 131F for 48 hours straight

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	Backplane architecture	Shock mounted drives	48 Hr burn-in at 131 degrees	Total ISA slots	100,000 MTBF Power supply	Built like an M1A1	Manufacturers SRP
Compaq 386SX Model 84	No	No	No	5	No	No	$3699
Texas Micro 2003	Yes	Yes	Yes	10	Yes	Yes	$3950

Both systems similarly configured with 2MB RAM, Texas Micro-104MB hard drive, COMPAQ-84MB hard drive, 1.2MB floppy, VGA graphics, keyboard, monitor not included, purchase price discounts may vary by quantity and reseller.

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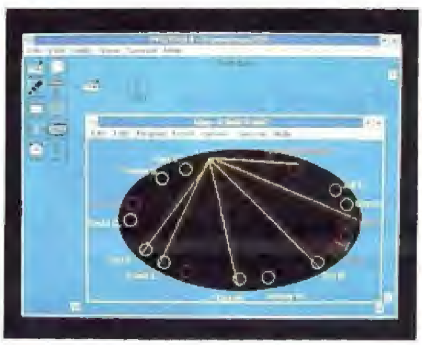
Link a Phone to Your Laptop

Laptop Phone Link connects a fax or modem directly to your office or hotel phone system without a dedicated phone line. A stand-alone unit, Laptop Phone Link works with any modem-equipped desktop, laptop, notebook, or fax, according to the manufacturer, and attaches to the RJ-11 phone handset connector. The device measures 3¾ by 1⅜ by 1⅛ inches and weighs less than 2½ ounces.
Price: $119.95.
Contact: Solectek Corp., 6370 Nancy Ridge Dr., Suite 109, San Diego, CA 92121, (800) 437-1518 or (619) 450-1220; fax (619) 457-2681.
Circle 1281 on Inquiry Card.


Laptop Phone Link works without software or external power.



ProTools Streamlines Protolyzer

ProTools has streamlined its Protolyzer network control system in version 1.1. The new Protolyzer simplifies network management with its protocol suites, a frame editor, and Sniffer data-conversion capabilities.

Protolyzer's new database lets you replace confusing hexadecimal node addresses with actual names that represent each workstation. You can also add your own information about a particular workstation.

Protocol support now includes XNS, expanded TCP/IP, and Banyan Vines. Optional adapter cards include IBM's 16/4 Token Ring TAP, Compaq's 16/4 32-bit Bus Master Token Ring, the NE3200 32-bit Bus Master Ethernet, and NCR's WaveLAN wireless LAN.

Protolyzer 1.1 converts Network General's Sniffer trace files into its own data files, allowing use of Sniffer data for extended analyses. Its frame editor lets you create or modify data frames traveling over the wire.
Price: $6995 and up.
Contact: ProTools, Inc., 14976 Northwest Greenbrier Pkwy., Beaverton, OR 97006, (503) 645-5400; fax (503) 645-3577.
Circle 1282 on Inquiry Card.

Micro Modems on the Move

The index-card-size MicroPorte modems fit easily into an attaché or laptop case. Designed to connect to PCs and Macs—notebooks to desktop systems—the MicroPortes feature V.42 error correction and V.42bis data compression.

The 9600-bps MicroPorte 542 runs on a 9-V battery for 1½ hours of use and has a sleep mode. The MicroPorte 1042 adds Microcom Turbo Mode for speeds exceeding 12,000 bps and provides dial-up communications. Both modems are packaged with batteries, cables, and Microcom's Carbon Copy Plus remote control/file transfer software.
Price: MicroPorte 542, $449; MicroPorte 1042, $649.
Contact: Microcom Systems, Inc., 500 River Ridge Dr., Norwood, MA 02062, (800) 822-8224 or (617) 551-1000; fax (617) 551-1007.
Circle 1283 on Inquiry Card.

Background Faxing in Windows

PC-compatible EZ-Faxit for Windows 3.0 lets you send or receive faxes from within any Windows 3.0 application. The card requires as little as 4 KB of RAM.

EZ-Faxit works from the Windows printer dialog box and lets you fax any fonts or graphics in your application. The product, working in the background, can concurrently send and receive faxes, convert a document to fax format, scan pages, and print received faxes.

EZ-Faxit includes a fax manager GUI that provides an on-screen display of received faxes and a preview of outgoing faxes prior to transmission.
Price: EZ-Faxit (4800 bps), $299; EZ-Faxit (9600 bps), $499; software only, $199.
Contact: Calculus, Inc., 522 Mercury Dr., Sunnyvale, CA 94086, (408) 733-7800.
Circle 1284 on Inquiry Card.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Sprint	139
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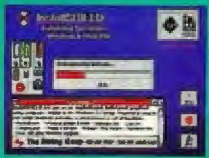

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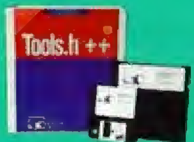

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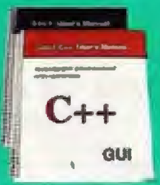

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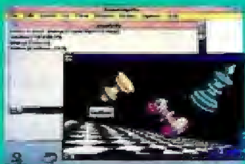

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With Zortech's C++ Developer's Edition 3.0, you can develop compatible applications for DOS, Windows 3.0, OS/2, and DOS 386 in one package. The package includes Windows development tools and documentation, letting you develop Windows applications without purchasing the Microsoft Windows Software Development Kit, the company says.

With the Zortech 386 DOS Extender, included in the Developer's Edition, you can develop applications of up to 4 gigabytes. The package also includes Zortech's WinC windows library, which can compile DOS-command-line programs into true Windows applications without source code modification.

Zortech also offers Zortech C++ for Windows 3.0. It includes WinC, plus DOS- and Windows-specific versions of the Zortech C++ debugger, the single-monitor workbench, resource editors, an icon editor, and on-line help. Included are Windows tools and documentation.

A Science and Engineering version has all the capabilities of the Developer's Edition, plus new features to simplify numerical computing. The compilers are IEEE 748 floating-point compliant. The package also includes the M++ Library of multidimensional array classes for C++.

Price: Windows version, $399.95; Developer's Edition, $699.95; Science version, $999.95.
Contact: Zortech, Inc., 4-C Gill St., Woburn, MA 01801, (617) 937-0696; fax (617) 937-0793.
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When combined with the KF-9500 Document Display System, Kofax Image Products' Developers Toolkit 1.2 lets you write applications capable of displaying a document in Windows 3.0 and other environments in less than a second, the company says.

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With the combination of Kofax Image Products' hardware controllers and version 1.2 of the Developers Toolkit, you can create high-speed image storage and retrieval applications for DOS, Windows, OS/2 Presentation Manager, and Unix environments. Version 1.2 of the company's Developers Toolkit supports the company's new KF-9500 Document Display System controller, which can compress and decompress images at rates of 50 Mbps. The company provides a variety of other controllers and the KF-910 software-only document retrieval engine.

Price: Developers Toolkit 1.2: DOS version, $1195; Windows, $1595; OS/2, $1795; Unix versions, $2495 each. KF-910, $195 and up. Controllers, $1395 to $3195.
Contact: Kofax Image Products, 3 Jenner St., Irvine, CA 92718, (714) 727-1733; fax (714) 727-3144.
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ATF Tests Your Windows Applications

A new program designed to test software in a distributed GUI environment automates the testing of Windows 3.0 applications. Softbridge's Automated Test Facility, which runs on OS/2 1.2 or higher, contains two components that mirror the client/server environment: the Executive, an OS/2 Presentation Manager program, and the Controller, a Windows 3.0 program.

Price: Starts at $19,000.
Contact: Softbridge, Inc., 125 CambridgePark Dr., Cambridge, MA 02140, (617) 576-2257; fax (617) 864-7747.
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ZBasic-PC 4.6, for writing programs on the 386 and 486, also lets you write programs on a non-386 machine and recompile them in the 32-bit version for 386- and 486-based hardware. Other features include device-independent graphics, supporting video cards for VGA and MCGA; advanced communications; dual monitor support; compiling within the editor; and network support.

Price: $99.95.
Contact: 32 Bit Software, Inc., 3232 McKinney Ave., Suite 865, Dallas, TX 75204, (800) 322-4879 or (214) 720-2051; fax (214) 855-0677.
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Windows DLL Added to C++ Library

With the new Windows 3.0 Dynamic Link Library included in CodeBase++ 1.01 you can create applications that are compatible with the data, index, and memo files of dBase III and IV. You can use it with C++ compilers for DOS, OS/2, or Windows, Sequiter says.

Price: $295.
Contact: Sequiter Software, Inc., Suite 209, 9644-54 Ave., Edmonton, Alberta, Canada T6E 5V1, (403) 448-0313; fax (403) 448-0315.
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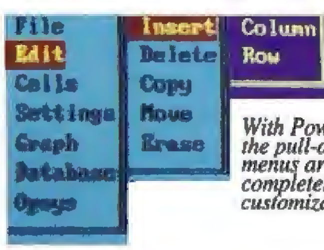
With PowerCell, you can modify the table-driven menu system to provide keystroke compatibility with products like Lotus 1-2-3, Quattro, and Excel. And with source code, PowerCell is infinitely customizable - you can add features to expand your application and remove features to save space or restrict your end users. PowerCell supports Pharlap's DOS extender, so you can build even bigger applications.



With PowerCell, the pull-down menus are completely customizable.

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PowerCell Features: Support for all standartd spreadsheet menu selections except graphics. Full complement of spread-sheet @functions, including financial and statistical functions. Keystroke compatible with most popular spreadsheets. WKS WK1, DBF, ASCII file formats supported. Microsoft C and Borland C compilers. C source code is available. No royalties. Supports: MS-DOS.

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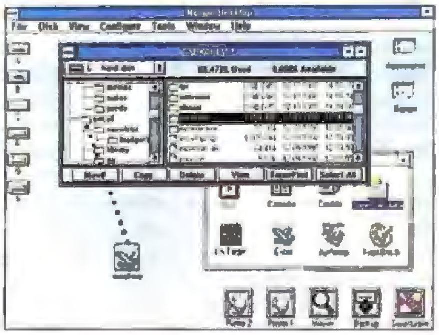
Now you can make Windows perform the way you've always wanted—without changing the way you use it. For just $149,* The Norton Desktop includes an impressive collection of Peter Norton's best programs that make Windows more accessible and a whole lot easier to use.



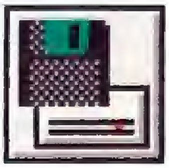
The Norton Desktop integrates a file manager and program manager into one seamless desktop.

For starters, you can move your programs and file groups from the confinement of the Windows Program Manager to the freedom of The Norton Desktop—it's like having your file manager and program manager transparently integrated!

The Norton Desktop's enhanced file manager allows you to launch, copy, move, view and delete a file or application by clicking and dragging icons on the desktop. You can also print documents by dragging files to any printer icon. In fact, our icon editor makes it easy to select any of the more than 150 icons provided, while The Norton Viewer enables you to instantly view files from over 30 Windows and DOS applications.

Not only does The Norton Desktop make sure that your files are well managed, it also ensures they're well protected.

We've included The Norton Backup™ for Windows,** the fastest, most reliable Windows backup you can buy. You can easily set-up automatic backups for any time of the day or night, whether you're present or not, and backup in the background, even to and from network drives.



Norton Backup

The Norton Desktop also provides the easiest UnErase™ ever, for stand-alone PCs *and* network systems, plus the industry's most powerful automatic disk diagnosis/repair.

UnErase

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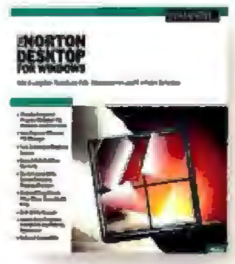
So if you're ready to improve your Windows, call **1-800-343-4714, Ext. 722P** for more information about The Norton Desktop. Or visit your nearest dealer and pick up a copy for yourself. It could be the best thing that ever happened to your PC.



SYMANTEC.

Circle 215 on Inquiry Card.

NEWS

WHAT'S NEW • BUSINESS SOFTWARE

WYSIWYG Added to 1-2-3

Lotus 1-2-3 for DOS release 2.3 now includes interactive WYSIWYG display and presentation-quality output capabilities, spreadsheet auditing tools, a file-viewing feature, and many other improvements. You can perform all your spreadsheet operations from within the WYSIWYG environment, including adding, modifying, or deleting spreadsheet information.

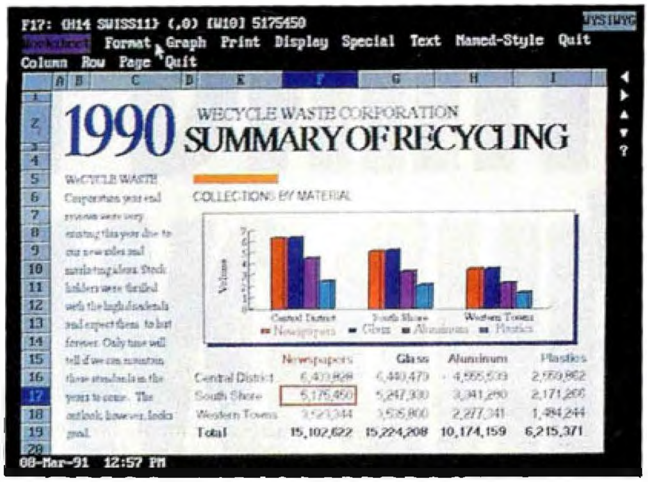
With the addition of the viewing technology of Lotus Magellan, you can quickly find and view the contents of a spreadsheet file without opening or retrieving it. Viewer technology eliminates the need to remember eight-character DOS filenames.

1-2-3 for DOS 3.1+, a spreadsheet for more advanced spreadsheet needs, includes 3-D multiple-page worksheet capabilities and the Solver, an advanced goal-seeking tool.

Price: 1-2-3 release 2.3 standard edition, $495; network server, $795; node edition, $495. 1-2-3 release 3.1+: $595, $895, and $595, respectively.

Contact: Lotus Development Corp., 55 Cambridge Pkwy., Cambridge, MA 02142, (617) 577-8500.

Circle 1295 on Inquiry Card.



The WYSIWYG display and printing capabilities in Lotus's two new DOS spreadsheets help you create presentation-quality output quickly and easily.

New Excel Knows System 7.0

Microsoft's Excel 3.0 for the Mac not only supports Apple's System 7.0, it is aware of it and thus supports virtual memory, Balloon Help, and Apple Events. The program supports System 7.0's Publish and Subscribe, which lets you "publish" (make available) all or a portion of your spreadsheet. Other users can "subscribe" to your document, and as you make changes to your work, these changes are relayed to the subscribers.

Version 3.0 integrates outlining, where you can collapse complex spreadsheets or expand them to view different levels of detail. A Consolidate feature lets you combine and summarize worksheets. The new spreadsheet also includes a Solver for multivariable goal seeking, and linear and nonlinear optimization. An Autosum button on the Toolbar lets you find the sum of a row or a column.

You can mix and match text and graphics on a worksheet. A Style feature lets you specify a group of formatting characteristics and reference it by name. Excel 3.0 offers 68 chart types, including 24 3-D charts that you can rotate.

Price: $495.

Contact: Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052, (206) 882-8080; fax (206) 883-8101.

Circle 1296 on Inquiry Card.

Flowcharting with 3-D Charts

Version 7.0 of EasyFlow, a program for quickly creating flowcharts, organizational charts, and hierarchical diagrams, now supports 3-D charts, which allow a single chart to contain multiple levels of linked charts. With this feature, you can link any number of subcharts to an overview chart. The top level provides a general view of an organization or work flow, but by highlighting a shape, you can get more detailed information. The program lets you easily modify diagrams.

Price: $230 before November 30; $280 after. Node 2-pack, $390 and $475, respectively.

Contact: HavenTree Software, Ltd., P.O. Box 1093, Thousand Island Park, NY 13692, (800) 267-0668 or (613) 544-9632; fax (613) 544-9632.

Circle 1297 on Inquiry Card.

Ace Files Low with Database for Windows

Hoping to capitalize on the lack of low- and midrange database programs for Windows 3.0, Ace Software developed AceFile, a dBase-compatible package that doesn't require programming. The program includes a screen painter for creating custom forms and offers numerous built-in form layouts. AceFile will let you load dBase files, organize data in AceFile layouts, and print the information in labels, letters, invoices, or reports.

The program lets you open a contact database with several views, such as list, record, mail-merge, report, cross-tabulation, and graph. You can open and manipulate multiple views of the same database concurrently. As you switch from one record to the next, AceFile automatically updates the record's various views.

The program lets you cross-tabulate records from different sources and view data in 2-D and 3-D graphs. AceFile's support for mathematical expressions lets you set up a database in spreadsheet-like fashion, where one field's value is derived from math operations on other fields.

By supporting Window's Multiple Document Interface, AceFile lets you open and view up to 10 databases at once, with 10 index files per database. Each record can have up to 128 fields with 4000 characters per record.

Price: $295.

Contact: Ace Software, 1740 Technology Dr., San Jose, CA 95110, (408) 437-3456; fax (408) 437-1018.

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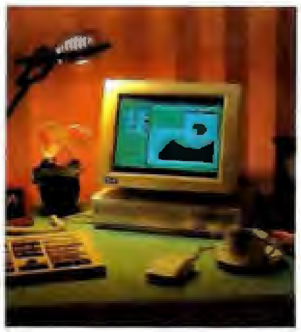

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Epson Changes The Face

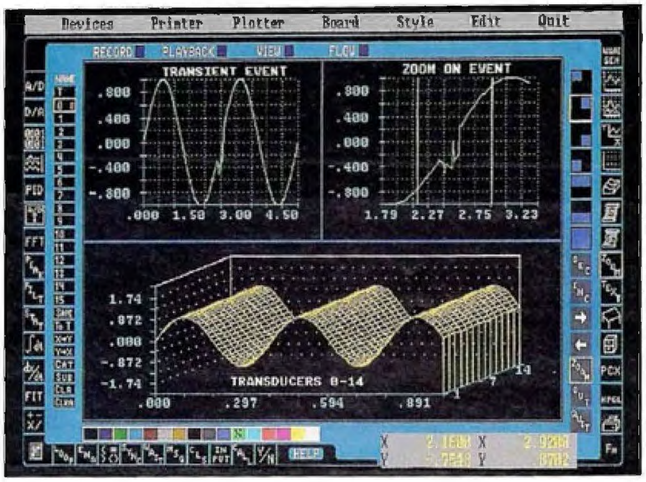
Acquire, Analyze, and Graph Data

The Easyest LX toolkit for PC-based data acquisition, analysis, and graphics offers interactive use and the ability to write programs by pointing and clicking on screen icons. The program executes operations immediately after you select them, without requiring you to string icons together. You can acquire data over as many as 16 channels each from up to 10 boards. Easyest LX lets you capture signals at maximum hardware speeds and supports multiple transducers, including thermocouples.

The package offers many tools, including a strip-chart recorder program that provides continuous real-time display and file storage of multiple channels, and a built-in waveform generator.

The program integrates graphics and analysis tools, letting you view and plot your data instantly. You can overlay an unlimited number of plots, the company says. Easyest LX can produce semi-log and log-log plots, waterfall plots, and others. It also lets you zoom and scroll through data.

You can analyze complete waveforms, not just perform point-by-point comparisons. Analysis functions include curve fits, peak/valley finds, descriptive statistics, integration, differentiation, basic math operations, fast Fourier transforms, and inverse FFTs.
Price: $1295.
Contact: Keithley Asyst, 100 Corporate Woods, Rochester, NY 14623, (800) 348-0033 or (716) 272-0070; fax (716) 272-0073.
Circle 1299 on Inquiry Card.



Easyest LX offers a range of tools for data acquisition applications. The interactive zoom and scroll lets you examine your data with ease. The waterfall plot lets you compare signals over different channels or runs.

Symbolic Math for the HP 95LX

The new version of Derive, a symbolic math system that runs on Hewlett-Packard's new 95LX Palmtop PC, lets you add to the program's built-in functions by writing your own recursively or iteratively defined functions. Version 2.0 also includes more than 200 functions and variables in the 23 new or revised utility files to extend the program's built-in capabilities. Soft Warehouse says these functions provide good examples of how to program your own extensions.

The Derive 2.0 symbolic math system applies the rules of algebra, trigonometry, calculus, and matrix algebra to solve numerous problems. The program can also produce 2-D and 3-D plots of expressions and do arithmetic that's accurate to thousands of digits, according to the company.
Price: $289.
Contact: Soft Warehouse, Inc., 3615 Harding Ave., Suite 505, Honolulu, HI 96816, (808) 734-5801; fax (808) 735-1105.
Circle 1300 on Inquiry Card.

Monarch's DSP for the PC

Monarch combines filter design, analysis, and graphics on the PC. In addition to the filter design portion, which includes finite impulse response filters and infinite impulse response filters, Monarch has a signal and system analysis section, called Siglab, for testing and verifying your design. You can generate test signals and system responses and display them in multiple graph windows. The program also offers 2-D and 3-D graphing.
Price: $595; adaptive filters, $399; code generators, $99 each.
Contact: The Athena Group, Inc., 3424 Northwest 31st St., Gainesville, FL 32605, (904) 371-2567; fax (904) 373-5182.
Circle 1301 on Inquiry Card.

Maple V Engine Soups Up Mathcad

Technical-calculation software developer MathSoft now offers a new version of its Mathcad program that adds support for Windows 3.0, electronic handbooks, and symbolic algebra calculating capabilities. Mathcad's new symbolic power is based on the Maple V symbolic algebra engine from the University of Waterloo and Waterloo Maple Software of Ontario, Canada. Other versions of Mathcad are available for the Mac and Unix.

Along with the Maple engine, the new Mathcad has electronic handbooks that act as on-line reference libraries, giving you instant access to standard formulas, many from CRC reference handbooks.

With the program's live document interface, you can use Mathcad as you would a scratchpad. As you enter formulas, the program typesets them automatically. You can set up formulas with variables and define a range of variables, and Mathcad will return a table of answers and plot them if you like.

The program's split-screen capability lets you view CRC formulas on one side and the live document on the other, and cut and paste between the two, combining equations with explanatory text and graphics. You can also do what-if analysis: The program automatically recalculates functions and graphs when you change a relationship or constant.
Price: $495.
Contact: MathSoft, Inc., 201 Broadway, Cambridge, MA 02139, (617) 577-1017; fax (617) 577-8829.
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NEWS

WHAT'S NEW • OTHER SOFTWARE

Do It Again in Windows

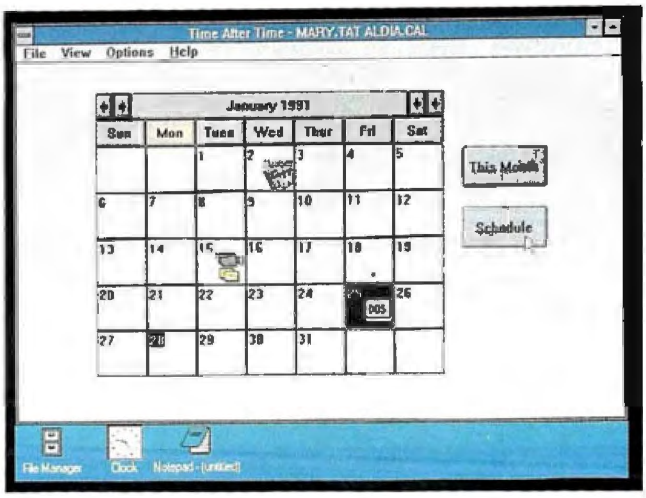
Time After Time, a new event-processing program from Aldia Systems, lets you automatically run unattended Windows and DOS applications at predetermined times and dates. If you're interactively running a Windows application when an event is scheduled to occur, the scheduled program runs in the background without disturbing you in your application, Aldia says.

You can use the program to back up a workstation or server, upload or download information, or perform statistical analysis or database manipulation at off-peak hours.

Price: $79.95.

Contact: Aldia Systems, Inc., P.O. Box 37634, Phoenix, AZ 85069, (602) 866-1786; fax (602) 866-2345.

Circle 1311 on Inquiry Card.



You can schedule single occurrences of an unattended program on Time After Time's calendar, or you can schedule events in the calendar program included in Windows 3.0, Aldia says.

Know Your Video Display System

If you work 40 hours a week in front of a video display, you average about the same number of hours a year face-to-face with your PC as you do with your spouse. And it's a safe bet that your PC is not nearly as easy on your eyes.

Sonera Technologies' new DisplayMate utility package is designed to evaluate and optimize the performance of video displays and adapters, allowing you to set up the display for optimum quality and comfort, test manufacturers' claims, and find the source of video and software incompatibilities. Managers can use it to track their video display system hardware.

DisplayMate has more than 200 patterns for testing displays and more than 100 diagnostic tests to evaluate video adapters. Although Sonera says DisplayMate can reduce eye fatigue and strain, the utility is not an eye-exercise program. A Screen Test Pattern lets you keep the display optimally adjusted, and you can use it through the course of the day as lighting changes or as setup parameters drift.

One set of tests lets you compare the actual resolution limit of the display with the manufacturer's claim; another looks for errors in the registration of red, green, and blue images, called the color convergence error; and a third test simplifies the process of measuring screen distortion. Many other tests are included.

Price: $79.

Contact: Sonera Technologies, P.O. Box 565, 4 Robin Rd., Rumson, NJ 07760, (800) 932-6323.

Circle 1312 on Inquiry Card.

Nutrition Software Works Out

Nutridata now offers a program called the Diet Balancer for controlling weight, reducing cholesterol, and improving general health and fitness. The program lets you access nutritional data on over 1700 foods, factoring in information such as sex, weight, and exercise activities.

You can create a list of daily nutritional requirements and explore the range of foods you can eat, instead of following a strict list of do's and don'ts.

Price: $79.95.

Contact: Nutridata Software Corp., P.O. Box 769, 223 Meyers Corners Rd., Wappingers Falls, NY 12590, (800) 922-2988 or (914) 298-1308.

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Read On for Foreign Language Comprehension

Instead of focusing on vocabulary, rules of grammar, and memorization drills, some college textbooks are focusing on techniques that use conversation and classroom interaction. Now a company called Transparent Language is using a similar technique in its line of software programs that lets you immediately read and understand foreign-language literature.

As you read a Transparent Language title, you can read as you would any other book, except you're looking at your PC screen. The top half of the screen contains the text in the original language. When you get stuck, you can use the information boxes in the lower half of the screen to translate the text.

You can translate text on a word-for-word basis or, in the case of an idiomatic phrase, use the phrase translation box. Other boxes give you the meaning of a segment as it might have been written if the text had originally been written in English or provide other notes and comments.

The company offers a package with four titles, each a separate work in a different language, plus an audiocassette. You can also buy additional titles. Titles are currently available in Spanish, French, German, and Latin.

Price: $95; additional titles, between $10 and $20.

Contact: Transparent Language, 9 Ash St., P.O. Box 575, Hollis, NH 03049, (800) 752-1767, (800) 244-8952 in New Hampshire, or (603) 465-2230; fax (603) 465-2779.

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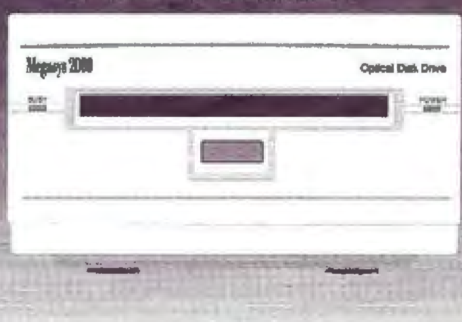

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NEWS

WHAT'S NEW • GRAPHICS

Conceptual 3-D Design in Windows

Alias Upfront, a program for architects, planners, and designers for creating shaded 3-D designs in Windows 3.0, lets you model and conceptualize designs in 3-D without having to think in x,y,z coordinates, as you do in many CAD programs. The package lets you draw shapes with only a few mouse strokes; add shading, color, and scanned background images; and rotate the view to any angle.

Alias Upfront lets you place a building design into a scanned photograph of its proposed site. You can match the building to the perspective in the photograph. If you alter or move the building, it retains the correct relationship to the site, the company says.

Upfront shades objects as sunlight would. You can set the sun's direction for a certain date, time, and location. The program can export in 3-D DXF, CSV, TXT, TIFF, PCX, and PIX.

Price: $995.

Contact: Alias Research, Inc., Alias Style Division, 110 Richmond St. E, Toronto, Ontario, Canada M5C IPI, (416) 362-9181; fax (416) 362-4696.

Circle 1004 on Inquiry Card.

Alias Upfront lets you place buildings and other objects into a scanned photograph. When you click on three vertices of an object in the scanned image, the program matches the building to the perspective in the photograph.

PhotoStyler Brings Prepress to the PC

When combined with one of the recent crop of Windows-compatible 24-bit graphics cards, the PhotoStyler color-image-processing software for PCs offers a variety of professional-quality image-manipulation tools. U-Lead Systems says it developed PhotoStyler with the goal of turning PCs running Windows 3.0 into affordable prepress art-production workstations.

With PhotoStyler, which works with EGA, VGA, 8514/A, and 24-bit displays, you can retouch, composite, and color-correct images. PhotoStyler provides several special effects (e.g., filters, simulated 3-D spatial distortion, and motion blur) to create pixel-perfect images.

You can save images in TIF, TGA, Encapsulated PostScript, PCX, BMP, and GIF formats and print on any Windows 3.0– or PostScript-compatible printer for producing publication-ready color separations. The program supports RGB, CMYK, and HSB/HLS color models.

Price: $795.

Contact: U-Lead Systems, Inc., 680 Knox St., Torrance, CA 90502, (213) 538-8911; fax (213) 538-2254.

Circle 1006 on Inquiry Card.

PhotoStyler offers photo-realistic image enhancement for processing 24-bit color, gray-scale, and black-and-white images.

TrueType Fonts Metamorphose in Infini-D

A new version of the Infini-D modeling, animation, and rendering package supports Apple's TrueType technology, letting you take letters and words and turn them into 3-D color animations. Through *morphing*, the process in which a letter of a certain font and color can metamorphose into a different letter of a different font and color, the program lets you take stagnant words and letters and make them come alive.

You can assign a different font to each word and use Infini-D's rendering and ray-tracing capabilities to add the appearance of surface textures, shadows, and light. Then you play back the animation in real time using the new real-time player. The program can also export in PICS format.

Price: $895.

Contact: Specular International, Ltd., 233 North Pleasant St., P.O. Box 888, Amherst, MA 01004, (413) 549-7600; fax (413) 549-1531.

Circle 1005 on Inquiry Card.

Fix

The June What's New item on Stuart-Matlock's Floppie Librarian V states that Floppie Librarian seeks out and identifies executable data. This is not the case. Instead, it reads directory data from the disk into its database. The company also says that when allowing for comments and data entry, the disk logging rate is closer to 20 per hour or less. The company has also raised the price from $59.95 to $89.95.

Icon-Based Menuing for DOS

The TitusDOS interface offers the look and feel of an icon-based GUI without requiring an upgrade in hardware or software, Titus Communications says. The program's menu system offers icons, windows, pull-down menus, and several utilities for under $50, while requiring just 16 KB of RAM during application execution.

Once you launch DOS programs using the mouse, TitusDOS unloads itself to extended memory or disk and runs the application. When you exit the application, you return to TitusDOS.

A control file configures the icons that are available for use in the program coordinator window. The PC can boot directly to that coordinator window, letting you run programs, format disks, and use the utilities without ever seeing the DOS prompt.

Price: $49.95.
Contact: Titus Communications Corp., 1001 Ross Ave., Dallas, TX 75202, (214) 954-0630.
Circle 1007 on Inquiry Card.

The TitusDOS program manager shows Lotus 1-2-3, DOS prompt, accounting, word processing, editor, and other application icons. You can also access the calculator, phone book, calendar, and directory from the manager.

Clean Up Your System 7.0 Windows

Kiwi Power Windows, a window cleanup and management utility for Apple's System 7.0, lets you arrange your windows according to your favorite layout with one command. You can use the program's preset layouts or create your own layouts, and you can ask the program to arrange only the windows in the current application or those in all your applications.

Kiwi Power Windows can also save all current windows as a set, so when you open the set, the program launches the appropriate applications, opens the specified documents and folders, and resizes the windows to re-create the same working environment, Kiwi Software reports. The program can have all your disks, not just your floppy disk, remember which windows were open when you ejected. Thus, CD-ROMs, AppleShare volumes, or FileShare volumes need not always open the same way.

Price: $79.95.
Contact: Kiwi Software, Inc., 6546 Pardall Rd., Santa Barbara, CA 93117, (805) 685-4031; fax (805) 968-1932.
Circle 1008 on Inquiry Card.

Disk Defrag and Recovery Added to BeckerTools

The upgraded BeckerTools file and data management utility for Windows 3.0 adds BeckerCompress, a disk-defragmenter component, that improves the performance of your hard disk drive. Features include a choice of optimization, sort by name, sort by extension, and the ability to exclude system or read-only files.

The BeckerRecovery component checks and repairs file and disk drive problems. It can examine a floppy disk or hard disk for damage, such as corrupted file allocation tables, improperly chained clusters, and corrupted files.

The new version also has a BeckerBackup module.

Price: $129.95.
Contact: Abacus, 5370 52nd St. SE, Grand Rapids, MI 49512, (616) 698-0330; fax (616) 698-0325.
Circle 1009 on Inquiry Card.

Windows File Manager Adds Compression

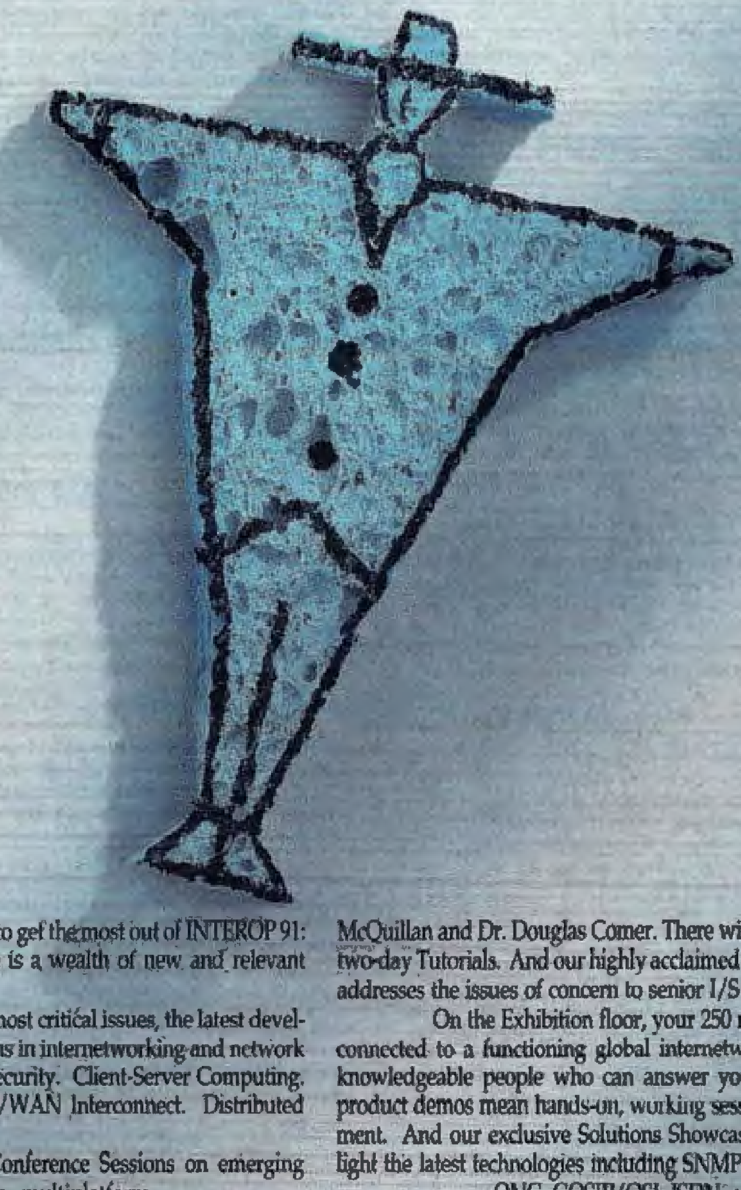
ZARC for Windows provides file and program management with a twist: ARC standard data compression and file archiving. With the program, you can work with files in an archive as if they were normal DOS files and perform operations like copying, moving, deleting, and searching for files. ARC compresses files to reduce on-line storage, to require less backup media for off-line storage, and to reduce transmission costs over telephone lines.

Price: $149.95.
Contact: System Enhancement Associates, Inc., 925 Clifton Ave., Clifton, NJ 07013, (201) 473-5153; fax (201) 614-9605.
Circle 1010 on Inquiry Card.

An Easier XTree

XTree, developer of the popular XTree file management system for DOS, now has a version called XTree Easy, which automatically searches your hard disk for over 700 applications and builds a personal application menu for you. You can invoke the pop-up XTree Menu to launch other applications and shield you from DOS. The program offers pull-down menus that organize commands by subject, a built-in ASCII editor, disk formatting, and the ability to perform DOS commands.

Price: $69.
Contact: XTree Co., 4330 Santa Fe Rd., San Luis Obispo, CA 93401, (805) 541-0604; fax (805) 541-8053.
Circle 1011 on Inquiry Card.



Say Hello to Hollywood

With Hollywood, you can create hard copy, transparencies, slides, speaker notes, charts, screen-show effects, and other components of a business presentation from within a single file. A master page—which can contain logos, frames, and other objects that you want to appear on every page of a presentation—lets you preserve consistency. Hollywood runs under Windows 3.0.

An integrated outliner lets you organize a presentation, check spelling, and create bullet or organization charts. The data manager's spreadsheet-like interface lets you enter or import data for chart or table generation. You can establish links to Excel or Lotus 1-2-3 spreadsheets to keep presentation data current.

Templates are optimized for various output devices, IBM says. When you create the presentation, you can invoke a template that matches the screen to your printer, slide-generation device, or plotter to get WYSIWYG output. The program also uses Bitstream's Speedo technology to generate fonts on-the-fly in sizes of from 6 to 360 points. Text tools let you rotate, mirror, stretch, curve, and color-wash characters. The program supports data charts (e.g., bar, line, scatter, and pie).

Price: $495.
Contact: IBM Desktop Software, 472 Wheelers Farms Rd., Milford, CT 06460, (800) 426-7699.
Circle 1012 on Inquiry Card.

Hollywood provides sophisticated drawing tools, such as polygons and Bézier curves, and lets you work with a variety of clip-art images.

Low-Cost Presentations in Windows

QuickGraph Plus offers capabilities found in many other Windows 3.0 presentation graphics programs, but for about $300 less. The program supports 11 types of 2-D graphs and five types of 3-D graphs. You can also create composite charts with overlaying and tiling.

For financial, medical, and statistical applications where a standard 8½- by 11-inch page isn't big enough, QuickGraph Plus supports sideways printing. You can produce banner-style charts that display up to 8192 data points. The program can take periodic snapshots of databases and build graphs that record changes in the database over time.

QuickGraph Plus supports Dynamic Data Exchange with other Windows programs and dynamic linking to a graph from multiple sources. It also supports batch printing for producing reports on a regular basis. The program produces area, bar, column, line, and pie charts.

Price: $149.95.
Contact: Sumak Enterprises, Inc., 39 Dawson Dr., Sudbury, MA 01776, (508) 443-5970; fax (508) 443-5895.
Circle 1013 on Inquiry Card.

Presentation Graphics for Windows

The presentation graphics category gets another entry with a new program from Chartersoft that's designed for business managers and executives who make frequent presentations that require speed and flexibility. Called GraphShow, the program lets you create true 3-D graphs that you can rotate and view along different axes.

For presentation management, the program lets you save all the pages of a presentation in a single file and use the title sorter to shuffle the presentation's pages by referring to their specific titles. You can display up to four presentations at once. A master page lets you standardize the background of the entire presentation; the program offers the ability to override the master file, page by page, for complete control.

Price: $495.
Contact: Chartersoft Corp., 80 Fennell St., Winnipeg, Manitoba, Canada R3T 3M4, (204) 453-4444; fax (204) 453-4400.
Circle 1015 on Inquiry Card.

Mac Graphing Program Masters System 7.0

By supporting System 7.0's Publish & Subscribe facilities, GraphMaster lets you subscribe to data from spreadsheet and database sources and automatically update charts as the data changes. You can then publish the data in a GraphMaster chart located in a desktop publishing program. Support for System 7.0 also lets the business/scientific charting program import data from remote computers and databases.

The program lets you create bar, column, line, pie, scatter, polar, and many other types of charts. You can choose from predefined charts or create your own, including charts with artwork that you scan in or draw. You can use the artwork in place of bars within a bar chart, according to Visual Business Systems.

GraphMaster can import WKS, Excel 2.2, SYLK, TEXT, PICT, PostScript, and Encapsulated PostScript files. It can export in PICT, Scrapbook, EPS, or Illustrator 88 formats. GraphMaster also supports TrueType.

Price: $295.
Contact: Visual Business Systems, Inc., 380 Interstate N, Suite 190, Atlanta, GA 30339, (404) 956-0325; fax (404) 988-0009.
Circle 1014 on Inquiry Card.

Express Editor for Big Business

ASCII Express provides functions you'd expect to find in a word processor (e.g., pull-down menus, word wrap, and spelling checking) plus features to improve productivity in heavy transaction environments. The program offers features designed for businesses like banks and insurance companies, such as a dedicated input processor.

The program's sort and extract functions let you create subsets of mainframe downloads to minimize the need for additional downloads. Express lets you search a defined column within a file and export the desired text to another file.

If a file you download from a mainframe is sorted by the first name instead of the last name, you can use the copy column command to re-sort the records in the order that you want. The program can change a word from all uppercase to uppercase and lowercase. Other features include a formula processing calculator, preprinted form processing, and undelete.

Price: $169.95; $189.95 with dictionary/spelling checker.

Contact: Vision Systems, Inc., 502 Bloomfield Ave., Bloomfield, CT 06002, (203) 247-4747; fax (203) 243-9150.

Circle 1016 on Inquiry Card.

In this example of ASCII Express's drop-down menu box in the editor, the cursor is positioned on the Check Spelling feature.

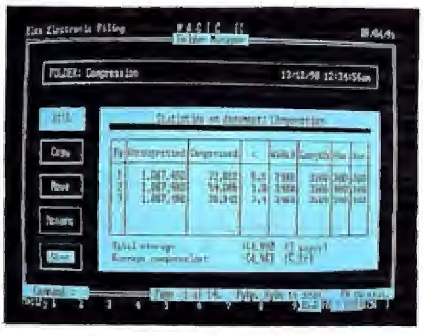
Document Imaging for the PC

The Elex Electronic Filing System provides a database-application-generator tool for developing applications that combine the filing functions of a document-imaging system and the ability to integrate images with its database. The system—suitable for image-catalog, scientific, real estate, and business applications—includes compression boards, PCs, and the imaging software. You can also buy the software separately.

Price: $35,000; software only, $12,000.

Contact: Elex Information Systems, Inc., 125–127 North Fourth St., Philadelphia, PA 19106, (215) 627-7202; fax (215) 627-2342.

Circle 1017 on Inquiry Card.



Elex's Electronic Filing System lets you develop sophisticated imaging database applications.

Design and Convert TrueType Fonts

The Fontographer and Metamorphosis Professional programs now support System 7.0, letting you design and edit TrueType fonts and convert existing PostScript typefaces to TrueType.

Fontographer lets you develop typographical character sets. It gives you the ability to produce TrueType and PostScript fonts by modifying existing typefaces, incorporating PostScript artwork, tracing scanned images, and using design tools.

The Metamorphosis Professional type-conversion utility creates editable outlines and other font formats from PostScript and TrueType fonts. You can convert Type 1 and Type 3 PostScript typefaces into hinted TrueType fonts for the Mac or the PC.

Price: Fontographer, $495; Metamorphosis Professional, $149.

Contact: Altsys Corp., 269 West Renner Rd., Richardson, TX 75080, (214) 680-2060; fax (214) 680-0537.

Circle 1019 on Inquiry Card.

Professional Type Design for System 7.0

The ATF Type Designer I program for the Mac lets you create TrueType fonts for the Mac and Microsoft Windows platforms. The program can read in existing PostScript Type 1 typefaces, provide the option of editing the type, and convert the faces into TrueType format.

The program supports the tracing of artwork, graphical editing of metrics data, multiple-character keyboard assignments, format conversions, bit-map editing, and other features.

Price: $549.

Contact: Kingsley/ATF Type Corp., Software Division, 2559-2 East Broadway, Tucson, AZ 85716, (602) 325-5884; fax (602) 325-0588.

Circle 1020 on Inquiry Card.

Never Mind the Database, Full Speed Ahead

PageAhead, a database publishing program, takes data from a DBMS and formats it for publishing. PageAhead works under Windows and acts as a bridge between databases such as Oracle and dBase and PageMaker. You extract the data via a query-by-example interface, and the data is sent directly to PageMaker. The program is useful for anyone producing price lists, catalogs, directories, or large reports, the company says.

Price: $795.

Contact: PageAhead Software Corp., 2125 Western Ave., Suite 300, Seattle, WA 98121, (206) 441-0340.

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DesignCAD for the Mac's System 7.0

DesignCAD Macintosh 3.0, a 2-D and 3-D CAD program, now takes advantage of Apple's System 7.0 operating system, including support for virtual memory and Balloon Help. Virtual-memory support lets you run applications that are larger than the computer's physical RAM.

DesignCAD Macintosh 3.0 increases overall program speed by as much as 400 percent, the company says. Predrawn symbol access is 12 times faster, and rendering is as much as 20 times faster, the company claims.

The program can now directly translate from one to any of the following formats: DXF, IGES, PICT, *x,y* or *x,y,z* coordinates, DesignCAD Macintosh, and MS-DOS DesignCAD 2-D and 3-D formats. New commands include undo and a global `save configuration`.

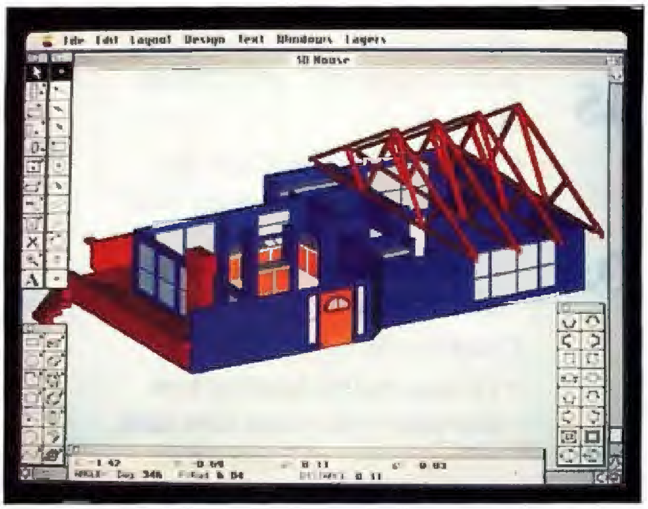

Image-rendering and manipulation options in DesignCAD 3.0 for the Mac now incorporate both Phong and Gouraud shading and transparent-object rendering.

As with previous versions, the program offers unified parametric representation of all geometry plus real-time rotation. The parametric-mathematics method uses a single parametric equation rather than a collection of equations to define geometric objects. As a result, wireframe, surface, and solid models are integrated in one database. This means you don't have to switch to three different programs—and three different geometries—for each model type. The unified approach is also taken in some mainframe-based CAD programs.

Price: $699.

Contact: DesignCAD, Inc., One American Way, Pryor, OK 74361, (918) 825-4844; fax (918) 825-6359.

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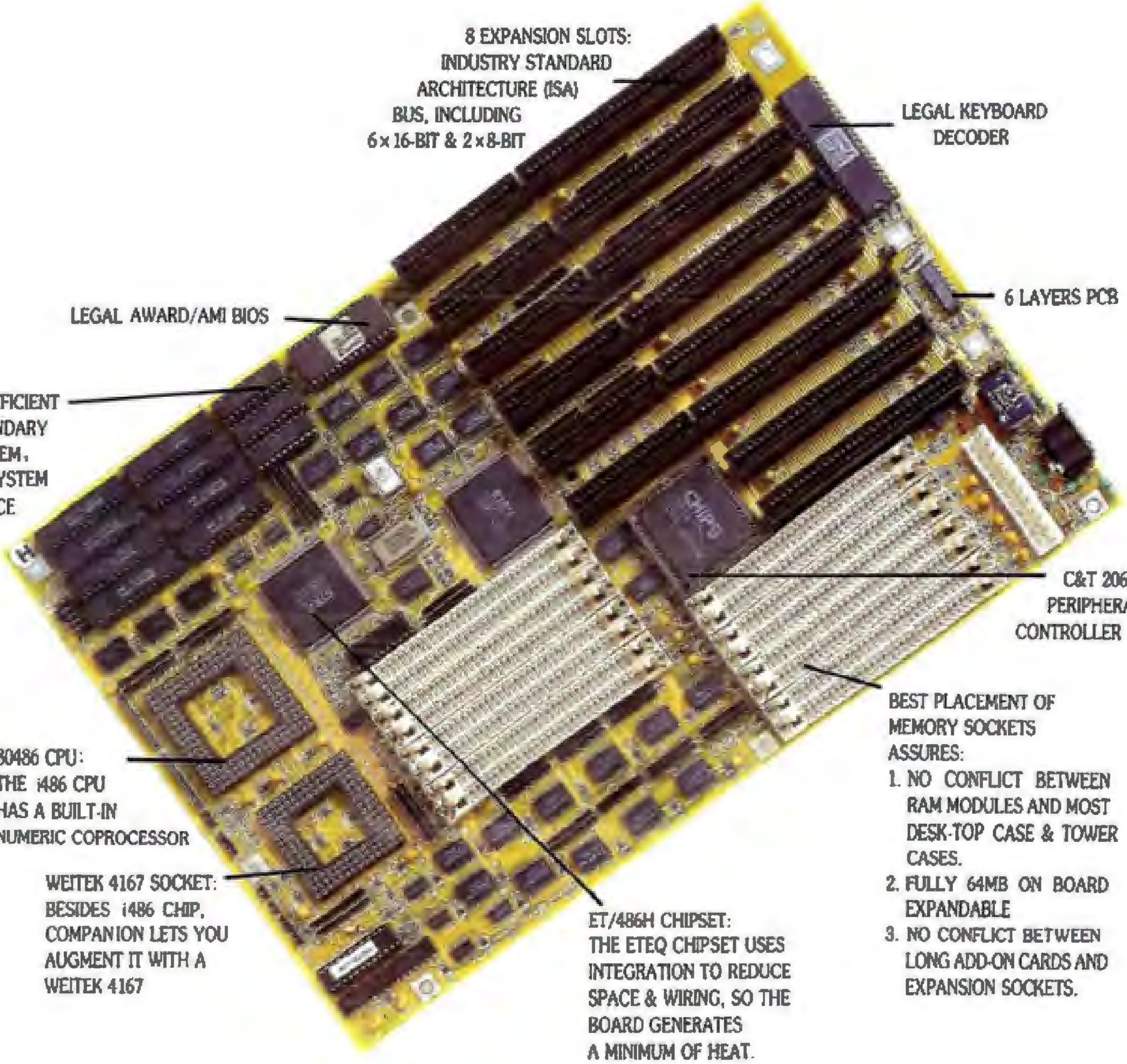

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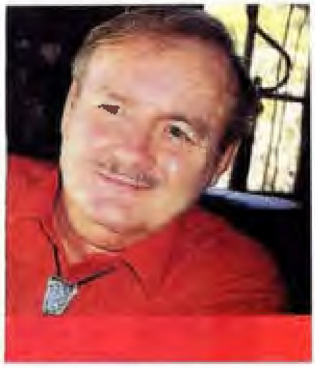


JERRY POURNELLE

ON THE ROAD AGAIN

This time, we're headed for Flagstaff for the meeting of the advisory board of the Lowell Observatory. This gives me a good opportunity to test a new notebook: I'm writing this column on a Panasonic Business Partner CF-270, which is a lightweight, no-frills 286 notebook computer with a 20-megabyte hard disk drive and a 3½-inch floppy disk drive. The battery pack is removable, and, unlike the Zenith machines, the power input does not plug into the battery, meaning that you could change batteries, or operate without a battery, without needing to turn off the machine.

Alas, there's no handle on this. The Business Partner is lighter than most notebooks, but I'd still prefer a foldout handle, like the one on the Zenith Minisport. One thing they did well: there's no warning beep-beep if you close the machine and leave it on. Instead, the power and battery lights are outside on top, where they're visible with the lid closed. Certainly makes sense.

Conditions right now couldn't be worse for a notebook: it's 5:00 in the afternoon on the Arizona desert. The sun is bright and low, so that even with the backlit screen turned to its brightest, it's very hard to see. The Business Partner has several video modes, and I've tried them all: bilevel color (I'm not quite sure what that means on a blue supertwist screen) is the best, and it's still hard to see. Hard, but not impossible.

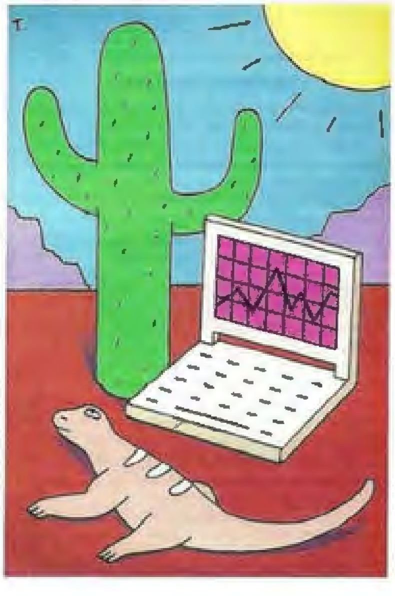
Many machines, including the Texas Instruments/ Sharp notebooks, would be completely unusable under these conditions. The only portable I have found that is always comfortably visible is the Zenith Supersport SX. I've worked with it in the desert before. Alas, it's *very* heavy for laptop use in a car. The Minisport (which is an XT) also has a screen usable in any light conditions I have found, including the beach at high noon.

There's a problem with the Business Partner's cursor: it's hard to locate in text. My normal practice with laptops is to load in SkiSoft's No-Squint, a tiny TSR program that not only slows the cursor blink rate, but also turns it into a solid blob rather than a mere underbar. Alas, with the Business Partner, No-Squint doesn't really work: it slows the blink rate, but instead of a blob I get a vertical line. It's better with No-Squint than without it, but just barely.

I'm also running IBMFIX. Panasonic has put the Caps Lock key to the left of the *A* key. IBMFIX is a small freeware TSR that swaps Caps Lock down to the space bar area and puts the Control key to the left of the *A* key, where God intended it to be. While we're on the subject of the *A* key, the letter *a* on the Business Partner's screen isn't like that on any other machine I've seen; in bad light conditions, it's nearly indistinguishable from the *o*. The descenders (e.g., *g*) aren't very pretty, either.

Jerry takes a new computer out where the sun shines and upgrades his hard disk drive controller card

None of these are fatal defects. I *can* see the screen, even in these horrible light conditions, and No-Squint lets me find the cursor. The keyboard is compact but clearly good enough, and the key layout is reasonable for a portable. It's also quiet, except that when I release the space bar it makes a pretty loud clatter; they ought to do something about that because it's loud enough to disturb meetings, and a notebook machine shouldn't do that.



In a word, the Panasonic Business Partner is another machine that's good enough. It's very fast and light, and it has what you'll need in a generic notebook machine. The model they sent me doesn't have a modem, but there's a place for one. It's heavier than the Toshiba T1000, but it has a hard disk drive; it's heavier than the Minisport, but it has a floppy disk drive. I've never lost anything I wrote on the Minisport (or indeed any laptop except the Z88), but I remain paranoid. To me, text isn't safe unless it has been saved onto a floppy disk as well as into the portable's memory, whether hard disk or "memory disk"; and I'm willing to carry the extra weight of a floppy disk drive.

The Business Partner's keyboard is at least as good as Zenith's. If I had to carry just one machine, I wouldn't be sorry to have this. On the other hand, when we get to Flagstaff, I'll be happy enough to set up the Supersport SX and work on it in the hotel room—but

I'm sure glad I don't have to hold that heavy sucker on my lap while Roberta drives!

Not Broke, But . . .
I suppose there are other hard disk drive controller companies, but for the past few years, the two that have interested me most have been Perceptive Solutions, Inc. (PSI) and Distributed Processing Technology (DPT), both of which make caching controllers for SCSI and ESDI hard disk drives. Each company uses an on-board CPU, and each has its own form of disk caching.

Both of these companies deliver products that work. DPT is a larger company than PSI and has more extensive resources. They also charge more, and their on-board memory is on their own proprietary boards rather than regular SIMMs, as PSI uses. DPT and PSI are serious rivals in terms of performance.

For the past several years, my main system—the one I write nearly all my books and columns with—has been a Cheetah 386/25 with a DPT controller and a Priam 330-MB ESDI hard disk drive. That system has been in continuous use, being turned off only for installation of new boards or if I'm going off on a trip. While there are many faster systems in the house, the Cheetah 386/25 has been plenty good enough, the DPT controller has performed splendidly, and I've had very little trouble with the system—as you'd expect, since I make my living with it.

However, the Cheetah 486/25 came with a PSI controller, and the combination was a great deal faster than the older Cheetah 386/25/DPT had been; not surprising, given that one was a great deal newer than the other, and a 486 is more efficient than a 386 anyway. Still, my intention was to check out a DPT controller with the Cheetah 486/25; alas, DPT kept sending me ESDI controllers, but the hard disk drive I want to use it with on the 486 is a Siemens 800-MB drive, which is a SCSI system. I do have a DPT noncaching SCSI controller, which works fine but, of course, isn't anything like as fast as the caching systems.

One day, I'll get things straightened out to have a fair test, but I already know that both DPT and PSI performance is plenty good; and I'm not really interested in fine-detail benchmarks. That's for the BYTE Lab.

Then when Cheetah's Larry Aldridge put together my test copy of the Cheetah 486/33, he used a PSI controller. Finally, PSI wanted to demonstrate their newest controllers, both ESDI and SCSI, and in particular to demonstrate mirroring. Mirroring involves two hard disks: every write operation is done to both of them, with the result that you have an automatic backup at all times. The notion was to install a mirroring system on my main machine, the Cheetah 386/25; and that was just attractive enough that I overcame my reluctance to mess with a working machine. The result was that Warren Lee, vice president for R&D at PSI, got an appointment to come to Chaos Manor to do the installation.

Preparations
The prospect of changing the hard disk drive and controller on the machine I write with was a bit daunting; still, I didn't see how any disaster could come of it. At the moment, Chaos Manor is awash with machines, any one of which would be good enough as my main machine. There are two Cheetah 486s: one, the 486/33, is still in the experimental setup stage, but it's certainly reliable enough for my usual work; and there's always the older Cheetah 486/25. In addition, there's one Arche Legacy 386/33 that's very solid and an Arche 486 that we've had long enough to have confidence in. And if those weren't enough, there are a few older machines, including a Zenith Z-386/25 that's rock solid.

Clearly, some of those machines have to go back, if for no other reason than to make room. But any one of them would let me do everything that I do on my main system.

First things first, then: make backups of everything on the Cheetah 386/25. Doing that ought to be simple enough: for years, I've been doing `XCOPY *.* /s/m` onto the Maximum Storage APX-4200 WORM (write once, read many times) drive that's part of the Cheetah 386/25 system. I not only have all my current files copied onto a WORM cartridge, I have older versions of everything as well, since when you copy over a WORM file you don't actually overwrite anything and the previous file is retrievable. Furthermore, WORM disk files are essentially eternal; at least, no one has seen any deterioration of WORM disks in the past decade.

There's only one problem with my WORM files: I filled up a WORM cartridge some time ago, and since I have been copying with the `/m` parameter (meaning that it copies only files that have been written to since the last `/m` copy was made), I don't have *all* of the 250 MB on the new cartridge.

It would be possible to copy all the stuff off the older WORM cartridge and

then overwrite with the files from the newer one, thus assuring that I restored everything to the way it was before we started. But that did seem like a lot of work. Time to think of something more ingenious.

As I reported last month, we have the Pioneer optical read/write disk drive connected to the Arche Legacy 486/33. The drive is in a SCSI daisy chain with Pioneer's Minichanger CD-ROM drive, with both controlled by a Corel SCSI controller. It all works fine. So, I thought, why not make use of the Pioneer optical read/write disk system? That way, I could put everything from the Cheetah 386/25 onto one Pioneer cartridge, and if anything went wrong, I'd have my reliable Maximum Storage WORM cartridges as well.

In fact, thought I, while I'm at it, I'll also make a Pioneer WORM cartridge, thus having yet another backup of the system.

First, though, I decided to make a copy on floppy disk of the very latest stuff I'd done on *The Moat Around Murcheson's Eye*, the novel Larry Niven and I are currently working on. That way, I'd be able to not only copy it onto the machine Niven works with, but also let him take a copy home.

Interlude: Clean That Machine

I couldn't make a floppy disk copy. I got "Drive Not Ready" errors. Retries did no good at all. I quit Desqview. That didn't do it. Reset the machine. No joy. Got out MicroClean's head-cleaning kit and tried that. Nope. Then I opened the machine and looked into the floppy disk drive—where I discovered an enormous fuzz ball, perfectly placed so that the disk head couldn't seek back to the home position. I removed that with forceps. I got out the compressed air can that comes with the MicroClean kit and blew out dust and grime from every cranny of the drive.

Now the drive worked, but the machine didn't want to boot. Shake the boards a bit, move the cables around, and eventually all is well, including the floppy disk drive.

Backing Up

Next thing then, I got out an Inmac blue 25-pin cable, connected one end to the printer port of the 386/25, connected the other end to a sex changer, and connected that to one of the new LapLink III "designer" parallel cables. This put the two machines about 16 feet apart. I got LapLink III running on both machines and blasted everything off the Cheetah 386/33 onto the Pioneer optical read/write disk drive on the Arche Legacy 486/33, which, incidentally, is running DR DOS 5.0. LapLink III in parallel turbo mode is really fast, but even so, this took a couple of hours, which was all right because it gave me a good excuse to play Wing Commander on the Cheetah 486/25 while things were transferring.

Everything went perfectly. I now had an optical read/write disk of everything from the Cheetah 386/25.

A SCSI Too Far

My next move was to make a WORM copy, but that presented a problem: I have only one Pioneer multipurpose drive. Clearly, I wasn't about to sit there and swap disk cartridges for a 250-MB transfer!

I have only one Pioneer drive, but I do have two Corel interface boards, and I

continued

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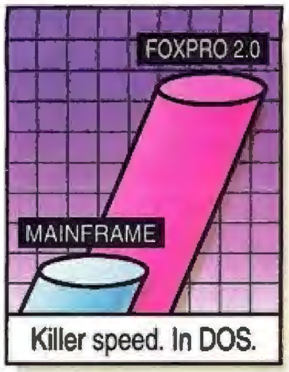

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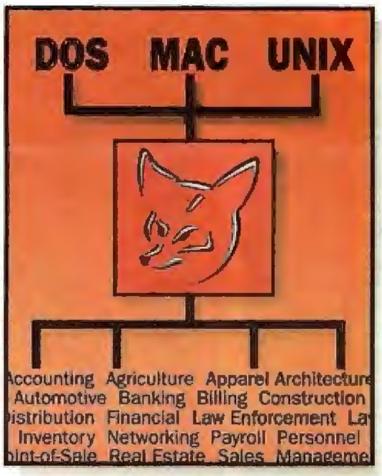

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11511 Tennessee Avenue, West Los Angeles, CA 90064 • (213) 473-2434 have a lot of extra space on the Siemens 800-MB hard disk drive in the Cheetah 486/33. All I had to do was XCOPY everything from the optical cartridge to the Cheetah hard disk and then go the other way onto a WORM. As it happened, the second Corel interface board was already installed in the Cheetah 486/33, so all I had to do was physically move the drive.

Alas, it wasn't that easy. Chaos Manor has become so cluttered that there was no place to *put* the optical drive. Worse, it's in a daisy chain with the Pioneer Minichanger, and the optical read/write disk drive isn't *terminated*; so I'd have to move both the Minichanger and the optical read/write disk drive, or I'd have to disconnect the daisy-chain cables and install the terminating resistors.

I muttered something to the effect that whenever I want to do anything I first have to do three other things—and one of those will be impossible. Then I had a bright idea. Just how long can you make a SCSI cable, anyway?

I got out my 10-foot Inmac blue 25-pin shielded cable and hooked it up. Incidentally, I've had that cable since CP/M days, when I used it for RS-232 data transfers. Inmac prices aren't cheap, but they sure do make good cables, and they deliver them fast.

Anyway, I hooked the Inmac cable to the Cheetah 486/33, thence to the sex changer, and plugged the Corel SCSI daisy chain into that. Fired up the Cheetah 486/33. Noted that I have drive E (the optical read/write disk drive) and drives F, G, H, I, J, and K (the Minichanger CD-ROM drives). Created a subdirectory called CHEETAH3 (for the Cheetah 386/25), did `XCOPY E:\*.* D:\CHEETAH3\ /s/e/v`, and stood back. Data flowed. The whole thing was over in about 30 minutes.

I didn't really fancy formatting the WORM cartridge over 13 feet of cable, so I connected the daisy chain back to the Arche Legacy 486/33 and used the Corel utility. That done, I connected the drives back to the Cheetah 486/33 with the Inmac cable and did `XCOPY D:\CHEETAH3\*.* E:\CHEETAH3\ /s/e/v`. Once again, data flowed.

Alas, it didn't work perfectly. About 100 MB into the operation, the system hung up. It took a reset to get out of it. At that point I could read the WORM drive just fine, but I couldn't write to it; I got a "Disk Full" error, although there was plenty of room left on the cartridge.

Corel furnishes a bunch of utilities, one of which is a program called Repair, which fixes a damaged WORM. Using it is simple, and that fixed the WORM at a cost of about 2 MB of data.

Tree86

At this point I had a mild dilemma: I'd sent about half the data from the Cheetah 486/33 to the WORM. I sure didn't want to do all that again; at the same time, I didn't want to send over another 100 MB one directory at a time. The obvious thing to do was erase all the data that had been previously sent from the Cheetah 486/33 and copy the remainder to the WORM. That meant erasing about seven major directories—but each of those had subdirectories, and most of the subdirectories had subdirectories, and so on ad infinitum. I would be all day erasing those files, and, alas, DOS, Norton Commander, and SWEEP won't let you erase a directory that has data in it.

Fortunately, I have a pile of DOS shells that have come in for review. The one on top was Tree86. A glance at the package showed that it would indeed kill nonempty directories. Installation was simple enough. You just copy the disk. So far, so good. If you have to use a manual on a DOS shell, the designer was unclear on the concept. Tree86 passes that test. It was a snap to invoke and simple enough to find out how to kill directories with all subdirectories.

There are a lot of DOS shells and disk management utilities. The one I use is Norton Commander, in part because I'm used to it, and in part because it has an MCI Mail utility that really works. But Norton Commander will not kill a directory, nor will it transfer a directory and subdirectories from one place to another in one operation. Consequently, I have now added Tree86 to the arsenal. So far it works fine (with and without mice), and I haven't had to look at the manual. There are far more complex disk management programs around, but Aldridge's Tree86 with Norton Commander is good enough.

Discoveries

Once I'd killed all directories that had already been transferred, I let XCOPY do its thing on the remainder, and everything transferred to the WORM cartridge without further incident. So. All done, except for testing.

First test: see if I can run Wing Commander off the WORM cartridge. Given the 13 feet of cable in the SCSI line, I was prepared for it not to work, and it didn't: the machine hung up. No problem, reset, and now copy Wing Commander from the WORM to the Cheetah 486/33 hard disk. Now run it....

It blew up. Locked up the machine.

This was a bit frightening. Did I have a corrupt copy? Had all that backup effort been wasted? Well, I also had a good copy of Wing Commander on the Cheetah 486/33. I'd been playing the game while LapLink transferred files. So, just to be sure that nothing had happened to the machine, try that one....

It blew up, too.

That took a few minutes' thought, and then enlightenment came. Wing Commander is a notorious memory hog. What had happened was that with the Corel optical read/write and CD-ROM drivers activated by CONFIG.SYS, the 486 didn't have enough memory left! Edit CONFIG.SYS to REM out loading the Corel drivers, reset, and invoke Wing Commander—and there it was, in all its glory. No problem.

Which got me thinking, because, as you'll recall from last time, I could run Wing Commander off the hard disk on the Arche Legacy 486/33, but as soon as I tried to run it off the Pioneer optical read/write disk drive, it died. Everyone said "timing errors," and we all let it go at that; but in fact that's not right. The Arche Legacy 486/33 with DR DOS 5.0 has, even with the Corel optical read/write and CD-ROM drivers installed, just enough memory to run Wing Commander; however, when you *use* the optical read/write disk drive, it grabs just a bit more memory—and that's memory Wing Commander is also trying to use. The result is a crash.

The remedy is simple enough. The Corel software will load into expanded memory if you tell it to. Then you have to make sure everything else goes into high memory, so that you have a good 580 kilobytes available (with DR DOS 5.0, I was able to get the optical drive and the mouse—and still have over 600 KB).

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After that, you can run Wing Commander right off the optical disk, either read/write or WORM. Alas, MSCDEX, the DOS extensions that let you access the CD-ROM drive, take up so much memory that you're back to 572 KB of usable memory, and that's just enough. You can run Wing Commander from the regular hard disk but not from the optical drive. However, I'm still fooling with this, so stay tuned: I may yet find a way.

In any event, the Corel SCSI system works just fine with a 486, under both MS-DOS 5.0 and DR DOS 5.0. My next step is to get all that running on a system with LANtastic; then I can access all those assets from another system entirely, and it won't much *matter* how much free memory the system with the CD-ROM and optical read/write drives has. But that's for another time.

The Cheetah Operation

Now that I had everything backed up—three times—I was willing, if not precisely comfortable, to have Warren Lee open up my main machine and replace its hard disk drive controller. The Cheetah 386/25 has been stable for several years. It's a tower-configuration machine, so I don't have much reason to notice it as long as it works—and Big Cheetah has always worked.

When I cleaned the dust out of the floppy disk drive, I did take the vacuum cleaner to the rest of the machine, but I'd obviously done only a cursory job. Once Warren got the cover off and the machine laid on its side, it was obvious that we had a major cleaning job to do. There were dust balls everywhere. The cleanup took half an hour.

Then it was time to reformat the Priam 330-MB hard disk drive. I've had that drive for three years with no glitches; since it has been in heavy use all that time, statistics say that it ought to be replaced. I'd as soon not do that, but I suppose I'll have to. On the other hand, the PSI media analysis and formatting program found essentially no bad sectors, which is pretty remarkable considering just how hard that machine has been used.

I had toyed with the idea of installing either DR DOS 5.0 or the final-test prerelease copy of MS-DOS 5.0 to replace the PC-DOS 3.3 I'd been using. But at the last minute I decided not to, and we installed PC-DOS 3.3 again. Formerly, the DPT controller formatted the disk out to drives C through L with 32 MB each, plus drive M with a few megabytes left over. The PSI controller formats only to drives C through K at 32 MB, plus L with 24 MB. This has to do with the sector sizing and error-correction codes, none of which I pretend to understand. However, it is an 8 percent loss in usable disk space.

That wasn't good news, but then there was worse: the machine wasn't booting up properly.

The newest machine at Chaos Manor is the Flytech Carry-I, which is smaller than the Ergo Brick. It sits on a normal sheet of paper.

Like the Old Days

First possibility: the battery. It hadn't been changed in a couple of years, so it was time anyway. The Cheetah came with a holder for four AA batteries, but I've for some time had a Raytheon lithium computer battery, which is supposed to be a lot better and more reliable. We installed that.

Still problems. The machine wasn't acting right. Warren Lee looked a bit nervous. I was thinking about which machine I'd use to get the next day's work done. Still, it was a bit early to give up. The machine had, after all, been run more or less without maintenance for three years. Time to be systematic.

We removed all the boards and disconnected all the cables. Vacuumed again. Cleaned all the cable connectors with alcohol. Cleaned the board contacts. Got out my Stabilant 22, the wonderful contact treatment liquid that comes from DW Electrochemicals in Canada, and ran a line of that along every board and on all the cable connectors. When we were finished, we put the whole thing back together and voilà! All of which proves what I've known since S-100 days: these machines do take a bit of preventive maintenance, and Stabilant 22 is one of your best friends.

Readdressing

There remained one problem: the system ran, but I couldn't get my full-size Desqview windows. Time to look at the system. There are two ways to do that: Manifest, which comes with QEMM-386 and Desqview, and System Sleuth. Both are good. They have overlapping capabilities. PSI is shipping System Sleuth with their boards; that way, if you call for technical support, they can tell you experiments to perform.

In our case, we'd used the default address space for the PSI board; that happened to be in the middle of the largest single block of high memory (which is the magic area between 640 KB and 1 MB that is crucial to enhancing system performance). This meant that we couldn't stuff the CD-ROM and WORM drivers up into high memory because there was no single block big enough. Readdressing the PSI controller board to be just after the video RAM fixed that.

The bottom line is that everything works the way it used to. The PSI controller performs about the same as the DPT one did. There may be some benchmark differences, but they aren't noticeable in use. My main machine works the way it used to: splendidly. A Cheetah 386/25 may not be the hottest thing in the house, but it's plenty good enough for just about everything I need.

It's Really Small

The newest machine at Chaos Manor is the Flytech Carry-I, a full 386SX, with 2 MB of memory and up to an 80-MB hard disk drive. And it's smaller than the Ergo Brick. The computer will sit on a normal sheet of paper. Computer, keyboard, power supply, and mouse—everything but the monitor—will fit into a small briefcase. The monitor is in another box with a carrying handle. I can literally carry the whole thing, with the computer on a shoulder strap and the monitor in my hand, and have a hand free; and it all weighs less than the Supersport laptop.

Tomorrow, the Carry-I goes down to the beach house with me, where I will thrash the devil out of it. I've already opened it up: looks well made. For the past week, it has been sitting here continually copying stuff from one subdirectory to another with no problems, so I don't anticipate any trouble. A full report next month, but if you need a machine that won't take up a lot of space, have a look at the Carry-I.

PowerBasic

When Borland brought out Turbo Basic, Microsoft was shocked into making

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frantic improvements to QuickBasic and BASCOM—an event that was greatly to be desired. Borland soon found that Microsoft would do whatever was required to keep a lock on BASIC, and in a Borland product shift, Turbo Basic reverted to its original authors, where it is now available as PowerBasic from Spectra Publishing.

PowerBasic has a lot of neat features that QuickBasic doesn't have, but, alas, what it doesn't have is compatibility with the Crescent BASIC toolkit. On the other hand, it does allow unlimited string space, it's *very* fast, and it has a whole bunch of built-in utilities (e.g., SORT, MIN, and MAX) that are in the Crescent toolkit. They also say that there will be Crescent tools for PowerBasic Real Soon Now.

PowerBasic is a superset of Borland Turbo, and it will compile all Turbo programs.

Bob Zale, the original author, is continually improving PowerBasic, which is good for all of us, since that will keep Microsoft from relaxing. My advice to serious BASIC users is to keep the latest and greatest of both Microsoft and PowerBasic around; but then I've always been a bit of a BASIC freak.

Winding Down

If you haven't already gotten your copy of *Fallen Angels* by Niven, Pournelle, and Flynn (Baen Books), it should be in your local bookstore now. I think you'll like it.

The book of the month is Martin Van Creveld's *The Transformation of War* (Free Press, 1991). I'm not at all sure I agree with his premise, but Van Creveld is always worth listening to.

The computer book of the month is Jim Seymour's *PC Productivity Bible*, which is the first of the new line of Seymour imprints from Brady Books. The book is filled with tips and tricks, some of which I use already, and some that I was pleased to learn about; and it's written in Seymour's enviable style. This is definitely recommended.

The game of the month remains Wing Commander. I suppose one day I'll find something I like a lot better, but not so far. Now, I'm off to the beach house to work on *The Moat Around Murcheson's Eye*. ■

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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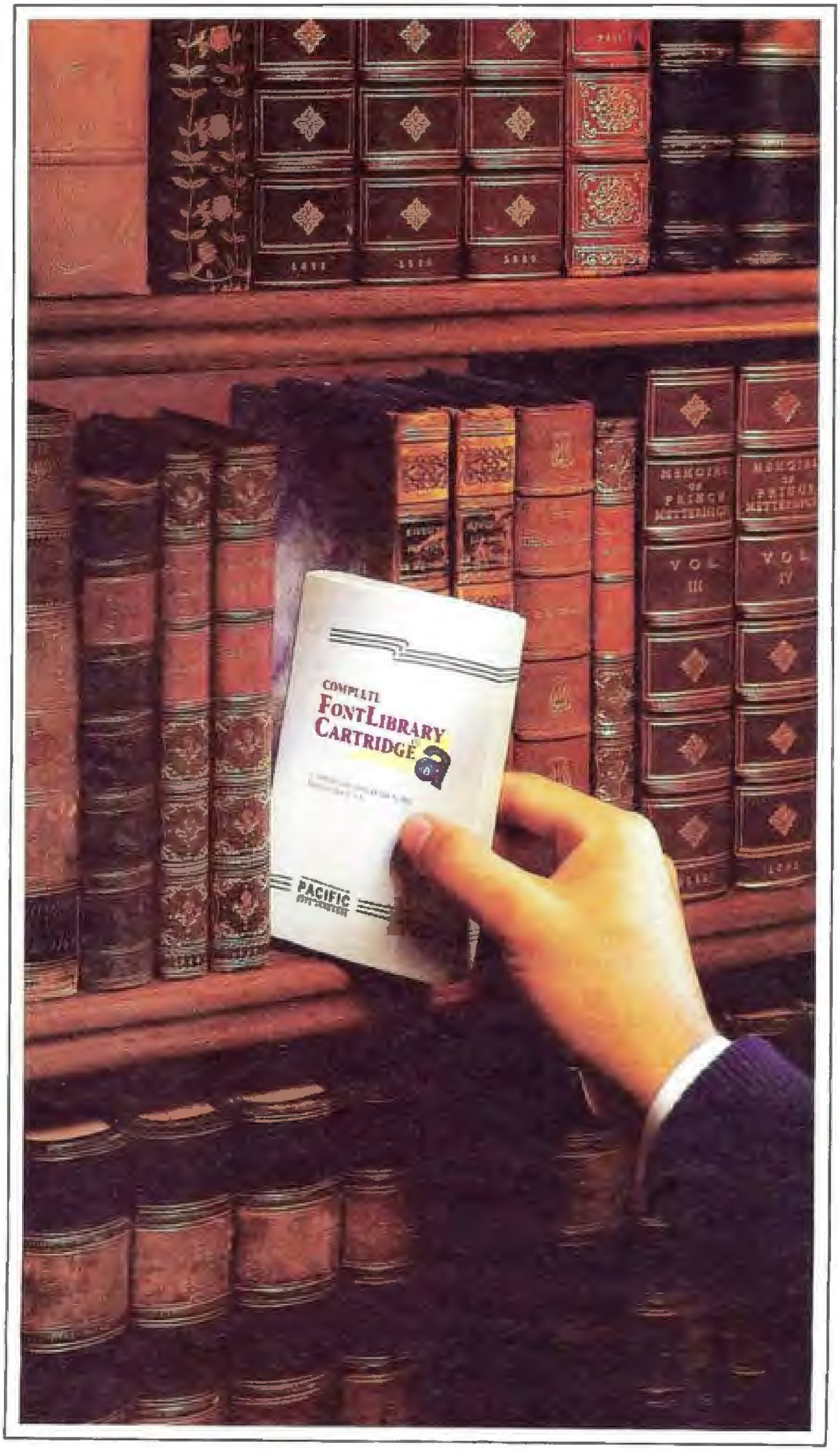

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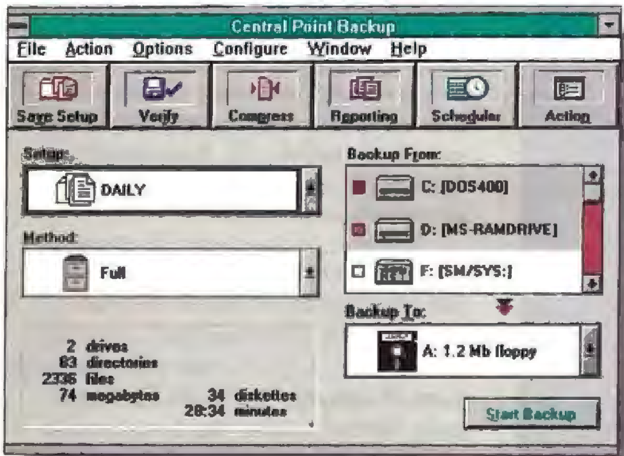

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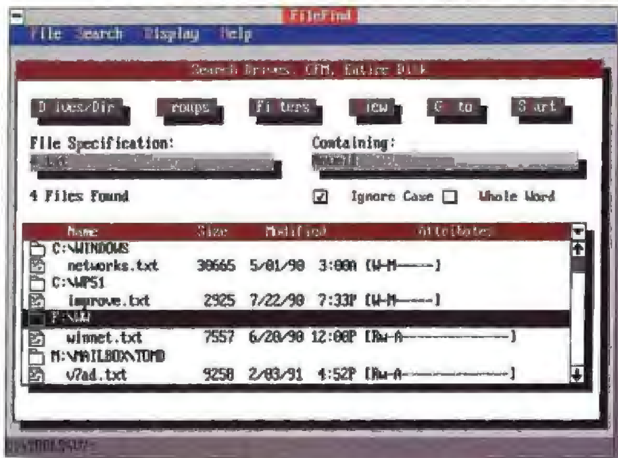

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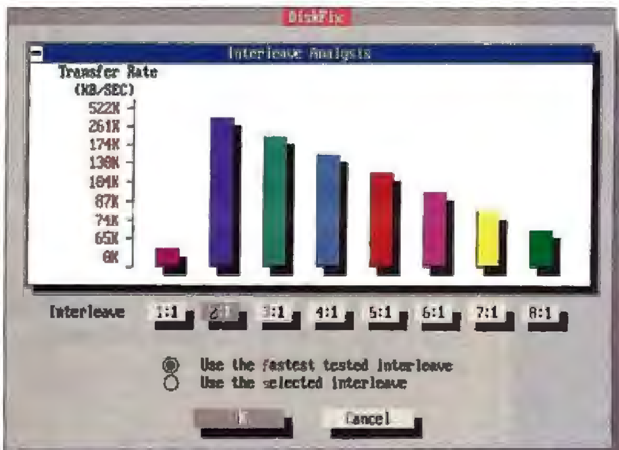

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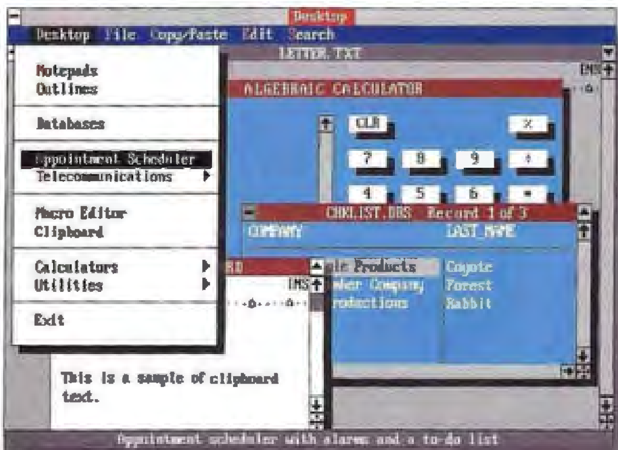

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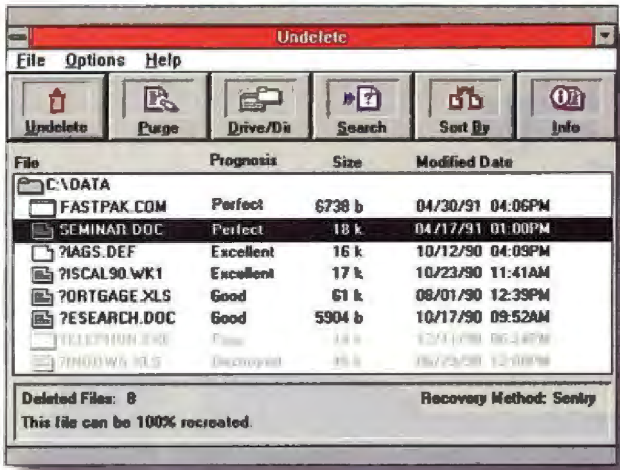

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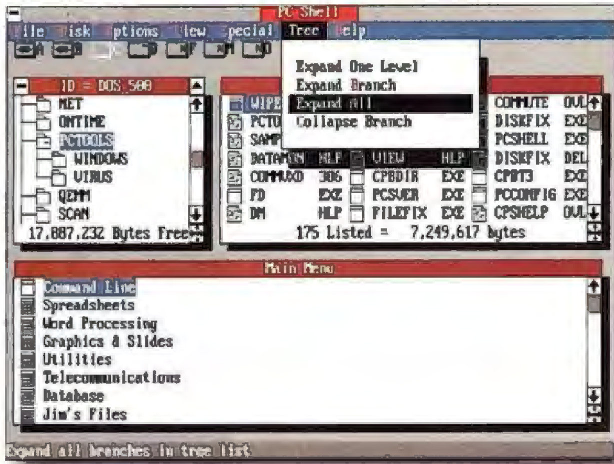

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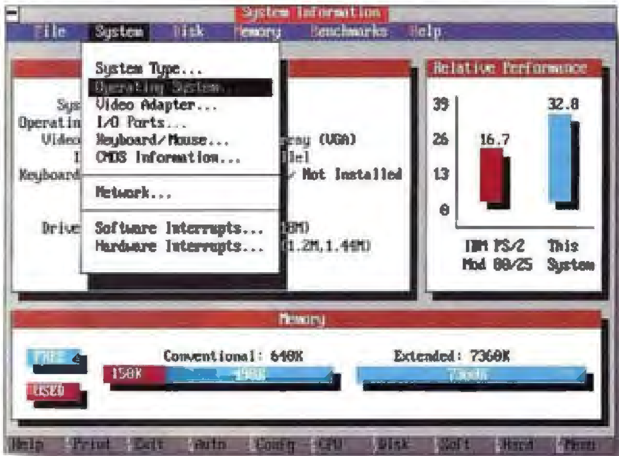

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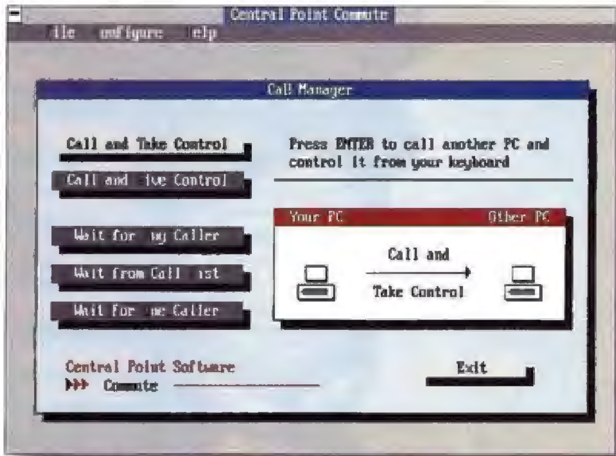

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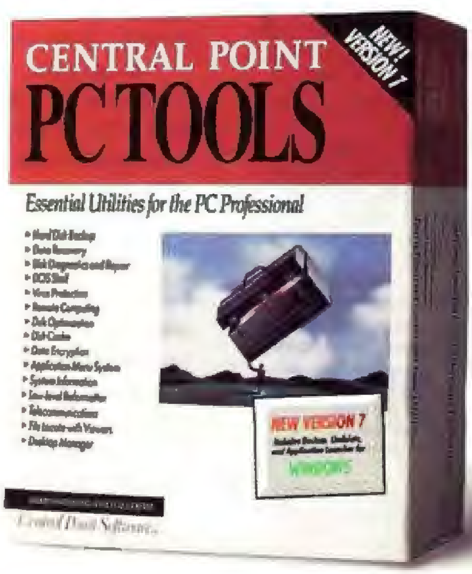

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Kory Washburn is the assistant manager of Prime Time Shuttle who set up the computer system. He started December 23, 1990 with one dispatcher's computer. Now he's running 30 machines on a LANtastic Ethernet system, and expects to add a new computer to the system every week until they reach 50 nodes.

He chose LANtastic because of the flexibility of its peer-to-peer structure. "Instead of a single overloaded server, we broke down the tasks, spread them over multiple servers and still fully interconnect the system with cheapernet cable."

Washburn praises Artisoft hardware and LANtastic software compatibility with other manufacturers' cards and systems. "You can't beat the price. And the speed is incredible, especially the way we abuse the system," he confessed.

"Artisoft tech support stuck with us until they solved our problems. They were great."

There's a myth that LANtastic is only suited to small, simple systems. But next time you need a ride from LAX, remember LANtastic is the Prime Time network.

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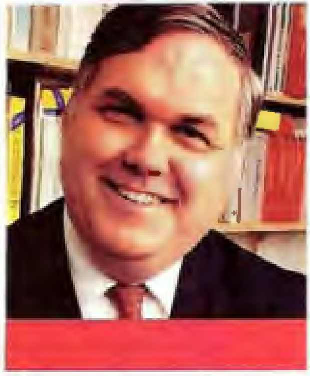

WAYNE RASH JR.

YOUR FIRST LAN

The woman was clearly weary of her search as she leafed through the book on Novell NetWare at Walden Books in Bellevue, Washington. "Looking for something good on NetWare?" I asked. She admitted that she was, but also that she really didn't understand a lot about networks and needed to learn about them. I steered her to a copy of BYTE and wished her well. Unfortunately, she's only one of the millions of computer users and managers who know nothing about the networks they're already finding themselves using.

Many of these same people are also finding themselves responsible for choosing and installing their first LAN. This process is daunting enough when you know what you're doing; when you don't know what you're doing, it can be overwhelming. Manufacturers of network operating systems or network hardware do little to make the process easier. Most of them clearly intend for their LAN systems to be designed and installed by professionals. There are exceptions, of course, notably Artisoft's LANtastic, but they are few indeed.

There's not a lot I can do to make the process of LAN design much easier (beyond pointing you to the books in my bio at the end of this column), but I can help you understand the process so you can at least figure out what's going on and what role you can play.

The LAN Process

Stop worrying about what LAN you're planning to buy and start worrying about why you need a LAN in the first place. In the consulting trade, we call this *requirements analysis*. What it boils down to is creating a detailed list of the functions you want your computer system (which might or might not ultimately be a LAN) to perform and the other requirements it must meet. Once you have done this, you may find that you do indeed need a LAN, and then you can start figuring out what kind. You might also find that all you really need is a better computer than the one you currently have.

The process of determining your requirements can tell you a lot about your business. You will probably also find things about your business that need fixing. Whether you fix them or not is up to you, but either way, you will have enough information to make some intelligent decisions about your LAN.

The Topics

I can't actually give you the questions you need to ask yourself in determining your requirements, because the questions will vary depending on the individual business. I will, however, cover some general fields of interest so you can develop your own list of questions and, from that, your own requirements.

In many cases, you'll hire a consultant to actually analyze your requirements. That does not mean that doing a requirements analysis yourself is a wasted exercise. Even with the help of a consultant, you still have to determine most of the requirements yourself.

Be careful not to confuse your LAN needs with your LAN wishes

Now that you know why you're asking yourself these questions, here they are. You will need to supply the specifics.

Why do I think I need a LAN? By this I mean, What are your objectives? What do you want the LAN to accomplish? What tasks will be made easier? What new tasks do you need to perform?

What am I doing now? By this I mean, Do you have any computers now? What functions are you using them for? Do you intend to retain your present computer equipment? Do you have manual systems or systems on minicomputers or mainframes that will migrate to the LAN?

What new tasks do I need to accomplish? In addition to providing support for your current operations, you may propose to add further tasks and perhaps even new equipment to your new network. What do you intend to add?

Who is going to use the LAN? You will need to decide who is going to use the network initially, who will be added over the next year or so, and what those people will need to do. Nearly every LAN grows larger and faster than even the wildest estimates, so be generous.

What are my organizational constraints? Most large organizations have standards for things like LANs. Nearly all organizations have limits on how much they can spend. You may have other constraints, including specifics about your physical location, your building

ILLUSTRATION: MARK STEARNEY © 1991

lease, or local fire and electrical codes. You might as well know about them now.

The Wish List

Once you've prepared a list of your actual requirements, you're ready to work on your wish list. Just remember to be honest with yourself about this list and avoid getting your wishes mixed up with your requirements. Confusing wishes with requirements can cost you astonishing amounts of money. I'll give you some ideas about what belongs on your wish list.

Wish-list items are often those things that would-be LAN users put right at the top of their list of requirements. Among them are things like hardware and software protocols and the network operating system. While those items should be driven by your requirements, many people let them drive their requirements.

Hardware protocols. Most people who read about LANs are aware of the seemingly endless discussions about whether Ethernet is better than Token Ring or vice versa. The truth is that performance in most installations is the same regardless of which hardware protocol you choose. There are exceptions, and I'll discuss them in another column.

Operating software. Another heated discussion concerns the choice between LAN Manager, NetWare, and Banyan Vines. For most users, they all work fine. There are reasons for choosing one over the other, including the applications you plan to run and the hardware you plan to use, and they should drive the choice of the network operating system. Don't let your wishes about the network operating system prevent you from using the applications you need.

Hardware brands. No doubt you have a favorite brand of computer hardware. Avoid the temptation to buy its latest offering before you get the other network issues ironed out. While you may make a good choice, you may find that your purchase is unsuitable for the final design.

Wiring types. There is no point in wishing about wiring, although many do. In a newer building, the wiring has probably already been chosen, because it was installed when the building was constructed. If you can, you will use it, because it keeps costs down. Otherwise, the wiring will be decided by other factors. Sometimes there are reasons to select a specific type of wiring, such as when fiber must be used in some areas that have a lot of electrical noise. But those are usually engineering decisions. What matters is that the wiring works and that it meets your cost objectives.

continued

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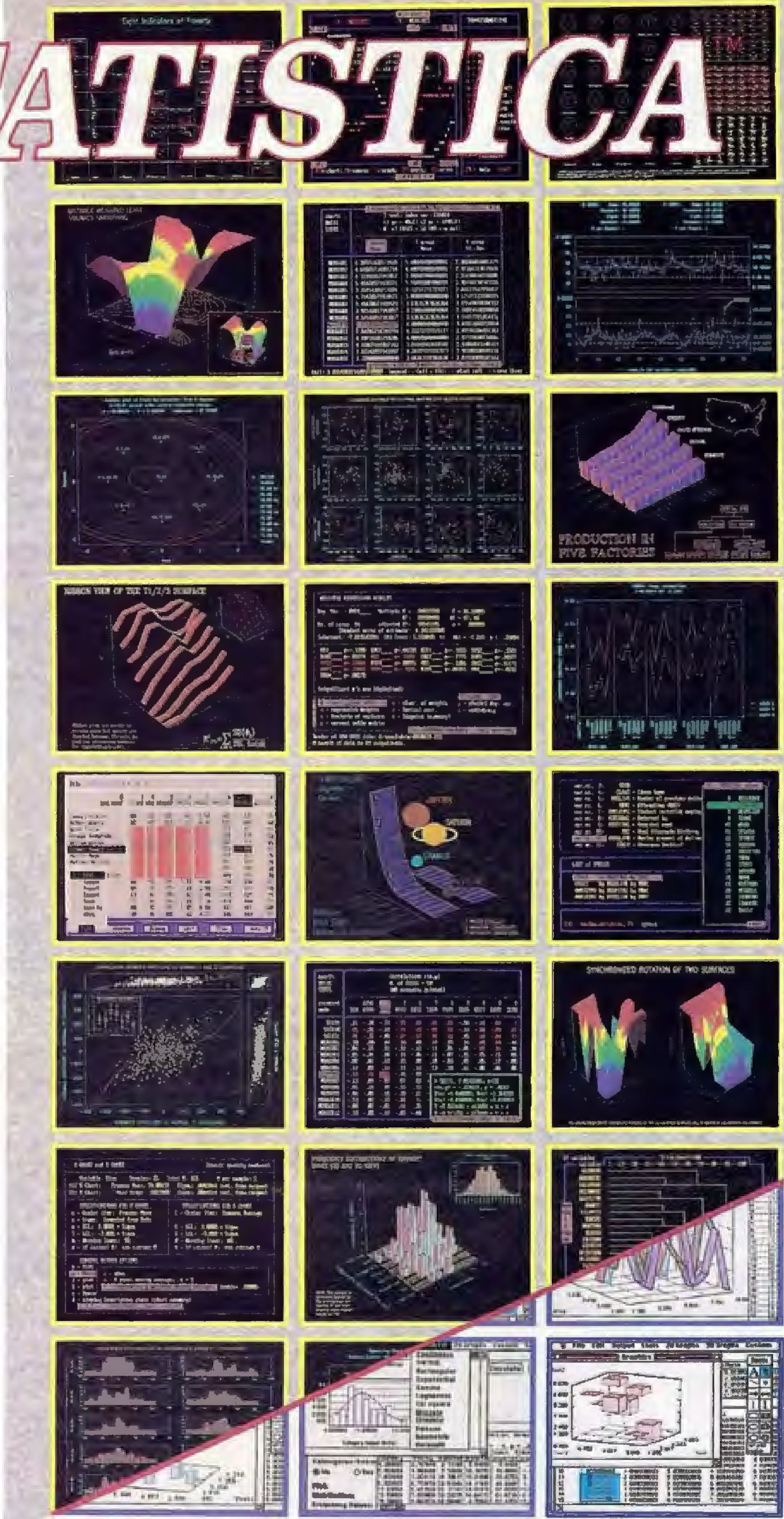

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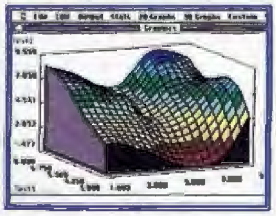

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Objectives Fallout

What you'll probably find out is that the answers to most of the questions about LAN selection and installation are obvious once you've defined your objectives and determined your requirements. In a way, it's a lot like going on vacation. First you have to decide where you want to go, and then you have to decide how you want to get there. By approaching your LAN design this way, you're trying to avoid ending up somewhere you don't want to be because you were too rigid in deciding how you wanted to get there. It's a lot like deciding that you're going to drive down Interstate 95 for your vacation and then being disappointed that you can't get to California that way.

Another reason for working on your requirements and objectives first is that it helps you decide whether you need to hire someone to design and install your LAN. This is an important decision, because a good LAN integrator can be expensive, and a bad one can cost you even more. One of the quandaries you may find yourself in is whether installing a LAN yourself saves you a lot of money or simply ensures that you'll have a bad LAN integrator.

To an extent, the decision to do it yourself depends on how complex your LAN is expected to be, what LAN you'll be installing, and how experienced you are. With the right LAN and the right circumstances, it can be done. For example, when Dave Carter networked his offices at Metropolitan Helicopters in Manassas, Virginia, he did it himself, using LANtastic. His installation worked well, and he continues to use it today. Installations by other users at comparable sites have ended in failure. Why did Dave do so well when others could not? A great deal of it had to do with his having his objectives in mind when he started.

More to Come

As you can tell, the discussion of your first LAN is far too complex to be completed in a single column. For this reason, the discussion will continue for the next few months and will include lots of examples that you can use to avoid problems and pitfalls. I'm particularly interested in hearing from you, because I want to be able to respond to your needs as this series continues. Please send me your questions, comments, horror stories, and success stories. You can write to me care of BYTE, or you can send me comments and questions on BIX. Please let me hear from you. ■

Wayne Rash Jr. is a contributing editor for BYTE and a principal and technical director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He is coauthor of two books for business network users: The Executive Guide to Local Area Networks *and* The Novell Connection. *You can contact him on BIX as "waynerash," or in the to.wayne conference.*

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

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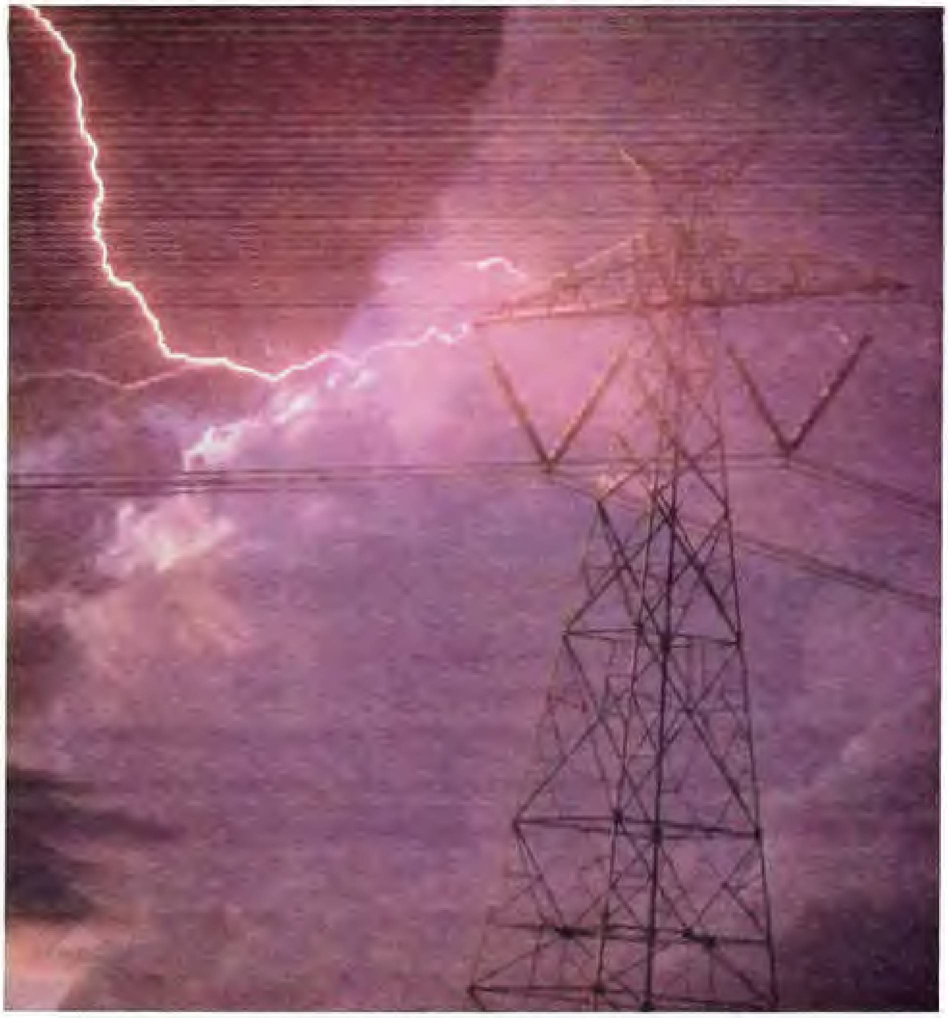

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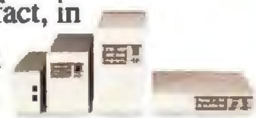

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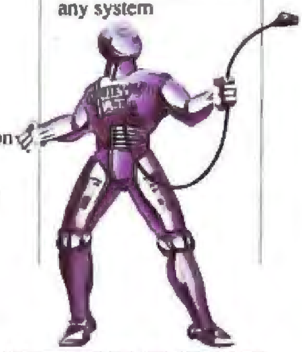

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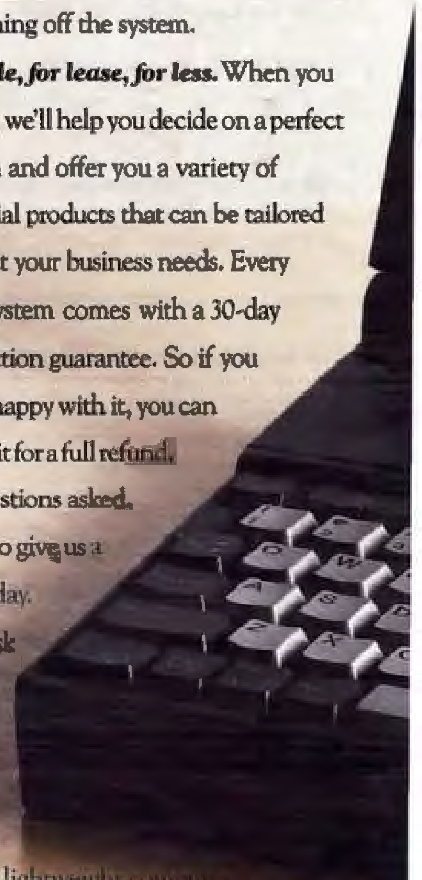

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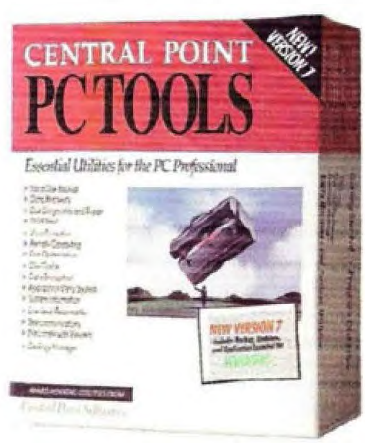

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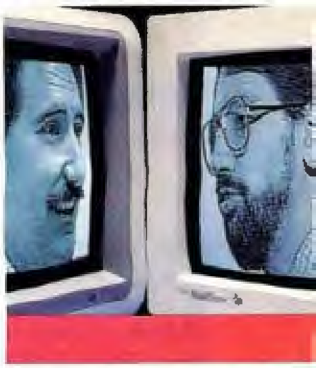

BYTE columnists, staff, and contributors debate the issues

What Is a Programming Language?

Roundtable is a forum in which BYTE editors, columnists, and contributors debate key issues that affect how you purchase and use hardware and software. The "conversations" take place on BIX, where you can participate in the round.table conference.

KEN SHELDON: Are HyperCard and other scripting tools programming languages? Surveys tell us that Mac owners use HyperCard (and HyperTalk) more than any other tool to create the applications they need. But since they're not stand-alone applications, are they programs in the strictest sense of the word?

So, what is a programming language? What is a program? Are we seeing a change in what constitutes programming? Does it matter what we call it?

LARRY LOEB: If it gets the work done, it doesn't matter what you call it. HyperCard trades off speed of execution for high-level handles on data constructs. It reduces the formalism of coding to a syntax that is English-like, and that makes for accessibility and productivity. If I want something that's easily modifiable and doesn't need blinding execution speed, HyperTalk would certainly be one of my programming choices.

Programming has always been a method to control machine activity. HyperCard does that quite well, and it deserves to be considered thus. I could put my developer hat on and note that selling the results of my HyperCard programming is not only profitable, it's productive for making version changes.

DENNIS ALLEN: In the case of HyperCard, its programming environment may be more important than its script language. Programming, per se, is being redefined at an increasingly high level of programmability. In other words, programming is getting easier for many types of application building. Programmers no longer have to reinvent the wheel with each new program they write—the "language" already knows how to assemble screens, manage simple data files, and so forth.

All this not only saves time for traditional programmers, it also paves the way for nontraditional programmers. Just because someone creates an application in a high-level programming environment or language does not mean the person's not programming.

DON CRABB: Of course HyperCard is a programming system. Its language, HyperTalk, constitutes a simple programming dialect similar to Pascal as described by the *Standard Pascal Report*. The HyperCard environment itself includes enough object-like data structures and programming aids to make it a quite useful development environment for both pros who do application prototyping and end users who must put together quickies to meet their needs.

Since when do stand-alone programs constitute the necessary end product for a programming language? That would automatically rule out any interpreted language, such as Lisp, Scheme, or Prolog, as a programming language. While having a compiler that produces optimized, executable code ultimately helps you sell an application and distribute it, the lack of a true compiler does not invalidate a language.

In my department at the University of Chicago, we define a programming language as any artificial language that can be parsed by a machine and used to create or implement any algorithm. That means that simple languages with only a few verbs, which can be used to implement different Turing machines, are, indeed, programming languages. We also allow that there are large numbers of differences among programming languages and the usefulness they have for specific research or developmental purposes. But as to their basic definition, we tend toward simplicity, as do most mathematics-derived computer science departments.

SHELDON: Don, do you have any sense of the percentage of Mac owners who actually program in Hyper-

DENNIS ALLEN
Senior Editor, BYTE Lab

DON CRABB
Contributing Editor

LARRY LOEB
Consulting Editor

RICH MALLOY
Managing Editor, News & Technology

BARRY NANCE
Consulting Editor

WAYNE RASH JR.
Contributing Editor

KEN SHELDON
Senior Editor, Features

PETER WAYNER
Consulting Editor

Card, versus those who just use it to run stacks?

CRABB: I've seen the figures that Claris has in-house. It breaks down like this: Of all current Mac owners (as of February 1), 7 percent have never touched HyperCard; 18 percent have used HyperCard a little to browse stacks; 23 percent use HyperCard to browse stacks or make slight modifications to existing stacks at least once per day; 30 percent use HyperCard to browse stacks, make slight modifications to existing stacks, and have tried to create their own stacks; and 22 percent use HyperCard regularly to create customized personal or departmental stacks (ranging from simple to moderately complex, including SQL front-end database access and application prototyping).

SHELDON: So that makes 45 percent of Mac users who use HyperCard regularly, and 75 percent who've actually programmed with it. This whole issue is going to become more thorny as we see the continuing development of products that let you develop programs without being a programmer. And what better use for all those MIPS that the chip folks are promising us? I don't have to be an automotive engineer to plan a day trip. Why should I have to be a programmer to make my computer do something new?

LOEB: Gee, Ken, you're sounding like an object-oriented weenie. But that's exactly it. Why should you have to know the compression ratio of the cylinders in your car to drive it? Elegance means simplicity lots of times, and it's probably true in programming. HyperTalk and the like give you high-level handles on your data. You can customize a stack.

RICH MALLOY: One thing to keep in mind is that you don't even really need a programming language to create an application. A spreadsheet program such as 1-2-3 allows you to create an application without using a language—even if you do not use macros. And a program such as Baler allows you to turn a 1-2-3 template into a stand-alone executable application.

The problem we get into here is in trying to compare one type of application development system with a totally different type. After all, both a blank canvas and a paint-by-numbers canvas can be used to create a painting, but you would not want to compare the two.

PETER WAYNER: Yes, HyperCard is a language, especially when you consider the scripts. I think most people have a huge fear of programming and need to be tricked into doing it.

I was at a Mac university conference, where people demonstrated products and work in progress. One librarian was showing a tutorial for "Shepardizing" legal references. It was constructed in a snazzier version of HyperCard called Authorware. She showed me all the slick cross-fades and effects and told me, "And it doesn't require any programming! I did this myself in two days!" While she was certainly giving commands to the computer to manipulate objects on the screen, she didn't feel that she was programming because it wasn't difficult and beyond her abilities.

Steve Wolfram also noted that if he went out and announced a new language, he would have been dead. Calling it Mathematica, a totally new system that just happens to have its own internal language, wasn't off-putting, though.

I would guess that in many cases, programming is a synonym for "difficult, if not impossible." Gosh, deconstructive computer science.

CRABB: I run into the same thing at the university. We deliberately don't use the word "programming" in our intro computer science courses for humanity students because they are scared of it. Then after 10 weeks, they discover that they have been programming all along.

SHELDON: Maybe "What is programming?" is one of those questions like "What is artificial intelligence?"—everybody essentially knows what you're talking about, until you look too closely and try to define it exactly, at which point everything falls apart.

On a related point, I'm putting together an article on graphical programming—languages, applications, and development tools that let you use graphical elements to create programs or applications. It's a tough topic to nail down since there are so many possible angles. Here's a comment that Jon Udell made to me:

"Sounds reasonable to me. I wonder, though, whether the point of the piece may end up being that graphical programming is a category with no raison d'être. That is, it looks like a category, but when you look closer, it sort of splinters apart into a bunch of different, not necessarily thematically related, things. It would explain why the subject has been so tough to nail down."

BARRY NANCE: Ummm...no. You can look at programming as closely as you want to without losing clarity and definition. As mentioned earlier, programming is the art (oughta be a science, but it's not) of instructing a computer to do one or more related tasks. The trick is to give the computer exactly the right instructions.

In a low-level language, each instruction is an infinitesimal part of the overall task. At higher levels, each instruction encompasses a larger part of what's to be done. Even with high-level languages, though, it's pretty tricky to specify the steps of a task correctly. Perhaps someday we'll have computers that program themselves, since we humans seem to do such a bad job of it.

Does dBase implement a computer language? ObjectVision? Or Word for Windows with its macros? Maybe. Some programs perform a fixed, unwavering task when you run them. Others digest whole files of parameters and script entries to determine the current task—but you are still limited by the bounds of what's permissible for parameters and scripts. (Are Procomm communications scripts "programs"?) Still other programs provide so much flexibility that you can clone the programs themselves by giving them the right parameters/scripts/instructions.

Is this true?: You have a computer language if you can do anything in it that you could do with assembly. Otherwise, it's only a script-reader.

CRABB: Each of those programs implements some artificial language. We can choose to call them macros, or scripts, or access methods, but they all fall into the generic realm of artificial languages. How complete their grammars are, of course, is another question. Perhaps that is how we can ultimately decide when something qualifies as a true computer language—by the richness of its grammar and syntax.

WAYNE RASH JR.: I tend to look at these questions functionally. If you can use a program to create useful applications, then it must be a language. You can use HyperCard to create a useful application, so it must be a language. Personally, I think most of these arguments proclaiming that something isn't a language are religious issues. What they are saying is that it isn't hard to use, and thus it will allow the great unwashed public to actually (gasp!) program computers. That being the case, maybe they can protect their rice bowl a little longer if they claim that it's not a "real" language. Such claims are, of course, hogwash. ■

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FEATURE

Smalltalk Yesterday, Today, and Tomorrow

A look back and a look ahead at this innovative programming language—first featured 10 years ago in BYTE

L. PETER DEUTSCH AND ADELE GOLDBERG

It's been a decade since the August 1981 issue of BYTE was published. That issue provided many people with a first comprehensive look at the then-fabled Smalltalk programming environment. In this article, we look back at how people thought about Smalltalk in those days. Then we'll look more broadly at how Smalltalk and object-oriented software technology has progressed since then; we'll also consider today's state of this technology and the market for it. Finally, we'll look ahead to objects in the year 2001, another decade hence.

1981: Sending Up the Balloon

In that BYTE issue of 10 years ago, we wanted to convey three ideas about Smalltalk and object-oriented software technology: first, that an interactive, incremental approach to software development can produce qualitative and quantitative improvements in productivity; second, that software should be designed in units that are as autonomous as possible; and third, that developing software should be thought of in terms of building systems, rather than as black-box applications. The Smalltalk-80 system described in that issue so long ago was the exemplar of these three ideas.

Smalltalk was widely known then—and yet, largely unknown. Alan Kay and others from the Xerox Palo Alto Research Center (PARC) had been giving talks with tantalizing glimpses of the technology, but few people knew or understood its content. Thus, the cover of BYTE's Smalltalk issue—depicting a brightly colored Smalltalk hot-air balloon leaving an isolated island—symbolized our feeling that the time had arrived to start publicizing what we'd been doing. We believed we had new ideas that could make a real difference in how people developed software.

Many research examples developed at PARC demonstrated that object-oriented design could produce an appealing, intuitive, and direct mapping between objects in the real world and objects in a software implementation. We saw this as a radical breakthrough in one of the most difficult and problem-prone steps in software development—identifying terms and relationships as understood by human participants of a particular situation with those understood by a computer.

We believed that this simple mapping of nouns to objects was all (or most) of the story about how to design with objects, and we presented it as such in the 1981


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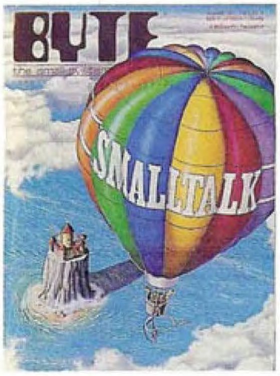


The motivation of the past decade was to move Smalltalk off its island.

BYTE articles. Subsequently, in examples given in our books in 1983, we demonstrated that the power of objects applied to more than nouns: It also applied to events and processes. But this power was not as well explained or exploited.

The Smalltalk research project was founded on the belief that computer technologies are the key to improving communications channels between people, in business as well as personal settings. Our activities focused on finding new ways to organize information stored in a computer and to allow more direct access and manipulation of this information.

The Smalltalk edition of BYTE introduced our approach to managing the complex information world of modern applications. It explained our methods for taking full advantage of new graphics and distributed computing and for improving the ability of experts in business and personal computing to describe their world models.

In retrospect, we are pleased that much of the software community has come to agree that the object-oriented approach to software organization is a new way to solve problems that is often better than the procedural approach. Although our ideas about problem-to-implementation mapping were incomplete—notably given the lack of formal methodologies—those ideas are widely accepted today.

1991: A Decade of Experience

What have we learned in the past decade based on the Smalltalk research and experience that was introduced to the public in those 1981 BYTE articles? The first idea, as we stated earlier, is simply that a highly interactive, highly incremental software development environment can produce a qualitative improvement in software development productivity. Even in 1981, Smalltalk systems were not the only ones with this characteristic—Lisp systems pioneered the approach in the early 1960s—but they were among the outstanding examples and were the ones that moved most successfully from proprietary hardware to the microprocessor mainstream. Today, the truth of this idea is widely recognized: The suppliers of environments for more-established languages like C, C++, and Ada are now aiming to provide the benefits that Smalltalk introduced a decade ago.

BYTE ACTION SUMMARY

When BYTE first broke the news about Smalltalk to the world, there were no PC versions of the language. Now, the principles that Smalltalk pioneered have permeated the microcomputer world, and powerful versions of the language are available for a variety of personal computer platforms.

The second idea is the basic idea of object-oriented software organization: that software should be designed in units that are as autonomous as possible, should correspond to identifiable entities in the problem domain whenever possible, and should communicate through identified interfaces. This idea grows out of work on modular software design that dates back, again, to the 1960s. Object-oriented terminology adds an emphasis on direct mapping of concepts in the problem domain to software units, the idea of shared behavior and multiply instantiated state, and a focus on the interfaces between the units.

The last of these (the interfaces between the software units) makes it easy to think about systems that are configured or that grow dynamically. Smalltalk has no monopoly on new concepts, but it has been a leader in the public relations necessary to get these concepts out into the computing mainstream.

Object-oriented software organization has a natural relation to two current trends in software construction: combinable applications and open systems. Our interpretation of the term *open systems* is that for systems to grow, evolve, and combine gracefully, they should be constructed out of software with published interfaces. Functional software should be designed to be used as a component by other software, as opposed to being monolithically united with a particular interface designed only for humans at a terminal.

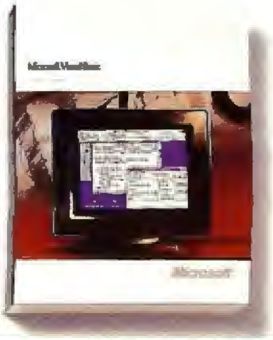
The third important idea that has grown partly out of the Smalltalk work is related to the open-systems idea—namely, that one should always think about building software in the context of building systems, rather than in the context of black-box applications. In other words, one should examine explicitly the nature of both the downward interfaces (the resources or facilities the software uses) and the upward interfaces (the client's use of the software) and make them as undemanding as possible. Separating functionality from the user interface, which is the Smalltalk concept of model-presentation-interaction known as *model-view-controller*, is just one application of this principle—but a very important one.

The motivation behind much of the activity in the past decade was to move Smalltalk off its island and into easy availability for the general programming community. We look at this activity as being aimed at creating a credible, concrete, and robust realization of the ideas that we could present only in sheltered research form in 1981.

As Smalltalk has moved into the commercial world, it has encountered the familiar phenomenon of technological life span. A technology comes into existence on paper, often at a university. It then progresses to research papers, research prototypes, and usable research-scale artifacts. Finally, it goes into commercial use, first by the adventurous and then by the broad mass of users—getting adapted, extended, patched, and transported as long as it continues to solve problems well, and eventually getting replaced in many or all of its uses by newer technology. Smalltalk is now in this third stage—past the scrutiny of the adventurous and experiencing wider commercial adoption. [Editor's note: *For a look at some new products that should help bring Smalltalk to a larger audience, see the text boxes "OOP Made Visual: Digitalk's Look and Feel Kit" on page 112 and "Smalltalk About Windows" on page 114.*]

A Framework for the Future

One of the promising new concepts in object-oriented design—being actively explored today in Smalltalk as well as in other



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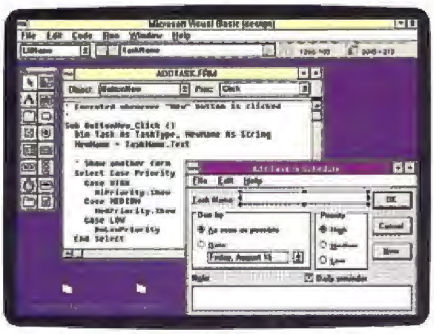

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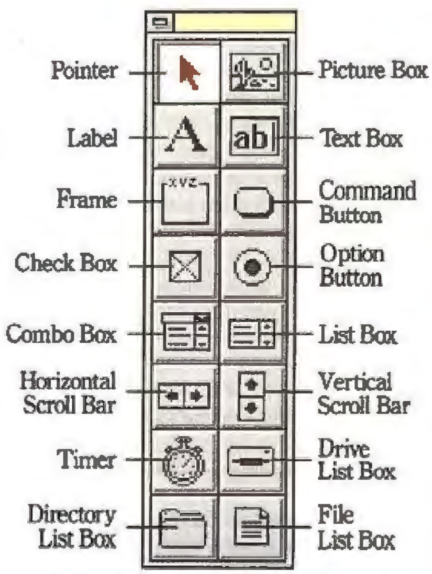

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OOP Made Visual: Digitalk's Look and Feel Kit

Ellen Ullman

Object-oriented programming is highly conceptual. Based on the ideas of encapsulation, inheritance, and polymorphism, OOP may seem to be the headiest and least visual of programming models. But the Look and Feel Kit from Digitalk manages a difficult task: It makes visible the concepts and mechanisms of OOP.

Based on the Smalltalk language, the Look and Feel Kit is more than a tool for creating GUIs. It provides a platform for creating complex object-oriented applications with a minimum of coding. It can also be used to integrate application components from a variety of sources, whether they're written in Smalltalk or another language, creating a consistent, object-oriented user interface. The screen at right shows an E-mail application in the process of being developed.

The development environment, running under Windows, has the familiar GUI. An iconic palette shows available categories of application components. The categories include windows, panes, buttons, menus, and tools. The palette is fully extensible and, when shipped, may include a category for database access, offering components for communication with Structured Query Language databases.

After you select a category, the palette shows the available components in that group. For example, selecting the panes category brings up options that include text, graphics, and list panes. The window category offers application windows and dialog boxes, and there is a range of buttons and menus. The tool category includes what are in essence fully functional "applets": a file accessor, an organizer tool for grouping collections of objects such as files, and the important dynamic link library (DLL) accessor for accessing modules written in other languages.

To create an application with the Look and Feel Kit, you drag selected components into the application editor window, placing them where you like. You can move components later. Pixel-level movement and alignment tools let you pinpoint placement.

After helping you arrange the graphical elements, most "visual" application tools stop being visual at that point. To get functionality behind components, you usually have to start writing code. But it's here that the Look and Feel Kit gets interesting.

To add functionality to a component, you first select an object. This elicits a pop-up menu showing the messages this object can send and receive. You select a message from the menu, and you get a "wire," which you then draw to the object that will receive the message. The wire is the communication line between objects. When you connect the wire to the receiving object, you get the receiving object's menu of messages. Selecting a message on the receiving object completes the connection. For example, a List Pane component showing the contents of a directory may send a `selected` message to a File Accessor com-

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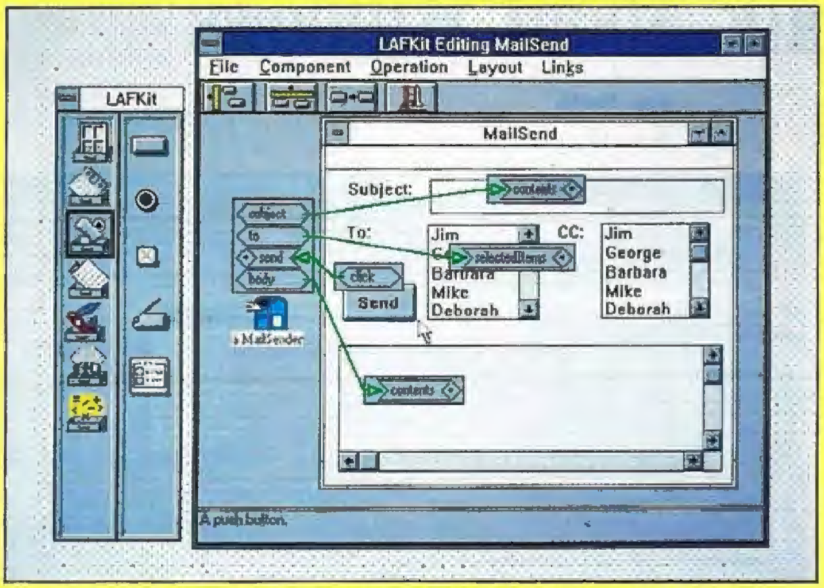
languages and environments—is the concept of a framework. In an object-oriented environment that supports inheritance, reusable software that implements a single concept frequently takes the form of a specialization hierarchy in which the superclasses are more abstract (e.g., the Smalltalk classes `Collection` and `Number`), with certain operations deliberately left to implementation by more concrete subclasses (e.g., `Array` as a concrete subclass of a kind of `Collection`, and `Integer` as a kind of `Number`). These holes in the superclasses (called *virtual functions* in C++ terminology) are an important part of the design.

A framework is a generalization of this idea to a group of classes working together. For example, the Smalltalk model-view-controller framework consists of three abstract superclasses that provide little more than definitions of how the concrete subclasses should work together, plus some bookkeeping code and default implementations of the most common operations. You reuse a framework by writing new concrete subclasses and combining existing subclasses in new ways.

Another example of a framework involves the notion of a discrete event-driven simulation, in which objects interact to represent tasks, workers, locations (where tasks are carried out by



Digitalk's Look and Feel Kit lets you develop applications—like this E-mail program—by choosing components and connecting them with "wires."

ponent, which, in turn, accesses a file.

The process of drawing wires between components continues, object to object, until you have described all the lines of communication. The Look and Feel Kit displays some wires in red, indicating incomplete connections—those that require argument input. Complete connections are shown in green. You can test these connections by launching the application at any time.

When you are satisfied with what you have constructed, you save the application. You can then use it in three ways: You can add it to the palette, extending the available programming components; you can execute it as an .EXE file; or you can make the application a DLL for distribution.

The Look and Feel Kit, with its so-called wires, externalizes language-level objects. By grabbing a component, you immediately see its graphical elements. You also "see" its message capabilities—what are usually the conceptual, nongraphical aspects of an object. In a programming world where code is invoked through the passing of messages, the wires provide a literal, visual representation of the OOP procedural model.

By drawing connections, you can create complex applications with a minimum of coding. The determining factor in this development process is the quality and completeness of your component set. You can extend the set with applications you have created using the Look and Feel Kit, with Smalltalk objects you have written, with components purchased from third parties, and with DLLs. With a thorough set of components, you should be able to construct nontrivial applications, relying mainly on visual programming.

After the current Windows release of the Look and Feel Kit, Digitalk plans to ship an OS/2 version in October or November. This powerful, interesting development tool should add momentum to the OOP movement. And it may win some converts to the Smalltalk cause.

Ellen Ullman is a San Francisco-based associate news editor for BYTE. She can be contacted on BIX as "ullman."

the workers), and statistically based schedules for introducing tasks and workers. New components, specialized tasks, workers, and schedules can be described in order to reuse the general framework to create specific simulations. This concept is described fully in the book *Smalltalk-80: The Language* by Adele Goldberg and Dave Robson (Addison-Wesley, 1989).

The other Smalltalk idea receiving attention today is that building software is building systems. Software should have the same property as a fractal design: Assemblies built out of parts should have the same qualitative nature (such as definable inward and outward interfaces) as those parts. Developers must realize that they cannot predict all the ways that a piece of software will be used or all the ways that it will be ported to use the facilities of new environments.

Smalltalk in the Marketplace

One of the powerful ideas that has attracted new attention as a result of the development of object-oriented software technology is the notion of reusable, combinable applications. Today, this idea is promoted at three levels: (1) operating systems, such as Unix pipes and `fork/exec`; (2) window systems, by way of interapplication communications conventions (e.g., Apple's Interapplication Communications, Microsoft's Dynamic Data Exchange, and the X Window System's Inter-Client Communications Conventions Manual); and (3) independent software architectures (including low-level ones such as Microsoft's dynamic link libraries and Sun Microsystems' shareable libraries, as well as high-level ones such as Patriot Partners' Constellation project and ParcPlace's object model and frameworks approach).

Many believe that the discipline of defined, published interfaces—which the object-oriented approach naturally promotes—will create a new marketplace for reusable software components. However, from our experience with many developers and users of Smalltalk systems in many environments, we think the key economic shift will be in a different area.

A public market is a loosely organized environment. Components placed in a market will face a wide variety of demands, and even well-designed components with minimally constrained interfaces will have trouble attracting a critical mass of customers.

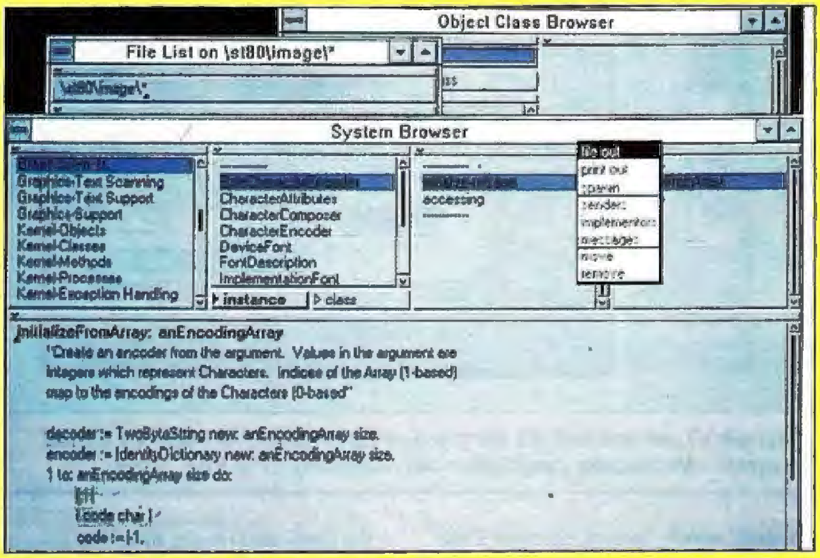
On the other hand, within a single organization, reusable components can be developed and redesigned to span a large fraction of their intended uses. In this way, the accumulation of

Smalltalk About Windows

Ben Smith

The Smalltalk environment has included windows since its inception. In fact, you might say that all the popular windowing environments grew out of the Smalltalk environment developed at Xerox Palo Alto Research Center (PARC). But, as with any evolving system, there are marked differences between the progenitor and its descendants.

Now, Smalltalk has recombined with the newest of the window environments, Microsoft Windows 3.0. The two major vendors of Smalltalk implementations for PCs have recently announced versions for Windows: Objectworks\Smalltalk for Windows from ParcPlace Systems, and Smalltalk/V Windows from Digitalk. While the core of both systems is Smalltalk, the Windows implementations are as different as the philosophies of the two companies.



Screen A: *Objectworks\Smalltalk for Windows looks similar to versions of the language that run on other platforms.*

A Question of Consistency

ParcPlace is the traditionalist; after all, the company *is* the tradition, since it spun off from the original group that developed Smalltalk at PARC. Objectworks\Smalltalk is a unique windowing environment with a mouse, window panes, scroll bars, and drop-down menus. You can use Objectworks\Smalltalk on a variety of platforms, and the window layout, icons, and window controls are always the same: the Objectworks style (see screen A).

Although this window style is not consistent with any of the newer and more widely used windowing systems, it has a great deal going for it. The most obvious feature is line wrap and rewrap: Long lines of text are wrapped around to the next line, breaking only between words. When you resize a window, the lines are rewrapped to reflect the new window size.

Another distinguishing feature of Objectworks\Smalltalk is its five-pane system browser window. (The system browser is the primary programming interface for Smalltalk.) Each pane is associated with a different function: class category, class, message category, message, and code editing. Each window pane has its own pop-up menu of operations. The pointers, icons, menus, and scroll bars maintain Objectworks' unique style on any platform.

Then there's Digitalk—the company that released the first commercial versions of Smalltalk (for DOS and then for Mac systems). Digitalk's Smalltalk/V Windows assumes that if you are programming for an established window environment, then you want to totally adopt that environment. In other words, if you develop a Smalltalk/V ap-

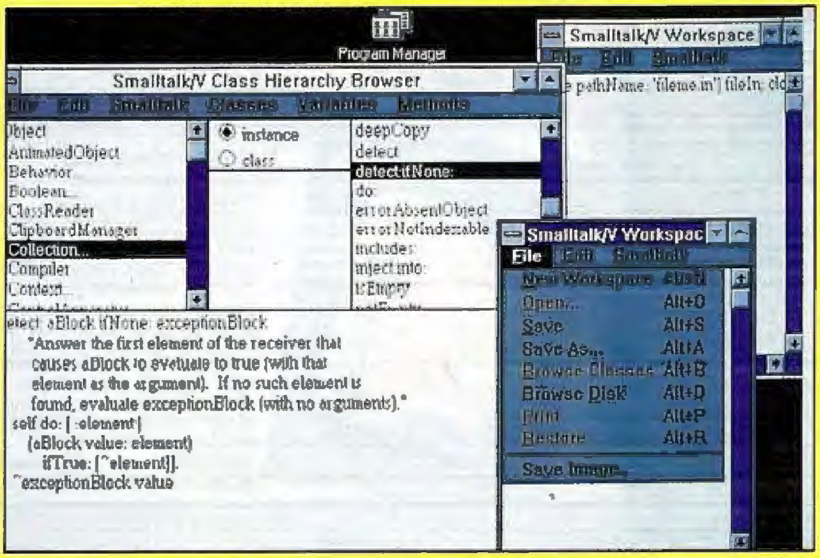
reusable code can become an important business asset and can be treated (appropriately) as an investment and a capital good, rather than simply as a cost (which is its present treatment).

In an object-oriented environment where inheritance is supported, it is not only individual components that are reused. As we have noted, the design of interfaces between objects is often more important than the implementation of functions within objects. Frameworks can capture the structural design of software objects that address a given (partial) problem domain. As such, the frameworks developed and reused within an organization will, over time, come to capture and eventually even define the expertise of the organization—and, as such, can contribute to the organization's ability to meet its customers' needs. (This is sometimes called *competitive advantage*, but it applies equally well in situations where competition is not involved.)

2001: A Smalltalk Odyssey

If we look into our murky crystal ball, how do we see software's use of object technology in the next decade? How do we see it evolving?

We hope that in 2001, objects will be boring. In comparison, radical ideas of past decades—that system software should be written in higher-level languages or in languages with strong type systems, and that computers can and should be seamlessly networked—are thoroughly accepted today. Whether to imple-



Screen B: *Smalltalk/V Windows applications are consistent with the Windows look and feel.*

plication for Windows, your application should look and act like a Windows application, not an application that merely runs inside of (and despite) Windows (see screen B).

The drawback to this attitude is that Smalltalk/V for the Macintosh looks and acts different from the versions for Windows, plain DOS, and the X Window System. The distinct advantage of Smalltalk/V for any environment is that you can take full advantage of that environment. Your applications will be consistent with the style guidelines for that environment. For example, Smalltalk/V Windows has full access to the facilities of the Windows application programming interface, including dynamic link libraries and Dynamic Data Exchange.

Tools and Classes

There's more to a Smalltalk implementation than a window environment and a language; there are the programming tools and the predefined class hierarchy. Smalltalk/V Windows provides fewer tools and a simpler class hierarchy than Objectworks\Smalltalk for Windows, but these limits are, in part, overcome by optional packages, like those from Digitalk (see the text box "OOP Made Visual: Digitalk's Look and Feel Kit" on page 112) and from third-party vendors such as Acumen Software. Acumen recently released a set of "user-interface construction kits" that let you develop interfaces for Smalltalk/V Mac, Smalltalk/V 286, and Smalltalk/V Windows programs—Widgets/V Mac, Widgets/V 286, and WindowBuilder/V, respectively.

Both Windows versions of Smalltalk maintain a text log of changes to the Smalltalk "image" (i.e., the Smalltalk gestalt of any moment). You can view the Smalltalk/V version of the log with the File utilities. With Objectworks\Smalltalk, you can view the change log as an object with a hierarchy that has separate instances for changes to classes, to methods, and to the system.

Both products provide a method for applying the changes of one project to another, a necessary operation if the system is to follow the objective of reusability. Both products also have an excellent debugger, as well as tools for file management, view management, and text management. As with all things, their styles differ: Objectworks maintains its own style, and Digitalk adopts the style of Windows.

Ben Smith is a technical editor for BYTE. He can be reached on BIX as "bensmith."

ment them is almost never an issue now, even though there is still plenty of discussion about how to implement them well.

In the same vein, we expect that 10 years from now, the object-oriented approach to software design and implementation will be an accepted, standard technique used in every language, library, database system, and operating system and will be taught in undergraduate computer science courses at every university. This is an issue of moving the technology further out into the world, and no major new thinking will be needed to accomplish it.

One significant technological advance will be that we will free ourselves even further from equating objects with the nouns in the problem domain. Some of the most remarkable advances in the usability of computer systems have come from recognizing that processes, as well as things, can and should be described, modeled, and manipulated. Therefore, we will see software objects being used to model time, places, actions, and events. We believe that this will lead to usability advances almost as dramatic as those resulting from the now-established window/icon/mouse/pull-down interfaces that were to a large extent inspired by the original Smalltalk work of the 1970s and 1980s. ■

L. Peter Deutsch is chief scientist and Adele Goldberg is president of ParcPlace Systems (Mountain View, CA). They can be reached on BIX c/o "editors."

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Programming the 68040

Programming for Motorola's high-powered processor means being aware of some tricks and traps

GREG LINDHORST, ANDREW ANDERSON, AND DAVID DAHMS

The MC68040 is Motorola's third-generation 32-bit microprocessor and the newest member of its 68000 family. In advancing from the 68030 to the 68040, Motorola incorporated many architectural changes and performance-enhancing features. (See "Motorola's 68040 Microprocessor," February 1990 BYTE.)

What do these changes imply for operating-system software and applications programming? How do programmers take advantage of the 68040's new features but avoid common programming pitfalls? To answer these questions, we examine the 68040 branch of the 68000 family tree.

Changes and Additions

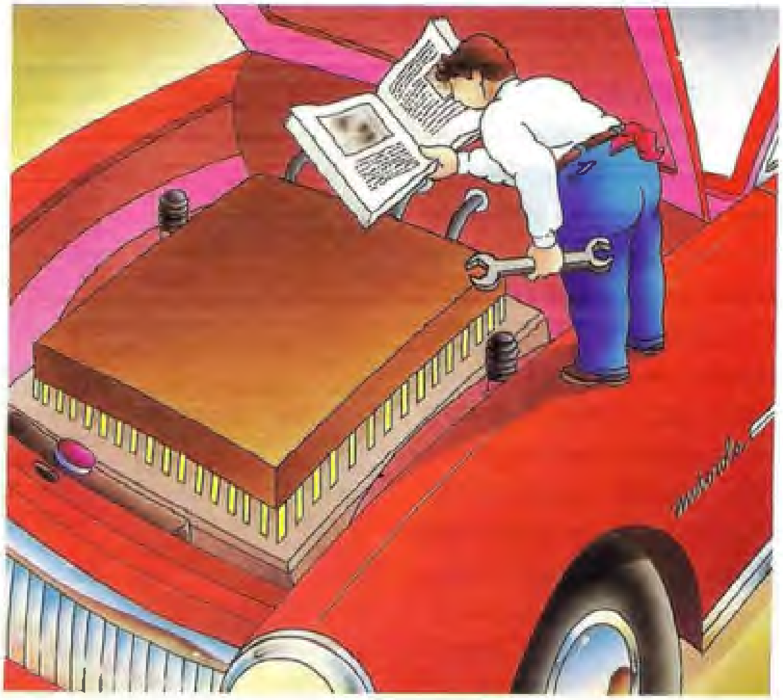
The 68040 essentially combines the 68030 and the 68882 (Motorola's associated math coprocessor) and adds significant on-chip cache memories, further integer pipelining, and some multiprocessor capabilities. Figure 1 shows the block structure of the 68040.

The 68040 is user object code–compatible with the earlier 68000 family members (i.e., if the code runs on the earlier chips, it should run on the 68040). The 68040 includes all the registers and instructions of the 68030 and the 68882 plus a new move16 instruction for faster block moves. As with each new addition to the 68000 family, the supervisor programming model has been enhanced over previous chips. As a result, the format, size, and access method of many supervisory registers are different than those of earlier designs.

RISC design has continued to influence this Motorola family. For example, the integer unit is now pipelined into six pipe stages, resulting in one clock cycle per instruction for many common instructions. The FPU is also pipelined, with most on-chip operations taking about half the number of clock cycles of the 68882.

The 68040 provides an on-chip paged memory management unit with dual 64-entry address translation caches (ATCs). It is less flexible than the 68030's MMU in that it does not support the programmable translation table depth found on the 68030, and it supports only 4-kilobyte and 8-KB page sizes. The pmove, ptest, and pflush instructions for MMU control have new formats but are similar to those of the 68030. The format, size, and access method of the translation control register have changed. On the 68030, you would access the TC register with the pmove instruction, but with the 68040, you access it with the movec instruction.

The 68040 on-chip caches are larger (4 KB for instructions, 4 KB for data) and live on the physical bus. The data



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cache is enhanced to operate selectively in copyback rather than write-through mode. In copyback mode, writes to memory do not necessarily generate bus cycles. Writes go into the cache, and the corresponding cache line is marked dirty. Only when normal replacement or an explicit push via the new `cpush` instruction occurs is the data written out to physical memory. This mode reduces the amount of memory bus bandwidth that the processor needs and increases write performance significantly. You can select the cache mode of operation on a page basis.

The 68040 supports bus snooping—the ability to monitor bus cycles by other bus masters to maintain cache consistency. In this mode of operation, the cache automatically maintains consistency with physical memory without requiring any interaction with system software. When you enable snooping, you increase the time required to perform each data transaction.

Floating-point operations on the 68040 are object code–compatible with the 68882 by means of on-chip hardware for the most common operations and off-chip software emulation for the remaining operations. The on-chip instructions include data movement, comparison and branching, addition/subtraction/multiplication/division, square root and absolute value computation, and negation. The remaining instructions are emulated in software and execute in about the same time as a comparable 68882. Denormalized and packed-decimal floating-point formats are also not handled directly by the 68040 and therefore are slower than the more common and directly supported, normalized representation.

The 68040 provides a restart exception model and does not support instruction continuation. A new access-error exception frame replaces the 68030's long and short bus error frames.

Operating-System Implications

Operating systems that run on 68030/68882-based architecture must be modified to run on the 68040. The major operating-system work involves getting the low-level virtual memory (VM) system to support the MMU and caches.

You must also modify the bus error recovery path. Additionally, you need to integrate emulation software for unsupported floating-point operations and data types.

BYTE ACTION SUMMARY

The 68040 can perform up to four times faster than a comparable 68030/68882 on integer benchmarks and up to 10 times faster on floating point. The engineering effort to support the 68040 can be minimal, since most applications and system software work without modification. The 68040 offers performance and compatibility that make it an excellent choice for many applications.

Programming the MMUs

If your MMU code is targeted for the 68030, you need to change it to control the 68040 MMU. The operating system must use a 4-KB or 8-KB page size. Some operating systems may require extensive changes to VM, I/O, file-system, and other subsystems if they are not already using one of these page sizes. The operating system needs to configure the MMU for three-level translation tables. The page-size selection dictates the structure of the translation tables. The 68040 tables can be the same on the 68030.

You will need to modify the operating system to use the new MMU's instruction and register formats. System software typically uses these in only a few places, so changes are usually minimal. Check the power-up code that enables and disables the MMU, check those places in the VM system that flush entries from the ATC, check the bus error handler since it may use the `ptest` instruction, and examine the MMU status register.

Managing On-Chip Caches

The operating system enables the caches and maintains cache coherency. You need to make changes to use physical rather than logical caches. For best performance, the operating system should enable copyback mode without bus snooping.

On the 68040, the new `cinv` instruction invalidates cache entries; it selectively throws away any information in the cache. You push cache entries with the `cpush` instruction, which writes dirty entries out to memory and marks them invalid, a distinction that is relevant only when the data cache is in copyback mode, because only then can there be a dirty cache entry.

Enabling the copyback mode of the data cache can be a system programmer's nightmare. If the system crashes when it's running entirely out of the cache, the cause can be difficult to see on a logic analyzer. Since you can select copyback on a page basis, it's best to start small. At first, you may wish to enable it only for user stacks. When that's working, you may wish to enable it for user data. Once you enable it for user processes, you can start enabling it for supervisory space segments.

The physical caches of the 68040 are actually much easier to manage than the logical caches of the 68030. For best performance, operating systems should leave the caches alone except under certain circumstances. On the 68030, an operating system will typically invalidate the logical caches at context switches and ATC flushes and after inbound DMA. On the 68040, the only time the operating system needs to push the cache is after writing instructions or while managing DMA. Rather than pushing the data cache after writing instructions, the operating system could elect to put the data cache in write-through mode for any pages containing instructions.

Emulations

The floating-point software emulator is primarily connected through the illegal instruction mechanism, used to indicate instructions not recognized by the hardware. The software emulator is also invoked by the underflow exception and a new unsupported-data-type exception that handles denormalized and packed-decimal representations. Denormalized numbers are special representations for very small numbers, and packed-decimal numbers are commonly used to convert between ASCII and floating-point binary.

Since the emulation software resides entirely in the kernel on a traditional Unix system, you would be unaware that these traps are being taken on your behalf. The instruction that caused the trap appears to operate as it did on a 68882. If the 68040 is in an application where these unsupported instructions and data types are not needed, the software emulator is not required. The required emulation software can be licensed directly from Motorola or written independently.

Recovering from Page Faults

Operating systems must be modified to handle the new exception model. The access-error (or page-fault) exception frame defines three writes that may have to be completed by system software after the cause of the fault has been fixed. Doing

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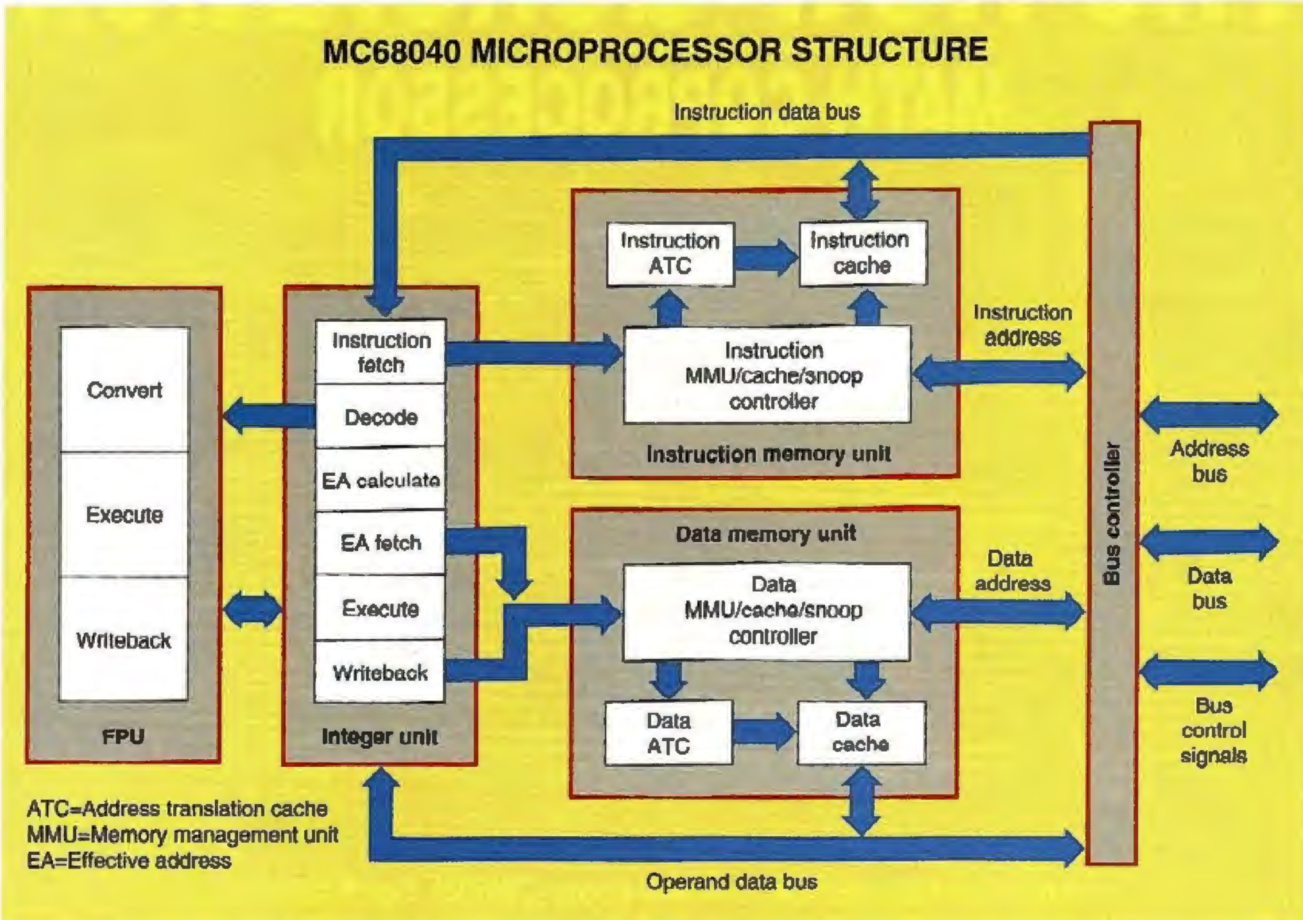

Figure 1: *The caches, floating-point processor, and MMU are built onto the 68040. (Source: Motorola, Inc.)*

writebacks can be tricky, because they may cause page faults as well. One approach is to use the `ptest` instruction to check the writeback address prior to doing the writeback. If the writeback faults, the handler can fix it before doing the writeback.

Another approach is to just try the writeback, and if it faults, let the access-error handler be reentered. You may wish to put an nop after the write instruction to flatten the pipeline and guarantee that the write will be alone in the pipe when it executes. This will limit complexity and recursion depth by ensuring that there are no other pending writebacks should it fault again.

Power-up Bootstrap

You need to modify the bootstrap code so it can identify the new hardware. On the 68040, the high-order bit of the cache control register is a read/write bit. On other 68000 versions, this bit is hard wired to zero. Once you've determined that you are on a 68040, you must clear the high-order bit of the CACR, unless you're prepared to run with the data cache on.

Unlike the 68030's, the 68040's on-chip caches are in an unknown state when they power up. Turning them on and off does not affect the state of individual cache lines; therefore, you must invalidate all entries in the caches before turning them on.

Access Reordering and I/O

To increase performance, the 68040 may use different read and write sequences than those used by the 68020 or 68030 processors. Data prefetches for several instructions in the execution stream may occur before the writeback for the current instruction. Because of the 68040's restart exception model, there may be more than one read access for a single instruction.

Generally, this behavior cannot be tolerated by an I/O subsystem. For example, some I/O devices may have destructive read registers. Once the register has been read, the data is destroyed and cannot be read again. If a data prefetch is discarded and rerun due to an exception, data is lost.

Serialization is a 68040 mechanism that forces explicit ordering of bus cycles; it is selectable on a page basis. When the operating system sets up the MMU translation tables, it should mark all I/O pages as cache inhibited and serialized, and map any user space to I/O space as cache inhibited and serialized.

Applications Software

The 68040 is designed to be user object code–compatible with earlier members of the 68000 family. Because of its new features, however, new opportunities and a few pitfalls exist that applications software developers should be aware of.

Self-modifying code can be a serious problem when it's used with caches. Specifically, the separation of the data and instruction caches has all but ensured that older self-modifying 68000 code will fail. All data writes (how new instructions are created) flow through the data cache. If instructions are already in the instruction cache at the same address as the new instructions, then the execution stream does not see all or part of the new instructions. Even without the instruction cache, the

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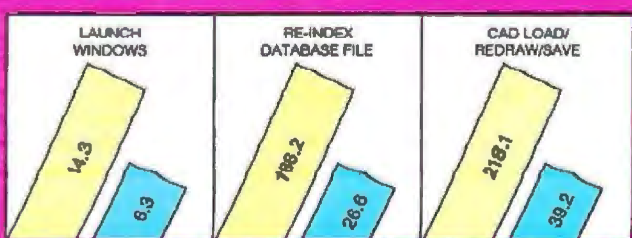

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The 68040 and the Mac

Scott Coleman

When it comes to 680x0-based computers, you most likely think of the Macintosh. Motorola's 68040 promises future Macintosh systems a huge performance boost while providing code compatibility for many applications. However, changes in the 68040 can create software difficulties for the Mac. I uncovered these problems while implementing the Radius Rocket, a 25-MHz 68040-based NuBus accelerator board for Mac II–class computers.

Since the 68040's built-in FPU supplies only a subset of the 68882 FPU's floating-point instructions, a mechanism to handle unimplemented instructions has to be in place. For example, when the 68040 encounters one of these unimplemented math instructions, it generates an F-line exception trap (not to be confused with the A-line exceptions used by the Mac Toolbox). An exception handler determines what the offending instruction was and then calls the appropriate math routine in the Motorola emulation library.

The 68040 integral memory management unit also uses only a subset of the 68030's MMU instructions. At boot time, the Mac ROMs use 68030- or 68851-specific MMU calls to set up the Mac's address space. These routines had to be patched to comply with the 68040 instruction set. The boot process occurs only once, but the Toolbox call SwapMMUMode (used to swap the Mac's addressing mode from 24 bits to 32 bits and back) is called frequently when the Mac accesses NuBus boards. This trap had to be patched as well.

Changes in the size and content of the 68040's exception stack frame also impacted on the operation of existing Mac system software. That's because the Mac operating system deals with an exception by extracting crucial information from the stack frame. When an exception occurs on the Radius Rocket, software massages the 68040 stack frame into a 68030-style stack frame before handing control to the Mac operating system, fooling it into thinking that it's running on a 68030.

Another problem occurs when the 68040 supports a mode in which both processor reads and writes are cached (the 68030 only caches reads). This means that the cache frequently holds different values than what's in memory. If the data that was written to memory is a portion of code that the processor is about to execute, the 68040's instruction cache—which operates separately from the data cache—fetches old values (or garbage) from memory, while the new code sits in the data cache. How does such a situation occur? First, many INITs install themselves by copying code into the system heap and then executing it. Second, some applications alter their capabilities on the fly by patching their jump tables. One solution is to include in the application the instructions that the 68040 uses to flush the cache, but this fix is at odds with the goal of software compatibility. A better solution is to configure the caches as write-through. This results in a slightly slower cache mode but provides the required compatibility. In the case of the Radius Rocket, you can set the cache modes. If an application doesn't modify its code in the manner described above, then you can set the cache mode to copyback for better performance.

Finally, for QuickDraw graphics, the 68040 `move16` instruction turns out to be quite valuable. For example, the Rocket accelerator board has special hardware that allows the 68040 to use the `move16` instruction in a NuBus block transfer. This way, graphics data can be burst to display boards that support the NuBus burst mode at rates of up to 20 MB per second. Combined with the 68040's processing power, this high transfer rate practically eliminates the need for most graphics accelerators.

I want to note that many of the issues I described are typically operating-system issues. But since the Rocket accelerator board replaces the Mac's CPU, Radius had to address them. Overall, the 68040's compatibility is excellent, and no one will dispute its performance.

Scott Coleman is a software engineer at Radius (San Jose, CA) and is responsible for the Radius Rocket accelerator's software.

copyback data cache may not write the new instructions to memory before they are fetched for execution. In the past, application programs have successfully ignored this problem, since caches were small and write-through.

We found this problem of cache coherency when working with dynamic loaders and hardware emulators. We needed to push and invalidate the caches at the particular addresses where they affect instructions. Unfortunately, the instructions to control the cache are supervisory only, and the operating system must provide a fast mechanism to do this task for you.

Instruction Selection

Selecting the best instruction for performance is an important job for the compiler as well as for the assembly language programmer. Avoid using the emulated floating-point instructions; instead, call a library routine linked into the user program to do the operation. Of course, additional library routines add to the size of the user program, but this is becoming less of a concern thanks to shared libraries.

The library solution is much faster than the emulation, since the trap and decode time (required to get into the operating system and figure out what to do) is comparable to the actual computing time. Also, the emulation routines calculate answers to extended precision (80 bits); this high precision is not always needed by the application. Extra precision usually requires extra calculation iterations and, therefore, more time.

One of the floating-point instructions that is not directly supported by the hardware is `fintrz`. This instruction has been widely used on older 68000 family members to conform to ANSI FORTRAN and C rules about conversions from floating

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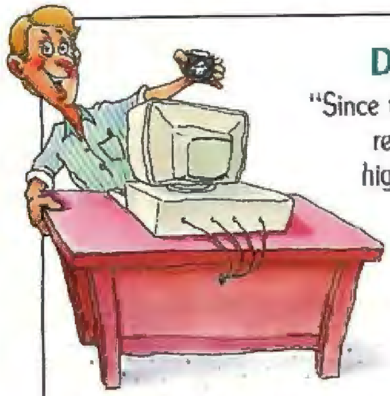

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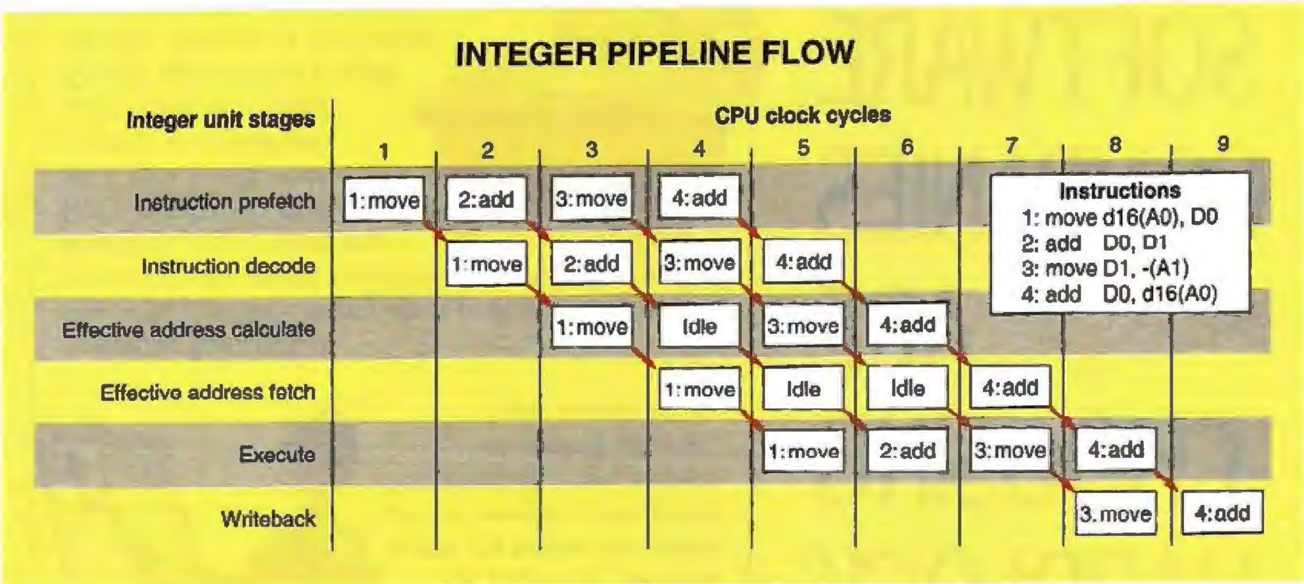

Figure 2: *Each of the instructions will occupy a pipe stage for only one clock cycle; therefore, one instruction can complete in each clock cycle.*

point to integer (the conversion should round to zero). You can do the same conversion in several ways that are much faster than the emulated instruction, including changing the floating-point control register and even doing an `fmove.l` into an integer register and then making any necessary adjustments.

Another common instruction in older code is `jsr` (absolute jump to a subroutine). On the 68040, the `bsr` instruction (relative jump to a subroutine) is one CPU clock faster than `jsr`. Since, on most systems, the two can be freely interchanged, the `bsr` form is now preferred. The same is true of `jmp` and `bra`, which perform a jump to a new location.

The only new user-visible instruction on the 68040 is `move16`, which moves 16 bytes of data at a time, resulting in faster block moves. From a compiler standpoint, the limitation of `move16` is that it operates only between aligned 16-byte memory locations. Since most data types in modern compilers are 8 bytes or less in size, `move16` is not useful for these atomic elements. Larger items, such as arrays and structures, can benefit from its use, but only if they are aligned on a 16-byte boundary.

Instruction Ordering

Both the integer units and FPUs are pipelined and functionally independent on the 68040. Thus, as with RISC processors, optimizing requires careful instruction ordering.

The integer unit is broken into six stages: instruction prefetch, instruction decode, effective address calculate, effective address fetch, execute, and writeback. Figure 2 shows how instructions flow through the pipeline. Each instruction shown, like most instructions, occupies a pipe stage for only one clock cycle; therefore, one instruction completes every cycle. This example ignores the time required to fetch an operand from memory, since we are assuming that the data is in the cache.

The FPU is similar to the integer unit, but it has only three stages: operand conversion, execute, and result normalization. Floating-point instructions flow through the integer pipeline until they reach the execute stage. At that point, the execute stage transfers its instruction and operands to the conversion stage of the FPU. If the instruction calls for data to be transferred back to the integer unit (and possibly on to memory), the execute stage waits for the data. If not, the integer unit is free to continue executing instructions.

Instruction scheduling can help keep these pipelines full. Long-running floating-point operations such as `fdiv` can run for 40 clocks or more while, at the same time, as many as 40 integer instructions could be executed. Creative ordering of floating-point and integer instructions can maximize this effect. Register or memory-location dependencies can create stalls in the pipeline. In some cases, this problem can be avoided by instruction reordering.

Memory Placement

Object alignment becomes an issue due to the cache-line behavior of the 68040. If possible, objects should be contained on one cache line, so that only one bus read is required to obtain the entire object. If an object straddles a cache line boundary, then two cache reads will be required, which is expensive. For this reason, we have moved to natural alignment of objects, where the size of the object is the same as the alignment of that object (e.g., an 8-byte object is aligned on an 8-byte boundary).

Branches are optimized for branch taken (two versus three CPU clocks), since it is estimated that 75 percent of all branches on the 68000 are taken. Thus, loops and other control structures should be optimized to take branches in most cases. Also, because of how memory fetches are handled, branches to instructions on 8-byte boundaries that miss the instruction cache benefit from a one-cycle bonus over branches to misaligned instructions. For this reason, branch targets could be aligned on an 8-byte boundary for optimal performance.

To take full advantage of the sophisticated design of the 68040, operating-system and compiler programmers need to take great care in the details of their work. It even helps the application programs to know the details of the 68040. ■

Greg Lindhorst, Andrew Anderson, and David Dahms are system engineers for Hewlett-Packard, responsible for designing, implementing, testing, and debugging 68040 support for HP-UX (Hewlett-Packard's implementation of the Unix operating system). They can be reached on BIX c/o "editors."

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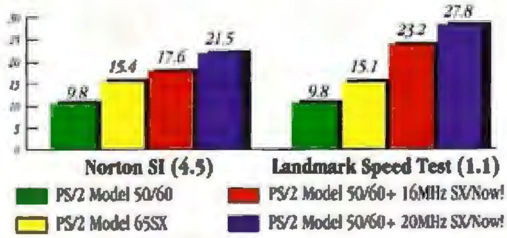

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This set of guidelines for naming program variables is becoming a de facto standard

CHARLES SIMONYI AND MARTIN HELLER

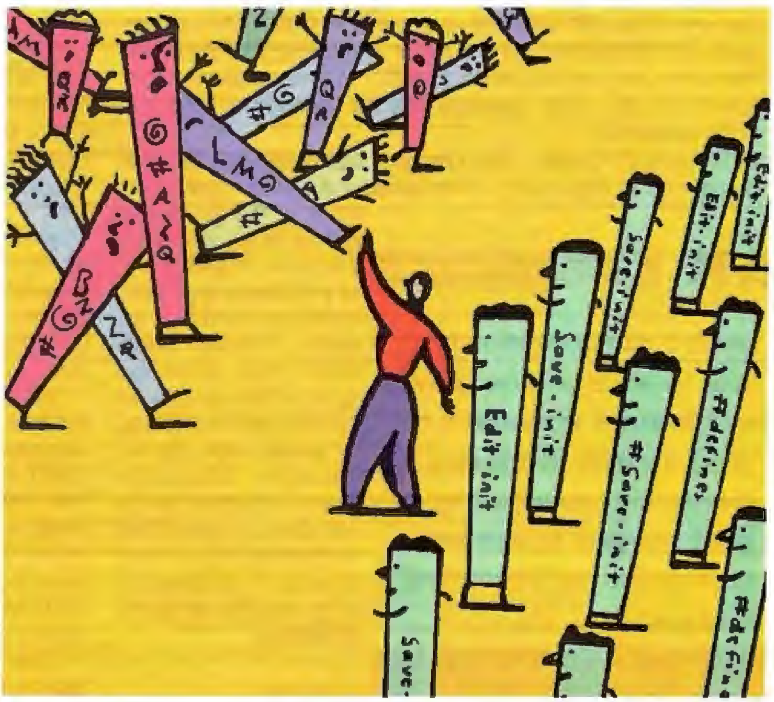
For all the attention given to names in literature and magic (for to name a thing is to control it), names in programming languages have received curiously little attention. Although today's computer programming languages force a rigid syntax on the programmer, they permit the use of more or less arbitrary names for variables, functions, and macros. A reasonable standard for variable naming helps the development and maintenance of software.

The Need for a Standard

In practice, programmers do not create names at random—most programmers have other things to worry about besides what to name a variable, so they fall into some more or less consistent naming pattern. (Any pattern in name usage can be called a naming *style*; a style explicitly codified is a naming *convention*.)

Why add structure to names at all? One reason is to get around the limitations of a language. For instance, suppose module level scope is desired in a flat name space (i.e., suppose you want to use the same name, say, `Init`, for different purposes in different parts of a program, but your language doesn't hide one module's name from the other modules). Prefixing a module identifier to all names differentiates the various occurrences of the name. For instance, you might use the names `Edit_Init` and `Save_Init` in your `Edit` and `Save` modules.

Another reason to adopt a naming structure is to help communicate additional information about a variable to anyone reading your code. For example, names in the Macintosh operating system show a distinct style. Problems with Pascal require the artificial scoping of field names by prepending the tag of the containing structure to the field names. Mac programmers were also burdened by a cute tradition of object-oriented programming (OOP), whereby the major `Obj` type parameter to a procedure is called `theObj`, another parameter may be `which` as in `whichItem`, and local instances are `myObj`, or `thisObj`. While the convention is amusing in a Cobolesque sort of way, you quickly tire of it because it is largely redundant and cannot be extended in any obvious way. Many of the Mac modules are free of `the`, but they still inherited the reverse Hungarian order of `theObj` in which the type is placed at or near the end of the names; for example, the first source region of some Mac operation would be called `srcRgnA`. In Hungarian, it would be `rgnSrcA`. The Mac is also hesitant about abbreviations: Programmers started with the



heroic `Handle`, progressed to `Hnd` (perhaps as the deadlines approached and passed), and then finally gave up and wrote `H`.

What Is Hungarian?

The Hungarian naming convention is of special interest, because so many programmers work with Microsoft Windows and OS/2 Presentation Manager, whose application programming interfaces are specified using the Hungarian convention. By this convention, names have two major parts: a *type* and a *qualifier*. For example, in the variable name `cpLim`, the type is `cp` and the qualifier is `Lim`.

Type names are constructed in the same way as types are made (e.g., a pointer to a `cp` would have `pcp` as its type name). Qualifiers typically come from a small set of standard names that have well-defined semantics. The qualifier `Lim` designates the open end of a half-open interval. The `cpLim` example comes from the source code for Microsoft Word; `cp` is a character pointer.

I (Simonyi) first used the Hungarian style in 1972. Since then, programming teams at Xerox, Apple, and 3Com have used it, as well as hundreds of Microsoft programmers in most Microsoft applications (e.g., Multiplan, Word, and Excel) and also in large parts of the Microsoft Windows system. Since its inception, many people have contributed to the refinement of the Hungarian style.

The designation *Hungarian* was originally a criticism of the conventions. Because the names do not appear to be readable, friends compared it to some obscure foreign language, such as Hungarian—since I am Hungarian born. The name stuck, and it still serves a purpose by fortifying novices for their inevitably negative first impression. In Hungary, the family name is written first and the given name second, just as the type is written before the qualifier in Hungarian. However important the order may be, it is not fundamental to the convention and is not a reason for the nickname.

Types

The effectiveness of Hungarian conventions depends on a modern interpretation of the concept of types. The latest update to the type idea—the one that is consistent with OOP—is that types are determined by the set of operations performed on them: Window and file numbers differ in that you use window numbers in the paint operation and file numbers in read and write operations.

To identify a type, first consider data representation and then the set of data values. Also consider the units of measurement, or the coordinate system (e.g., distances measured in inches are of a different type than those measured in pixel units). Finally, think about what operations apply to the quantity to see if it has an existing or a new type. As an example: Microsoft Word is written in C, and the type `cp` in Word is represented as a `long` integer. A declaration of a variable could be written as:

```
long cp;
```

BYTE ACTION SUMMARY

Using a standardized naming scheme lets you increase the information embedded in variable names. Hungarian, a connection developed by a chief architect at Microsoft, is a standard that's becoming widely popular.

Or, using one of the macro features of C:

```
#define CP long
CP cp;
```

Using a macro is not a real extension of the language's type system, but it makes writing the code more convenient, and, of course, any change in the representation of cps could be easily implemented.

The association of types and operations creates a form of algebra called *type calculus*—conceptually, it is the same as dimensional analysis, where a formula such as speed= distance/time is checked against the units of measurement: mph=miles/hour.

Assignment is the simplest case in type calculus. Both sides must be of the same type. For example,

```
wnFirst = wnLast;
```

is a correct assignment of one `wn` (window number) to another. However,

```
wnFirst = cpLast;  //Wrong!
```

is as painfully incorrect as *das Mutter* is to a German.

The type calculus can get more complex:

```
*pwn = WnShowCp(cpLast);
```

The type assigned here is still a window number, but the * indirection operator makes sure that the pointer to a window number is properly dereferenced. From the point of view of type calculus, the procedure `WnShowCp` converts, or *maps*, the character pointer into a window number.

Your compiler or assembler may already have performed some of these calculations. Type correctness is only one of the benefits of using type calculus while programming. The other benefit lends a certain rhythm to writing the code in the first place: "I am trying to assign a `wn`. What have I got? A `pwn`? A * neutralizes the `p`, so `*pwn = wn`, and so on."

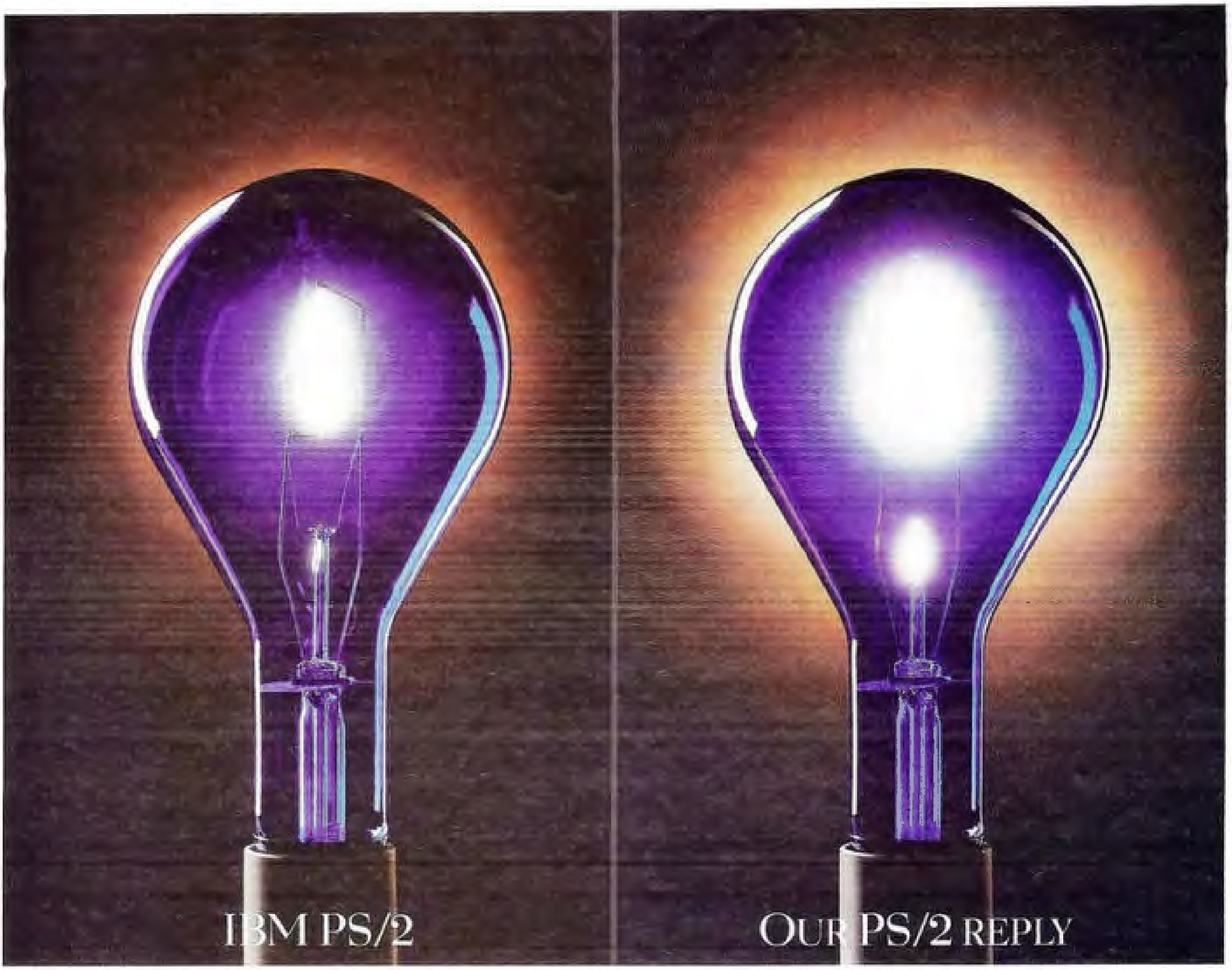
This rhythm becomes second nature to programmers who code in Hungarian. In addition, it gives them confidence in the minutest details of their code. Writing declarations and giving names to new quantities with existing types also becomes routine, and programmers can concentrate on more important issues.

Type Construction

As mentioned above, all names start with the type followed by a qualifier (see the text box "Base Types" on page 134). Putting the type first helps to make type calculus a reflex action. Capitalization is used to separate the parts of the name, as well as to make other distinctions.

You should define base types as abbreviations or acronyms of the type's description, or as some other memorable or random sequence of characters, preferably two or three characters long. Don't let the difficulty of choosing a satisfying tag frustrate you. Programmers rarely regret a bad type tag (there isn't really such a thing), but they often regret failing to make a necessary type distinction. So when in doubt, you should create a new type tag. If it is truly necessary to refer to the undifferentiated underlying machine-byte, word, unsigned-word, and long-word types, the tags `b`, `w`, `u`, and `l` are acceptable.

Type construction means that the name of a new type is related to the names of existing types. The most informal method



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BASE TYPES

f (flag) A Boolean type, either fTrue or fFalse. The qualifier indicates the condition under which the value is true; for example, fOpen and fNotReady. Unqualified use is rare but legal.

ch A 1-byte character in the default character code.

sz A zero-terminated string of characters. In C, we found it useful to define sz to be a pointer to the start of the zero-terminated string.

TYPE PREFIXES

p A pointer. For example, pch is a pointer to a character ((char*) in C).

h A handle. Typically a double pointer or as defined by the environment; for example, hdc is a handle to a dc (Windows display context).

mpT1T2 (for *map*) An array, indexed by quantities of type T1 and containing elements of type T2. The component types historically have not been capitalized, but lowercase letters were hard to read, so in modern Hungarian, the components start with capital letters; for example, mpWnPwdd, an array of pointers to wdds (window descriptors). This array is always indexed by Wns.

rgT2 (for *range*) An array of elements of the given type T2, which is the range of the map. The array is indexed by type IT2.

i An index into an array of elements with the given type; for example, iwd is an index into the array rgwd of elements of type wd.

c Some count of instances of the given type (e.g., cch is a count of characters).

d The numeric difference between two instances of the given type (e.g., if xp is a coordinate, then dxp is the length of an interval, such as the width of a rectangle).

of construction is *subtyping*.

To create a special version of a type (e.g., to denote the measurement units of an analog type), you can append a letter or two to the underlying type. This is similar to applying a qualifier to the type, but the type tag is not capitalized; for example, x may be the tag for a generic *x* coordinate, while xi and xp may be the coordinate types measured in inches and pixels, respectively. Because this construction is informal, you must document it carefully. The other name constructions describe the most common type constructions (see the text box "Type Prefixes" above).

It is also possible to define new constructions for other situations (e.g., union types or groups of juxtaposed variable-size structures), or a new base type can be defined in such cases. If repeated constructions result in a name that is too unwieldy, the name, or one of its components, should be replaced with a new base type. For example, the name mpWnPmpFnPpop should really be written as mpWnPfm, especially in code that does not care about the internals of the inner map (i.e., mpFnPpop, renamed as *fm*).

All variables and constants are simply named by their type, possibly followed by a qualifier to make the name unique within its scope. The qualifier can further document the quantity. When types themselves have to be named, as in the C language, a fully capitalized version of the type tag can be used, as in the following declarations:

```
CP cp;
CP *pcp;
CP **hcpNext;  /* or */  HCP hcpPrev;
```

Special rules govern procedure names and labels. Procedure names are capitalized to separate their name space from variables and constants. In the languages that discourage or don't support goto statements, labels are rare and not important. To separate labels from all variables and constants and from most procedures, you use an uppercase *L* for the label and capitalize the name space; for example,

```
goto LFound;
LFound:
```

If labels are frequently used in your environment, you may also have to use other existing conventions.

Qualifiers

Qualifiers distinguish quantities with identical types in a naming context. They are also available for documenting other important properties. Unlike types, English words can be used for qualifiers. Because qualifiers are practically always used together with a type, there is no danger of ambiguity, and because they are not built up like types, their length need not be curtailed to the same extent. Multiple qualifiers can be combined when necessary. Individual words will be capitalized, as in the example cpMacPrev. The qualifier can also just be a number, as in cp2, or it can be completely empty, as in pwn.

The criteria for choosing qualifiers are as follows:

• For Boolean (f) variables: Describe the condition under which the variable is true (e.g., fOpen).
• For values in enumerated sets: Describe the particular element. Consider, for example, a type of color value with the tag co. Constant elements of this type would be called coRed, coGreen, and so on.

In cases when there is a relationship to another type, you can use the name of that type as the qualifier. For example, if fm is a variable-size structure, its size, which is measured in words, might be called cwFm (count of words for fm).

The text box "Standard Qualifiers" on page 136 shows a list of qualifiers that are standard. You should use them when it seems appropriate. When more than one qualifier is used, you should first place the standard qualifiers used with types that index arrays (e.g., cpFirstT).

Procedures

The type-based naming rules that are used for variables and constants do not work directly for procedures. This is because many procedures do not return any value, so they have no type tag. You expect a procedure name to tell you what the procedure does, not what it returns. In addition, procedure names must be unique over the whole program, or at least over large parts of it, while a typical Hungarian variable name, such as pchFirst, can be repeated in many local scopes. So it is reasonable to pack more information into procedure names. The following three-part name has been used successfully to accomplish this:

```
[Type] [Action(s)] [Parameter(s)]
```

continued

STANDARD QUALIFIERS

`Temp` (or `T`) A temporary. Typically used for loop variables or other temporary purposes.

`Sav` A temporary from which the value will be restored.

`Prev` A save value that lags behind a current value by one iteration.

`Cur` Current value in some enumeration.

`Next` Next value in some enumeration.

`Dest`, `Src` Destination and source in some consumer/producer relationship.

`Nil` A special illegal value that you can distinguish from all legal values, and it typically denotes some absence.

`1, 2` You also use numbers to distinguish values; for example, formal arguments to a commutative function.

You should use the following standard qualifiers with types that index arrays:

`Min` Smallest legal index. Typically defined to be 0.

`Mac` (current maximum) A strict upper limit for legal indexes, the top of some stack. Also, the number of elements in the array when `Min` equals 0; for example, if `Min` is 0 and `Mac` is 2, the legal indexes are 0 and 1 (two values).

`Max` The allocation limit of some stack. `Max` is greater than or equal to `Mac`.

`First` First element of some interval `[First, Last]`.

`Last` Last element of some interval `[First, Last]`.

`Lim` Strict upper limit of some interval `[First, Lim)`. Note the mathematical notation `[,)` for half-open intervals defined as the set of all *x* such that `First<x<Lim`. This representation is preferred to `Last`, because empty intervals are easier to represent this way, and `Lim - First` is the number of elements in the interval.

The brackets indicate that any part of the name can be empty. You write each word in the name with a capital letter, including the type. The initial cap in each name distinguishes procedure names from variable names so that they won't conflict. The *Type*, when it appears, shows the value type that the procedure returns. You write it first, just as with other quantities, to help with type calculus.

You can use the `[Action(s)]` part of the name to describe what happens when the procedure is executed. It can be a single transitive verb such as `Print` or `Find`, a connective such as `From` or `Of`, or any other descriptive text.

The `[Parameter(s)]` part of the name lists the type tags of the formal arguments. These tags appear as the objects of the verb, or as the `From` or `Of` connective when the whole name is read. A pedantic listing of all parameters is not required in all cases. Also, you can list the base type of a parameter when it is clear what form of pointer or handle is used to pass parameters. For example,

```
UpdateWwd(pwwd, fPartial)
```

This name is informal OOP, where the object is a `wwd` and the program sends an `Update` message to the object. The second argument is a flag and is not thought to be important enough to be included in the name. Of course, the more complete name `UpdatePwwdF` could provide a degree of type checking that could prove to be useful in environments that otherwise lack such checks.

The following is a function transforming one type into another:

```
XpFromXi(xi)
```

This form is effective for writing as well as for reading code such as

```
*pxp = XpFromXi(rgxi[ixi] + dxiScroll)
```

An Illustration

To better understand the use of Hungarian notation, follow this solution to a simple programming problem. You can begin by writing, in C, a procedure that inserts a new item in front of a singly linked list. The naming starts at this point, even before the problem statement is given. This is so that your "design document" can already benefit from the conventions. You can quickly create a tag for the items; for example, you might use `li` for list item (it is easy to pronounce, and it is somewhat mnemonic).

The procedure needs two parameters: one to identify the list, and one to somehow describe what you insert. There are many ways to do this. The choice is expressed simply and directly. The designer can just say: "Write a procedure `AddLi(ppliHead, pliItem)`, with

```
struct LI {
   struct LI *pliNext;
   <other stuff>
   }
```

At this point, a programmer who understands the Hungarian style knows exactly what has been decided without additional documentation or discussion. Even if this knowledge were uncertain, it creates a receptive frame of mind for the design elaboration shown below.

The lists are identified by some head pointer to the first element, linked through a `pliNext` field and ending with the value `pliNil`. The caller of `AddLi` allocates and initializes the new item to be linked in. The code now writes itself.

```
AddLi(struct LI **ppliHead,
      struct LI *pliItem)
     {
     pliItem->pliNext = *ppliHead;
     *ppliHead = pliItem;
     }
```

You can also quickly add a more complex operation:

```
AppendLi (struct LI **ppliHead,
        struct LI *pliItem)
     {
     struct LI **ppliPrev = ppliHead;
     while (*ppliPrev != pliNil)
        // find the end of the list
        // note: '&' (the "address of" operator)
        // "adds" a "p," and '*' takes one off
       ppliPrev = &( (*ppliPrev)->pliNext );
      AddLi ( ppliPrev, pliItem);
      }
```

continued

Note how the two parameters were given the nonstandard qualifiers `Head` and `Item`, even though their types are different. However, the base types are the same, and a simple typing mistake could easily transform a `ppli` into a `pli`. Besides, the old-fashioned documentation value of the qualifiers is perfectly compatible with the spirit of the conventions. Note also how the type calculus can guide the error-prone coding when `ppliPrev` has to be "advanced" using `pliNext`. You have `ppliPrev`, and you need `pliNext`, which is contained in a structure pointed to by some `pli` that you get by using `*` on `ppliPrev`, which yields a `pli`. After `->`, you have a new `pli` (i.e., `pliNext`), but you need `ppli`, which you get using the `"address of"` ampersand operator.

Who Benefits?

The above example demonstrates the simplicity of name giving once you decide on the basic type names. Name finding is easy because name giving was so simple in the first place. Finally, you also do name interpretation so quickly that it becomes a valuable type-checking tool; this adds up to a great improvement in the precision of discourse about the structures used, the interfaces, and the detailed statements of the programming project. With Hungarian, every communication carries sharp quanta of exact information to puncture sloppy thinking or sloppy programming.

The most common objection to Hungarian notation is that it is unreadable. But unreadable compared to what? To read Hungarian, you have to be familiar with basic data types and standard constructions. You can learn the latter once; the former are always needed to get involved with a program.

Some people complain that Hungarian makes variable names too long without adding information that the compiler doesn't already know. The type calculus can make coding errors painfully obvious in context; to find the same errors without type tags, the reader has to constantly jump from code to variable definition.

Some think that with more descriptive names, learning time could be shortened. But beware of readable names: You may be misled as often as not. For example, you can reasonably assume that a `CharPtr` is some pointer to a character (`pch`) when, in fact, as it is actually used in Microsoft Word, it is an abstract index into a virtual array of formatted characters. There are simply too few readable names for too many possible abstractions; therefore, the kind of instant readability people yearn for is just a snare.

Why not try to make the basic types more readable? Once you learn the tags, their compactness is a continuing benefit. Type construction is simply not practical with longer names, and type construction itself gives exceptional leverage to the programmer.

Hungarian variable-naming conventions are easily implemented. Once they have been implemented, they provide subtle but far-reaching benefits for any programming organization. They improve the precision and speed of thinking and communicating, which are the most fundamental, highest-leverage steps in the software development process. If you improve thinking and communicating, you'll have fewer bugs, better productivity, and the ability to handle more complex problems. ■

Charles Simonyi is chief architect at Microsoft and the originator of Hungarian notation. Martin Heller is an independent software developer and a BYTE contributing editor. You can reach them on BIX c/o "editors" and as "mheller," respectively.


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National Software Testing Laboratories Supplement

33-MHz 386 SYSTEMS

NSTL evaluates 8 popular 33-MHz 386 PCs from Acer, ALR, American Mitac, Arche, AT&T, Compaq, Dell, and Everex

33-MHz 386 SYSTEMS

Computers equipped with 33-MHz 386 processors provide sufficient power for multitasking, multiuser, and LAN environments and are well suited for demanding graphical CAD or desktop publishing applications. Well-equipped 33-MHz 386 systems compete with 486-based systems for use as network servers, multiuser systems, and stand-alone workstations for software development, engineering, and programming. Many provide the mass-storage capacity needed for departmental servers and for managing large databases shared by many users. (See the text box "The 386 vs. the 486" on page 168 for a comparison of the capabilities of these two computer classes.)

NSTL reviewed eight 33-MHz 386 machines: the Acer 1100/33, the American Mitac MPC 4000G, the ALR BusinessVEISA 386/33, the Arche Legacy 386-33, the AT&T 6386E/33 WGS, the Compaq Deskpro 386/33L, the Dell System 333D, and the Everex Step 386/33. The systems differ significantly in terms of pricing, performance, features, and usability.

List prices for the models tested range from a high of $16,334 (for the AT&T) to a low of $6316 (for the Dell). Compaq and AT&T are well known as computer manufacturers that spend a good deal of money on product development, marketing, and support; their systems carry a high premium. Compaq sells largely through a dealer network; AT&T sells directly to businesses.

Dell sells directly to the public through Soft Warehouse, which does not discount Dell equipment. Everex and ALR offer their systems through authorized distribution channels. Arche and American Mitac sell directly and through authorized distribution channels. Acer, one of the 10 largest producers of personal computers worldwide, markets systems directly and through distributors, OEMs, and value-added resellers (VARs).

Because vendors frequently extend discounts to volume purchasers and retailers offer variable discounts, prices fluctuate considerably. Vendor pricing for upgrades and options such as extra disk drives and memory differ even more sharply. Larger vendors discount their products but not to the extent that the smaller firms do.

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National Software Testing Laboratories (NSTL) is an independent organization that tests personal computer and LAN hardware and software. It provides unbiased performance, compatibility, comparison, and usability testing for personal computer users and vendors. Founded in 1983, NSTL pioneered this use of objective, real-world-based, and comparative methodologies to gain its position as the leading independent testing and evaluation facility in the microcomputer industry.

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Ratings Key

(On a scale of 0 to 10)

Overall Evaluation

- ***** 9.0 or higher
- **** 8.0 – 8.9
- *** 7.0 – 7.9
- ** 6.0 – 6.9
- * 5.0 – 5.9

All Other Ratings

- 🔵 7.0 – 10.0
- 🔴 5.0 – 6.9
- ⚫ Under 5.0

(1) Includes the cost of an Intel 33-MHz 387 math coprocessor ($994), which isn't available from American Mitac or Acer America.

Testing Procedures

The review systems have varying expansion architectures, memory architectures, and prices. To provide as consistent as possible a basis for comparing price and performance, NSTL established minimum configuration requirements. In addition to a 33-MHz 386 processor, each system included an Intel 33-MHz 387 coprocessor, at least 8 megabytes of 32-bit RAM installed on the system board or in proprietary memory slots, a hard disk drive with a primary partition of 100 MB, one floppy disk drive, an appropriate drive controller, a VGA adapter providing 640- by 480-pixel resolution (higher resolution modes require special software drivers and were not tested), a VGA color monitor, and MS- or PC-DOS 4.01. All of the models support the Unix operating system.

NSTL's test suite for 386 systems consists of standard DOS and OS/2 applications. Rather than measuring the performance of individual components, the application benchmarks demonstrate the interaction of a system's memory architecture, processor, hard disk drive, and display when running in real and protected modes. The relative importance of each of these components varies according to the application being used. The efficiency of a system's memory architecture, for example, is critical in spreadsheets but less important in databases.

DOS Benchmarks

Whenever possible, NSTL ran the benchmark tests using the version of MS- or PC-DOS provided by the manufacturer. For the dBase IV benchmark, the Arche was tested with PC-DOS 4.01 because an incompatibility exists between the application and certain revisions of MS-DOS and PC-DOS 4.01. The application's reporting function could not properly reference the index when formatted with the MS-DOS 4.01 disks provided with the test system.

For the ALR, NSTL installed the machine's UltraStor DOS device driver for each of the DOS benchmarks. The device driver replaces the BIOS disk-service routine and stays resident in memory.

OS/2 Benchmarks

For the most part, NSTL's OS/2 benchmarks used the proprietary versions of OS/2 1.2 supplied by the machines' vendors. ALR, American Mitac, and Arche sell IBM OS/2 1.2. For the ALR, the UltraStor OS/2 1.2 device driver was installed for the OS/2 benchmarks. Because OS/2 1.2 cannot be installed on the American Mitac's 663-MB Seagate SCSI hard disk drive, the test system was configured with a 212-MB Conner Intelligent Drive Electronics (IDE) hard disk drive.

OS/2 1.2 was configured with the High Performance File System (HPFS) enabled, with lazy writes active (except for the Oracle test) and with the CONFIG.SYS protect-only switch set for maximum memory use by OS/2 applications.

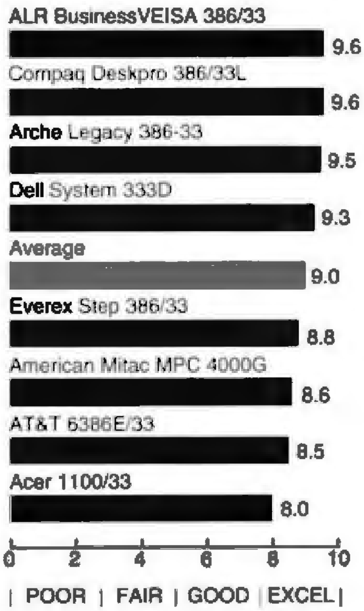
All OS/2 tests were executed from a full-screen command prompt (the screen did not contain graphics); a spooler captured output going to LPT1.

Ratings Analysis

To provide a well-rounded view of the strengths and weaknesses of the eight test systems, NSTL judged each computer on its performance, the quality of its features, and its usability. A system's overall rating in each category was computed by taking a weighted average of the individual test results within the category.

Overall Performance

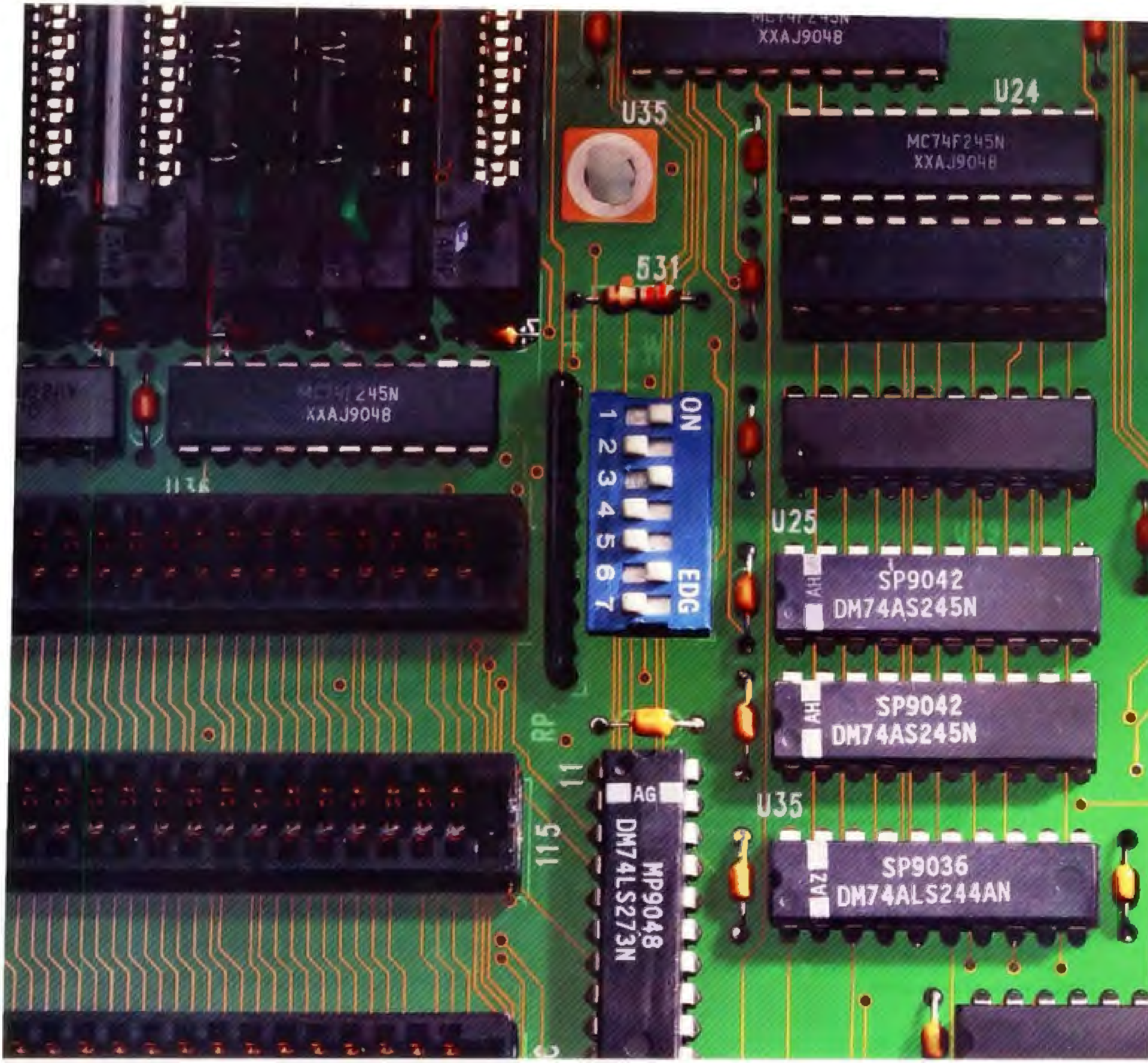
NSTL's performance benchmarks measure the speed of execution for a variety of operations in a variety of programs. Results are based on indexes calculated from individual performance scores for the weighted benchmarks. A system's performance rating for a single benchmark is the best time out of the eight systems reviewed divided by the system's time. The overall performance score is a weighted average of the indexes for the individual tests. (See the text box "Performance Tests" for detailed information on performance benchmarks.)



Weight	*Benchmark*
1	Lotus 1-2-3
1	Lotus 1-2-3 with QEMM 5.0
2	dBase IV
1	Microsoft C 5.0
2	AutoCAD release 10
2	Microsoft Word 5.0
2	FoxPro
2	Microsoft Excel 2.1C under Windows 3.0
1	IBM C/2
1	IBM C/2 Multitasking
2	Microsoft Word 5.0 for OS/2
2	Microsoft Excel for OS/2
2	Oracle for OS/2

Feature Comparison

The rating system for features is computed as a weighted average of scores for individual features. NSTL verifies each system's features, noting which are standard and optional.



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i386
Intel '90
U7
U1

Space does not permit printing a complete list of the criteria and weighting system used to obtain the overall feature ratings. The following paragraphs summarize the strengths and weaknesses of the systems in the critical areas.

Bus Architecture

A system's internal expansion bus handles communication with system components, including network adapters. That means that an efficient bus architecture improves overall system performance.

EISA is gaining support among system vendors. It offers high throughput, easy system configuration, and support for more than one intelligent device. The EISA bus offers compatibility with existing 8- and 16-bit adapters and supports 32-bit I/O, which makes it a logical match for 386 (and 486) processors that handle data in 32-bit chunks. EISA's high-speed burst modes move data across the expansion bus much faster than it travels in ISA environments. EISA's 32-bit burst-mode DMA transfer rate (33 MB per second) is over 16 times faster than the rate of a 16-bit ISA DMA transfer (2 MBps).

EISA supports bus-master adapters that can improve overall system performance. These adapters can take control of the system bus and manage the bus's address, data, and control signals that move data between system memory and bus-resident I/O devices—without intervention from the CPU. Nonbus-master I/O adapters use interrupt-driven or polling methods that require CPU processing of device interrupts or that force the CPU to wait while the I/O device completes an operation. A truly efficient bus-master implementation with multiple bus-master adapters communicating across the system bus requires no CPU mediation. Operating-system software improvements will be necessary for more effective bus-master implementations.

Architecture

- ALR and Compaq feature EISA expansion buses.
- Acer, American Mitac, Arche, AT&T, Dell, and Everex are built around ISA expansion buses.

Expansion Slots

- AT&T and Compaq provide six open expansion slots.
- American Mitac, Dell, and Everex provide five open slots.
- Acer, ALR, and Arche offer four free slots.

System Memory

The applications and operating environment you use dictate the amount of memory your system requires. Memory expansion options are particularly important for businesses running high-end engineering, programming, and database applications.

Standard DOS environments often use extended memory configured as a RAM disk, cache, or expanded memory. Many network operating systems, Unix implementations, and applications utilizing DOS-extended software make use of extended memory. Large amounts of RAM are required to run many 32-bit applications (a minimum of 2 MB in the case of Foxbase+/386 and to take advantage of the 386 processor's virtual mode. Virtual-86 mode supports multitasking under which each application is allocated a portion of conventional memory up to the 640-kilobyte DOS limit. Microsoft Windows 3.0 is one of the many programs designed to use the 386's virtual mode. To perform multitasking under OS/2 requires 3 to 4 MB of RAM to avoid constant swapping of data to the disk.

Memory installed on the system board or in proprietary 32-bit memory slots is faster than memory added through the expansion bus.

Highlights

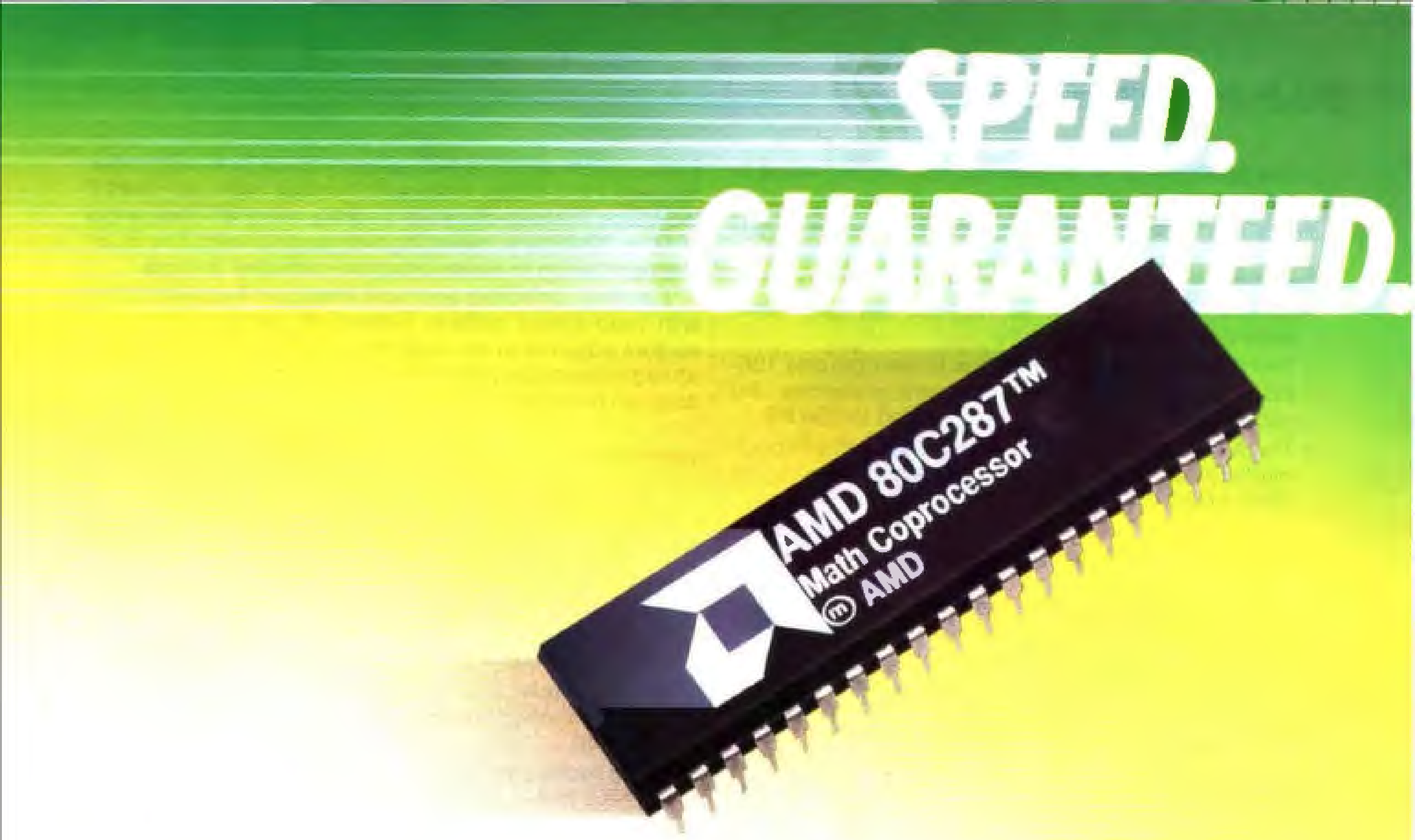
- Compaq supports 100 MB of 80-nanosecond RAM via proprietary 2-MB, 8-MB, and 32-MB modules added to a six-socket, 32-bit memory board.
- The ALR supports upgrades of up to 17 MB of 80-ns RAM on its host board; a memory upgrade board supports an additional 32 MB.
- The Dell and Everex machines can support as much as 16 MB and 64 MB of 80-ns RAM, respectively, on standard memory boards.
- The Acer, American Mitac, Arche, and AT&T systems support up to 8 MB of RAM on standard memory boards and provide high-speed memory slots for additional upgrades. The Acer and American Mitac support up to 24 MB of 80-ns RAM. The Arche expands to 32 MB of 80-ns RAM, while the AT&T supports 40 MB of 100-ns RAM.

Memory Caching

The test systems were configured with high-speed memory caches that improve performance by reducing or eliminating wait states for memory access. Write-through caches pass the writes through to the system memory; they do not cache memory writes. Write-back cache designs cache memory writes as well as memory reads.

Highlights

- The ALR offers an optional 64-KB two-way set-associative write-back memory cache module that resides in a dedicated slot.



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- The ALR's 64-KB write-back memory cache module is optional.
- The Acer uses a relatively small 32-KB two-way set-associative write-through memory cache; the Dell uses a 64-KB set-associative write-through memory cache.
- Compaq features a 64-KB four-way set-associative write-through memory cache.
- The American Mitac, Arche, and Everex provide 128-KB direct-mapped write-back memory caches; the cache on the Everex may be expanded to 256 KB.
- The AT&T uses a 64-KB direct-mapped write-through memory cache with slow 100-ns memory (most of the other systems use 80-ns memory chips).

Mass Storage

The overall storage capacity of a system depends largely on the size of its case. Small-footprint systems generally provide less room for expansion than larger desktop models. Tower units, such as the AT&T, generally provide sufficient internal storage capacity for most environments. Most of the review systems were configured with ESDI-based subsystems that typically permit only two hard disk drives. The Compaq supports disk-array technology that provides high capacity, data redundancy (i.e., it stores data in more than one location over multiple drives), data integrity (a result of the data redundancy of the disk array), and fast, sequential transfer speeds.

Expansion

- The AT&T system supports eight half-height or four full-height devices.
- The Acer, American Mitac, Arche, and Everex accommodate five half-height or one half-height and two full-height devices.
- The ALR provides two half-height and two 3½-inch storage bays.
- The Compaq supports one third-height floppy drive, two half-height devices or one full-height device, and four half-height 3½-inch devices or one full-height 5¼-inch device.
- The Dell accommodates three half-height devices and one 3½-inch IDE device.

Maximum Hard Disk Capacity

- The Compaq supports 840 MB of drive-array storage; ESDI fixed disk storage expands to 1.3 gigabytes.
- The ALR and American Mitac accommodate 1.2-gigabyte SCSI hard disk drives.
- The Acer, Dell, and Everex support ESDI hard disk drives with capacities of 760 MB, 650 MB, and 677 MB, respectively.
- The Arche and AT&T accommodate 338-MB and 300-MB ESDI hard disk drives, respectively.

Hard Disk Controllers

IDE hard disk drives feature embedded controller functions and can transfer as much as 10 MB of data per second. The device-level ESDI specifications define communication between a drive's logic board and the ESDI controller in the host system; ESDI controllers provide transfer rates of 5 to 24 MBps. SCSI specifications define a bus system structure with asynchronous bus rates in the range of 1 to 2 MBps, while synchronous rates vary from 2 to 5 MBps. Drive-to-controller data transfers fall in the range of 15 to 22MBps in newer high-capacity drives. The SCSI bus handles up to seven attached controller devices.

Caching controllers are more intelligent than controllers with read-ahead buffers; instead of caching blocks or sectors adjacent to the data requested by the CPU, read-ahead caches use proprietary algorithms to estimate what data will be requested next.

Highlights

- The Dell uses an UltraStor ESDI controller with a 32-KB look-ahead buffer.
- The ALR's UltraStor ESDI bus-master controller contains 512 KB of look-ahead cache.
- The Acer, AT&T, and Everex contain standard ESDI controllers; Everex offers an optional UltraStor ESDI controller with a 32-KB look-ahead buffer ($200).
- The Compaq's advanced ESDI controller, which includes a look-ahead buffer, transfers 15 MB of data per second.
- The Arche uses a 20-MHz Lark ESDI controller with a 32-KB look-ahead buffer.
- The American Mitac contains an IDE hard disk drive subsystem.

I/O Ports and Integrated Functions

Having an integrated display adapter and an array of I/O ports on the system board can eliminate the need for adapter cards. The test configuration for each system was equipped with at least one parallel and one serial port.

Highlights

- The American Mitac, Arche, Compaq, and Dell provide one parallel and two 9-pin serial ports.
- The Everex contains one parallel and two 25-pin serial ports.
- The Acer and AT&T supply a parallel, a 9-pin serial, and a 25-pin serial port.
- The ALR contains one parallel and one 25-pin serial port.
- The ALR, AT&T, Compaq, and Dell supply mouse ports on the system board.
- The Compaq and Dell contain built-in VGA ports; the Dell supports resolutions of up to 1024 by 768 pixels.
- The Compaq's integrated 16-bit VGA adapter provides increased BIOS execution and enhanced video-memory arbitration, which improves scrolling and graphics display speed.
- None of the systems comes with a 16550 universal asynchronous receiver/transmitter chip for reliable data transmission with high-speed modems.

Security

In addition to keyboard and chassis locks, vendors of 386 machines frequently offer password protection and security features designed to protect the integrity of applications that run unattended—perhaps on network file servers or gateways.

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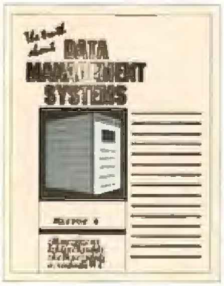

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Highlights

- The AT&T, Compaq, and Dell provide chassis locks and support boot and keyboard passwords.
- The ALR and American Mitac contain chassis locks. The ALR supports keyboard passwords and the American Mitac supports boot passwords.
- The Acer, Arche, and Everex provide keyboard locks; Arche and Everex accept boot passwords.
- All machines, except the Compaq, boot completely without a keyboard.
- The AT&T and Compaq provide server modes.

System Software and Utilities

Changing a system's configuration by adding memory, a coprocessor, another drive, and so on dictates that changes be made to its original configuration information. Systems generally use a configuration, or setup, program built into the system ROM to accomplish this. Typically, you access such a setup program at start-up, either by pressing a key combination at the operating system prompt or by running the program from a floppy disk.

Highlights

- The ALR and Compaq provide disk-based EISA setup utilities.
- The Acer and AT&T use ROM-based and disk-based setup routines.
- The American Mitac, Arche, Dell, and Everex are configured using ROM-based setup routines.
- All of the test systems provide low-level format utilities; on the ALR, Arche, and Dell, these utilities are built into the hard disk drive controller's BIOS.
- The AT&T, Compaq, Dell, and Everex include diagnostic utilities; you must pay extra for the ALR's diagnostics.
- The Acer, ALR, Compaq, and Everex supply proprietary disk-caching utilities.

Highlights

- The Acer, American Mitac, Arche, AT&T, and Dell maintain toll-free customer support lines. ALR and Everex offer free telephone support, but customers must pay phone charges.
- The Compaq offers free basic support and advanced support for $3000 a year.
- The ALR, Dell, and Everex do not supply technical reference guides.
- The Acer and Arche offer two-year warranties covering parts and labor; the other vendors offer standard one-year warranties. Shipping coverage varies.
- The Acer, Compaq, and Dell rely on third-party computer-repair services for warranty service.
- The AT&T offers no on-site warranty service; Compaq lets its dealers decide whether to offer on-site warranty service.
- The Acer and Arche do not offer extended warranties; Compaq lets its dealers decide whether to offer extended warranties.

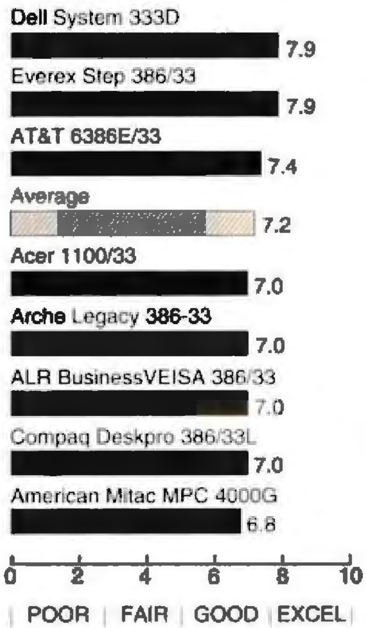
Other Noteworthy Features

- The Compaq supports Intel 387 and Weitek 3167 coprocessors; the other systems support an Intel 387 or a Weitek 3167.
- All review units let you adjust the speed of the CPU.
- All also support system-selectable video and ROM BIOS shadowing.
- The ALR, American Mitac, and Arche do not market proprietary versions of OS/2.

Usability

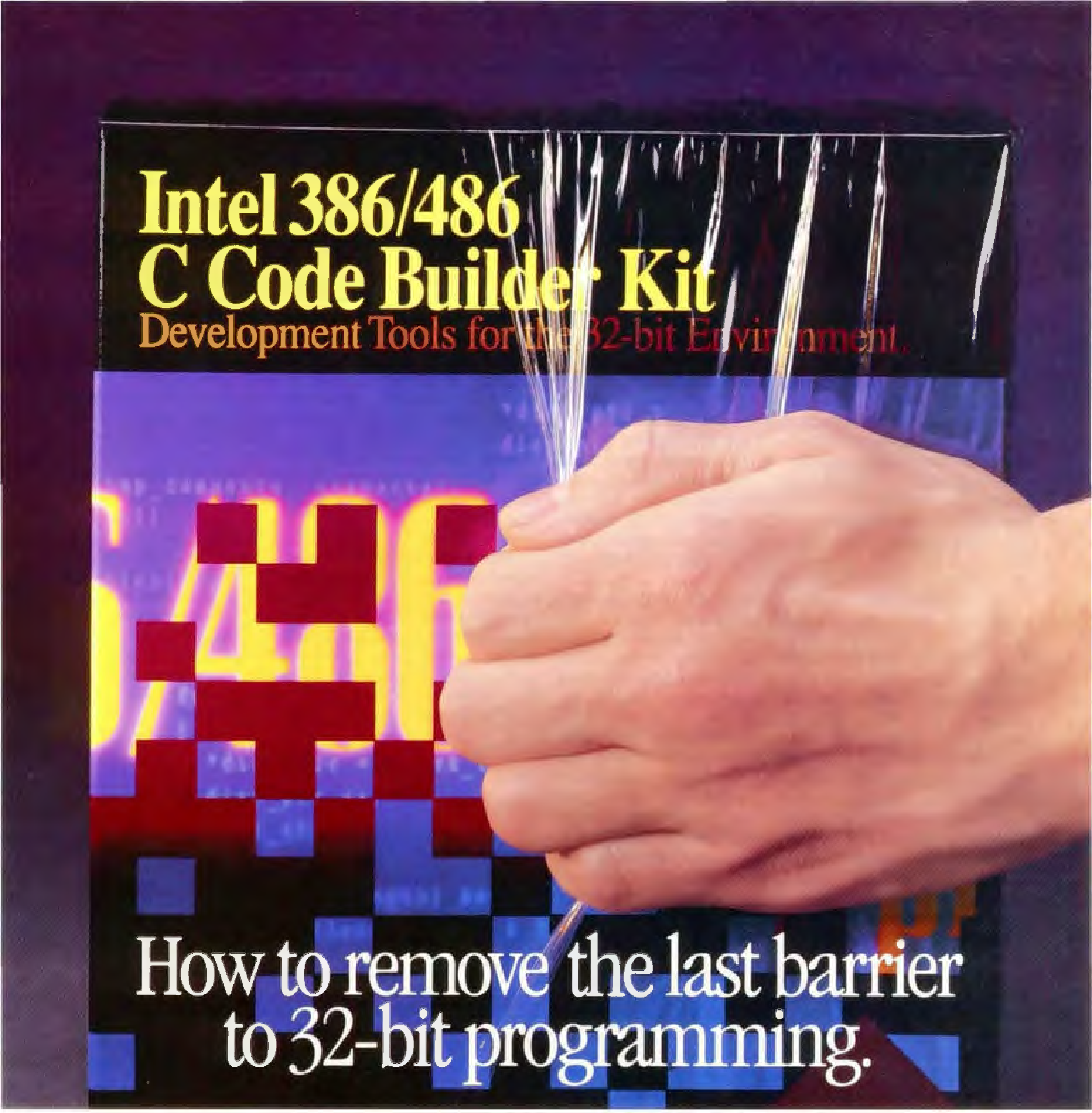
Many factors contribute to the overall usability of a computer system. Among the most important are the ease with which a user can set up the system; the ease with which memory, a math coprocessor, and a hard disk drive can be installed; and the comprehensiveness of the manuals that accompany the system.

The usability rating is a weighted average for individual criteria.



Weight	*Criteria*
3	System Setup
2	Cover Removal
3	Memory Installation
3	Coprocessor Installation
3	Hard Disk Drive Installation
3	System Teardown
2	Organization of Manuals
2	Clarity of Manuals
3	Completeness of Manuals

You can easily access Dell's internal components by loosening five hand-tightened cover screws, but the power supply and 3½-inch drive bay obscure much of the system board. Four SIMM sockets are free. The system automatically detects the amount of RAM installed and the presence



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of a coprocessor. The ROM-based setup utility displays useful help messages as you scroll through the utility options.

Color and shaded diagrams in the Dell documentation highlight important information. Separate manuals cover software support, diagnostics, and troubleshooting. MS-DOS 4.01 includes an enhancement that provides details on the utilities Dell includes to improve system performance. The system's SmartVu LED display relays status and error information.

The system board on the Everex is very accessible, which simplifies upgrades and repairs. A proprietary memory card holds 16 SIMM sockets, and the system detects the amount of RAM installed and the presence of a math coprocessor. Users access the ROM-based setup utility by pressing a hot-key sequence during boot-up. Comprehensive on-line, context-sensitive help accompanies the EEPROM and CMOS menus, which provide options for adjusting I/O bus speed, port addresses, and system passwords. A clear and comprehensive owner's manual includes an introduction to DOS, as well as a section dedicated to networking. The control panel features eight LEDs, key lock, CPU speed switch, and on/off buttons for the reset switch and the speaker.

An oversized power switch on the AT&T tower makes it possible to turn on and shut off this tower unit by foot. The ample interior provides plenty of room for expansion and enough elbow room for conducting repairs, but you'll first have to remove the four screws in the cover plate protecting internal components. The ROM-based setup utility is accessed by pressing a key sequence. The Customer Diagnostics disk, which includes an advanced setup utility, also features a diagnostic program that can test the entire unit or a single subsystem. During testing, it provides impressive scanned images of each subsystem. The system board and proprietary expansion boards have eight SIMM sockets. Although the system automatically detects the amount of RAM installed, users must set a jumper for the system to recognize the coprocessor. The user's guide is clear and comprehensive, but it forces users to jump back and forth between text and fold-out diagrams at the back, and it fails to mention that you must set a jumper after you install a math coprocessor.

Acer's ROM-based setup utility, which is accessed by pressing a hot-key sequence, provides basic help messages, a low-level formatting option, and write-protection options for hard and floppy disk drives. You can add SIMMs to eight sockets on the system board; jumpers must be set correctly for the system to recognize the additional RAM and the presence of a coprocessor. A loose-leaf user's guide with tabbed dividers supplies basic setup and configuration information but few details.

Arche's ROM-based setup program displays available options as you scroll through the utility's menu. DRAM SIMMs can be installed in eight sockets on the system board, and the system automatically senses the amount of RAM and the presence of a coprocessor. A drive cage partially obscures the coprocessor socket, however. A control panel, which includes a reset button and LED indicator, displays the CPU speed.

The Arche's loose-leaf reference manual is average (the manual sent for evaluation was improperly drilled and did not easily fit into the binder. Separate manuals cover the ESDI controller and I/O adapter.

The ALR's EISA configuration utility offers on-line, context-sensitive help; its setup utility resides in ROM. CPU, memory cache, and additional memory modules fit in proprietary slots; you must remove adapter cards to access the SIMM sockets on the host board. The system automatically detects the amount of memory installed and the presence of a coprocessor, which you can install on the CPU module. A comprehensive reference manual and EISA configuration guide are included.

Little space is wasted inside the Compaq's case, which is held shut by two hand-tightened screws. The upgradable system board resides in a proprietary slot and provides sockets for an Intel 387 and a Weitek 3167 coprocessor. Memory modules fit on a proprietary memory-expansion board, and the system automatically senses the amount of RAM installed and the presence of a coprocessor. All adapters must be removed to access the host board, which also is partially obscured by the drive bays. The disk-based EISA configuration utility provides on-line, context-sensitive help but the help fails to provide specific information. Overall, the documentation is comprehensive. The most informative reference is *The User's Program Guide*, which contains details regarding utilities that improve performance.

A side panel on the American Mitac case provides access to the drive bays, but four metal clips that align the panel complicate its replacement. The ROM-based setup utility's messages are of little help to novices because you must proceed through the highlighted topic one page at a time, rather than scrolling to select an option. SIMM sockets on the system board are partially obscured by the power supply, and the presence of a coprocessor is not automatically detected. A loose-leaf user's guide covers system basics but lacks detailed system information.

About the NSTL Review Supplements

Each month, BYTE evaluates dozens of products in a broad range of categories. We cover a lot of ground, but we are always trying to do more. To that end, BYTE is proud to bring you the NSTL Review Supplement series. As reports appropriate to our readership become available, BYTE will present the results of product comparisons from the National Software Testing Laboratories, a division of Datapro Research Group and a BYTE sister company. NSTL is one of the world's premier independent hardware and software testing facilities.

These pages are supplemental; nothing has been cut from the regular issue of BYTE to make room for them. And the BYTE Lab will continue its long-standing tradition of producing comprehensive, hard-hitting product comparisons.

NSTL provides a scoring system based on numerical weightings assigned to key attributes such as performance, ease of use, versatility, and overall quality. While some of these ratings are by nature arbitrary, the criteria within the evaluation are consistent for each package and do provide a legitimate means of comparison. BYTE has not tried to duplicate NSTL's tests. NSTL retains full ownership of the results published here.

Due to space limitations, we could not publish all the data that NSTL provided in its report. Instead, we boiled down the information to its essential core. The full report is available for sale from NSTL (see the text box "About NSTL" on page 145).

We bring you these supplements as a service. The additional pages allow us to provide you with more product comparisons in a wider range of categories. NSTL's format and methodology might differ from what BYTE provides, but they offer a reasonable, alternative means of comparison that complements BYTE's own extensive product reviews.

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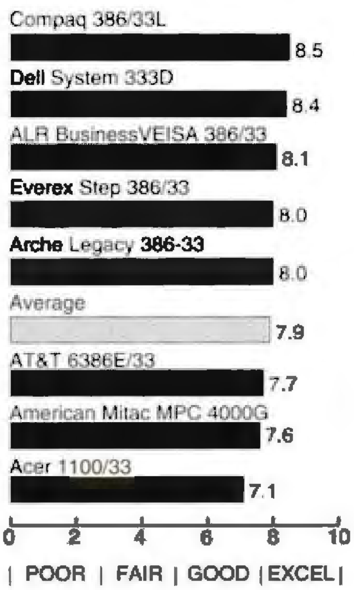
Overall Ratings

Recognizing that users look for different capabilities in a 386 system, NSTL evaluated system quality in two ways: with an eye toward judging which machine is best overall and with an eye toward judging which machine is best suited to a business environment, database environment, and engineering/programming environment.

To assign an overall rating to each machine, NSTL computed a weighted average of each system's scores for performance, features, and usability. NSTL recommends as good buys the systems designated with a check mark (✓).



Weight	*Criteria*
5	Performance
2	Features
2	Usability

✓ COMPAQ DESKPRO 386/33L

The outstanding memory capacity (100 MB) and mass-storage potential (seven drive bays) of the Compaq make it an excellent choice for environments that demand exceptional 386 computing power.

The review model included a 64-KB memory cache; one parallel, one mouse, and two 9-pin serial ports; a 320-MB ESDI hard disk drive; a 300-watt power supply; and an integrated VGA controller with increased BIOS execution speed and enhanced video memory arbitration. The seven slots on the 32-bit EISA expansion bus let you take advantage of the latest advances in bus-master technology while preserving compatibility with existing 8- and 16-bit adapters. Disk-based EISA configuration and various system utilities are included. The system's processor board contains separate sockets for the Intel 387 and Weitek 3167 coprocessors.

An optional 32-bit Intelligent Drive Array (IDA) controller supports up to 840 MB of storage for network and multiuser environments; ESDI fixed-disk storage expands to 1.3 gigabytes. Optional external storage enclosure and a 486 upgrade mean that the system can grow with the needs of its users.

While on-site service and extended warranties vary from dealer to dealer, all customers have access to Compaq's toll-free user hot line.

✓ DELL SYSTEM 333D

Dell markets its ISA-based system as a cost-effective alternative to the Compaq. The machine works well with performance-sensitive applications such as desktop publishing and CAD/CAE and with multiuser operating systems such as Dell Unix System V and Microsoft OS/2. An integrated high-resolution VGA adapter is a plus for graphics applications. System RAM expands to only 16 MB, however—a potential limitation in network environments.

The test unit performed impressively owing to the system's 64-KB memory cache and optional UltraStor ESDI controller. The system case has reasonable expansion potential: room for three half-height and one full-height 3½-inch storage device, as well as one 8-bit and five 16-bit ISA expansion slots. You can rely on the SmartVu LED display to keep you abreast of system errors.

The Dell review model included an integrated high-resolution VGA adapter; a VGA color monitor; integrated serial, parallel, and mouse ports; and a 330-MB ESDI hard disk drive. Dell's warranty includes 12 months of on-site service and toll-free customer support; extended warranties are available.

✓ ALR BUSINESSVEISA 386/33

ALR markets the BusinessVEISA as a midrange machine for power processing applications such as CAD/CAM, multitasking, and desktop publishing. You can upgrade to a 33-MHz 486 system by swapping processor boards, but limited mass-storage options reduce the system's usefulness in multiuser and network server environments. As a file server, the ALR is best suited to networks with 15 or fewer nodes.

The system's CPU, RAM, and cache memory can be upgraded independently by installing the appropriate modules in proprietary slots. RAM expands to 49 MB—up to 17 MB on the host board using DRAM SIMMs. An optional 64-KB memory cache and an UltraStor ESDI caching controller enhance the system's performance in programming, engineering, and database environments. The EISA expansion bus takes advantage of the latest developments in 32-bit bus-master technology and maintains compatibility with existing 8- and 16-bit adapters. Embedded I/O ports and an integrated AT controller save expansion slots. The system supports two half-height and two 3½-inch storage devices. A disk-based EISA configuration utility and disk-caching software are included.

EVEREX STEP 386/33

The ISA-based Everex system is designed to handle multiuser operating systems, complex graphics, and database and programming/engineering applications. The system is available in small-footprint, standard, and tower models. The standard chassis accommodates five half-height or two full-height and one half-height device, and includes 8- and 16-bit expansion slots. You can convert the machine to a 486 system by replacing the 386 processor with the optional Instep CPU card.

System RAM expands to 64 MB on a proprietary memory board that resides in a 64-bit slot. A 128-KB memory cache expands to 256 KB and caches memory writes and reads. One parallel, one mouse, and two 25-pin serial ports; a 200-W power supply; and an UltraStor controller with a 32-KB

February 25, 1991. *InfoWorld* reports:

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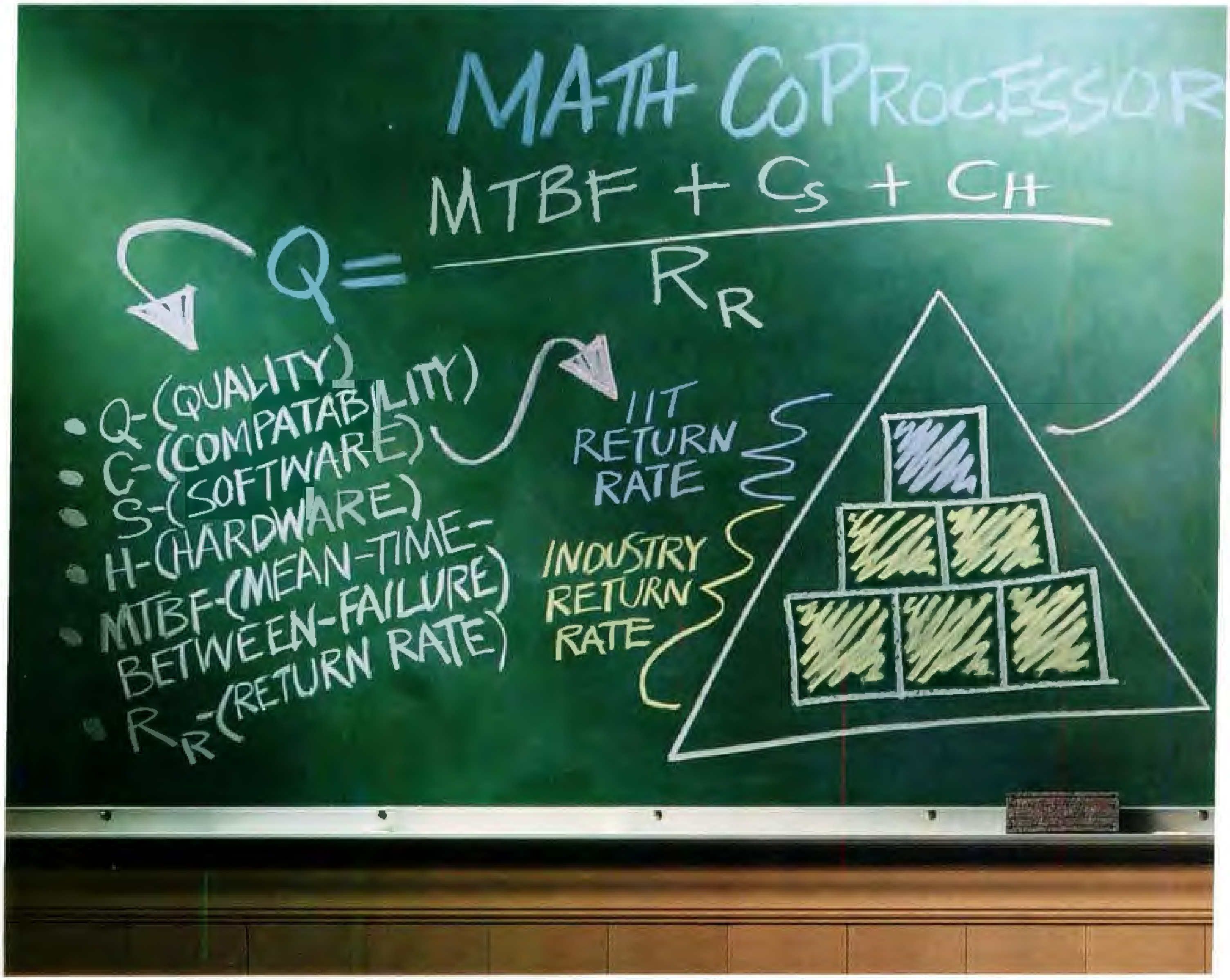

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read-ahead buffer came with the review unit. MS-DOS 4.01 (with GW-Basic), Microsoft Windows 3.0, diagnostics, and enhancement utilities accompany the system.

For peace of mind, Everex offers a unique eight-character LED control panel that displays status and error information, a keyboard lock, boot and keyboard password protection, and a one-year warranty with on-site service.

ARCHE LEGACY 386-33

The ISA-based Arche provides excellent overall performance in multitasking, multiuser, and networking environments. The 128-KB flagged-register copy-back memory cache offers four levels of write posting, and DMA cycles run parallel with the CPU. The standard 20-MHz UltraStor ESDI controller with a 32-KB look-ahead buffer enhances disk performance; an optional advanced controller supports disk mirroring and duplexing. Inside the standard desktop case you'll find room for five half-height devices (or two full- and one half-height device), 8 MB of memory on the system board, and an additional 24 MB of 32-bit RAM using two proprietary memory slots. The case provides six 16-bit ISA slots; an 8-bit Arche I/O adapter provides one parallel and two 9-pin serial ports. The price of a basic system includes MS-DOS 3.30, GW-Basic, and a two-year full system warranty, but on-site service costs extra. And the Arche lacks a few standard and optional features, including system diagnostics and a proprietary version of OS/2.

AT&T 6386E/33 WGS

The pricey ISA-based AT&T offers the expandability necessary for multiuser and multitasking operating systems, telecommunications, and network servers. AT&T also markets the system as a workstation for CAD/CAE, database, and large spreadsheet applications. The large tower case accommodates eight half-height or four full-height mass-storage devices, as well as one 8-bit and seven 16-bit ISA expansion slots. The system is powered by a large 396-W power supply; memory expands to 8 MB on the system board and to 40 MB of RAM using two 32-bit memory slots. Two proprietary 32-bit memory slots accept 8- and 16-bit adapters.

The review model AT&T came with one parallel, one 9- or 25-pin serial, and one mouse port; a 64-KB direct-mapped memory cache; and a 300-MB ESDI hard disk drive (its Western Digital ESDI controller is slower than more advanced ESDI controllers). A setup program and diagnostic utilities also come with the system. AT&T provides toll-free telephone support and offers extended warranties.

AMERICAN MITAC MPC 4000G

Designed as a LAN file server or CAD/CAE workstation, the American Mitac minitower accommodates five half-height devices or two full-height and one half-height device. A 300-W power supply ensures that you'll have plenty of power should you fill all the bays. An ISA expansion bus provides seven 16-bit slots; one parallel port, two 9-pin serial ports, and an IDE hard disk drive interface are integrated on the system board. Although the test unit's IDE hard disk drive is fast, it cannot compete with the performance of ESDI drives with advanced ESDI controllers. American Mitac sells an optional 1.2-gigabyte SCSI drive for the system.

System RAM expands to 8 MB on the system board using DRAM SIMMs; you can increase memory to 24 MB by installing a proprietary 32-bit memory board. The large 128-KB direct-mapped cache caches memory writes as well as reads. MS-DOS 4.01, GW-Basic, expanded memory management (EMM) software, and low-level formatting utilities are included. For the security conscious, American Mitac equips its system with a chassis lock and boot and keyboard password protection. Along with toll-free telephone support, American Mitac offer a one-year warranty; on-site service and extended warranties cost extra.

ACER 1100/33

Acer markets its 1100/33 ISA system as a multiuser host, network file server, or CAD workstation. Unfortunately, the system's standard ESDI controller does not perform at the level of ESDI controllers with large read-ahead buffers. In addition, the Acer is configured with a slow, 8-bit Cirrus Logic VGA adapter and performs video-intensive benchmarks poorly, which account for its poor showing in the AutoCAD drawing and screen redraw tests. The machine does, however, provide a 32-KB two-way set-associative write-through memory cache that reduces wait states on memory accesses.

The standard desktop case supports five half-height or two full-height and one half-height device. System RAM expands to 8 MB on the system board using DRAM SIMMs and up to 24 MB using a proprietary 32-bit memory slot. An ISA expansion bus provides six 16-bit and one 8-bit slot. An IDE hard disk interface saves an expansion slot. One parallel and one 9- or 25-pin serial port is standard along with a Microsoft serial mouse. MS-DOS 3.30 (NSTL performed benchmarks with MS-DOS 4.01), GW-BASIC, Microsoft Windows 3.0, and various system utilities are included, but diagnostic software is not. The Acer is backed by an impressive two-year warranty covering parts, labor, and return shipment. On-site service is an option.

Performance Tests

In analyzing the overall performance of each review system, NSTL conducted a battery of 11 benchmarks that tested the speed of execution for common operating-system, database, spreadsheet, programming, word processing, and CAD operations. The results for each test follow.

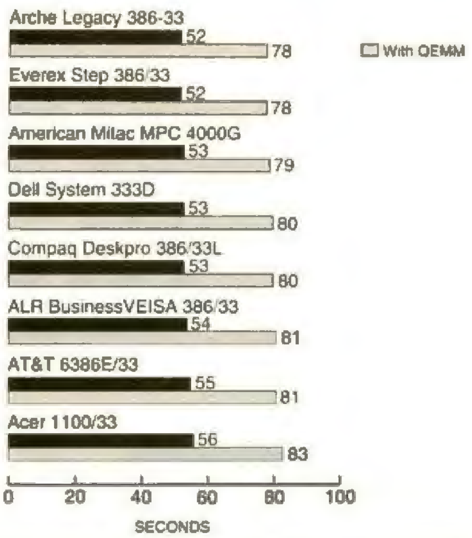
DOS Results

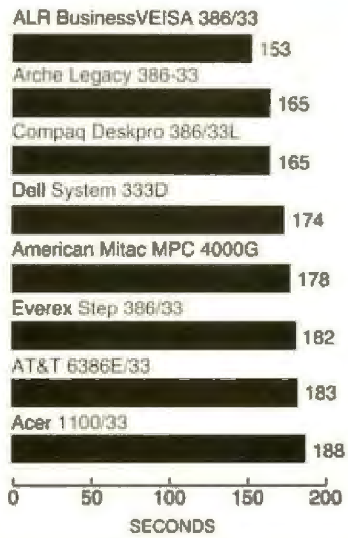
A. Lotus 1-2-3

A Lotus macro performs a series of recalculations in a 75- by 75-cell matrix. The macro enters a number in the first cell of the matrix and subsequently copies to the rest of the matrix a formula using that number. The spreadsheet recalculates three times, each time with a different number entered in the first cell. The procedure is repeated using five formulas (one each for addition, multiplication, subtraction, division, and exponentiation). The macro then executes a block move and erases the entire matrix. The benchmark is repeated with EMM software installed.

Performance Factors

These operations primarily measure processor speed, memory architecture, and system memory speed. To a lesser extent, the efficiency of a machine's video subsystem also influences the results.

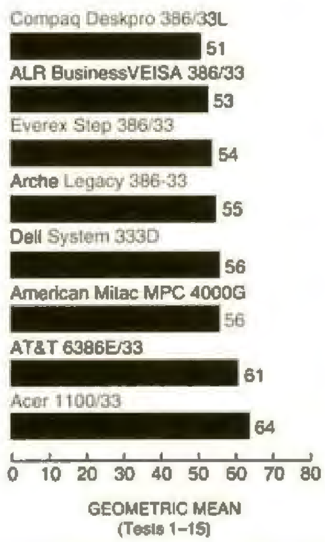




B. dBase IV

For this benchmark, dBase IV runs a series of 15 transactions against a banking database.

Tests 2, 3, 4, 5, 8, 10, and 12 test the hard disk subsystem. Tests 3, 5, and 12 test sequential reads. Tests 6, 8, and 10 test random reads. Tests 1, 7, 9, 11, 13, 14, and 15 test memory architecture.



C. Microsoft C 5.0

Microsoft C 5.0 compiles and links XLisp (a public-domain program comprising 25 source-code files written in C) and generates a working XLisp program. The systems are tested with a 256-KB cache in extended memory.

Performance Factors

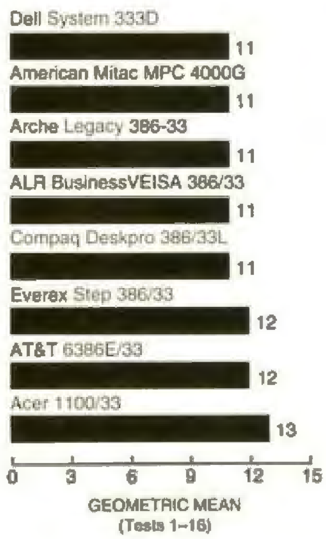
Test results are affected primarily by the hard disk subsystem, although processor speed and memory architecture also influence outcomes.

D. AutoCAD Release 10

AutoCAD release 10 inserts a drawing from disk, pans the drawing, creates multiple viewports with the same view, then inserts the drawing into the multiple viewports, inserts the drawing in multiple viewports with different views, regenerates one active viewport and then all active viewports with different views, redraws a single viewport and then all viewports, creates a three-dimensional array using an AutoLisp routine, rotates the array and then zooms out, creates a Garden Path using a Lisp routine, creates a Garden Path in multiple viewports with the same view, and generates a drawing with filling on and then with filling off. The systems are tested with a 256-KB cache in extended memory.

Performance Factors

Processor speed, memory architecture, floating-point processing, and the video subsystem primarily influence results, although the hard disk subsystem also comes into play.

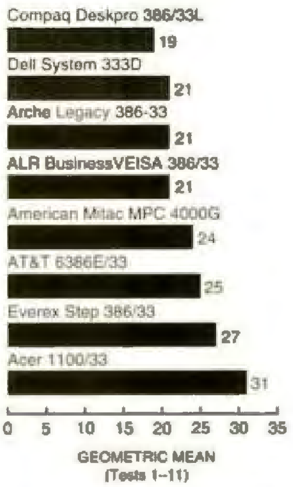


E. Microsoft Word 5.0

Microsoft Word 5.0 loads and exits, loads a 90-page file 50 and 100 times, copies the entire document 100 times, performs a search-and-replace operation five times, spell-checks and repaginates the document, scrolls 1000 lines in graphics and text modes, saves the file 25 times, and prints the document to disk. The systems are tested with a 256-KB cache in extended memory.

Performance Factors

Processor speed has the greatest effect on test results, but a system's hard disk subsystem and video subsystem influence results.

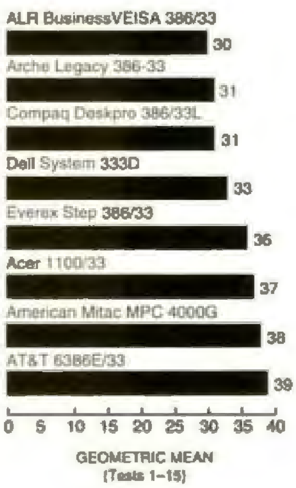


F. FoxPro

Using FoxPro, NSTL repeats the database test suite described in Benchmark B.

Performance Factors

Tests 2, 3, 4, 5, 8, 10, and 12 test the hard disk subsystem. Tests 3, 5, and 12 test sequential reads. Tests 6, 8, and 10 test random reads. Tests 1, 7, 9, 11, 13, 14, 15 test memory architecture.



G. Microsoft Excel 2.1C Under Windows 3.0

Microsoft Excel executes transcendental calculations, cut-and-paste operations, charting, insertions and deletions, financial calculations, array functions, database functions, file operations, defined functions, and recalculation. Excel runs under Microsoft Windows 3.0.

Performance Factors

Processor speed, memory architecture, floating-point processing, and the video subsystem primarily influence results, although the hard disk subsystem also influences outcomes.

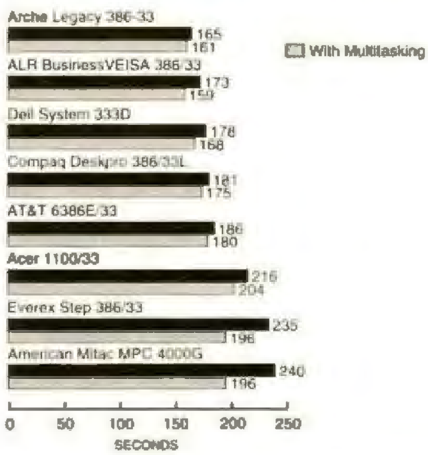
OS/2 Benchmarks

H. IBM C/2

Benchmark C is repeated with IBM C/2 running under OS/2. Test is repeated with two OS/2 command files executing concurrently, each compiling 13 source-code files.

Performance Factors

The hard disk subsystem has the greatest effect on test results, but processor speed and memory architecture come into play. With multitasking, the CPU works harder as you increase the number of tasks running simultaneously.

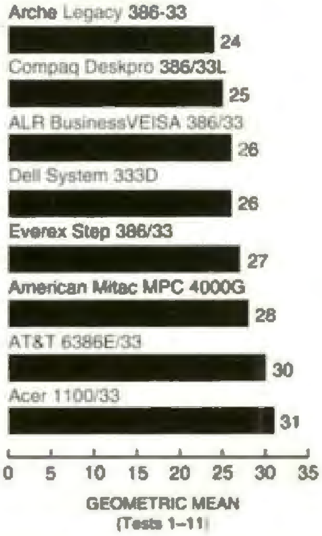


I. Microsoft Word 5.0 for OS/2

A DOS batch file loads the program, and a Microsoft Word autoexecution macro loads a 35-page document, runs a search-and-replace operation, spell-checks the document, and prints the first page to a null printer.

Performance Factors

Processor speed primarily influences test results, but the hard disk subsystem and video subsystem also affect results.

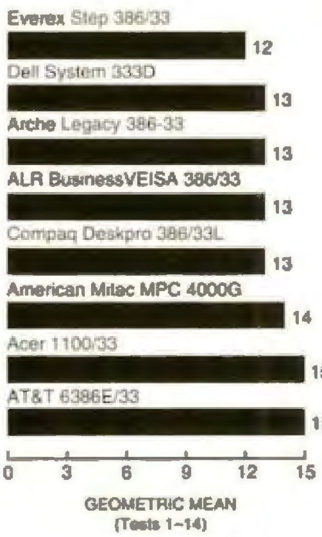


J. Microsoft Excel for OS/2

Benchmark G is repeated with Microsoft Excel for OS/2.

Performance Factors

Processor speed, memory architecture, floating-point processing, and a computer's video subsystem largely determine test results, but the hard disk subsystem also affects outcomes.

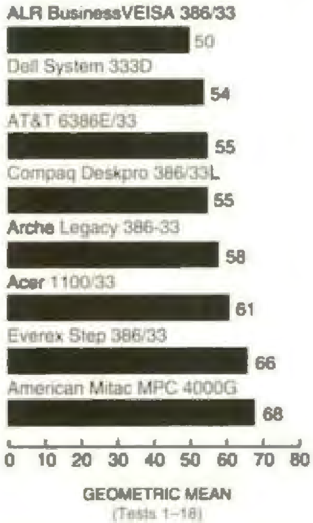


K. Oracle for OS/2

The 18 Oracle tests run in a 100-MB disk partition. All drive write-caching capabilities are disabled in accordance with Oracle's recommendation.

Performance Factors

Tests 3, 4, 5, 7, and 9 test the hard disk subsystem. Tests 4, 14, and 16 test sequential reads. Tests 7, 9, and 12 test random reads. Tests 1, 6, 8, 13, 15, 17, and 18 test memory architecture.



The 386 vs. the 486

As more 486 machines are introduced and the prospect of lower prices looms, many users wonder whether the 386 is about to become obsolete. For right now, the 386's capabilities are more than adequate in most computing environments. A 386 chip's 32-bit processing registers are twice the size of those in the 286, and the 386 supports a virtual-86 processing mode. Virtual-86 mode enables the 386 to simulate multiple 8086 processors, each running a different applications program to which 640 KB or more of memory are allocated.

The 486 processor combines all the features of the 386—a 32-bit data and address bus, virtual-86 mode, and so on—plus an integrated 387-compatible numeric coprocessor and an 8-KB memory cache with a high-speed controller. The 486 is a complex instruction-set computer (CISC) processor with features similar to those of RISC processors, which enable instructions to be processed in a single clock cycle. The 486 is available in 25- and 33-MHz versions.

The high-end features typical in 486 systems, such as high hard disk storage capacity, EISA or Micro Channel architecture, and support for a network operating system, can be implemented in less expensive 386 systems. But in one area, at least, buying a 486 can save you money: You don't have to buy a separate numeric coprocessor. But the 486's integrated coprocessor will likely contribute little to file-server performance until server operating systems are tuned for the 486's built-in coprocessor.

Still, a 486 chip executes many instructions faster than a 386 chip, which gives 486 systems an intrinsic speed advantage over 386 systems for most tasks. When executing floating-point and CPU-intensive tasks, a 25-MHz 486, for example, performs about 50 percent faster than a 33-MHz 386. A 33-MHz 486 can be as much as 100 percent faster than a 33-MHz 386.

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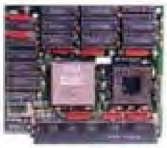

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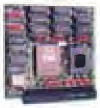

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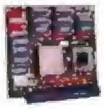

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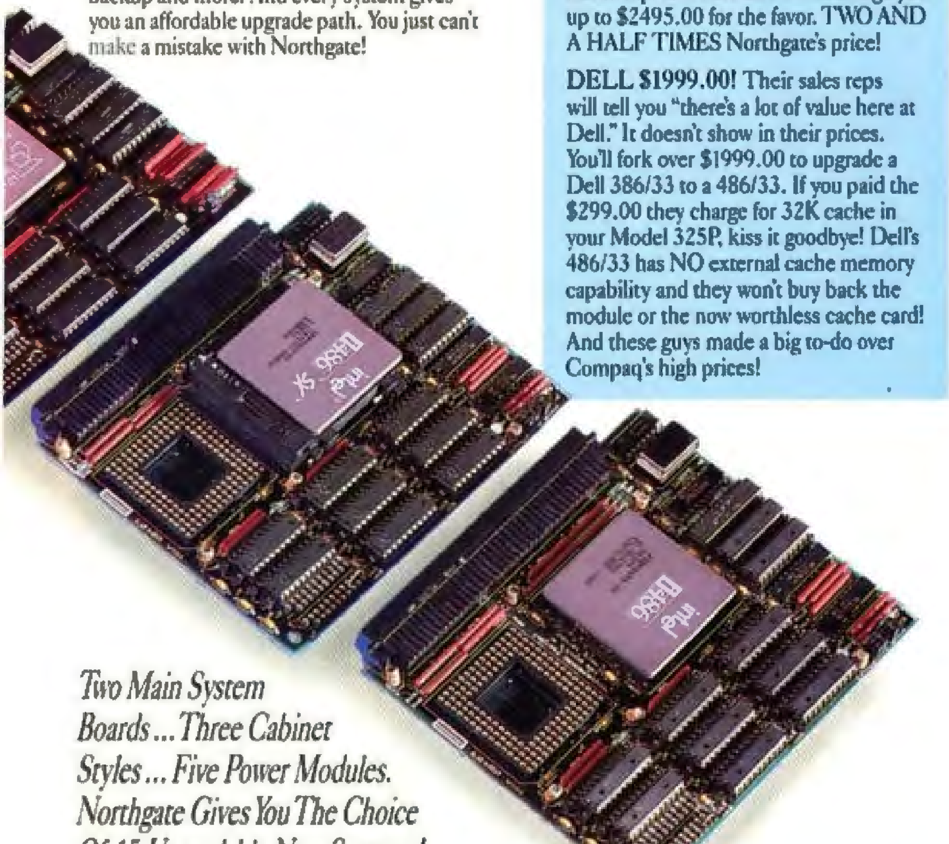

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FAULT TOLERANCE

Imagine a world where things work. Take a minute now. I realize that in the 1990s this may be a radical concept (and I'm being only *slightly* facetious when I say that). In recent years, despite all the spoken emphasis on excellence and the inauguration of the Malcolm Baldridge Awards, excellence has become an elusive quality.

How many of us spend hours on the phone trying to straighten out mixed-up billing? How often do we purchase items only to find that they are defective in some way? Twenty percent of the time? Ten? If it's an item that's critical to what we're doing, even 5 percent seems too much.

This is not an indictment of the American way; Japanese and European items don't necessarily work, either. The quality crisis is a global disease. However, there is a medicine that will, if not cure the disease, at least make it easier to live with. The prescription? Take a few fault-tolerant technologies, and you won't need to call me in the morning.

Fault-tolerant computing increases the dependability of your system by selectively providing more hardware, software, or information than it needs. This redundancy means that the system can continue to perform despite the occurrence of a number of faults. In "Safety in Numbers," Victor P. Nelson explores how fault-tolerant computing can extend your system's useful lifetime as well as help you get more work done.

When we talk about improving reliability, we tend to think of the big picture—whole systems or subsystems—but fault tolerance applies at the component level as well (e.g., redundancy in the basic circuits of an IC). In "Chips That Work," Mike Riezenman discusses how fault-tolerant chips make inexpensive memory possible today and how they will increase yields and make automatic backups for primary circuits available tomorrow.

At the subsystem level, few ideas can command more attention than keeping your disk storage up and running and protecting its data from mechanical disaster. Fault-tolerant mass storage can be an important element in system reliability. In "Disk Insurance," Steven J. Vaughan-Nichols looks at both software and hardware solutions to disk problems: disk mirroring, disk duplexing, and redundant arrays of inexpensive disks.

As you might expect, large systems also need fault tolerance. And in the world of microcomputing, you don't get much larger than a network—at least not yet. As businesses have come to rely more and more on LANs and enterprise connections, fault tolerance in the network has become more important. In "Perpetual Networks," David Fowler examines how redundancy in hub and backbone topologies is able to improve your network's reliability.

Excellence may be elusive, but it is not unattainable. Companies and individuals reach for it continually, but only a few attain it—and then only occasionally. The problem lies in the complexity of the work we have undertaken. No more the simple, one-person task: Now we produce products that pass through a thousand steps and a thousand pairs of hands. The opportunities for error have mushroomed. It is not surprising, then, that we get errors.

Fault-tolerant technologies provide the tools we need to bypass the inevitable errors. They enable us to deal with the errors and still produce excellent work ourselves. Fault tolerance embodies the seeds of *no-fault* technology, where we won't know or care that a fault has occurred. Today we have a treatment for the quality crisis, but like tomorrow, the cure may be just around the corner.

—Jane Morrill Tazelaar
Senior Editor,
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SAFETY IN NUMBERS

Redundancy lets a system perform its intended functions despite some number of faults

VICTOR P. NELSON

Fault-tolerant computing can increase the dependability of a computer system by providing more hardware, software, or information than is necessary. This redundancy lets a system perform its intended functions despite some number of faults.

Quantitatively, you can measure how dependable a system is in terms of either reliability or availability. System *reliability* is the probability that the system won't fail by a given time. If a system needs continuous error-free operation, a minimum reliability level must be maintained over the system's useful lifetime.

A system's maximum useful lifetime is the length of time in which its reliability remains greater than some specified minimum value. Fault-tolerant computing is one method for increasing a system's useful lifetime.

It's important to note two things, however. First, for a given application, a system could be sufficiently reliable without fault tolerance. And second, using fault tolerance doesn't necessarily guarantee that a system will be sufficiently reliable for a particular application.

If occasional, brief periods of downtime are acceptable in an application, an availability goal may be more appropriate. *Availability* is the probability that a system will be operational at any given moment; thus, it is the ratio of the system's uptime to the sum of its uptime and downtime. Availability is increased by using fault-tolerant designs to maximize uptime or minimize downtime.

Faults and Errors

The words *fault* and *error* sound like synonyms; they're not, however, and the

BYTE ACTION SUMMARY

With fault-tolerant computing, you can increase your system's dependability by selectively providing more hardware, software, or information than you need. You can also increase your system's useful lifetime. Fault tolerance means being able to detect, mask, and confine errors; diagnose faults; and repair, reconfigure, and recover your system. What is the key? Redundancy.

distinction between them is important. A fault is a physical condition that occurs in a hardware or software element, making the element unable to perform its intended function. An error, on the other hand, is a symptom of a fault and manifests itself as an incorrect output or invalid state for the faulty element.

A fault is referred to as *latent* when it occurs without producing errors during system operation. A common example would be a fault that alters the contents of a byte in memory. If the byte is not accessed after this change, no error occurs.

You can characterize faults by duration and extent. Fault *duration* may be permanent, transient, or intermittent. A *permanent* fault doesn't disappear once it occurs. It results from failures of electronic components or interconnections, physical damage, or design errors. Design errors are especially difficult to detect, since the affected hardware or software often performs as designed.

Transient faults are temporary conditions, usually the result of electromagnetic interference, temperature, humidity, incorrect operating voltage, or other external disturbances. Transient faults typically disappear as soon as the external condition is eliminated.

An *intermittent* fault alternates between active and dormant states and is usually caused by poor design, borderline operating conditions, or the marginal operation of a component prior to failure. For both transient and intermittent faults, errors may remain after the fault disappears.

Many systems use diagnostic programs to locate faults. However, these diagnostics are only effective for permanent faults. Systems need to use other methods to locate transient and intermittent faults, which are far more likely to occur in real systems.

The *extent* of a fault indicates how much of the system it affects. A local fault directly affects a single component, while a global fault influences multiple components. Most fault-tolerance strategies deal with a limited number of localized faults; they tend to leave systems vulnerable to global faults.

Transient faults associated with external disturbances tend to be global in nature, since the entire system is typically exposed to the same condition. In contrast, the failure of a transistor junction would directly affect only the component that contains it.

Campaign Strategies

The ability to tolerate faults requires a design strategy that includes one or more of the following elements: error detection, error masking, error confinement, fault diagnosis, system repair and reconfiguration, and system recovery.

To detect errors, you need to have enough redundancy that the system can distinguish between correct and incorrect information. You can create redundant information by replicating the modules that produce the information, by encoding the information so that errors result in detectable noncode words, or by using heuristics to determine whether the information is valid or reasonable (e.g., a square-root algorithm that produces a negative result would be faulty).

For continuous error-free operation, the system must dynamically correct or mask errors. Error masking requires more redundancy than error detection does, because the system must extract the correct information from the information that the redundant configuration produced. Error masking also typically uses duplicate modules or extra bits to encode information.

You can often mask the effects of transient faults simply by retrying the operation that failed. The bus interfaces of several current microprocessors let externally detected errors initiate bus-cycle retries transparent to the software.

To minimize the impact of a fault, you must establish error-containment boundaries to confine errors to their originating modules. You don't want them to propagate through the rest of the system. Error-containment boundaries prevent errors from spreading into or out of a module by checking all its inputs and outputs, respectively, and then isolating the module from the rest of the system if an error is found.

In systems that have enough resources to continue operating without one or more modules, you must not let a failed module affect the remaining resources. Whether or not the system can continue, limiting error propagation minimizes the amount of time needed to repair any damage.

To repair the system, you must first analyze the errors to identify which components are faulty. How detailed a diagnosis you need depends on your system repair and reconfiguration strategy. If you plan to replace faulty modules, whether automatically or manually, you just identify which module is faulty.

You don't gain any benefit by analyzing faults further unless you plan to repair faulty modules; for example, the diagnostic programs of the Bell System's 1A Processor, which was the heart of the company's first electronic-switching systems, focused on isolating a problem only to the three replaceable modules it might occur in. This broad-brush approach minimized repair time and increased system availability.

In a fault-tolerant system, you must either replace a faulty component or route information around it to keep it from interfering with how the rest of the system operates. In most commercial and industrial applications, repair is manual; circuit boards are replaced by hand.

Some commercially available fault-tolerant systems incorporate a "hot repair" capability. This lets you deenergize a faulty board and remove it from the system, install and energize a spare board, and integrate the new board into the system, all without bringing the system down. The rest of the system can continue operations during this process.

Where it's not practical to repair a system manually—such as in space vehicles or aircraft during flight operations—reconfiguration must occur automatically. The system must be able to isolate the faulty module by switching off its power or otherwise segregating its outputs from the rest of the system. Once the system isolates the faulty module, it can switch on a spare module to replace the faulty one, or it can transfer the module's tasks to another operational unit.

If errors have propagated in a system, if new hardware is introduced, or if work has been transferred between modules, you may have to restore the system's state or set it to some acceptable value before operations can continue.

System recovery can be either forward or backward. To implement *backward recovery*, the system saves its state at various checkpoints. After repair or reconfiguration, the system's state is restored to that of the last good checkpoint, and all processing is repeated from that point. It's important in backward recovery to identify those operations that can't be repeated, such as posting a deposit to a customer's bank account.

When errors have not been significantly propagated through the system, you can implement *forward recovery* by masking errors or otherwise deriving a correct system state following the occurrence of a fault. System operation can then simply continue without having to roll back to an earlier state. You would initialize any new hardware introduced during repair or reconfiguration to the current state of the system prior to continuing.

But if error propagation has been more significant, further recovery actions may be necessary. You may have to undo an interrupted database update to put the database in a consistent state. Or you may have to reacquire an object that a radar system was tracking. To minimize recovery time, it is critical that you enforce error-containment boundaries.

Multiple Modules

Active/backup module pairs. The most common form of modular redundancy is to simply replace a faulty module with a spare (see figure 1a). To do this, the active module must include internal error-detection mechanisms, and the system must properly transfer program control to the backup module.

The backup unit can be hot or cold. A *hot* spare performs all computations in parallel with the active unit, and thus it always contains the correct state of the system, making the switchover instantaneous. A *cold* spare can be either unpowered or used for other work until the active module fails.

Tandem Computer's (Cupertino, CA) NonStop systems use active/backup process pairs. The backup process remains dormant, letting the computer perform other tasks. The active module sends state information to the backup at various process checkpoints, so the backup can initiate execution from the last checkpoint if the active module fails. A cold spare, which is used for other work, increases overall production, but at the expense of a longer transition time for the backup to replace the failed unit.

Duplex operations. You can often detect errors more completely by using identical modules in a duplex configuration (see figure 1b). In this approach, two modules perform all operations in lock-step fashion, and they use a *comparator* to detect any mismatch between

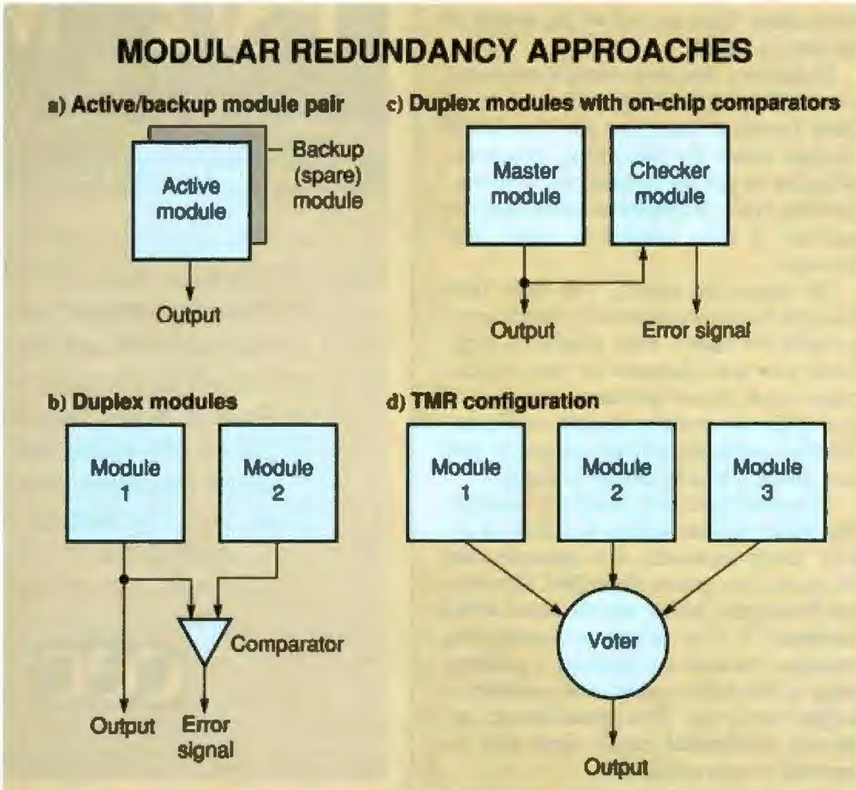


Figure 1: (a) *The active/backup module pair simply replaces a faulty module with a spare.* **(b)** *Duplex operations use two identical modules performing all operations and a comparator to detect any mismatch in outputs.* **(c)** *Duplex operations with on-chip comparators provide comparators at each output pin and master/checker operating mode.* **(d)** *In the triple-modular-redundancy (TMR) configuration, three identical modules perform each operation concurrently, and a voter determines a majority ruling, thus masking failures in any one module.*

the two sets of outputs.

As soon as the system detects an error, it disables the outputs of the module and issues an error signal. You can then discard the entire duplex module and reassign its tasks, or you can run additional diagnostics to determine which of the two units in the module is faulty so that the good unit can continue on its own.

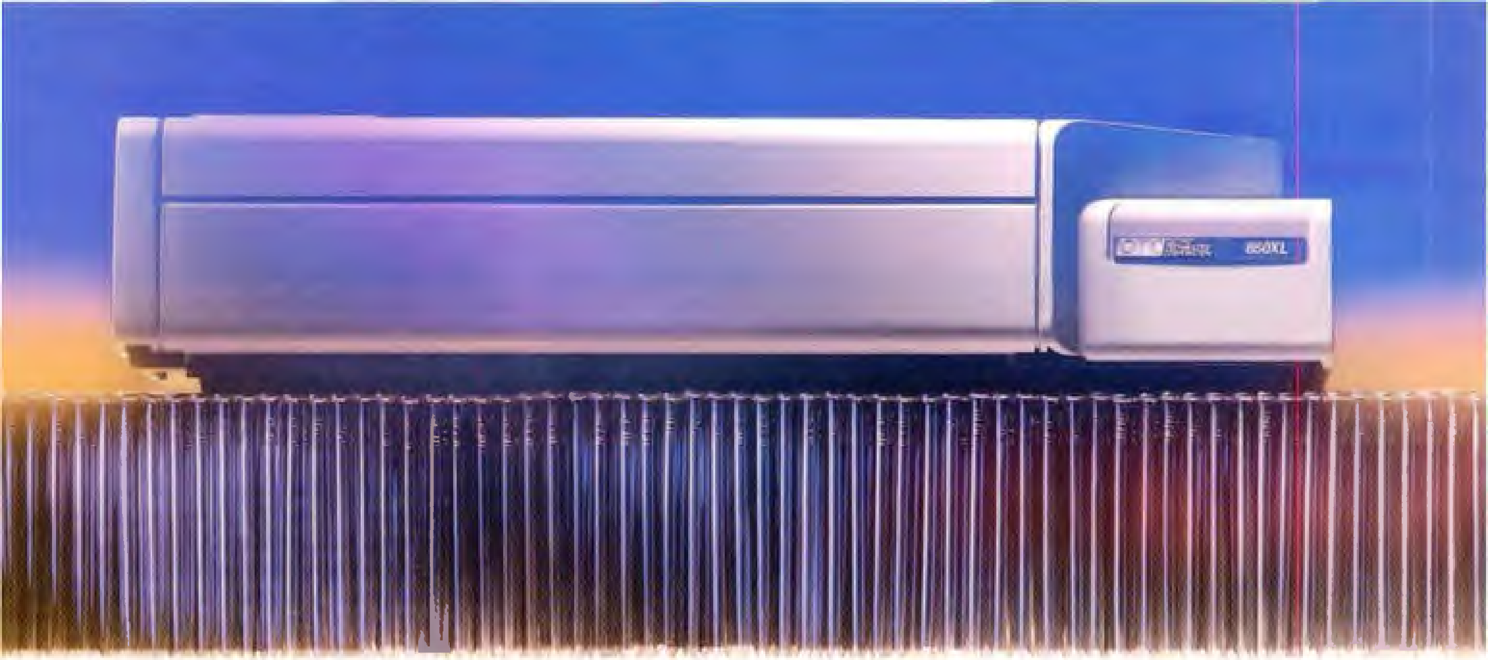
Bell's 1A Processor used two identical processors that brought 12 internal points out to comparators—two points during each clock cycle. If an error was detected, the diagnostics selected one of the two processors to continue operations until repairs could be made.

Duplex operations with on-chip comparators. Several recent VLSI devices, including the Intel APX-432 microprocessor family and the AMD 29000 RISC processor family, have incorporated support for on-chip duplex operations. Each device includes comparators at each output pin and master/checker operating mode.

One chip in each pair is designated the master and drives all outputs normally. The second chip, designated the checker, disables its output drivers and samples the outputs that the master chip supplies. The on-chip comparators within the checker detect any disagreements between the two chips and provide the error signal (see figure 1c).

Process outputs can also be compared in software, allowing the two standard modules to operate in a loosely coupled duplex configuration. Typically, the two processes would exchange all critical information and compare the two copies in software prior to using that information.

Triple-modular redundancy (TMR). Duplex configurations detect errors without identifying which module is correct or faulty. If you need continuous real-time operations, you do not have the time to stop the system to find out which unit is correct. Continuous operation requires that the system mask errors instantaneously. Repair and reconfiguration operations have to take place either in parallel with normal operations or later



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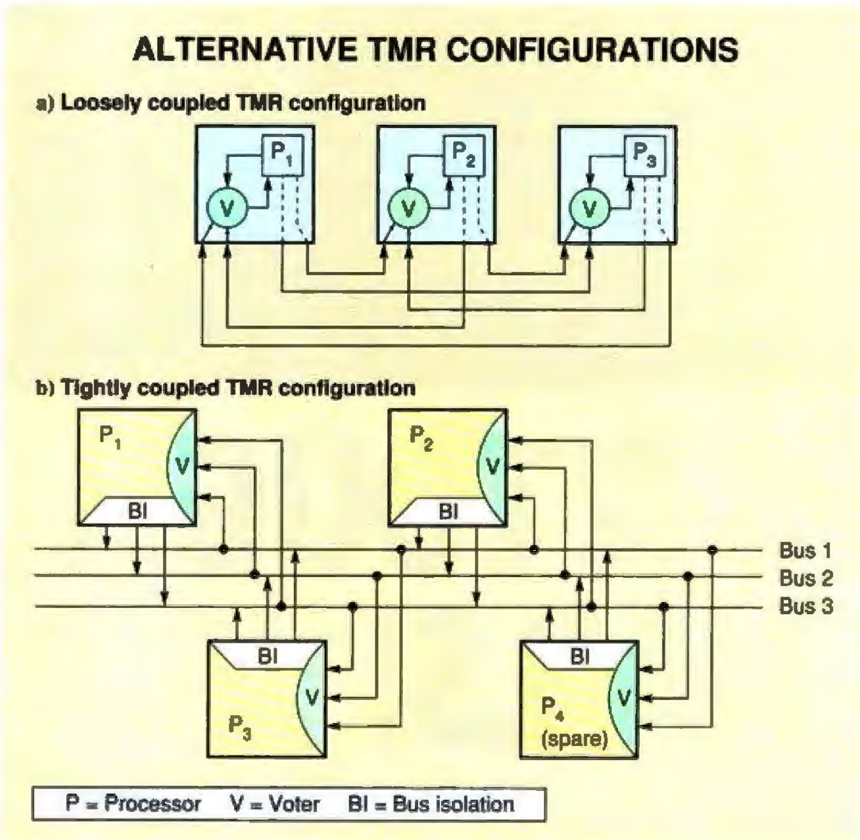

Figure 2: (a) *In a loosely coupled TMR configuration, software performs the voting.* **(b)** *In a tightly coupled TMR configuration, processors are each assigned to drive one bus through their bus-isolation logic and read all three buses via their input voters.*

at a more convenient time.

TMR is the most common fault-masking configuration in which three identical modules perform each operation concurrently (see figure 1d). A voter selects the overall output to correspond to the majority vote of the three modules, thus masking failures in any one of them. You can readily extend this process to *n*-modular redundancy with *n* identical modules and a corresponding majority voter.

As in duplex operations, the vote in an *n*-modular redundant configuration can be performed in hardware, on a cycle-by-cycle basis, or in software, with modules exchanging data and using software voting (see figure 2a). TMR is used in the Space Shuttle computer complex (which uses four processors) and in the experimental SIFT aerospace computer and its commercial counterpart, the August Systems industrial process-control computer (three processors). These systems exchange all critical data values and vote on them before they are used in any program step.

While the TMR configuration in figure 1d tolerates any processor failure, it is still vulnerable to voter failure. If the probability of voter failure is significant, you can use three voters; for example, figure 2b shows the configuration of the Fault-Tolerant Multiprocessor (FTMP) developed at Charles Stark Draper Labs (Cambridge, MA) for aerospace applications.

In FTMP, you can group any three processors into a TMR triad, with each processor driving one of the redundant buses, reading all three buses, and voting on their inputs; thus, the failure of any processor or any voter disables the entire processor/voter pair. You can assign any other processor to replace the failed unit within the affected triad simply by telling it which bus to drive.

Self-checking module pairs. One alternative to voting that can perform continuous error-free operation is to use self-checking module pairs. The quadruplex configuration (see figure 3) has been used in the 68000-based Stratus 32 systems (Stratus Computer, Marlborough, MA).

In the quadruplex configuration, two pairs of duplex modules (a total of four processors and two comparators) perform all operations concurrently. Each duplex module is self-checking in that a comparator detects any disagreements between its two processors. If such an error occurs, the system disables that module's output, and while it replaces the faulty module, the remaining duplex module continues operating alone.

Several techniques are used to design modules that are self-checking but not replicated. The Bell System's 3A Processor (successor to the 1A) uses two processors that operate autonomously except for periodically exchanging state information. Coding and self-checking logic within each processor enable a faulty processor to identify itself; when that happens, the second processor takes over, providing continuous error-free system operation.

Information redundancy. Applying coding techniques to redundant bits can make it easier to detect and correct errors within an information word. Error-detecting and -correcting codes are the most widely used form of fault tolerance, with applications ranging from aerospace and military systems to laptop personal computers.

The main attraction of coding is that it can detect and correct errors with significantly less redundancy than you find with replicated modules. However, most coding schemes apply only where information is not transformed, such as in information storage or retrieval (e.g., memory, disk, and tape) and in data transmission over buses or communications channels.

How well a coding scheme detects or corrects errors depends on how well it can sort out the valid code words. A given number of errors must not be able to transform one valid code word to another; it must turn the code word into a noncode word. With additional redundancy, the separation between the two can be wide enough to associate specific noncode words with specific code words. When this occurs, a limited number of errors can be corrected.

The separation between two binary words—referred to as the *Hamming* distance—is defined as the number of bit positions in which the two words differ. Suppose two valid code words differ in a single bit position (i.e., they have a separation of one). An error in that single bit position will transform one valid code word into another, and the error will be undetectable.

If the minimum separation is two, then

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for any valid code word, a single error can only produce a noncode word, and the error can be found. However, if two errors were to occur, one valid word could be converted to another valid word, and the errors would not be seen.

If the minimum separation increases to three, however, each single error produces a noncode word that can be uniquely associated with its original code word. When this occurs, the system can produce the correct data during decoding.

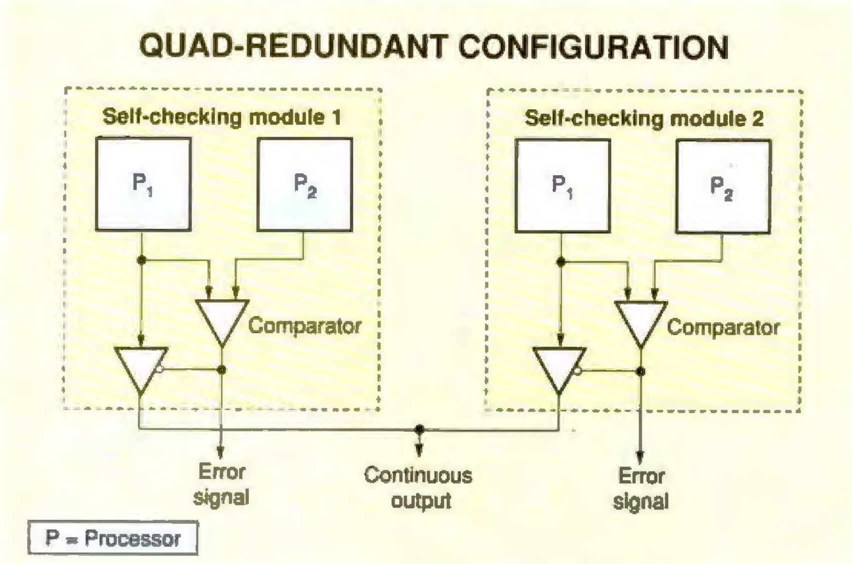

Figure 3: *This configuration is used for continuous error-free operation. A detected error disables the output of a faulty module, letting the other module continue.*

Simple parity checking uses a single redundant bit to provide a minimum separation of two. Words with even parity have an even number of 1 bits; therefore, a single error produces a word with an odd number of 1 bits, which identifies it as a noncode word.

Hamming codes (often used to protect memory systems) compute multiple parity bits for overlapping subsets of the bits within each data word. For a single error-correcting code, the overlap provides a minimum separation of three, enabling error correction.

Figure 4 illustrates a memory system utilizing an error-detection and -correction circuit. Check bits are computed and stored with the data during each memory write, and they are rechecked during each memory read; the data is corrected if errors are found.

Cyclic-redundancy-check codes commonly protect devices and communications channels that use serial data transfers. In CRCs, linear-feedback shift registers compute a set of check bits over an entire string of data and then store or transmit the check bits after the data. The same operation is performed when retrieving or receiving the information; the computed check bits are compared to the original check bits to detect errors. Some CRC codes, such as those used on some high-performance disk drives, also provide sufficient redundancy to correct a limited number of bit errors.

Other Error-Detection Mechanisms

The state of a digital system in the clock period following the current one is a function of only its current state and the system inputs. In any particular state, the number of "next" states and inputs that can occur is relatively small. Hence, special hardware or software can often detect an improper input or an incorrect next state.

Several computer networks and system buses, especially those used in military and aerospace systems, are designed to ensure proper protocols during data transfers. They detect out-of-sequence or late-arriving events as system errors.

Typically, the limits on how long it can take to perform a particular event are known. Special watchdog timers can determine when an event fails to occur within its time frame and signal that problems exist. A wide variety of systems include time-out checks as an inexpensive way of detecting system failures, since such failures typically prevent an event from completing within its given time limit.

On several computers, operating-system software implements other protocol checks to ensure that the application programs follow proper procedures. In addition, most computers use special hardware to detect such errors as divide by zero, improper memory access, and nonexistent op codes. Most of these devices are relatively inexpensive to implement, and they often supplement other error-detection mechanisms in a fault-tolerant system.

The Three Rs

For continuous system operation, a fault-tolerance strategy must include the three Rs: repair, reconfiguration, and recovery. You must render a faulty component unable to affect other system elements

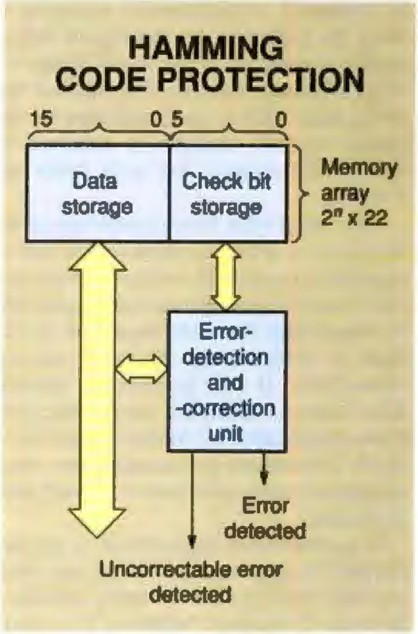

Figure 4: *A 16-bit memory array protected by a Hamming code. Six check bits enable single-error correction and double-error detection.*

by manually or electrically removing it from the system or by routing all information around it to effectively isolate it. After isolation, you can either replace the faulty unit with a spare and restore the system to full strength or continue to operate the system, but with fewer resources.

Operating with fewer resources is referred to as *graceful degradation* and is especially popular in multiprocessor systems. In most multiprocessors, a number of processing elements share the workload by distributing the tasks among themselves. If one processing element fails, then its tasks are redistributed to allow operations to continue; however, fewer processors performing the same amount of work will reduce overall performance.

If performance degradation is not acceptable for a given application, you must provide some number of spare modules. Synapse Computer (Milpitas, CA) marketed a multiprocessor called the N+1 system; it provided $n+1$ processing elements for applications requiring n processors to achieve the desired performance.

The N+1 system stored all tasks in a queue in a common memory area. Each processor continuously selected a new task from the queue after completing its current task. If any single processor failed, it was disabled and its task reentered on the queue. The remaining n processors continued to select tasks from the queue, ensuring continued correct operation.

Once a system has been restored to full strength or reconfigured to isolate a faulty unit, its operational state must be set to a correct value. The extent of the recovery depends on the extent of the error propagation. The most common approach is to restore, or roll back, the state of the system to a known good value.

Current Trends

With the ability to put more devices onto a single chip, VLSI designers are incorporating on-chip fault-detection mechanisms to improve testability for initial part checkout, to support diagnostic operations, and to provide on-line error detection during normal operations.

Additional on-chip features to support fault-tolerant system design are also beginning to appear, such as comparators at output pins to support duplex operations. Many current memory chips include on-chip logic to reconfigure the rows and columns of a memory array to isolate faulty storage cells (see "Chips That Work" on page 187). This is normally done at initial testing time to increase yield by eliminating manufacturing defects. In some cases, faults occurring during normal operation can be tolerated in the same manner.

While fault-tolerant design principles were once limited to special-purpose systems that had to be highly dependable, their use is beginning to extend to general-purpose minicomputers and mainframes, as can be seen in current offerings from IBM and DEC. This trend will also continue into the personal computer arena, making fault tolerance an integral and cost-effective part of all computer systems. ■

Victor P. Nelson is an associate professor in the electrical engineering department at Auburn University (Auburn, AL). He has a Ph.D. from Ohio State University. He can be reached on BIX c/o "editors."

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CHIPS THAT WORK

The availability of low-cost, high-density memory chips is the most obvious result of employing fault-tolerant technologies at the circuit level

MIKE RIEZENMAN

Ever since semiconductor memories reached the 64-kilobit level, IC manufacturers have used fault tolerance to boost yields. While fault tolerance was introduced into computer systems to make them more reliable in the field (to make equipment less inclined to fail with use), its purpose in IC manufacturing was to make the semiconductor devices work in the first place.

That emphasis is still valid. Today, when you speak of fault-tolerant chips, you're generally talking about methods of making perfectly functioning memory ICs out of less-than-perfect chips. In the future, fault-tolerant chips may include VLSI circuits other than memories with increased operational reliability, but those ideas are only beginning to become commercial realities.

As with systems, the key concept behind fault-tolerant chips is redundancy. Extra circuits are built into the devices to replace circuitry found to be defective. Why chip defects require this special treatment and how redundant elements can be substituted for bad ones on fabricated ICs is an interesting story.

The Yield Problem

The problem addressed by fault-tolerant chips lies chiefly in the way silicon is prepared for circuit fabrication. The process begins with the growth and purification of a silicon boule (a salami-shaped crystal of ultrapure silicon, characteristically some 6 inches in diameter and several feet long). Ideally, the boule consists of one perfect crystal; in practice, the boule has a number of defects, such as inclusions and crystal dislocations, randomly scattered throughout its volume.

continued

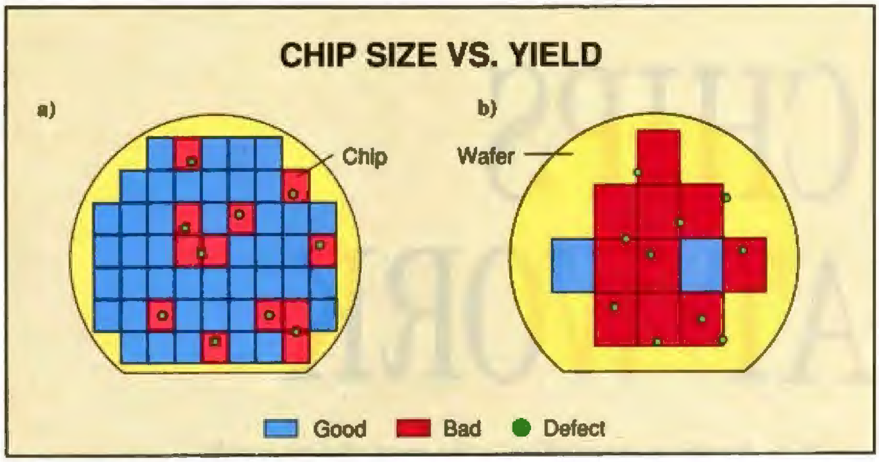


Figure 1: *Yield goes down as chip size goes up. Both of these wafers have the same 10 defects distributed in the same way. Fifty relatively small chips fit on the wafer* (**a**). *The 10 defects cause 12 failures, with a yield of 76 percent. If the chip area is quadrupled, the number of defects stays the same, but the number of chips drops to 12* (**b**). *In that case, with the 10 defects causing 10 chips to go bad, the yield is only 17 percent. (The numbers of defects and chips in this example are unrealistically small to make the illustration easier to understand, but the conclusion remains valid.)*

The second step in making an IC is to slice the boule into wafers, in much the same way you would slice a salami. Because silicon is rather hard, the slicing is done with a diamond saw. In slicing the boule, many more defects (e.g., tiny pits, scratches, and additional dislocations) are added to those already present. Many of these are removed by polishing the wafer, but when the process of photolithographically fabricating the circuitry onto the wafer begins, there are a number (apparently irreducible) of defects scattered over the wafer surface. During fabrication, additional flaws occur, mostly from contamination by airborne particles.

BYTE ACTION SUMMARY

Unlike fault-tolerant technologies that increase the operational reliability of a system or device, semiconductor manufacturers employ redundancy to increase the yield of memory circuits. The use of such techniques to increase operational reliability in logic chips is limited almost exclusively to ASICs.

The result is that some of the chips on a wafer will have defects of one kind or another and will not work properly. Whether that constitutes a serious problem depends on the size of the chips (see figure 1). If the chips are fairly small, then several hundred of them will fit on a wafer, and the percentage of bad chips due to wafer defects will be fairly low (see figure 1a). As they get larger, however, the percentage of bad chips will increase (see figure 1b). The identical defect distribution produces a larger percentage of bad chips as the chip size increases.

But that's only part of the story. Making larger chips is only one of the steps manufacturers take to increase chip complexity. Another, more powerful strategy is to make the circuit elements even smaller. However, as circuit features get smaller, tiny imperfections that caused no problems with lower-density circuits grow in importance. The definition of a defect gets tighter as features become smaller. A wafer that had a defect density of five defects per square centimeter when used in the fabrication of small-scale-integration or medium-scale-integration devices may have a density of 50 defects per square centimeter if VLSI products are being considered.

For example, consider the effect of an open-circuit defect on two generations of ICs (see figure 2). In the older chip, where the line width is 10 microns across, a 1-micron flaw will have practically no effect. On a modern chip with a line width of 0.8 micron, it causes a failure. Clearly, there comes a point when increasing chip density is no longer economically viable.

At that point, manufacturers have but three options. The first option is to reduce the defect density. Although experiments indicate that crystals grown in the weightlessness of space have much lower defect densities, this enterprise seems to have been pushed as far as it can be on Earth. The second possibility is to cease trying to make denser circuitry and to accept low yields as the natural limit on how far nature can be pushed. The third choice is to exploit redundancy and build fault-tolerant devices.

Exploiting Redundancy

The basic concept behind redundancy is simple: Provide a few extra rows and columns (word lines and bit lines, respectively) in a memory array. Then, if defects make a couple of lines inoperative, disable them and enable a couple of the spares, programming the spares to respond to the addresses of the disabled lines. The key to the success of this idea is that the redundant circuitry not add too much to the chip area, because, as has been demonstrated, increasing the size of a chip adversely affects the yield. Generally speaking, redundancy is most effective when it adds about 5 percent or 10 percent to a chip's area.

Semiconductor devices are tested after wafer fabrication and before the wafers are split into individual chips and packaged. Wafer probers (arrays of very fine metal probes attached to sophisticated test equipment) contact test points on the wafer surfaces and electrically test each device on the wafer. Those probers can determine not only whether a device is good or bad, but what parts of it, if any, are not working properly.

Suppose the testing reveals that a certain line in a memory array is bad. How can it be disabled, and how can a spare be activated in its place? The important fact to remember is that the addresses in a memory array are applied to all the lines simultaneously—the spares and the main array elements. Each line has its own decoder, which determines whether it is being addressed. So, the question actually has three parts, not two: How do you disable a bad line, enable a spare line, and then program the decoder on the enabled spare line to recognize a specific address, namely, that of the disabled line?

Links and Latches

Two main methods have emerged for reconfiguring chips: fusible links and nonvolatile latches. Of the two, fusible links are more widely used, with nonvolatile latches being used mainly in nonvolatile types of memories, such as EEPROMs.

Fusible links are electrical connections that can be selectively broken to accomplish the desired reconfiguration. A typical arrangement of these fuses is to have them in three places: (1) in series with the outputs of the main line decoders, where breaking them disables the line; (2) shorting the outputs of the spare line decoders, where breaking them enables the line; and (3) in series with the inputs of the spare lines, where they can be broken to make the address of the spare line match that of the line that it is replacing (see figure 3).

The scheme of figure 3 is only one of many possible arrangements. It has the advantage of not increasing the memory-access time and the disadvantage of using a lot of fuses, which take up valuable silicon area. There are other arrangements that combine a smaller number of fuses with a small amount of combinatorial logic circuitry to achieve the same result, but usually at the price of adding a gate delay time to the memory-access time.

There are two main ways to break fusible links: by passing a high current through them or by zapping them with a laser beam. Each method has its proponents. If the current-fusing approach is chosen, it means that driver transistors must be included on the chip to drive the fusing current through the fusible links, and that logic circuitry must be included to control those drivers. The disadvantage of the approach is that it takes up extra silicon area. The advantage is that it allows the reconfiguration to be done at any time, even after the individual chips have been packaged. In particular, it holds out the possibility of reconfiguring devices in the field, if that should ever prove attractive. (The vast majority of the electronic-equipment failures in the field, especially for equipment that has been properly burned in, are failures of mechanical interconnections. Even when an IC does go bad, the problem is most likely to be with its bonding wires. Because such problems are not repairable by these methods, it seems doubtful that field repairability at the chip level will ever be an important issue.)

The laser-zapping method requires little extra chip area, but it can be done only when a laser can get access to the chip surface, ordinarily at the wafer-testing stage, but certainly not after packaging. When lasers are used, if a device is found to be bad after it is packaged, the device must be thrown out. And, of course, field repair is not possible.

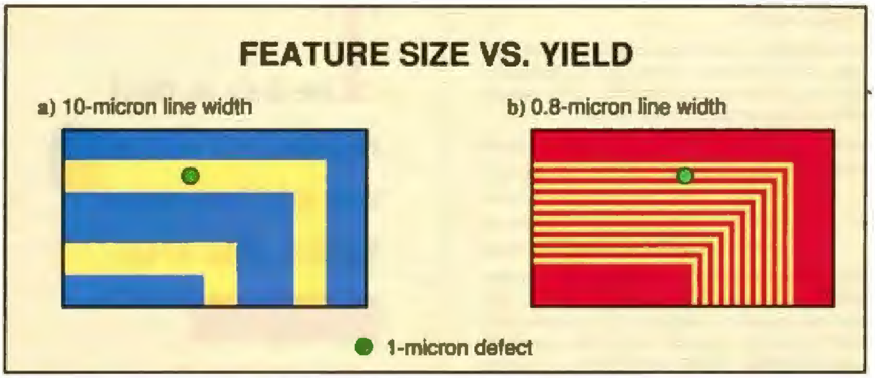
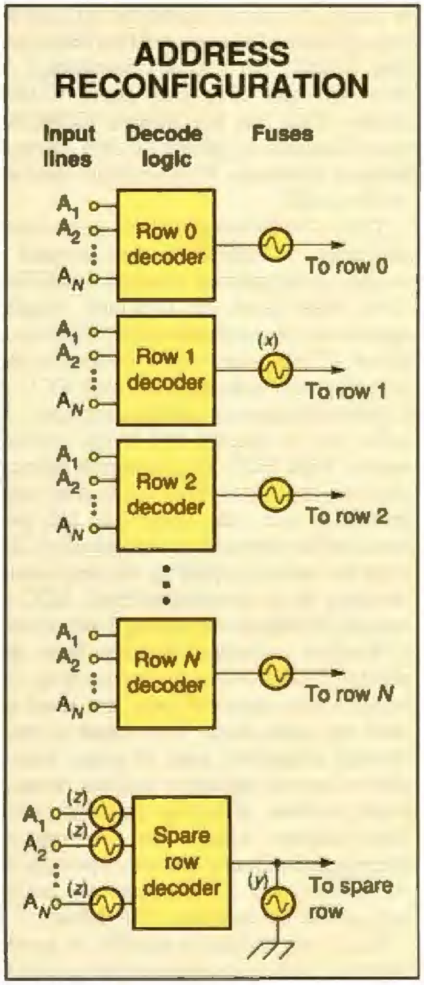


Figure 2: *Whether a wafer defect constitutes a flaw in a chip depends on the feature size. A chip with 10-micron metallization line width will be essentially unaffected by a 1-micron open-circuit flaw* (**a**), *whereas the same defect will kill a chip with denser circuitry* (**b**).

The method of breaking fusible links varies from manufacturer to manufacturer, because each has its own unique fabrication process with its own unique (and secret) set of failure modes and statistics. Just how much area can most profitably be dedicated to fault tolerance depends on several factors—most important, on the yield experienced without redundancy.



Redundancy is most dramatically effective when yields are low, as they tend to be with newly introduced devices. Adding about 5 percent of redundant circuitry to a new design can increase yields by an order of magnitude. But once a product matures and the bugs have been worked out of the fabrication process, the benefits of redundancy diminish considerably. For that reason, many manufacturers stop using fault tolerance once yields go above a certain point without it. They still build the chips with the redundant elements on them, but they don't take the trouble to use those elements. If the chips are bad, they are discarded. It makes economic sense to do that rather than take the time to identify where the trouble is and repair it.

EEPROMs Are Different

The use of nonvolatile latches is a rather specialized business, because it's only practical for chips that will be processed in such a way as to make nonvolatile memory possible. (*Nonvolatile memory* refers to memory that is not lost when the

Figure 3: *This arrangement of fuses for reconfiguring memory has the advantage of not affecting the memory's speed. Breaking one of the main array output fuses (x) will disable that line. Breaking one of the spare output fuses (y) will enable that line by removing a short circuit to ground. The fuses on the input of the spare line decoder (z) can be broken selectively to program the spare line so that it responds to the address of the line that was disabled.*

The key is that redundant circui[illegible] not add too much to the chip area.

power is turned off, such as disks.) For such devices, the instructions for reconfiguring the chip can be programmed into a set of latches, which perform the same function as the fusible links, but without the necessity of breaking a connection. An advantage offered by latches is that they can be reprogrammed at any time.

Actually, EEPROMs have a reliability problem that differs in a fundamental way from other memories. EEPROMs can be reprogrammed a limited number of times. A typical EEPROM cell can be reprogrammed about a million times before it fails, but a small percentage of them will fail after only about 10,000 cycles. That fact has limited EEPROM specifications to about 10,000 cycles, because a memory IC is no better than its weakest cell.

To deal with that problem, some manufacturers of EEPROMs have adopted a couple of redundancy schemes that differ from those used for ordinary volatile memories. One scheme is the implementation of error-correction codes on the chip to detect and correct errors. ECC is a generalization of parity checking: It adds bits to detect and even correct errors. With ECC, the more redundancy you add, the more effective the error correction is (i.e., the more bad bits per word can be corrected automatically). To keep the area occupied by the redundant circuitry at an acceptable level, ECC is usually limited to correcting 1-bit errors.

Another technique that has been applied to EEPROMs is *majority voting*, in which three identical cells are used to store the same data. The output is read through a majority gate, or voter, which allows for one defective cell out of each triple without affecting data integrity. This scheme violates the principle of keeping redundancy down to 5 percent or 10 percent, and it's therefore not really very useful for ordinary EEPROMs.

Majority voting is useful in semicustom circuits (also referred to as application-specific integrated circuits) based on standard cells. Those are circuits that are customized by combining and interconnecting standard subcircuits, or standard cells, out of a semiconductor manufacturer's library. The triple modular redundancy scheme makes sense for EEPROM standard cells, because such cells will typically contain only a few hundred or a few thousand bits and will represent only a small fraction of the total chip area even with TMR. Because EEPROM cells without TMR are likely to be the weakest part of any ASIC, the relatively small amount of extra space devoted to the EEPROM portion of the chip is likely to be space well spent.

What About Logic?

As the preceding discussion implies, fault tolerance at the chip level has been applied almost exclusively to memories. Because they are the densest of all chips, memories have the most need of fault tolerance, and their regularity makes the concept easy to apply.

But what about VLSI logic circuitry? Is fault tolerance being applied there? Yes, but not in standard catalog parts from makers of ICs. It is appearing in ASICs, mainly in the form of TMR. But no one knows how widespread the practice is, because only customers know whether they have designed an ASIC to implement fault tolerance. In the development of an ASIC, customers use CAD tools to lay out their circuits in accordance with the semiconductor manufacturer's guidelines. They then supply the semiconductor foundry with specifications, typically a spool of tape, detailing where to place the standard cells and how to interconnect them. But customers do not explain the function of the chip. (It's like supplying people with object code and withholding the source code: They have the program, but they don't know how it works.) To the semiconductor foundry, the ASIC is a sea of gates with an unknown function.

So, fault tolerance at the chip level is extensively used in memories to increase yields. It is used elsewhere in forms that can increase yields and improve operational reliability, but the extent of that usage is a mystery. In the 1990s, as production-memory densities successively break the 16-, 64-, and 256-megabit barriers, the only thing between you and multithousand-dollar memory chips is fault-tolerant technology. ■

Mike Riezenman is a freelance writer specializing in microelectronics. You can reach him on BIX c/o "editors."

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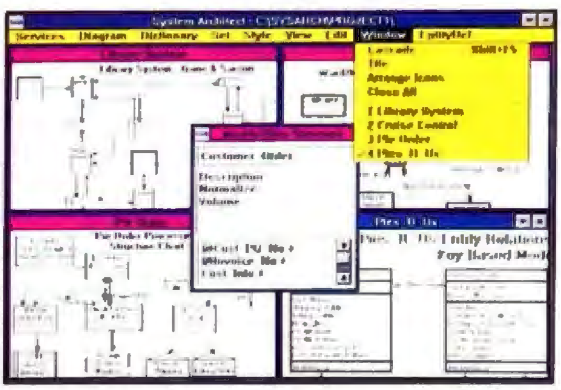

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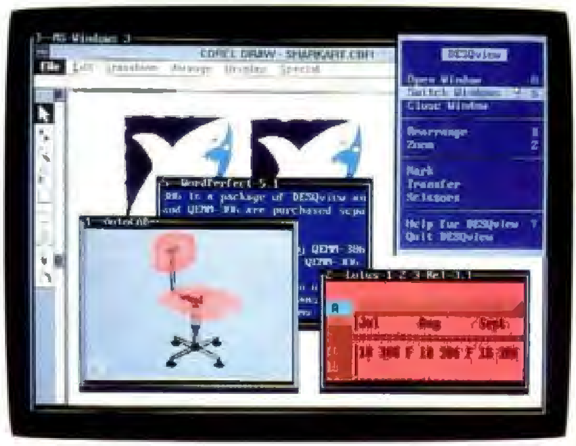

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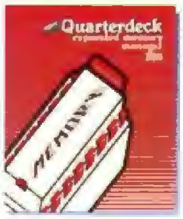

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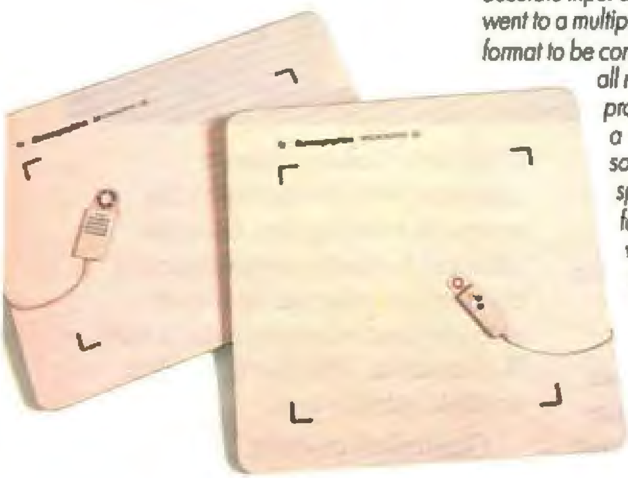

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DISK INSURANCE

Fault-tolerant mass-storage solutions, including disk mirroring, disk duplexing, and RAID, can insure against system failure.

STEVEN J. VAUGHAN-NICHOLS

Our ever-increasing appetite for faster, more powerful systems has driven demand for faster mass-storage devices, too. This demand is propelling fault-tolerant disk arrays into the limelight. Higher performance means lower tolerance of failure—on any system.

Fault-tolerant designs recognize system error as a normal part of the operating process and take steps to ensure that it doesn't lead to system failure. The same techniques used to prevent failures in spacecraft and nuclear reactors have been used in mainframes and minicomputers for years; now they are making an impact on microcomputers as well.

Fault-Tolerance ABCs

The idea behind fault-tolerant systems is simple: Because all systems must eventually fail, install redundant subsystems. Thus, when a component fails, the system can continue to provide uninterrupted service, because another component can take over. This sounds simple, but it isn't necessarily easy to put into practice.

When an error occurs, fault-tolerant systems initiate at least a four-step damage-control process. There may be as many as 10 steps, but these four will always be present in one form or another.

The first step is to detect the error in real time. The second is to identify it. In the third step, the system tries to assess the damage the error has caused. And in the fourth, the system tries to recover. These steps all occur in real time. If the system is successful in all four steps, you don't realize that anything has happened until you check the system log.

On hard disks, errors are usually the

BYTE ACTION SUMMARY

The demand for faster, more reliable mass-storage systems is continuing to grow, and with it the need for fault tolerance. Fault-tolerant designs recognize system error as a normal part of the operating process and therefore take steps to ensure that it doesn't lead to system failure. Responses to this need may be found in software (disk mirroring and disk duplexing) or in hardware (redundant arrays of inexpensive disks, or RAID).

result of disk-surface imperfections or noise in the read/write heads. These errors can be corrected through a variety of methods, including interleaved error-correction coding, alternative data-block maintenance, defect skipping, and rereading. Any disk drive controller can use these methods.

In disk arrays, successful fault tolerance starts well away from the disk drives and their controllers. The finest fault-tolerant disk array is only as good as its weakest link. For example, if a file server with a Dell Disk Array is attached directly to line power without an uninterruptible power supply, the DDA's protection is only as good as the local power company's electrical supply. Disk drive fault tolerance is part of a greater whole. Neglecting any element of a fault-tolerance scheme defeats its basic purpose.

Fault-tolerant systems are not a panacea. Bill Long, vice president of engineering for MicroNet Technology (Irvine, CA), a company that develops fault-tolerant disk arrays, notes that fault tolerance is "insurance against hardware failure, but it isn't any protection against software crashes or bombs. Software corruption is a real danger for Mac users, especially with old software that can't handle the newer Mac file systems." Software-induced disk failures, like the ones Long describes and those caused by viruses, cannot be stopped by fault-tolerant disk arrays.

Software Solutions

Possibly the best-known disk-protection product is System Fault Tolerant NetWare from Novell (Provo, UT). SFT includes two types of protection—disk mirroring and disk duplexing—that form the core of disk-array fault-tolerance plans.

In most disk mirroring, data is duplicated on two disks. In the event of a disk drive failure, the mirrored disk is still on-line, and there's minimal loss of service. In this kind of system, the twin disk is often called a *hot backup*.

The good news is that data redundancy provides excellent system reliability. The bad news is that the same redundancy reduces an array's storage capacity by half. Data storage is cheap and getting cheaper, but it's not so cheap that you want to give up half your disk space for safety.

Space isn't the only thing you give up

with disk mirroring. Disk I/O also suffers, because the operating system must perform twice as many read/write operations. This increase in transaction activity can be eased by attempting to balance reads from any pair of disk drives. Novell and 1776 (Los Angeles, CA), maker of Fault Freedom 2.4, a Unix disk-array management program, utilize this approach.

But disk mirroring doesn't absolutely require two disks. For instance, Fault Freedom 2.4 mirrors by partition rather than by disk. Depending on the operating system, this kind of approach can potentially reduce the time that disk mirroring requires.

Disk mirroring provides no protection against the failure of a disk drive controller. In single-controller systems, the mirrored disks are at the mercy of the controller: no controller, no disk access, mirrored or not.

Disk duplexing is employed to protect against disk drive controller failure. Not only is the disk duplicated, but the controller is duplicated as well. With duplexing, even a complete controller failure won't bring down a system. The problem? Duplication is expensive.

Disk mirroring and disk duplexing on the software level also have problems. Clock cycles and memory, which might be more profitably used elsewhere, must be devoted to maintaining fault tolerance. More important, software solutions aren't portable. A controller with mirroring embedded in the firmware, however, should work no matter what the operating system is.

It's a RAID

The hottest news in fault-tolerant disk technology is redundant arrays of inexpensive disks, or RAID. The odd thing is that RAID isn't really about fault tolerance at all. It's a way of classifying several different concepts designed to get the most from today's inexpensive mass-storage devices. RAID uses intelligent controllers and multiple disk drives to maximize data transfer rates.

RAID technologies are moving from the drawing board to disk arrays, because mechanical data-storage devices are lagging behind today's high-speed buses and CPUs. Caching helps disk drives keep up, but it comes with its own problems. Multiprocessor systems have problems with cache coherency (see "Catch As Cache Can," June BYTE). Systems that attempt real-time transaction processing (TP), with its demanding requirements for numerous random I/O requests, are also not well served by caches.

For these kinds of systems, personal computers, and file servers, RAID offers the promise of significant speed increases over conventional mass-storage alternatives (see "Strength (And Safety) in Numbers," December 1990 BYTE). Unfortunately, these speed increases come at the cost of reduced reliability. To balance this cost, RAID provides hooks for several fault-tolerance schemes.

RAID schemes have the potential to break through the mechanical performance limits of standard hard disk technology. By constructing logical disk drives from multiple disk drives, you can obtain significant performance benefits by organizing files so that they can be accessed independently and concurrently.

The difficulty with the logical disk drive approach is that it needs to be supported by system administration

intervention or direct operating-system support. Both of these require CPU cycles and thus degrade overall system performance. While this penalty can be managed, there is another way.

A more common fault-tolerance approach for RAID is data striping, which resurrects the old idea of contiguous data placement. However, instead of placing a file's blocks in a single area of a physical disk drive, data striping places them in logically contiguous blocks on several different physical disk drives. While a file's blocks may be far apart physically, the system sees the file as a readily accessed contiguous block on a single disk drive.

Disk striping isn't new, and it has an Achilles' heel. Making physical devices work together as a single unit increases the odds of device failure. For example, on a simple SCSI-device daisy chain, when a single disk drive goes bad, it's relatively simple to pull it out and bring the system up again. In a system using data striping without fault tolerance, when a single disk drive goes out, the entire disk array is finished. Worse yet, the chances of this happening are directly proportional to the number of disk drives in the array. In other words, if an array contains five disk drives with a mean time to failure of 20,000 hours, then the MTTF for the array goes down to 4000 hours.

For RAID systems to work, fault tolerance isn't an option; it's a necessity. Fortunately, fault tolerance is an integral part of RAID theory.

Level 0

RAID has six implementation levels. Level 0 supports naked disk striping without any fault tolerance. It assures maximum disk I/O performance, but with an increased danger of potential system failure.

If you need speed, Level 0 systems are what you need (e.g., MicroNet's Raven series SCSI-driven Macintosh disk arrays, capable of sustained 4.4-megabyte-per-second throughput).

Level 1

Level 1 was well known long before it was classified in RAID methodology, and it means disk mirroring, the most brute-force weapon in the fault-tolerance arsenal. In level 1, every disk runs parallel with a twin disk that contains a copy of every data block that is on the working disk.

There are two differences between generic disk mirroring and a level 1 system. The first is the level at which mirroring occurs. Some mirroring programs duplicate a disk only to the file level, whereas level 1 products mirror a disk to at least the sector level. The second difference is data striping, which enables level 1 systems to perform better than systems using only disk mirroring.

The problem with level 1 systems is that disk mirroring's reads and writes reduce the I/O performance benefits realized from disk striping in the first place. The exact amount of performance degradation depends on the system's design. It appears likely, however, that a level 1 array would be slower than an equivalent single, large, expensive disk.

Thus, level 1 systems are competitive with disk-mirroring systems, not with the run-of-the-mill mass-storage systems that dominate the personal computer field. Even so, if you can afford the space requirements, level 1 small-file read/

write performance is good enough to support even TP with the right implementation.

Level 2

Level 2 improves read/write performance by bit-interleaving data across the disk array with Hamming (error-correction) codes. Hamming codes are mixed in with every character's bits. While new to mass storage, this is an old idea borrowed from memory-array error-correction schemes.

The controller in level 2 uses several disks strictly for checking on errors at the bit level on an array's working disks. While it doesn't require as many disks as disk mirroring, level 2 does need at least four check disks for a typical small array of 10 disks.

A more serious concern about level 2 RAID is that a single data read or write must access every disk in the array. This requirement terribly depletes level 2's small-file data transfer rate, whether you measure it by disk or by array.

Supercomputers, with their largely sequential I/O requirements, can deal just fine with a pure level 2 system. But an unadorned level 2 array isn't suitable for personal computer or file-server use.

Level 3

Level 3 reduces the number of disks that are required for implementing RAID by using a single parity disk. Interleaving bits across the data disks reduces the storage space in each disk, but it allows you to devote only one disk drive to error checking.

Overall, level 3 leaves up to 85 percent of the array's space available for storage. Therefore, more real storage is available under level 3 than under either level 2 or level 1.

The parity calculation uses the XOR logical operator to combine the corresponding bits on each disk and writes the result on the parity disk:

```
parity check bit = drive1/bit1 XOR
   drive2/bit1 XOR drive3/bit1
```

When a disk fails, you can restore its data by comparing the remaining disks' parity with the recorded parity of the complete array and calculating the missing data. For example, if disk drive 2 fails, you could restore the data to a replacement with the following method.

```
drive2/bit1 = drive1/bit1 XOR
   parity/bit1 XOR drive3/bit1
```

This method creates an accurate bit-by-bit reproduction of the lost data. If the parity disk is lost, you are able to recreate it by recalculating the parity values of the data disks and storing them on the new disk.

Unfortunately, level 3 still has some of level 2's I/O problems. While reads are fast, writes are slowed down. The need to recalculate parity and write the result to the parity disk takes time. In addition, level 3 RAID systems can only perform one I/O transaction at a time.

Finally, since data is interleaved between disks at the bit level in level 3, parity calculations are processor-intensive. An intelligent controller is almost a must here. While you could implement level 3 in software on the main processor, the resulting increase in CPU activity would make it impractical.

Even with a high-powered controller, level 3 is too slow for real-time systems.

continued

However, it might be fast enough for personal computer–based uses.

Level 4

RAID level 4 systems interleave data by sector rather than by bit while continuing to use a single parity disk. This method improves read speeds by allowing multiple reads per array as long as the reads are not to a single disk. This parallelism, the ability to perform multiple data transfers at one time, greatly improves the array's productivity.

Write speeds are still restricted to a single write at any given time, because the system must access the parity disk for each one. Despite this restriction, level 4 systems reduce the overall data transfer time by using the array's entire bandwidth. This feature is particularly valuable for supercomputer applications, where huge data-block transfers are the norm.

Level 4 small data transfer I/O is also faster than level 3's, because the parity calculation is simpler. Level 3 calculates parity at the bit level in the appropriate sector of every disk in the array—a time-consuming process. Level 4 only uses the replaced data value, the new data, and the old parity value in its calculation.

```
new parity = (old data XOR new data)
         XOR old parity
```

In other words, level 4 systems only need to read and write to the appropriate data disk and the parity disk in any write operation. Thus, level 4 is faster than level 3, because level 3 consults every disk for the same write.

Level 5

In level 5, the parity disk disappears. The parity information used to check the error-correction codes is stored directly on the data disks. Level 5's advantage is that multiple simultaneous reads and writes are possible. In addition, level 5 leaves as much as 85 percent of the available disk space for data.

As you might imagine, level 5 is the most difficult type of RAID to implement. While offering high performance, it places great demands on the controller. Loading data, parity-check bytes, and error-correction codes all through the data disks means that the controller must be capable of fast reads and writes

Also, the controller should have powerful computing abilities to generate parity values on the fly. This is one reason companies have stuck to lower-level RAID systems in early releases. RAID level 3 and level 4 systems may not be as fast as level 5 systems, but they are as reliable and much easier to build.

Depending on their implementation, level 5 systems must also cope with other possible performance problems. For example, a level 4 system could use caching to optimize the parity disk. The right combination of high-speed intelligent cache and controller could make a level 4 system perform better than a level 5 system.

MASS Storage

Legacy Storage Systems (Markham, Ontario, Canada) is bringing a RAID level 5 disk array to market. Its software-enabled solution provides protection for three to eight disk drives.

The most novel aspect of Legacy's proposed system is the hot-fix device. An HFD is a hard disk drive designed for easy access for installation and removal in Legacy's Multi Additional SCSI Subsystem (MASS) disk array.

In MASS, a cabinet holds multiple SCSI disk drives, each plugged directly into a fixed backplane. MASS supports SCSI-1 and SCSI-2. It provides storage space of from 480 MB to over 8.5 gigabytes. The company asserts that MASS is compatible with DOS 3.0 and higher, OS/2, and Unix operating systems, as well as with Novell NetWare 2.2 and NetWare 3.x.

When there is a MASS disk failure, the system continues to operate normally and alerts the operator that a fault has occurred. The operator just pulls out the bad unit and plugs in a new one while the system continues processing. You don't have to prepare or format the replacement disk. The on-board ROM automatically formats the disk logically and brings it on-line as a background operation.

Intelligent Arrays

Compaq Computer (Houston, TX) has been a leader in bringing fault-tolerant systems to microcomputers. Its newest entry in the field, the Intelligent Array Expansion System (IAES), with its 32-bit intelligent drive array expansion controller for the Systempro, continues in this tradition.

IAES comes standard with 2.6 GB of SCSI storage, which can be expanded to 9.1 GB. A Systempro with 2 maximum-size IAESes would have nearly 20 GB of storage. You can add storage to IAES in the form of 1.3-GB hard disk drives. Novell NetWare 3.x and SCO Unix System V now support IAES. Compaq's plans include support for Banyan Vines, OS/2, and Microsoft LAN Manager.

Like the Systempro, IAES uses data striping to address the disk array as a single fast logical drive. Fault tolerance is a controller-supported option.

IAES supports three fault-tolerance features: disk mirroring, hot backups, and controller duplexing. Essentially, in RAID terminology, IAES with fault tolerance is a level 1 system with an additional layer of protection and speed provided by duplexing the controller.

Hot backups are optional. To activate this feature, you need more than disk mirroring. You must also configure an additional disk drive as an on-line spare to automatically take over for the failed disk drive.

Dell's Disk Drives

Dell Computer (Austin, TX) has also thrown its hat into the fault-tolerant disk-array ring. The DDA is built around a high-performance disk drive controller that comes with a 32-bit Intel 16-MHz 960KA RISC chip. Firmware for the controller comes in 512 kilobytes of 32-bit burst-mode ROM. The DDA also has 256 KB of static RAM (SRAM) for caching and, as an option, firmware that dynamically loads at boot time.

The array comes ready for up to five pairs of Intelligent Drive Electronics disk drives. It requires at least two 200-MB disk drives, but the system can hold up to 10, for a total of 2 GB of storage.

The DDA implements data striping at the sector level using 512-byte sectors. A single logical disk can hold as many sectors as five physical disks. The disk's rotations are synchronized so that concurrent data transfer can exploit the full data transfer bandwidth of all five drives. This means that disk drives capable of 1-MBps transfer rates can potentially

deliver a 5-MBps input or output.

Alternatively, the DDA can establish file or block concurrency. Up to seven seeks can occur at once—that's a SCSI-enforced limit.

No matter which way the DDA is set up, the firmware also increases its data transfer speed. DDA firmware looks for single-sector reads and writes and then checks to see if it can combine these operations into multisector activities.

For fault tolerance, Dell has elected to go with a level 4 approach. The DDA performs an XOR on corresponding sectors of the data disk to generate the sectors of the parity disk.

This level of protection won't work unless you have at least five disk drives installed. But once in place, the DDA can work indefinitely with a single disk drive failure in one logical volume. To replace the bad disk drive, however, you must bring the DDA off-line.

Dell's engineers are still improving DDA firmware. They are investigating level 1 and level 5 arrays. The DDA was designed to be flexible and extendable.

If the company produces alternative fault-tolerance programs, it has several installation possibilities. The first is to load new instructions into the DDA controller's SRAM. Another is to patch the firmware—there's plenty of room in the ROM for improvements. Either way, the DDA offers great upgrade potential.

Reliability—Then and Now

Historically, system reliability has been maintained by avoiding faults. If systems are built from the best components, they are less likely to fail. This process works for most designs, but not everyone is convinced that just putting off the day that a system dies is an acceptable solution.

Today, fault-tolerant mass storage can be an important element in system reliability. Where is fault-tolerant mass storage headed? While disk mirroring and duplexing will gain converts, I believe that some RAID implementations will become industry standards.

Other mass-storage alternatives, such as solid-state disks, promise a revolution in access speeds, but they are years away from becoming desktop computing staples. It seems far more likely that RAID will point the way for fault-tolerant mass storage in the near future. ■

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Steven J. Vaughan-Nichols is a freelance writer from Lanham, Maryland. You can reach him on BIX as "sjvn."

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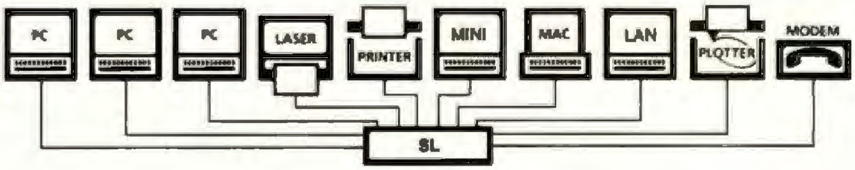

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PERPETUAL NETWORKS

If your business depends on your network, then you need fault-tolerant technology

DAVID FOWLER

Once seen as a novelty, a convenience, or an efficient way to share resources, LANs have become an integral part of the computing infrastructure of most businesses. Yet, unlike other services that are essential to corporate life—telephones, heat, electricity, coffee machines—networks are often viewed with suspicion, because they are seen as being less reliable than they should be. It is no longer enough for networks to work; they must work as needed. The solution is to make the network fault-tolerant.

Fault tolerance in a LAN is not an all-or-nothing proposition. The amount you build into a network depends on the importance of the operations the network supports. However, you can enhance the fault tolerance of any network without significant added expense by careful planning and installation. For example, you can deploy existing bridges in a way that adds redundancy between links. You can also avoid placing cables next to large electric motors.

Beyond such basics, you can take steps to ensure that your network will be available when you need it. These steps need not dramatically increase network costs. Indeed, if the cost of being without critical applications or data is considered, adding fault tolerance may dramatically *reduce* costs overall.

The three key aspects of network fault tolerance are design, equipment, and installation. If any one of these is overlooked, the network will not be fault tolerant (e.g., a network may have redundant power supplies, but they won't help much if a backhoe digs up a cable and takes out a link).

continued

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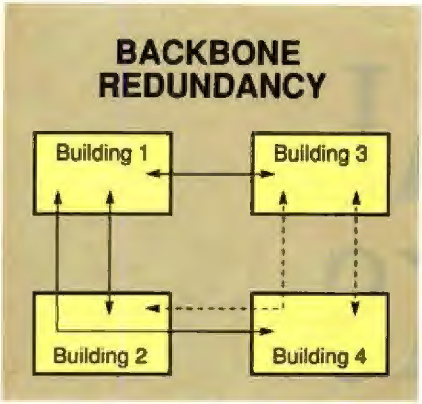

Figure 1: *Providing increased fault tolerance is often a matter of redeploying network assets or making modest investments in equipment. Here, the backbone between the four buildings can be made completely redundant by adding two links (dotted lines).*

Fault Tolerance by Design

Often, you can make a network more fault tolerant merely by reconfiguring the existing components. However, mixing networks, hubs, media, and protocols is as much an art as a science. Do you need a totally redundant network, or can you get away with only backing up some key links? Do you need fault tolerance on every desktop? Although the permutations may seem limitless, there are guidelines you can follow in designing a fault-tolerant network, with an eye to costs and your needs.

The network's fault-tolerance requirements depend on the importance, number, and distribution of its applications and workstations. These factors determine the network's size and topology.

BYTE ACTION SUMMARY

As LANs usurp minicomputers and mainframes as the corporate computing platform of choice, making them fault tolerant becomes a priority. You can achieve varying degrees of fault tolerance using a hub/backbone topology by providing redundant pathways for network traffic.

First, you have to define the scope of the network. The fault-tolerance plan for a workgroup network will be different from one for a facility network that spans an entire building or campus. Chances are, the larger the network, the more valuable it is going to be, and the greater the need for facilitywide fault tolerance.

Once you define the scope of the network, you need to identify the mission-critical applications. Sometimes it's not the number of computers that determines the need for fault tolerance but the importance of the applications. If all the traders in a securities company need access to market feeds, then the links to those market feeds must never fail. On the other hand, it may not be a severe problem for any workstation (or even workgroup) to go down if other workstations are available to access key links. It's the link to the mission-critical application that requires fault tolerance.

The obverse of the mission-critical application is the mission-critical user. The premise of enterprise computing is that key users, such as the company president, can monitor most of a company's critical activities from their desktops. From a key user's point of view, all applications may be mission-critical. So, regardless of the fault-tolerant strategy of the network as a whole, according to this person, the whole network may need to be fault tolerant.

Critical applications and key users notwithstanding, it is size and topology that drive most networking decisions. As networks grow, their topologies change to serve more people at a lower cost per user. Rather than have one large network serving everyone, most companies install many small networks dedicated to individual workgroups and then tie these networks together. An important benefit of this natural evolution is that many small networks are generally more reliable as a group than one large network. If a small network fails, the other networks keep working (unless they rely on the failed network as a common link or backbone).

A basic principle of fault tolerance is that topological changes yield the greatest reliability for the money since they require the smallest incremental investment per user. Because companies usually change their network topologies to accommodate growth, they may as well select topologies that are inherently more fault tolerant than others. Once those topologies are in place, a company can go to the next level of fault-tolerance considerations: deciding which links to make

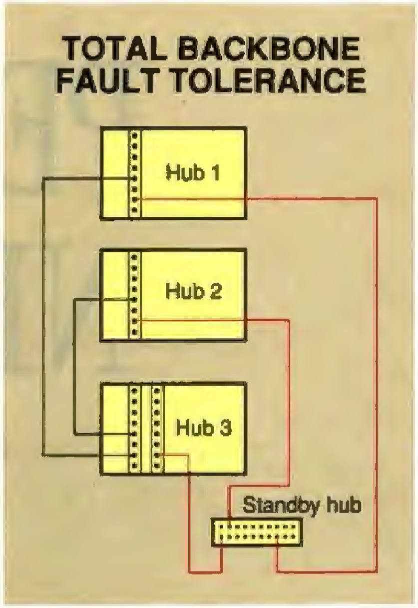

Figure 2: *Making a backbone truly fault tolerant requires redundant hubs as well as redundant cabling. The standby hub ensures that the link between any two primary hubs will not be lost if the third hub goes down.*

fault tolerant, usually by making them redundant. The greater the need for the link (because of either the number of workstations, the importance of the application, or the importance of the user), the greater the need for redundancy on that link.

Fault-Tolerant Topologies

A topology achieves fault tolerance to the extent that it decreases the number of *hops* (a connection between two networks) between redundant links and workstations. A network may be fault tolerant even though no workstations are attached to redundant links, provided that the end links are connected to redundant intermediate and backbone links. In the past, networks were interconnected on a large scale, and workgroups of 40 users were common. Today workgroups of eight users are typical. The difference is that those eight users can reach a much larger network that is more fault tolerant than the workgroup LAN.

While traditionally thought of as loops or buses, most workgroup LANs being built today are actually star configurations, with each workstation in the star tied directly to a single LAN module in an intelligent hub. Hubs (also called concentrators) provide a central facility to interconnect dozens of network links. You can connect LAN modules inside a hub to provide a path between the workgroups and tie the hubs together on a backbone to interconnect everyone. To enhance reliability, you make backbone links between hubs redundant and create multiple links to tie workgroups to a hub.

The prime candidate for redundancy is the network backbone, because it is the link that ties your subnetworks together. As the network grows larger, backbone fault tolerance contributes progressively less toward the total network costs, because larger networks have more links available for use as backup. Figure 1 shows how you can make a backbone connecting four buildings redundant by adding two links.

You can accomplish backbone redundancy at two levels: cable redundancy and hub redundancy. In the former, a second physical wire links each of the hubs. While this protects the network if one of the wires is broken, it doesn't help if one of the hubs fails. To ensure against hub failure, you can add a third, smaller backup hub, as shown in figure 2. If one of the three main hubs fails, the other two can still communicate.

Figure 3 shows how a hub/backbone-style topology is inherently fault tolerant and how it provides a natural platform for additional levels of fault tolerance. Some of the inherent fault tolerance results from using hubs to divide workstations into groups. Even without redundancy, the failure of a link to a workstation would not affect the ability of the workstations on the other hubs to communicate.

You achieve further fault tolerance to the extent that you isolate the workstations at each hub from each other. If all workstations share the same LAN module, as in hub 3 in figure 3, that card is a single point of failure for those workstations. If workstations are connected to different modules, as in hubs 1 and 2, a failure in one card won't affect the workstations connected to the other card. In hub 1, half the workstations are connected to one module, and half are connected to the other; a module failure will affect only half the workstations. In hub 2, each workstation is assigned its own module so that one link failure will affect only one workstation.

By using hubs with large numbers of slots for LAN modules, you can increase the number of workstations with direct access to the redundant backbone and decrease the number of workstations on nonredundant links. Some hubs even provide the ability to set up redundant links between the modules in the hub.

Having a network with a high level of fault tolerance may not help much if the link to a critical user or application goes down. In those situations, you may need a redundant link directly to critical applications or users (as shown in figure 4) to achieve *to-the-desk* fault tolerance. Here a transceiver splits the link coming from the application's host computer, and each link goes to a different module in the hub or to a different hub.

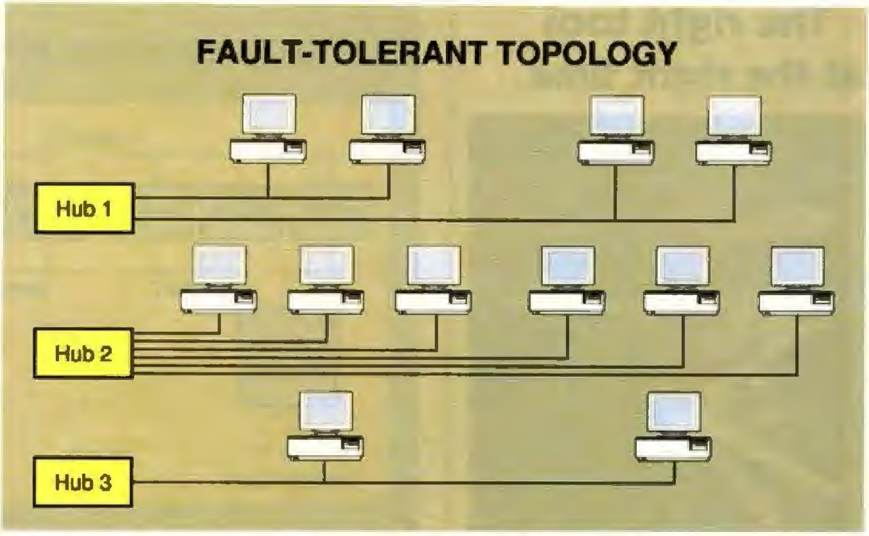

Figure 3: *A hub/backbone topology isolates parts of the network, ensuring that the failure of one module will not affect all the rest. The higher the ratio of modules to workstations, the greater the fault tolerance of the network as a whole.*

Selecting the Right Equipment

Network components are critical to fault tolerance for two reasons. First, if equipment did not fail, there would be no need for fault tolerance. Second, the most fault-tolerant network topologies cannot be built unless the equipment being used supports them.

Nearly every network component can contribute to the overall goal, either by being fault tolerant itself or by delivering features that make the network fault tolerant in a substantial way. The most vulnerable components in any computer system are those with moving parts and those that generate a significant amount of heat. Such components present the best opportunity to directly build in fault tolerance.

In major network components, such as hubs, power supplies are appropriate points for redundancy. You can enhance the fault tolerance of the power supply by monitoring its operation and reporting any irregularities to the management system. Such monitoring can include hot-spot detection and fan diagnostics, which

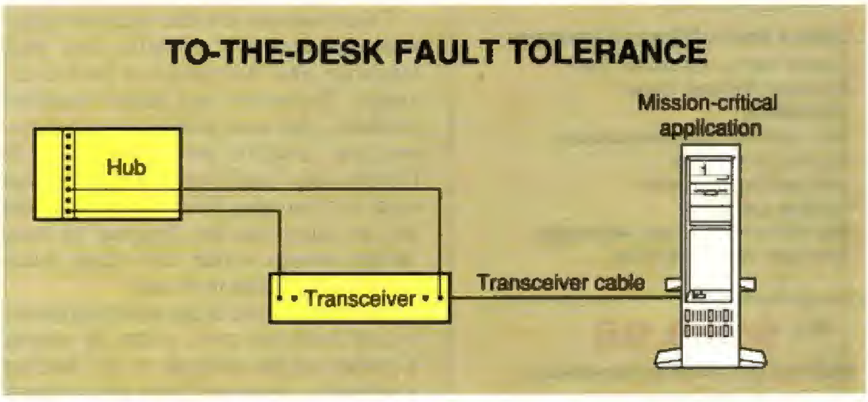

Figure 4: *Often it is the connection to a critical user or application that must be made fault tolerant. Here, the machine supporting a mission-critical application has two links to the hub. You could provide even greater fault tolerance by making the links to two different hubs.*

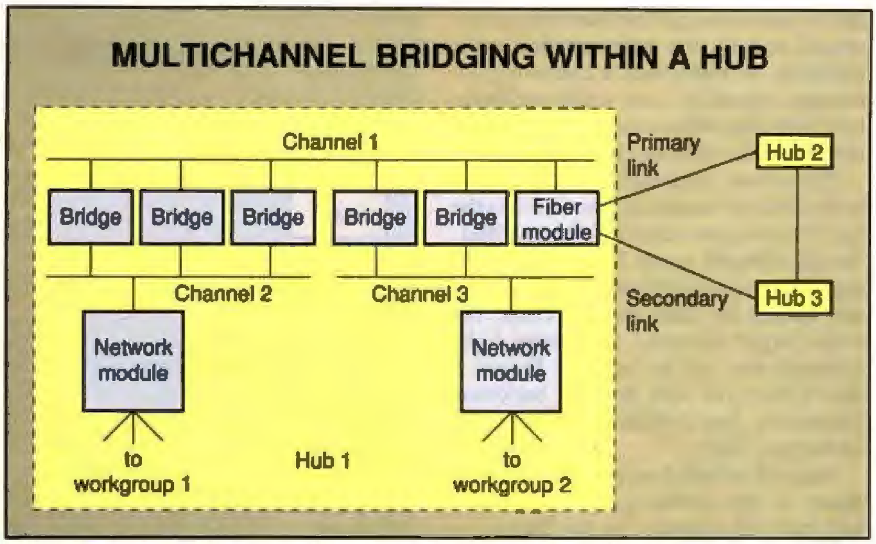

Figure 5: *The use of bridges within a multichannel hub provides fault tolerance and, using a spanning tree, congestion control. No module will be isolated if any bridge fails, and the failure of any channel will not affect the workstations on the other channel.*

anticipate trouble before it happens.

Redundancy is of limited value unless there is a clean *switchover* of control between units after a fault has occurred. The switchover should be accomplished, either automatically or under management control, without disrupting the network.

Other network components that contain redundancy features may include modules with built-in switch-over logic between ports so that redundant backbones can run off the same module. However, the ability to install redundant hardware takes the network only so far. Being able to automatically switch between the primary and backup units without service interruption makes a network component truly fault tolerant.

Other features can also increase a network component's reliability and fault tolerance. *Hot swapping* is a perfect example. To remove and install standard modules, you must power down the system (e.g., a hub) to prevent the change in the resistance load from causing a voltage spike and harming the circuitry. But slots and modules can be designed to keep voltage swings within safe limits when swapping modules in or out.

Another feature is the ability to isolate a card from any port, either by setting a switch on the module or by sending a software command from the network manager. This feature is helpful if you need to isolate the networks running off a hub from a backbone during testing.

At another level, module isolation can also be important. In Token Ring networks, a failed network module in a workgroup can bring down the LAN for the entire group. With an *auto-wrap* feature installed in the module for link failure and card failure, the card becomes a passive part of the link if the module fails or loses power. Thus, other network users can send data to each other through the module as if it were still functioning.

Another instance where module isolation comes into play is in spanning-tree software used in bridges that tie two networks together. This software enables bridges to passively adjust the network traffic load running over parallel links, based on transmission loads or link outages. If two networks are connected by three bridges and one of the three fails, the other two will take over without operator intervention.

At the most basic level of component fault tolerance are reliability enhancement features—those that reduce the likelihood of a problem occurring in the first place. One such feature is placing female plug connectors in the hub slot rather than in the modules. This way, if a pin is bent during installation, the module must be repaired or replaced, not the hub.

Components need not be completely fail-safe to deliver features that are critical to network fault tolerance. The key system that defines network topology is the hub, and not all hubs are created equally fault tolerant. Simply by having more slots, a hub can support more links to workgroups. More links mean greater redundancy, and more connections to the

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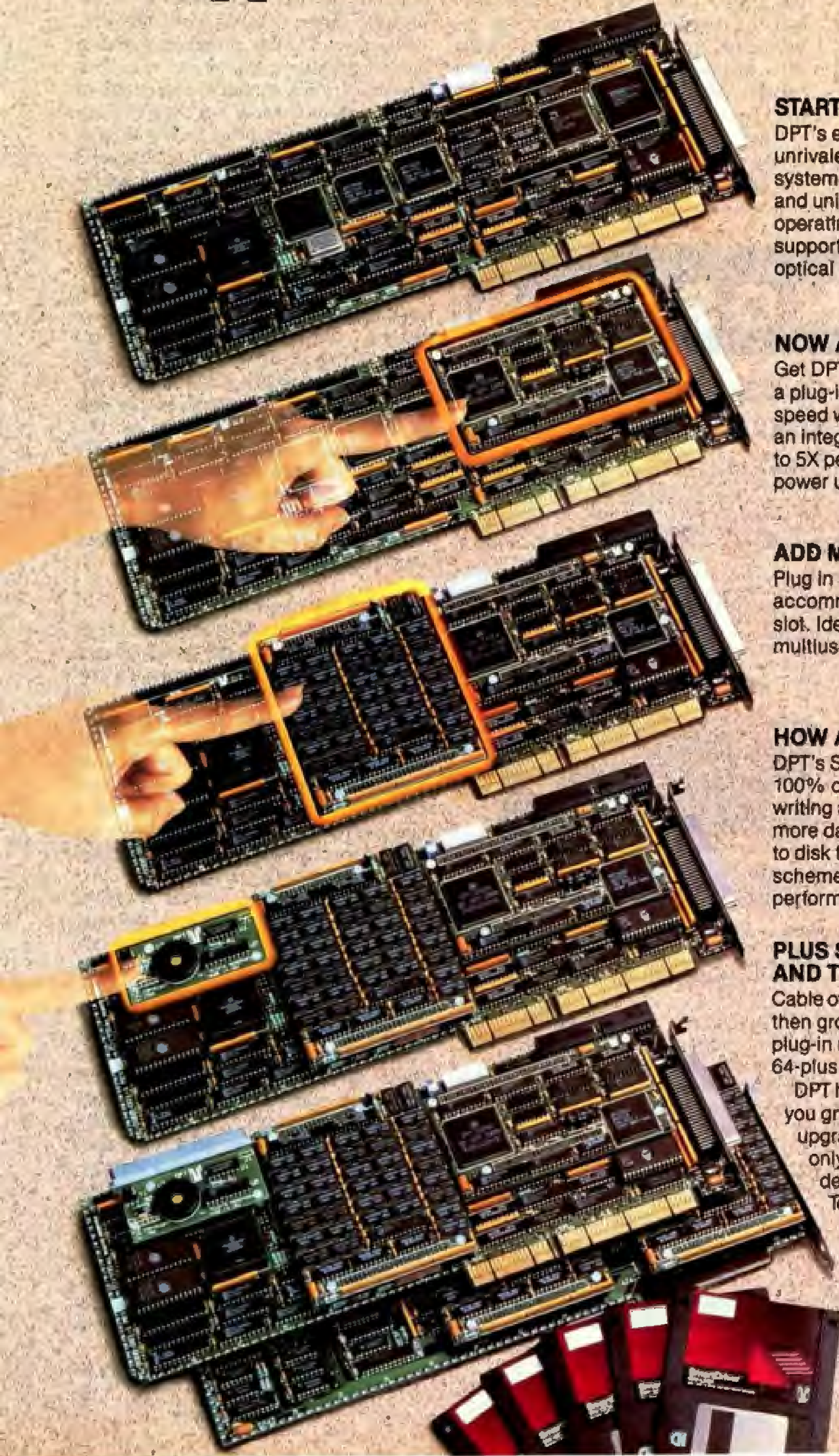

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Hubs and Connections

Much more critical than the number of slots is the way the hub creates connections between all the links coming into it, including the backbone, and how those connections are managed during network operation. The basic function of a hub is to offer a channel between several links. Networks attached to the hub can talk to each other and to the backbone over these channels. The greater the number of channels available in the hub, the greater the variety of possible network topologies, and the greater the opportunity for fault tolerance. If a hub has three channels, one might be used as a standby for the other two (a so-called $n+1$ redundancy strategy).

The number of channels inside the hub is important; so is the way those channels are implemented—whether they're hard-wired or use bridges. Bridging a link/channel or a backbone/channel connection lets you use a spanning tree to reroute around failed channels, links, or bridges. Figure 5 shows how a hub with three channels uses a spanning tree to achieve multilevel redundancy over four bridges. In this example, either one of the bridges on channel 2 or channel 3 can fail without interrupting traffic to anyone. A failure in channel 2 or channel 3 would not affect workstations on the remaining channels.

Another aspect of topology is the device used to assign channels to links. *Software topology switching* lets you define channels and reroute traffic using software commands. This is more productive (and inherently more reliable) than shutting off the hub and rewiring the chassis. A prerequisite for software topology switching is that the hub be able to define channel protocols on the fly. For example, implementing an $n+1$ strategy on three channels—one Token Ring, one Ethernet, and one standby—is impossible if the standby channel cannot be defined dynamically as either Token Ring or Ethernet.

Network Management Issues

Network management is another component that helps define the fault tolerance of a network. Can the management system initiate recovery after a fault, or does it simply flash a red light on a screen? What amount of detail is reported by the top level of the network management hierarchy? Can an operator running NetView identify a user on a specific port of a specific Ethernet module at a specific hub and change that person's access privileges?

Operators of fault-tolerant networks need to know what is going on throughout the network and to be able to take direct action from the management console. Industry-standard management protocols, such as the Simple Network Management Protocol, provide a way for devices from different vendors to send status information over a network and to receive operational instructions (see "Dueling Protocols," March BYTE). The protocol specifies both mandatory and undefined frames within a management data packet. Vendors are able to utilize these undefined frames to add significant functionality to the basic protocol. Typical SNMP status information consists of the number of devices, the number of errors, the incidence of device failure, and the number of packets transmitted.

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ties can provide information about the following:

- ports (e.g., the on/off status, the security privileges, and the identity of the users)
- modules (e.g., the networks they belong to)
- backup links (e.g., the links they back up)
- bridges (e.g., the networks they bridge and the configurations they support)
- networks (e.g., the active and backup configurations)

How management systems capture and use status information varies from vendor to vendor. To support fault tolerance, a system should make the information as clear as possible to the operator. Some systems support a point-and-click option that lets you select devices on a network map to display their status information; some support a window hierarchy that lets you click through successive levels of networks, subnetworks, and devices. For example, if you click on the picture of a hub, the system displays the front panel of the hub, complete with status indicators. You can then click on a module to display its ports, with a list of which users are connected to which ports.

A management system should allow for preprogrammed and proactive responses to network situations. A preprogrammed response is necessary when problems occur and the network manager is not available. It can take actions that can be planned in advance, such as switching to a backup channel when a primary channel fails. Proactive responses are measures an operator can take to make the network run better—before a problem occurs (e.g., fine-tuning spanning-tree parameters to reallocate traffic passing through selected bridges).

The highest level of management control is to be able not only to operate the existing network but also to create the network by bringing up new topologies, device configurations, and equipment from the management station. For example, in response to network commands, intelligent bridges and network modules within the hubs can establish or cancel links, define channel protocols and configurations, and allocate ports among workgroup subnetworks. The fault-tolerance benefits of such network-creating capabilities are that they allow the network manager to define solutions to problems that may not have been entirely foreseen when the network was installed.

Remember the Basics

Ironically, the primary issue surrounding fault tolerance is the one most likely to get you into trouble: installation. In fact, the most common source of network failures is the wiring. Wires are attached to the wrong connectors or installed over fluorescent lights. Other problems occur because planners forget to measure the equipment closet before ordering the equipment. Or they remember to measure the equipment closet but neglect to order enough cable extensions.

Many of these issues, no doubt, will fade as the presence of networks in the business environment becomes more familiar. As networks become more reliable and more commonplace, we may even start taking them for granted. ■

David Fowler is vice president of marketing at Chipcom Corp. (Southborough, MA), a manufacturer of fault-tolerant LAN products for facility networks. You can contact him on BIX c/o "editors."

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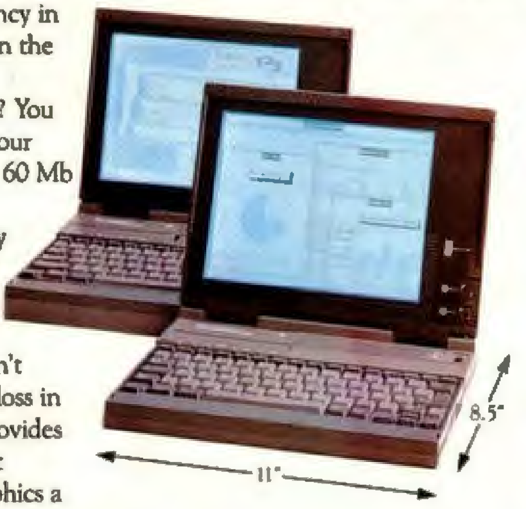

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CODE 8##

℞ FOR SAFER DATA

Your company's core data is vulnerable to many internal and external threats. These security, antivirus, and disk-mirroring products promise to increase your protection.

STANFORD DIEHL, STAN WSZOLA, BRADLEY KLIEWER, AND LARRY STEVENS

The first distress call Joan (not her real name) made to her computer dealer was just after electronic balls suddenly started bouncing across her PC screen. After more phone calls to the dealer and an unnecessary repair bill, Joan's Washington, D.C., law firm still found itself infected by a virus.

On the advice of her dealer, Joan had backed up her hard disk and paid the company $100 to reformat the drive. In the process, she unwittingly infected the backup software and each of the floppy disks to which she transferred data. Because the virus resided in the master boot record, the intruder was untouched by the reformatting. Joan then decided to phone the National Computer Security Association (NCSA).

"Fortunately, the virus proved to be benign and didn't damage any of her data before I destroyed [the virus]," says David Stang, NCSA director. "But how she got the virus is a good story. Her law firm had been given an infected application disk that had infected three law firms in all. Viruses normally travel on bootleg stuff. If I had to pick the most common cause of virus transmission, it would be that."

From private law firms to international corporations, organizations that rely on computers are vulnerable to downtime, data destruction, and monetary losses due to viruses, equipment breakdowns, or human intervention. In a recent survey, 53 percent of BYTE readers said their companies had suffered losses of critical data that cost an average of $14,000 per occurrence. In addition, 28 percent said their companies had been victims of a computer virus that damaged or destroyed program and data files.

The best protection for critical data is an organization-wide implementation of security products and techniques that control access to hardware, software, and

BYTE ACTION SUMMARY

- **WHAT SECURITY SOFTWARE DOES**
  It lets you selectively restrict access to files, directories, floppy disk drives, and even external ports. Many programs can also track program use through logging trails.

- **LIKES**
  Security programs can make sensitive files or the entire hard disk inaccessible to unauthorized users. The packages' resource controls can give you a clear idea of how your computers are being used.

- **DISLIKES**
  Software can't deter advanced hackers or protect your organization against willful destruction of data.

- **RECOMMENDATIONS**
  For basic security and resource control for PCs, our choice is PC/DACS. It's a flexible program that meets the needs of a wide range of users, and it stays out of your way as you work. For Macs, DiskLock (for single users) and Empower II (for multiple users) are our picks.

BYTE ACTION SUMMARY

- **WHAT AN ANTIVIRUS PROGRAM DOES**
  It detects, identifies, and removes computer viruses.

- **LIKES**
  The best programs provide a quick and inexpensive way to guard against most common but destructive viruses.

- **DISLIKES**
  The lack of frequent updates for new strains of computer viruses.

- **RECOMMENDATIONS**
  For PCs, we like the shareware Viruscan series from McAfee Associates. For the Mac, we like Disinfectant 2.4 by John Norstad.

SECURITY PROGRAM FEATURES

Table 1: *The best security programs restrict access to files, directories, floppy disk drives, and external ports, as well as providing extensive audit trails (● = yes; ○ = no; N/A = not applicable).*

	PC PROGRAMS							
	Access II	**OnGuard**	**PC/DACS**	**PC Watchman**	**Protec**	**Security Guardian**	**Watchdog**	**AME**
Price	$165	$295	$249 (single user)	$195 (one site)	$295	$250	$295	$279
RAM used (min./max.)	10/68 KB	20 KB	8/39 KB	12 KB	54 KB	5 KB	17/58 KB	164 KB
Number of users	16	24	Unlimited	Unlimited	52	Unlimited	Unlimited	Unlimited
Boot protection	●	●	●	●	●	●	●	●
Time-out								
Log-out	●	●	●	●	●	●	●	●
Screen save	●	○	●	●	●	●	●	○
Continue processing	●	○	●	●	○	●	●	●
Restrict								
Directories/folders	●	●	●	●	●	●	●	●
Files	●	●	●	○	○	●	Option	●
Serial ports	●	○	●	●	○	○	●	●
Printer access	●	○	●	●	○	○	●	●
Floppy disk drives (R/W)	●	●	●	●	○	●	●	●
Network drives	●	○	●	●	○	○	○	○
Encryption								
Proprietary	Option	Option	●	●	●	●	●	●
DES	Option	Option	●	●	●	●	●	●
Automatic	Option	○	●	○	●	●	●	●
Menuing interface	●	○	●	●	●	●	●	●
Transparent DOS interface	●	●	●	●	●	●	●	N/A
User log-in scripts	○	●	●	●	○	●	●	●
Hide restricted directories	●	○	●	○	○	●	●	●
Works with Windows 3.0	●	○	●	○	●	●	●	N/A
Audit trail								
Invalid log-in attempts	●	●	●	○	●	●	●	●
Program usage	●	●	●	●	●	●	●	●
Track time on system	●	●	●	●	●	●	●	●

[1] All four Kent Marsh products are designed to work together as a single security system. [2] Yes when used with QuickLock. [3] Yes when used with NightWatch.

sensitive files. In this Solutions Focus, we look at three components of a data-security strategy, each of which operates as a supplement to standard procedures such as regular data backups.

First, we examine software security systems for PCs and Macintoshes. These programs provide a front-line defense against unauthorized access by restricting individual users from specific files. Although software solutions offer only very basic security and thus are not for everyone, many companies will find such programs the most economical and easiest security systems to install.

Second, we evaluate antivirus products for PCs and Macs. Although the threat of viruses may outstrip actual incidences, prudent computing in the 1990s demands a simple but effective barrier to destructive programs.

Third, we look at disk-mirroring products for PCs, Macs, and Unix, presenting a subset of redundant-storage techniques that keep disk drive failures from bringing companies to a standstill.

SOFTWARE SECURITY PROGRAMS: Batten Down the Data Latches

The best DOS and Mac security products can help keep data from falling into the wrong hands or, more likely, from passing before curious eyes. In addition, security packages can provide you with outstanding control over your computer resources. Look for programs that let you selectively restrict access to files, directories, floppy disk drives, and even external ports. You should also be able to track program usage with extensive audit logging and prevent software piracy by making floppy disk drives read-only. In general, security software gives you a good idea of how your computer resources are being used.

The BYTE Lab looked at 12 software-only security programs for Macs and PCs (see table 1). Except for the most demanding security requirements, software products are sufficient. Many hardware products offer a higher level of control, but they are more expensive and are not a practical solution for large installations. Also, software-only solutions provided an acceptable level of security for many BYTE readers: Only 7.4 percent blamed sabotage as the cause for lost data, while only 5.7 percent were victims of data theft. Software packages can deliver a significant layer of protection even if they cannot deter advanced hackers.

Security programs can make the hard disk drive "inaccessible" on a boot from a floppy disk (this is called *boot protection*). Nevertheless, an experienced programmer is still able to see the disk drive as a physical device and look at raw disk sectors.

LANs amplify security problems. Because most LANs send packets around from station to station, a data thief need only install a program to intercept the

SECURITY PROGRAM FEATURES (CON'T.)

MAC PROGRAMS

DiskLock	Empower II	FileGuard	FolderBolt[1]	MacSafe II[1]	NightWatch[1]	QuickLock[1]
$189	$296	$249 (one user)	$129.95	$189.95	$149.95	$59.95
256 KB	1 MB	200 KB	384 KB	384 KB	384 KB	384 KB
1	Unlimited	Unlimited	Unlimited	Unlimited	255	N/A
●	●	●	N/A	N/A	●	N/A
○	●	●	N/A	N/A	○[2]	○[3]
●	●	●	N/A	N/A	○	●
●	●	○	N/A	N/A	○	●
●	●	●	●	N/A	N/A	N/A
●	●	●	●	●	N/A	N/A
○	○	○	○	N/A	N/A	N/A
○	○	○	○	N/A	N/A	N/A
○	●	●	○	N/A	N/A	N/A
○	○	○	○	N/A	N/A	N/A
●	●	●	●	●	○	N/A
●	●	●	○	●	○	N/A
Option	●	●	N/A	●	○	N/A
●	●	●	●	●	●	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
○	N/A	○	○	○	○	○
●	●	●	●	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
●	●	●	N/A	N/A	●	○
○	●	○	N/A	N/A	○	N/A
○	●	●	N/A	N/A	○	N/A

packets. *Data encryption* can solve this problem. Encryption is simply a means of encoding data so that it is unreadable. The recipient of the data must have a similar program to decrypt the data on the other end. Regard any unencrypted data sent over a LAN as fair game for thieves or the overly curious.

To deter the advanced intruder, we suggest a program of data encryption. If you intend to subvert even the most savvy intruders, we cannot recommend simple access control by software. In addition to a program of encryption, a hardware solution may help to meet your rigid security requirements. For most security needs, the products reviewed here will do the job.

In developing test scenarios for the security products, we did not expect any of these software solutions to be unbreakable. We sought only to ensure that they could not be bypassed by readily available tools. All these products successfully withstood the scrutiny of disk utilities such as the Norton Utilities and Mace Emergency Room. We also tried other obvious avenues, such as booting from a floppy disk and breaking out of the normal boot-up routine. In other words, we made sure that breaking the security capabilities of our test programs would not be a trivial matter.

We also wanted to see how well these products could protect your organization against willful destruction of data. We came to a clear conclusion: They can't. If intruders are bent solely on destruction, without concern for recovering any usable data, they can succeed with little difficulty. In this case, no software access-control product that we reviewed can protect you. For the most part, we just performed a low-level format to erase a protected drive.

PC Solutions

Rather than go through the tedious step-by-step, directory-by-directory approach to administration that is taken by some security programs, Access II from Kinetic Software allows you to select multiple directories in one easy operation. In fact, the interface takes this tack for most administrative chores. When you set up an application, you can immediately select every user who should have access to it. It works the same with access rights. You simply fill in a table, giving all your users access rights in one easy step. Access options include floppy disk drives, serial and printer ports, and the system timer.

Access II also supports a Directory Assistance feature. When you're setting up directories, pressing a function key will call up all the directories on the disk, allowing you to pick and choose with simple cursor movements. In this way, you select as many directories as you need at one time.

Setting up an organized menu structure is also a simple task, or you can grant direct access to the DOS command line. All directory and resource restrictions will remain in force.

Access II takes up a good chunk of RAM (68 kilobytes), but you can select an option to decrease this to 10 KB. Kinetic also offers a hardware complement to Access II. If you anticipate heavy administration needs, Access II can make that job much easier.

We ran into serious problems when working with OnGuard from United Software Security. The company insisted that some of the problems could not be occurring on the system. However, after many reinstallations and reconfigurations, we could not resolve the problems we encountered.

For instance, when we enabled boot protection, the floppy disk drive didn't work correctly. In fact, simply running a DIR command made the system hang. The program did not work properly with Windows. It successfully kept us out of protected directories, but then the entire system locked up.

Some security loopholes also caused us concern. We were able to TYPE files that had no rights assigned to them, and we could even change protected files. For example, we could not delete or edit the AUTOEXEC.BAT file when it was protected. However, we could copy the file into an unprotected directory, edit the file there, and then copy it back to the root. The program does have some nice touches, but its operation is too flaky. We cannot recommend it.

The PC/DACS system from Pyramid Development offers a decided enterprise-wide solution. It's clear from the organization of the program that setup and administration are geared toward large installations and multiple users.

continued

Screen 1: *PC/DACS follows a clear and consistent user interface. When adding new users, you can establish resource privileges and set up directory rights in one smooth operation.*

One feature, called "deploy," lets you set up a system configuration and then install preconfigured users across a LAN. The software, by its very structure, promotes a complete program of security consciousness.

Setting up a configuration is easy (see screen 1). The program gives you a complete listing of directories (including subdirectories). You can select a directory with simple cursor key movements. Once you have highlighted the chosen directory, you can designate the entire directory for protection or select individual files. Next, you're given a selection of access rights to enable as required. The whole process proceeds simply and logically.

PC/DACS also supports a range of wild cards for more flexibility. For example, C:*.* matches only files in the root directory, while C:\= includes all directories under the root. The same scheme will work with extensions (C:*.COM protects only COM files in the root, while C:\=.COM protects all COM files on the C drive).

Pyramid also provides a network solution with NET/DACS. A special windows module supports Windows 3.0 operation. From Windows or from DOS, users will simply not see any restricted files or directories. You can also specify encryption areas for automatic encryption of files.

PC Watchman from Harcom Security Systems works differently from many of the other programs reviewed here. Instead of specifically protecting files and directories, PC Watchman grants access to selected tasks. Even after you grasp this philosophy, the program is difficult to use.

Each user must be assigned to a group, and each group has a set of tasks assigned to it. This causes some annoying limitations. Assume you have a group called "accounting" with a set of users assigned to it. Suppose that you have one user who needs all the tasks assigned to "accounting" plus an extra task that you don't want the other accounting members to have. PC Watchman can do this, but the procedure is complicated.

Because you must assign a user account to one (and only one) group, the only way to give a single user access to multiple groups is to set up a new account each time. If a user needs access to a variety of groups, that user must remember passwords for every group. We did not object to the task philosophy so much, but we disliked PC Watchman's implementation of it.

Protec from Sophco lets you control directory access, but its main strength is controlling specific programs. You can set up applications and, unlike with PC Watchman, easily assign the applications to users. By configuring data directories separately from the program directory, you can force applications to store data files in custom directories.

You enable many of Protec's features through independent programs. This makes the program somewhat difficult to use. For example, to set up applications for all users to execute, you must run the NOEXEC program and set up an INCLUDE list. You would then administer a command line such as `-fc:\lotus\123.com -r -d i@c:\user\,menu\include.txt`. Protec would be more inviting if this kind of operation were included in the standard interface. There is a nice file management utility for encrypting files.

Some serious limitations prevent us from recommending the software. With Protec running, we were unable to load all the necessary files for network access. Also, the program offers no access protection for floppy disk drives, external ports, or individual files. Other products that we reviewed provide more features and a smoother interface.

Security Guardian from Command Software Systems is a powerful and flexible program for data security and control. Unfortunately, the very features that make it so powerful and flexible also make it difficult to learn. For each user, you can start off with all directories locked and then selectively enable them, or you can start with all the files enabled and then selectively lock individual ones. You can set up a directory table for the system or for individual users and switch back and forth among the configurations. Perhaps you can see the problem: Because there are so many different ways to set up the system, the process can quickly get confusing.

Menus are easy to establish, and by restricting access to DOS, you can make these menus the primary interface. This enhances control and ease of use. Other system controls prevent a secondary program from accessing DOS, disable Control-Break and Control-C, prevent writing to the hard disk, and allow complete read/write control over the floppy disk drive. You cannot use Security Guardian to restrict the use of printer or communications ports.

Security Guardian can also keep extensive logs. Besides the usual tracking of resource use, the program will record inactive time to show how long the system remains unused. This comes in handy when you want to determine PC utilization. Security Guardian consumes a scant 5 KB of RAM and is a solid product with outstanding flexibility.

Watchdog from Fischer International Systems has a strong, well-deserved reputation for security. If your principal concern is safeguarding sensitive data, Watchdog is a top choice. In addition to an impressive software approach, Watchdog supports a hardware option for those workstations requiring stronger access control.

However, we weren't entirely happy with the Watchdog interface. You must first add directories to the system table. Once a directory is added, you then give users specific rights to it. Adding all these directories is tedious, especially since you can't call up a listing of current directories on your hard disk.

Watchdog grants direct access to the DOS command prompt, and, if you prefer menus, it has an excellent menu builder. With Watchdog's global libraries, you can give all users access to files in a directory while still protecting those files from unauthorized changes. Transparent data encryption is another big win on the security front.

Watchdog offers impressive resource control, including restrictions on printer and communications ports. Establishing these restrictions is a breeze. Watchdog worked well with Windows 3.0.

Mac Solutions

AME (Access Managed Environment) from Casady & Greene is the most complete of the Mac software packages in this review. Besides protecting your hard disk files, it takes control of serial ports and printers as well as the floppy disk drive. Another nice feature is AME's "Trusted Software" list. The administrator can specify that certain applications on the hard disk are safe for the general user base to access. Running any other application from either the hard disk or a floppy disk will bring about a security violation. Violations cause the activation of an alert box and/or an audio alert. If you activate all the port and file security, you can sleep better at night, knowing your data is secure.

Even with all these features, we simply can't recommend AME. All security software has to interface with the Mac operating system at a fairly low level. Most of the software packages manage to tell you about security violations in a polite, controlled manner. AME, on the other hand, brings up a dialog box and then returns an error to the operating system. The Mac dutifully displays a message along the lines of "Unable to... (source disk was modified during copy)" and then aborts the operation. A simple click in the wrong spot shouldn't trigger such horrific alerts.

Even worse is the sequence that occurs if you boot an AME-protected Mac from a floppy disk. The Mac reports that your hard disk has to be formatted. If you tell it to proceed, the dialog boxes suggest that it's actually formatting the drive. Again, other packages handle errors much better. AME may be excellent at protecting data, but the error displays are enough to scare even the most knowledgeable Mac user.

DiskLock 2.0 from Fifth Generation Systems (the Suitcase II people) is a simple utility that prevents anyone else from booting your Mac or accessing your files. When you boot the machine, a dialog box asks for the password. If you don't know it, the machine won't boot. You can also opt to use the FolderLock feature to encrypt entire folders. Even if you choose to let someone else use your Mac, you can still restrict access to specific folders. The FileProtect feature uses your choice of three security levels: FastLock (simple but speedy), QuickCrypt (somewhat slower), and DES (slow but secure).

Screen 2: *With Empower II for the Macintosh, administrators assign specific access rights to individuals and groups for boot, file, and folder protection.*

If you leave the machine idle for a prescribed amount of time, a screen saver kicks in and locks the machine. When you return, you simply reenter your password to start working again. You can opt to have DiskLock automatically relock any FolderLocked folders before it blanks the screen.

DiskLock is simple yet effective protection for a Mac that is primarily used by one person. It should prove to be more than enough for many people's security needs.

Empower II from Magna gives you boot protection, file and folder protection (à la AppleShare; see FileGuard, below), and controlled access to the floppy disk drives. It won't do anything to protect your serial ports or printers.

The system administrator creates the users and groups and sets up specific access rights (see screen 2). Each folder receives Owner, Group, and Everyone rights, just as with FileGuard. If you walk away from the Mac, the screen saver blanks the screen and waits for a password. Data encryption is optional, and so is a complete audit trail of file access, user log-ins, and security violations.

Empower II's operation is transparent, and security violations are handled without making you feel like a criminal. Empower II is one of those rare products that do exactly what they advertise without any surprises.

FileGuard from ASD Software uses an interface familiar to anyone who's ever used an AppleShare file server. Each folder allows different access levels to the folder's owner, a specific group, or everyone. For each of the three user categories, you specify whether a user can make changes (including deleting files), see the files (read and execute rights), or simply see any contained folders. The FileGuard administrator creates all the users, assigns them to groups, and grants access to public folders and applications. If you like, FileGuard will encrypt selected documents to make them harder for other users to access. If you choose the automatic encryption feature, FileGuard will bring up a dialog box and ask for a password whenever you save a file. After you leave your application, any "automatic" files will be reencrypted by the program.

One especially nifty feature is the automatic time-out on applications. The administrator can decide that a particular application can be accessed only a set number of times or run for a preset period of time. After that many executions or that time period, you are alerted with a dialog box and the application is terminated.

The software protects files only on your hard disk—if you want to prevent people from inserting floppy disks in your machine or accessing your serial ports from communications software, you will have to look elsewhere. Another potential security leak is that you can't restrict the format of the passwords (they are always greater than three characters, and any combination of letters is permitted).

Kent Marsh has a modular solution to Mac system security. To keep other people from starting up your Mac, you use NightWatch. This product simply modifies your hard disk drive so that if you boot from a floppy disk, the hard disk won't mount. When you are ready to shut the machine off, a shutdown utility relocks the hard disk drive to secure it. To reboot the machine, you need a User Disk, which contains a database of users and passwords. You boot from this special floppy disk and identify yourself by name. If you enter a correct password, the hard disk drive is unprotected and your Mac reboots. This approach is kludgy, but it works.

Another module is QuickLock—a security screen saver. If you leave the machine unattended, the screen goes blank. You have to enter a password to awaken it. If you don't know the password, the machine will shut down. If you're also running NightWatch, QuickLock will automatically execute NightWatch's shutdown facility.

Unfortunately, this procedure has a serious bug. Before NightWatch will reprotect your disk, it brings up a screen and gives you the opportunity to cancel. Let's say you don't know the machine's password. The machine will try to shut down and activate the NightWatch screen. You simply click on Cancel, and you're back at the Finder. Actually, it's worse than that. During testing, this sequence repeatedly destroyed the System and Finder, causing the screen fonts to disappear.

The last two pieces of Kent Marsh's security solution are MacSafe II and FolderBolt. MacSafe is an application that lets you create a "safe" in which to store specially encrypted files. Anyone can see the safe, but no one except you can use or delete it. FolderBolt is a file access-control package similar to DiskLock's FolderLock. The modular approach is a good idea, but the pieces simply don't work well together. FolderBolt is worth a look, as is QuickLock. We didn't like NightWatch's key disk implementation, and it was dangerous to have NightWatch and QuickLock working together.

Building Your Data Fortress

No piece of software alone will solve your microcomputer security needs. But for establishing a complete program of resource control for your corporation's data, you won't find a better platform than PC/DACS. No other system provides such a complete solution for program control. PC/DACS emphasizes an overall approach for numerous installations, as reflected in the "deploy" feature as well as in the design and philosophy of the software as a whole.

PC/DACS is flexible enough to meet the needs of a wide range of users. It also does an excellent job of staying out of your way as you work. Novice users will see only those resources pertaining to them. More advanced users can command impressive levels of control. And the whole security mechanism is tied into a consistent backbone of user management, resource control, and audit logging. With PC/DACS as a guide, you'll find it easier to build a total security solution.

Depending on how you use your Macintosh, either DiskLock or Empower II should do the trick. Neither one has the companywide support of PC/DACS, but both do the job. DiskLock is our choice for a single-user machine, and we'd pick Empower II for any machine with multiple users who aren't concerned about I/O access control. If you need better control than Empower II provides, your only choice is AME; if you go with this program, be prepared for lots of panicky phone calls from your users.

continued

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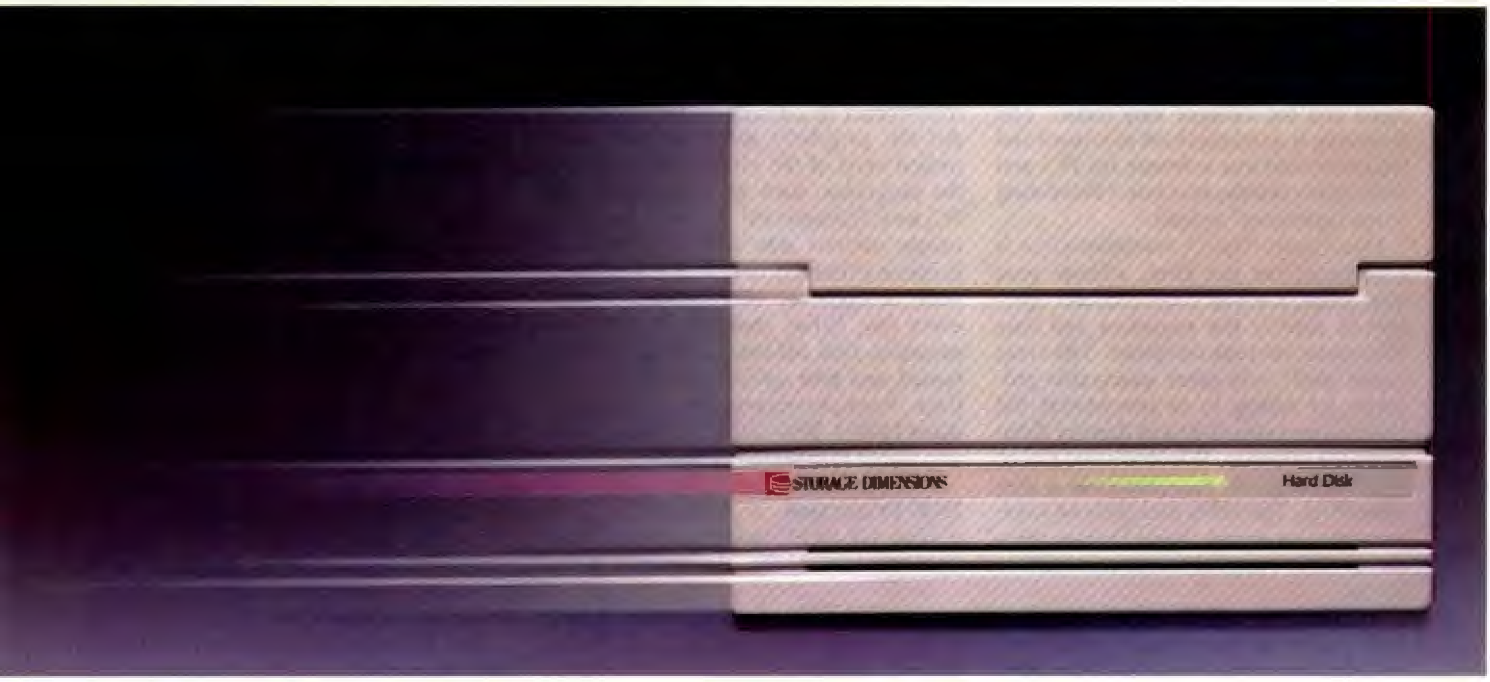

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VIRUS PROTECTION: Strong Medicine for a Fast Cure

The surge in computer communications has spawned a great deal of confusion and fear about computer viruses. BBSes are awash with talk—some based on fact, some on myth—of viruses and the damage they cause. The following is a rational look at viruses and the latest antivirus software for PCs and Macs (also see the text box "Preventing Virus Infections" below).

First things first: A computer virus is a program that can alter, without your knowledge, the way your computer operates or modify the programs and data files stored on your computer. The virus copies itself onto other executable programs by adding to or overwriting the existing program code and thereby damaging the program. Whenever you run an infected program, the virus code is executed first. The virus then goes on to infect other programs. Some viruses operate as TSR programs and can hide in RAM.

Antivirus programs detect, identify, and remove the intruders. Typical antivirus programs will scan RAM and hard and floppy disks for infections. These programs can identify the virus infecting the system and tell whether the virus resides in memory, the boot sector, the partition table, or a file. You can then delete the infected file or disk sector, or you can repair the file by deleting only the virus program code.

An antivirus program searches the system for program-code sequences or patterns that are unique to each computer virus and then reports their presence. This method works for viruses that the antivirus program recognizes. Many programs let you enter the identifying characteristics of a new virus into a data file to help you cope with newer strains.

Many of the antivirus packages provide for system protection and immunization. A TSR antivirus program will constantly monitor your system looking for virus activity. Some antivirus programs will log all the program files on your hard disk and calculate a cyclic redundancy check (CRC) on each file. The original checksum of the file is then compared to the current checksum for discrepancies and possible infections.

In this roundup we chose 10 PC and four Mac products (see table 2). We limited our tests to software solutions because of the effectiveness, ease of installation, and economy of these programs compared to hardware solutions.

Isolation Test

To test the packages, we set up a PC and a Mac in an isolation area in the BYTE Lab. On the PC side, we ran tests using eight of the most pervasive and destructive viruses in circulation (see table 2). All the programs identified and controlled most of the viruses. A couple of the programs, such as Viruscan on the PC and Disinfectant 2.4 on the Mac, caught all our test viruses. This is a function primarily of how often the software is updated. New viruses appear every day. When choosing an antivirus program, find out how often updates are issued and how easily you can receive them. For most people, downloading updates from a BBS is the quickest way to stay ahead of evolving viruses.

DOS Protection

Among the 10 PC-based antivirus packages we tested, Dr. Solomon's Anti-Virus Toolkit from Ontrack Computer Systems, Virex PC from Microcom, VirusCure from International Microcomputer Software, Viruscan from McAfee Associates, and Vi-Spy from RG Software Systems identified all our test viruses. These five also represent the high and low in prices, ranging from $279.95 for Dr. Solomon to $35 for all the modules in the shareware version of Viruscan.

Dr. Solomon's Anti-Virus Toolkit's menu-based front end integrates several programs to scan a disk for a virus, check for viruses on system boot-up, prevent a particular virus from infecting your disk, remove boot sector and partition sector viruses, and view a hard or floppy disk sector or view a file. The documentation details virus types and ways to remove them.

Virex PC is a two-part package. The first program scans RAM and your floppy disk looking for a virus. The scanner can also remove a virus and restore a file. The other half is a TSR monitor program. You register all the programs you normally use with this TSR to grant them access to your hard disk.

The Virex program also calculates a CRC checksum to create a signature for the registered programs. These checksums are stored in a data file. The Virex TSR will alert you if an attempt is made to format your hard disk, if any attempt is made to write to the hard disk, if any program attempts to terminate and stay resident, if an unregistered program is run, or if a registered program's checksum is modified, and it will alert you if any user-specified operations are attempted.

You can use VirusCure as a standalone virus scanner, or you can install it to run automatically on boot-up. The installation program initially scans your hard or floppy disks for viruses. You have the option to remove a virus from an infected file and repair the file. VirusCure also creates CRC checksum signature files for all the files in your system. The program alerts you if any changes are made to the boot sector, partition table, DOS, or other critical system files. You can repair the boot sector and partition table using a reconstruct option. VirusCure also features two TSRs that constantly monitor your system and check for viruses every time you boot up. VirusCure is based on the highly regarded McAfee software.

The Viruscan series of shareware programs from McAfee Associates includes a virus disinfection program, a scanning program, and an automatic log and file

Preventing Virus Infections

There are no known ways to make a general computing system completely immune from virus attacks, but the following practices can help you decrease the risks.

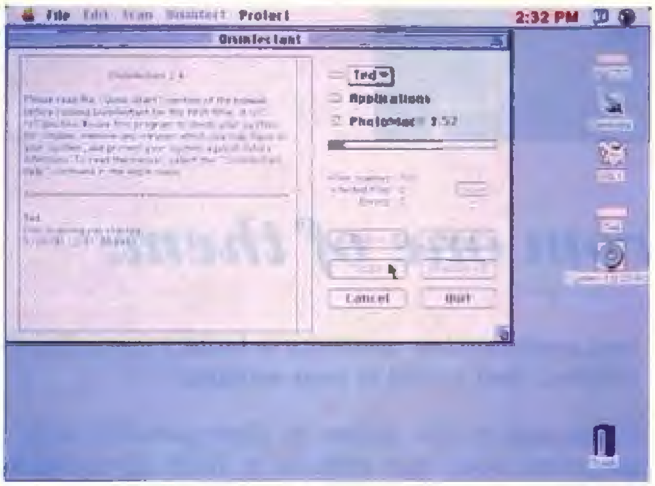
- Avoid using programs whose origin is unknown.
- Don't allow others to run their programs on your computer.
- Use only shrink-wrapped software packages and check them for viruses.
- Make regular antivirus checks of all your files.
- Back up your hard disk and store the backup in a safe place.
- Make backup copies of all your program and data files so that you can easily replace infected files.
- Beware of all programs downloaded from BBSes, or use only BBSes where all software is checked before it is posted (e.g., BIX).

ANTIVIRUS ARSENALS

Table 2: *The test results show that some antivirus programs couldn't recognize the Jocker virus (● = yes; ○ = no).*

PC PROGRAMS	Price	Updates	Viruses detected and removed							
			1701	1704	Izrael	Musician	Vienna	W13_A	W13_B	Jocker
Central Point Anti-Virus	$129	BBS/quarterly	●	●	●	●	●	●	●	○
Certus 2.1	$189	BBS	●	●	●	●	●	●	●	○
Data Physician	$49	BBS	●	●	●	●	●	●	●	○
Dr. Solomon's Anti-Virus Toolkit	$279.95	Quarterly	●	●	●	●	●	●	●	●
Norton Anti-Virus 1.0	$129.95	BBS	●	●	●	●	●	●	●	○
Virex PC	$129.95	Quarterly	●	●	●	●	●	●	●	●
VirusCure	$99.95	BBS	●	●	●	●	●	●	●	●
ViruSafe	$80	$60/quarterly	●	●	●	●	●	●	●	○
Vi-Spy	$250	Quarterly	●	●	●	●	●	●	●	●
Viruscan	$15-$35	BBS	●	●	●	●	●	●	●	●

MAC PROGRAMS	Price	Updates	Modm	WDEF	nVIR
Disinfectant 2.4	Free	BBS	●	●	●
Symantec AntiVirus for the Macintosh	$99.95	BBS	●	●	●
Virex	$99.95	$75/year	●	●	●
VirusDetective/ VirusBlockade	Shareware	BBS	●	●	○



Screen 3: *Disinfectant 2.4 by John Norstad uses standard Mac pull-down menus and buttons to select the scanning and disinfection functions.*

check. The shareware programs are frequently updated to incorporate information about new viruses. You also can try the programs before you buy them.

Vi-Spy is designed to run from a floppy disk or be installed on your hard disk. The floppy disk version lets you check several computers. The hard disk version uses the Disk Watcher TSR to scan the RAM and your hard disk and monitor the system's activity. If a virus is detected, Vi-Spy will display the filename, size, date and time, and the name of the virus. Vi-Spy then asks if you want the infected file wiped out. Vi-Spy scans the boot sector and partition tables and can repair those areas on the hard disk.

Mac Protection

Disinfectant 2.4 from John Norstad is a freeware program, widely available on many BBSes, that is frequently updated to incorporate information about new viruses. You can run Disinfectant from a floppy disk or install it on your hard disk. Clicking on the No Viruses icon pops up a menu from which you select a scan of your hard and floppy disks, remove viruses, and install a protection INIT to prevent a reinfection (see screen 3). On-line documentation is included. (VirusDetective and VirusBlockade from Jeffrey S. Shulman are also freeware products available on BBSes.)

Symantec AntiVirus for the Macintosh consists of two components: SAM Intercept and SAM Virus Clinic. SAM Intercept consists of an INIT and a cdev. The INIT alerts you to any activity on the system that might be a virus attempting to infect your files. SAM Virus Clinic is a stand-alone program for scanning files, folders, and hard disks for the presence of known viruses.

Virex from Microcom also consists of two components: the Virex INIT/cdev and the stand-alone Virex scanner. The Virex INIT examines floppy disks whenever they are inserted into the disk drive and compares each file with its prerecorded checksum to look for changes. The Virex scanner lets you examine selected files and volumes and remove detected viruses.

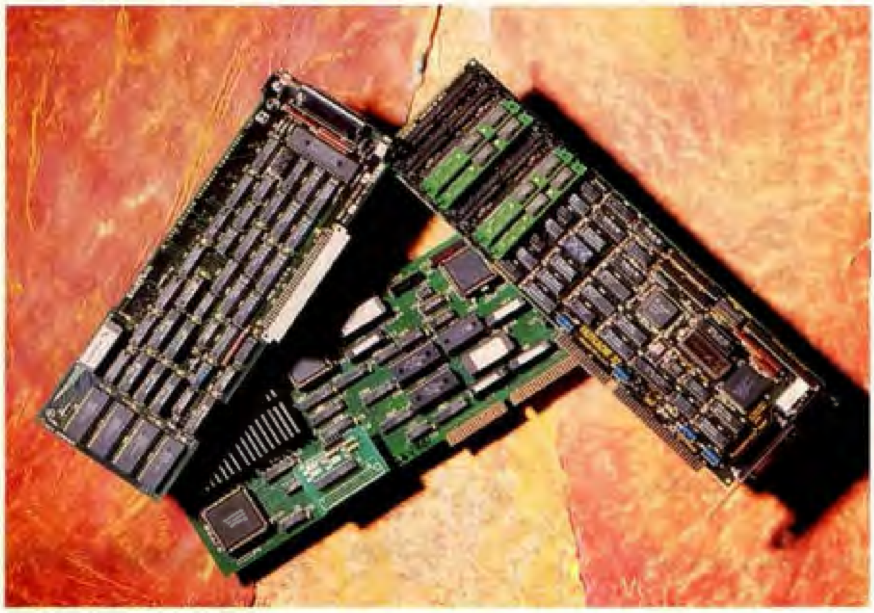
The Prescription

For the PC, one of the best sets of programs is the shareware Viruscan series. The programs caught all the test viruses, the price is reasonable, regular updates are available on many BBSes, and you can try the software before you buy. The highly regarded McAfee technology is also the basis for commercially available packages.

For the Mac, Disinfectant 2.4 did equally well. It caught all the test viruses, the price is right, and regular updates are available on BBSes. The screen display is straightforward and easy to use, and on-line documentation is included.

continued

DISK MIRRORING: When Two Disks Are Better Than One



DiskTwin (left), for Macs, and LDP Cache II (center) and FastCache 32 (right), both for PCs, offer effective hardware-based disk mirroring.

As large hard disk drives measure their capacities in gigabytes, backing up becomes an increasingly important issue. On a single-user system, daily backups place as much as one day's worth of work at risk should the disk crash at quitting time. But on a busy network, several people can each lose up to a day's worth of work—a potentially expensive and frustrating problem.

As a solution, several companies in the microcomputer industry have borrowed a concept from the world of larger systems: RAID (for redundant arrays of inexpensive disks). For more about RAID, see "Strength (and Safety) in Numbers," December 1990 BYTE.

RAID is defined in five levels. At the simplest, the technique mirrors data to two drives. Mirroring systems are convenient because they require no action on the part of the user. Data backup is continuous—once a failure occurs, the system can be up and running with little delay. And finally, as drive prices continue to fall, mirroring is becoming price competitive with removable media for some systems.

Currently, several mirroring systems are available for PCs, Macs, and Unix platforms (see the text box "Affordable Mirroring for Unix" on page 232 for one example of Unix-based mirroring). Although not as powerful as full-blown RAID systems, these systems do provide an extra measure of real-time data security. We looked at a representative sample of mirroring products for the PC and Mac platforms. As we discovered during our tests, the different implementations are better suited to particular systems or tasks.

PC Mirroring Choices

When using Immunity Plus from Unitrol Data Protection Systems, you must format the disk drives with DOS FDISK or ONTRACK Disk Manager, and the operating system must be DOS. This keeps you from running on servers such as NetWare, OS/2, or Unix, which use their own disk formats and drivers.

The resynchronization (i.e., initialization) took about half an hour on our system. Our first drive was one cylinder shorter than the second, which caused a mirroring problem (one partition could not be mirrored). It would be nice if the utility could mark small reserved areas on the primary partition to reduce the size of the partitions and allow mirroring of the entire drive. Of course, in a situation like this, you could leave a tiny partition at the end of the disk or swap the drives, but that is inconvenient.

Immunity Plus was the only tested system that allowed partial mirroring. It is thus possible to mirror only critical data and increase the total space available on the drives. It also allows you to use drives of different sizes to their full capacity. For example, you could mirror a 40-megabyte drive to an 80-MB drive and use the remaining 40 MB on the larger drive for unprotected storage.

We could not test a total drive failure because whenever we removed power from a drive, the drive controller quit working. Thus, the software never got a chance to "fix" the problem. We did disable mirroring, made changes to one of the drives, and attempted to reestablish mirroring. The software caught the discrepancy, flashed a warning message, and refused to enable the mirroring. A similar process is supposed to occur during a real failure. Note that it is impossible to reboot if the primary drive fails, since mirroring is not enabled until the device driver has been loaded.

LDP Cache II from Lomas Data Products is register compatible with the Western Digital WD1003-WA. As a result, it can be used without special drivers (an important consideration for systems running Unix, OS/2, or NetWare). However, it can also run in an enhanced mode that improves performance when special drivers or the on-board ROM is used.

The controller cannot implement parallel reads. However, its 4 MB of RAM cache negates much of the need for such a feature. The cache can be enabled for write-through mode (the drive is updated immediately) or buffered mode (writes are delayed until the buffer is full or the drive is not busy). Because both drives write simultaneously, the write performance is the same as with a single drive.

When we cut off power to the primary drive under OS/2, OS/2 system response went dead. The system would not boot from the second drive, although we were able to get up and running by removing the "dead" primary drive and restrapping the secondary as the primary. The system then responded normally (other than giving a warning message at boot time that a drive error had occurred).

To get a better feel for the process, we tried the procedure again under DOS while running a disk search with Norton Utilities. When we removed power from the primary drive, the search continued, but at a greatly diminished pace (at the rate of one sector every few seconds, rather than many sectors per second).

LDP Cache II continues operations on both drives until a write failure occurs. Thus, when a drive totally fails, the system may respond quite slowly as it first attempts to read the primary drive and then switches to the secondary drive on

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CAPACITIES AVAILABLE	52-535Mb	20-45Mb	21-42Mb
MAXIMUM ON-LINE	3,745Mb	623Mb	85Mb
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WORKSTATION COMPATIBLE	Yes	No	No

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Affordable Mirroring for Unix

Tom Yager

Data protection through disk mirroring isn't new; most of the ideas now available for PCs and workstations have been used for years on minicomputers and mainframes. Powerful, expensive Unix file servers commonly have disk mirroring, as well as automatic backups and power protection, as part of their typical configuration. But most people moving into Unix today don't have such deep pockets. Fortunately, there are solutions that can satisfy both your needs and your budget. As an example, I'll describe one system that provides a well-rounded data-integrity solution.

The Altos System 5000 is a 33-MHz 486 EISA-based system that is tuned for file and compute serving. It is also built to run Unix exclusively. Altos has its own "private-label" version of SCO Unix System V (which is derived from AT&T System V release 3.2). Altos Unix 5.3.2, as it is called, includes several enhancements added by Altos with data protection in mind.

At the heart of Altos's failure protection is support for multiple SCSI channels. While mirroring multiple drives on the same SCSI host adapter is fair insurance against drive failures, it can't do much to guard against host adapter or cable failure. The System 5000 can support up to three independent SCSI channels, each handling up to seven devices. One channel resides on the system's base I/O board, and the other two are part of the optional High Performance File Processor.

Altos's disk-mirroring capability is part of the standard operating-system software. Drives are mirrored by *divisions* (i.e., blocks of disk cylinders, similar to DOS partitions). An Altos utility, `vdutil` (virtual disk utility), presents a menu-driven interface to the mirroring system. Through `vdutil`, you can also stripe and span multiple drives, enhancing performance and extending available contiguous storage.

When mirroring is first applied, the source division can be one that already exists or a new division on a freshly formatted hard disk drive. I'm glad this choice is available—you can forgo mirroring at first and phase it in as your needs grow without reloading your data.

Once you have enabled mirroring, the "from" and "to" divisions are combined into a single Unix virtual device. From then on, the mirrored divisions can be treated like any physical Unix device. Since the mirroring is part of the operating system, no external utilities or background processes are needed to maintain the mirroring facility.

All types of disk failures are trapped by the mirroring system. As long as it can respond (i.e., the system hasn't crashed, and the SCSI and system buses haven't frozen from a short or some such incident), the mirroring system reports the failure to the system console and shuts down I/O on the faulty drive of the mirrored pair. Applications using that drive, if they are actively involved in I/O, will receive an error during the change. The switch doesn't take much time, so applications that are built to automatically retry failed I/O operations will hiccup and then recover.

I was a bit disappointed that the system doesn't make the switch without applications being aware of it, but an error notification is preferable to the passing of bad data. And only processes that are actively reading from or writing to the failed drive will be affected.

Altos's mirroring does carry measurable overhead; after all, all data has to be written twice. The versatility of SCSI improves things considerably, though: Write operations are slowed by about 20 percent, while reads are about 10 percent slower. Performance would have been better if I had mirrored between two controllers (they would operate asynchronously), but even these numbers aren't too frightening considering the level of protection offered and the solid performance of Altos's file I/O.

I tested the mirroring software by hooking up a pair of drives: a Plus Development Impulse 3½-inch 168-megabyte drive and a Micropolis 5¼-inch 330-MB drive. I placed them on the System 5000's internal SCSI channel following the system's single internal drive and configured the new drives for 168 MB of mirrored space. It took only about 10 minutes to get the drives fully on-line (they were already formatted).

I invented a simple test that created a huge (16-MB) file and then read its contents repeatedly until interrupted or an error occurred. I tested the failure recovery by pulling the power connector out of one of the drives while the read cycle was under way. Sure enough, the system spat out error messages until the threshold I had set was reached, and it then took the primary drive off-line and rerouted everything to the "to" side of the mirrored pair. My test program sensed an error at the time of the switch (the switch will not take place if the drive returns to service before the threshold is exceeded), but no bad data was passed, and the file was in precisely the same state following the switch as it was when the failure occurred.

Once the system takes a drive off-line, it remains off until the system administrator returns it to service. In some cases, the primary drive can be reactivated after a cable is tightened (or, in my test, the power is returned), and users will experience no interruption of service. At some point, however, the data on the two drives will have to be reconciled. This involves a high-speed copy of the entire division between the drives. The `vdutil` program takes the mirrored pair off-line for this; I'd have preferred the option of an on-line restore. Even so, Altos's goal of minimal downtime is largely realized. And, more important, no data is lost.

Disk mirroring is combined with on-line diagnostics and power-failure handling (with the optional UPS) to give the System 5000 a well-rounded data protection solution. Altos's solution is not the only one, but its transparency and affordability place it among the best.

Tom Yager is a BYTE technical editor who manages the BYTE Unix Lab. He can be reached on BIX as "tyager."

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Circle 62 on Inquiry Card (RESELLERS: 63) each read failure. Of course, with a partial failure, such as a bad sector, the performance difference should be negligible, and you retain the benefits of continual backup for the remaining sectors.

FastCache 32 from Corporate Systems Center represents something of a hybrid hardware/software approach. The mirroring function is controlled by the BIOS, so it is actually software controlled. But, unlike Immunity Plus, it does not use space in RAM. Because writes are not cached and access is sequential (writing first to one drive and then the next), mirrored writes are not as fast as with LDP Cache II. Nevertheless, writes outperformed our MFM-based system by a significant margin. FastCache 32 is not register compatible with the WD1003-WA, so we could not use it with OS/2 (instead, we used IBM PC LAN 1.3).

Like LDP Cache II, FastCache 32 has a 4-MB RAM cache and does not read from both drives. When we removed power from the primary drive, read time increased but was not nearly as slow as with LDP Cache II. Although the system continued to run, we could not get it to reboot without restrapping the secondary drive as primary. On the other hand, you probably would not want to boot from only a secondary drive because of the performance disadvantage.

The floppy disk drive always reported errors during our system's power-on self test. However, the drive functioned normally. Since we were using an IBM AT with an Inboard 386, the error might have stemmed from a timing problem.

Mac Mirroring Choices

For immediate and almost transparent disk backups, DiskTwin 2.0, a hardware plus software disk-duplexing system from Golden Triangle Computers, is the only solution available on the Macintosh. Unlike mirroring applications, which write to disks sequentially, first to the primary disk and then to the backup disk, DiskTwin writes to both simultaneously. As a result, we noticed no degradation in the speed of disk operations when using DiskTwin. However, stopwatch in hand, we determined that most disk writes actually took about 4 percent longer with DiskTwin than without it.

The hardware part of DiskTwin is a NuBus card. (The company recently also released an SE/30 version.) The software part of DiskTwin is a Control Panel device (cdev). Once you install the card and the cdev, setting up the system is easy. If you have more than one disk drive, you can daisy-chain them. You then indicate, via the Control Panel, which disk or disks (connected to the Mac's SCSI port) are to be primary and which (connected to the DiskTwin's SCSI connector) are to be their twins. DiskTwin then "synchronizes" the paired disks, creating an exact duplicate of the primary disk on the twin. Synchronization took just over 3 minutes for an 80-MB drive. From that point on, every write to the primary disk is auto-

COMPANY INFORMATION

Altos Computer Systems
(System 5000)
2641 Orchard Pkwy.
San Jose, CA 95134
(800) 258-6787
fax: (408) 433-9335
Circle 1375 on Inquiry Card.

ASD Software, Inc.
(FileGuard)
4650 Arrow Hwy., Suite E-6
Montclair, CA 91763
(714) 624-2594
fax: (714) 624-9574
Circle 1376 on Inquiry Card.

Casady & Greene, Inc.
(AME)
22734 Portola Dr.
Salinas, CA 93908
(408) 484-9228
fax: (408) 484-9218
Circle 1377 on Inquiry Card.

Central Point Software, Inc.
(Central Point Anti-Virus)
15220 Northwest
Greenbrier Pkwy.
Beaverton, OR 97006
(800) 888-8199
(503) 690-8090
Circle 1378 on Inquiry Card.

Certus International
(Certus 2.1)
13110 Shaker Sq.
Cleveland, OH 44120
(800) 722-8737
(216) 752-8181
Circle 1379 on Inquiry Card.

Command Software Systems, Inc.
(Security Guardian)
1061 East Indiantown Rd.,
Suite 500
Jupiter, FL 33477
(800) 423-9147
(407) 575-3200
fax: (407) 575-3026
Circle 1380 on Inquiry Card.

Corporate Systems Center
(FastCache 32)
730 North Pastoria Ave.
Sunnyvale, CA 94086
(408) 737-7312
fax: (408) 737-1017
Circle 1381 on Inquiry Card.

Digital Dispatch, Inc.
(Data Physician)
55 Lakeland Shores Rd.
Lakeland, MN 55043
(800) 221-8091
(612) 436-1000
fax: (612) 436-2085
Crcle 1382 on Inquiry Card.

EliaShim Microcomputers, Inc.
(ViruSafe)
520 West Highway 436,
Suite 1180-30
Altamonte Springs, FL 32714
(800) 771-7233
(407) 682-1587
fax: (407) 869-1409
Circle 1383 on Inquiry Card.

Fifth Generation Systems, Inc.
(DiskLock 2.0)
10049 North Reiger Rd.
Baton Rouge, LA 70809
(800) 873-4384
(504) 291-7221
fax: (504) 295-3268
Circle 1384 on Inquiry Card.

Fischer International Systems Corp.
(Watchdog)
4073 Merchantile Ave.
Naples, FL 33942
(800) 237-4510
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fax: (813) 643-6357
Circle 1385 on Inquiry Card.

Golden Triangle Computers, Inc.
(DiskTwin 2.0)
4849 Ronson Court
San Diego, CA 92111
(619) 279-2100
fax: (619) 279-1069
Circle 1386 on Inquiry Card.

Harcom Security Systems
(PC Watchman)
130 William St.
New York, NY 10038
(212) 766-1802
fax: (212) 732-0596
Circle 1387 on Inquiry Card.

International Microcomputer Software, Inc.
(VirusCure)
1938 Fourth St.
San Rafael, CA 94901
(415) 454-7101
fax: (415) 454-8901
Circle 1080 on Inquiry Card.

Jeffrey S. Shulman
(VirusDetective/
VirusBlockade)
P.O. Box 1218
Morgantown, WV 26507
Circle 1388 on Inquiry Card.

John Norstad
(Disinfectant 2.4)
Northwestern University
2129 Sheridan Rd.
Evanston, IL 60208
Circle 1389 on Inquiry Card.

matically also written to its twin.

If the primary drive fails, you simply disconnect the twin from the NuBus card and reconnect it to the Mac's SCSI port (in essence turning the twin into a primary drive), and you're back in business. The entire process takes less than 2 minutes. DiskTwin's biggest drawback is that the twin has to be at least as large as the primary drive. If the twin is larger, its excess capacity cannot be used. (The company has recently provided a partial solution to this problem by bundling another cdev, PartitionTwin, that lets you choose partitions to replicate instead of complete disks.)

When using DiskTwin, your disk operations will only be as fast as your slower drive—primary or twin. When using a 40-MB 12-millisecond Quantum drive as primary and a 46-MB Seagate rated at 32 ms as the twin, performance decreased about 7 percent.

While disk duplexing ensures continuous protection against mechanical disk problems, it provides no help when files are accidentally trashed or corrupted, say through a virus, since the problem would occur on both the primary and twin disks simultaneously. (DiskTwin has a standby mode, which creates a copy of the primary disk on command, thus allowing you to archive whenever you want. But you can archive that function just as easily using the Finder.)

DiskTwin was recently upgraded, and version 2.0, which we received mid-evaluation, adds an important feature: Automatic Cutover. This is supposed to automatically and instantly activate the twin when the primary disk fails. The screen then displays a flashing Apple icon to indicate the failure. (On a network, the icon flashes on the server, where it might not be noticed. The company just released a utility that will send messages over Microsoft Mail.)

In our tests, the Automatic Cutover feature worked only about 65 percent of the time; at other times, the Mac bombed (system error) or froze. Admittedly, the way we were forced to test Automatic Cutover—by powering down the primary drive—is much more likely to cause a Mac to bomb than is a head crash, which is the most common way a disk fails.

In spite of its minor shortcomings, DiskTwin is an efficient way to ensure continuous backup of your data. Once installed, it's barely noticeable. And if the backup drive is needed, getting it on-line takes virtually no time. ■

Stanford Diehl and Stan Wszola are testing editors for the BYTE Lab. You can contact them on BIX as "sdiehl" and "stan," respectively. Bradley Kliewer is principal of DK Micro in Minneapolis, Minnesota. You can reach him on BIX as "bkliewer." Larry Stevens, a freelance technical journalist based in Belchertown, Massachusetts, has extensively tested and written about Macintosh products. You can reach him on BIX c/o "editors."

COMPANY INFORMATION

Kent Marsh, Ltd.
(FolderBolt, MacSafe II, NightWatch, QuickLock)
1200 Post Oak Blvd.,
Suite 210
Houston, TX 77056
(800) 325-3587
(713) 623-8618
Circle 1390 on Inquiry Card.

Kinetic Software Co.
(Access II)
240 Distillery Commons
Louisville, KY 40206
(502) 583-1679
fax: (502) 583-1104
Circle 1391 on Inquiry Card.

Lomas Data Products, Inc.
(LDP Cache II)
182 Cedar Hill St.
Marlborough, MA 01752
(508) 460-0333
fax: (508) 460-0616
Circle 1392 on Inquiry Card.

Magna
(Empower II)
2540 North First St.,
Suite 302
San Jose, CA 95131
(408) 456-2500
fax: (408) 943-0651
Circle 1393 on Inquiry Card.

McAfee Associates
(Viruscan)
4423 Cheeney St.
Santa Clara, CA 95054
(408) 988-3832
Circle 1394 on Inquiry Card.

Microcom, Inc.
(Virex, Virex PC)
P.O. Box 51489
Durham, NC 27717
(919) 490-1277
Circle 1395 on Inquiry Card.

Ontrack Computer Systems, Inc.
(Dr. Solomon's Anti-Virus Toolkit)
6321 Bury Dr., Suites 15–19
Eden Prairie, MN 55346
(612) 937-1107
fax: (612) 937-5815
Circle 1396 on Inquiry Card.

Pyramid Development Corp.
(PC/DACS 2.02)
70 Inwood Rd.
Rocky Hill, CT 06067
(203) 257-4223
fax: (203) 257-4245
Circle 1397 on Inquiry Card.

RG Software Systems, Inc.
(Vi-Spy)
6900 East Camelback Rd.,
Suite 630
Scottsdale, AZ 85251
(602) 423-8000
fax: (602) 423-8389
Circle 1398 on Inquiry Card.

Sophco, Inc.
(Protec)
P.O. Box 7430
Boulder, CO 80306
(303) 444-1542
fax: (303) 444-1454
Circle 1399 on Inquiry Card.

Symantec Corp.
(Symantec AntiVirus for the Macintosh/ Norton AntiVirus 1.0)
10201 Torre Ave.
Cupertino, CA 95014
(800) 441-7234
(408) 253-9600
Virus Newsline:
(408) 252-3993
Circle 1400 on Inquiry Card.

United Software Security, Inc.
(OnGuard)
8133 Leesburg Pike,
Suite 380
Vienna, VA 22182
(703) 556-0007
fax: (703) 734-3368
Circle 1401 on Inquiry Card.

Unitrol Data Protection Systems, Inc.
(Immunity Plus)
815 Hornby St., Suite 604
Vancouver, BC,
Canada V6Z 2E6
(604) 681-3611
fax: (604) 687-0814
Circle 1402 on Inquiry Card.

Other products used in our testing:

Adaptec, Inc.
(AHA-1542B)
691 South Milpitas Blvd.
Milpitas, CA 95035
(408) 945-8600
fax: (408) 262-2533
Circle 1403 on Inquiry Card.

Micropolis Corp.
(1684)
21211 Nordhoff St.
Chatsworth, CA 91311
(818) 709-3300
fax: (818) 709-3396
Circle 1404 on Inquiry Card.

Plus Development Corp.
(Plus Impulse 170S)
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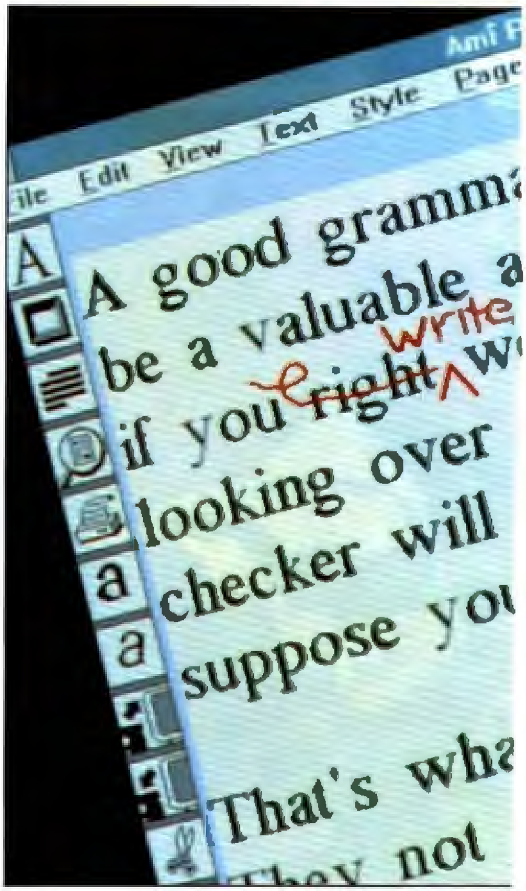
SOFTWARE

Can a Grammar and Style Checker Improve Your Writing?

HOWARD EGLOWSTEIN



It could be a simple office memo, the Great American Novel, or anything in between. Whatever you write, you're likely to use a personal computer and word processing software. There's also a good chance that you use your software's spelling checker to help catch typos. But what about your grammar? How easy is it for your target audience to read your text? Just as a spelling checker can catch spelling errors, a grammar and style checker can help you improve the clarity of your writing.

Grammar and style checkers work the same way as spelling checkers. You create a document in your word processor, save it to disk, and then bring up the grammar and style checker. The software applies the most commonly used rules to your text and points out areas where it thinks your text varies from the accepted norm. In most cases, you have a choice between an interactive session (i.e., the software explains each error and lets you correct it) and a markup session (i.e., the software writes out a second copy with its comments embedded). In the latter case, you go back to your word processor to read the comments and make changes.

In this review, I include nine of the most popular grammar and style checkers for Macintosh and MS-DOS computers. WordStar International makes Correct Grammar for the Mac and the PC. Reference Software International's Grammatik comes in versions for character-based DOS, Windows 3.0, the Mac, and Unix. From RightSoft/MacMillan Computer Publishing, there's RightWriter for the Mac, Tandy DeskMate, MS-DOS, and networked MS-DOS machines. Finally, there's Sensible Grammar for the Mac from Sensible Software. For this review, I only include Mac, MS-DOS, and Windows versions, although versions for DeskMate and Unix work in much the same way.

Arrggh!

Testing grammar and style checkers turned out to be much harder than I thought it would be. First, I needed something to check. I wanted some *real* text from someone's *real* desk. I spoke with a couple of folks on BIX and hooked up with Andy Tauber, an executive at a midsize company and a budding science fiction author. Tauber sent me a couple of memos from his desk, some computer network proposals, and a few examples of his short stories. To this collection, I added several internal memos from my days at MultiMate and the executive summary from a business plan.

Next, I needed something to compare the software's output to a known benchmark. I sent copies of the text to Pat Sullivan, a college English professor in Connecticut. Sullivan read through the text and marked each of the samples with the kinds of errors that a grammar and style checker should catch. I specifically asked him to skip over errors in content and spelling, except where these errors caused grammatical errors. Some comments were straightforward and referred to missing commas and the like, and others (primarily those in the business plan) suggested that the text was next to unreadable. In several passages of the business plan, Sullivan threw in the towel and simply wrote *Arrggh*.

The testing plan was simple—classify and count all of Sullivan's comments, run the text samples through each software package, and score the software based on its ability to mimic Sullivan's suggestions. While all the packages are generally useful, none were good enough to be compared so objectively. So much for plan A.

Plan B involved comparing each software package's suggestions with Sullivan's comments and rating them as "on the right track" or "not even close." I subjectively based my conclusions on the number of times the software stayed on track. The best packages were those that found the most errors without nitpicking on a zillion little points. If software hammers you with annoying messages, it's likely that you won't notice the important ones when they come along.

Correct Grammar

Correct Grammar from WordStar International (previously from Lifetree Software) is available for the Mac and the IBM PC. Although it's still in beta, I got a peek at Correct Grammar for Windows. All three have a similar look and feel and did a good job of picking out most errors. You have a choice of several writing styles, and you can turn specific warnings on and off.

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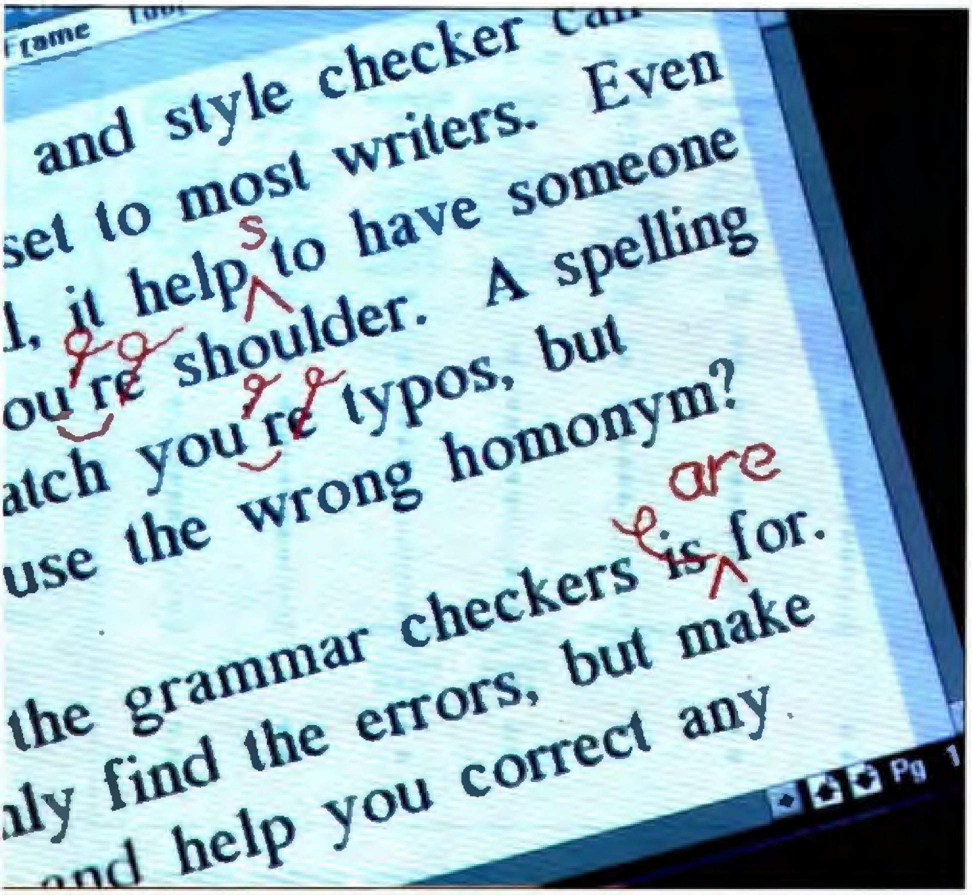
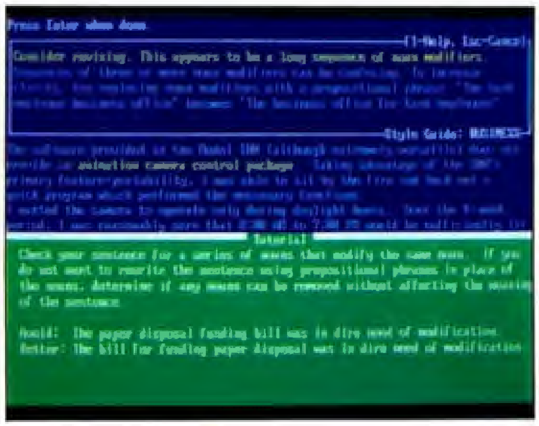


During an interactive session, you can bring up tutorial help if you don't understand a suggestion. Screen 1 is from the DOS version, with the software explaining why it disliked the phrase *animation camera control package*. The standard controls include Ignore, which accepts an error and continues; Quiet, which tells Correct Grammar to forget the rule that flagged the error; and Tutorial, which brings up the help panel. The Windows and DOS versions allow you to scan an entire document and save the suggestions to disk. The Mac version requires that you use it interactively.

Correct Grammar tends to point out lots of spelling errors. Usually, these words aren't misspelled but are simply not in its dictionary. Other than the spelling errors, Correct Grammar was pretty mute on the test documents. Most of the packages reported tons of picayune mistakes—things that could be considered personal style. When I used Correct Grammar's default settings for the various styles, it picked out the spelling errors and not much else. Because the messages were few and far between, I tended to take the suggestions more seriously than I did with other packages. Overall, its suggestions were valid, and it made few "bad" suggestions.



Screen 1: *The DOS version of Correct Grammar, showing one of its excellent tutorial panels. In this case, it got grumpy about the phrase "animation control camera."*

BYTE ACTION SUMMARY

- **WHAT GRAMMAR AND STYLE CHECKERS DO**
  Catch word-usage errors and make good companions to spelling checkers.
- **LIKES**
  Generally easy to use. Can pick out typos that a spelling checker may miss.
- **DISLIKES**
  Some question too many sentences or make incorrect suggestions. A grammar and style checker will not replace your own ear for the English language.
- **RECOMMENDATIONS**
  RightWriter or Grammatik will suit most DOS users. Grammatik offers an interactive checking mode; RightWriter does not. If you're running Word for Windows or Ami Pro, Grammatik Windows is your only choice—and a good one at that. Keep an eye out for Correct Grammar for Windows, though. On the Mac, you will be happiest with Grammatik Mac's solid performance and interactive checking mode.

Grammatik

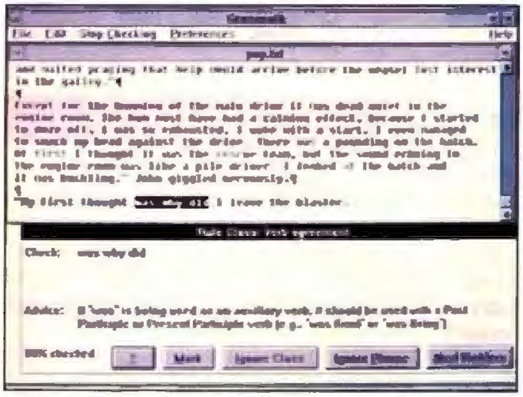
Grammatik's versions for the Mac and Windows are similar (see screen 2). Although the DOS version has the same functions as the others, it has a somewhat clunkier interface. It uses function keys in place of the graphical buttons and tends to scream at you with annoying two-tone beeps if you press a wrong key.

All three versions performed similarly. In my tests, Grammatik easily flagged most of the errors. Its only real problem was that it tended to point out perfectly good text as incorrect. For example, it liked to suggest *a* or *an* as a replacement for any use of the word *one*. The standard interactive controls include Next Problem, which skips past the

GRAMMAR AND STYLE CHECKER SYSTEM REQUIREMENTS AND CAPABILITY

Corporate Voice checks your overall style; the others check your grammar (● = yes; ○ = no; N/A = not applicable).

Product	Corporate Voice 1.0	Correct Grammar 3.0	Correct Grammar 2.0	Grammatik Mac 2.0	Grammatik IV 2.0	Grammatik Windows 2.0	RightWriter 4.0	RightWriter for the Mac 3.10	Sensible Grammar 1.6.2
Minimum system requirements	IBM XT/AT compatible, DOS 2.0+, 2 floppy disk drives, 512 KB RAM	IBM XT/AT compatible, DOS 2.0+, hard disk drive, 512 KB RAM	Mac SE, 1 MB RAM, hard disk drive, System 4.2+	Mac SE, 1 MB RAM, 2 800-KB floppy disk drives, System 5.0+	IBM XT/AT compatible, DOS 2.0+, hard disk drive, 512 KB RAM	286 or 386 compatible, 1 MB RAM, hard disk drive, Windows 3.0	IBM XT/AT compatible, DOS 2.0+, 2 floppy disk drives, 512 KB RAM	Any Macintosh, 512 KB RAM, 1 800-KB floppy disk drive	Mac 512KE, 512 KB RAM, 1 800-KB floppy disk drive
Price	$249.95	$99	$99	$99	$99	$99	$99	$95	$99.95
Checking modes									
Interactive	○	●	●	●	●	○	○	○	○
File markup	●	●	○	●	●	●	●	●	●
Word processors supported									
ASCII	●	●	●	●	●	●	●	●	●
WordStar	●	●	○	○	●	●	●	○	○
WordPerfect	●	●	○	○	●	●	●	●	●
MultiMate	○	○	○	○	●	○	●	○	○
Microsoft Word	●	●	●	●	●	●	●	●	●
Microsoft Works	○	●	●	●	●	●	●	○	●
MacWrite	○	○	●	●	○	○	○	●	●
MacWrite II	○	○	●	●	○	○	○	●	●
WriteNow	○	○	●	●	○	○	○	●	○
Windows Write	○	○	○	○	○	●	○	○	○
Ami Pro	○	○	○	○	○	●	○	○	○
Word for Windows	○	○	○	○	○	●	●	○	○
Others	WordStar 2000	WordStar 2000, pfs:Write, Total Word	N/A	N/A	DisplayWrite, RTF files	DisplayWrite, RTF files, Volkswriter, XyWrite	DeskMate text, Q&A, Volkswriter, pfs:Write	N/A	N/A
User-configurable writing styles	●	●	●	●	●	●	●	●	●
Readability report	●	●	●	●	●	●	●	●	●



Screen 2: *Grammatik Windows correctly identified the problem but came up with a wrong fix. A few quotation marks would fix this sentence, but Grammatik doesn't know that.*

error; Ignore Class, which squelches any further messages of that type; and More Help, which brings up an extraneous help window. Usually, the initial message is enough to help you fix the error.

If you're concerned only about readability, you have the choice of forgoing the grammar check and getting just a readability summary. Grammatik will calculate and report a document's readability (i.e., its grade level and reading ease), its use of passive voice, and statistics on average word, sentence, or paragraph length. Grammatik (for DOS) also shares RightWriter's ability to start up from within a word processor. Grammatik is easy to install and easy to use, and it makes suggestions that are generally helpful.

RightWriter

RightWriter has a few traits that make it better suited for long-document use by workgroups. For one thing, the DOS product is available in a network version. A network administrator would install a master package on a network to make it available to the network users. Otherwise, the network version is like the DOS version. The standard network package comes with the software, five manuals, and a license for five users.

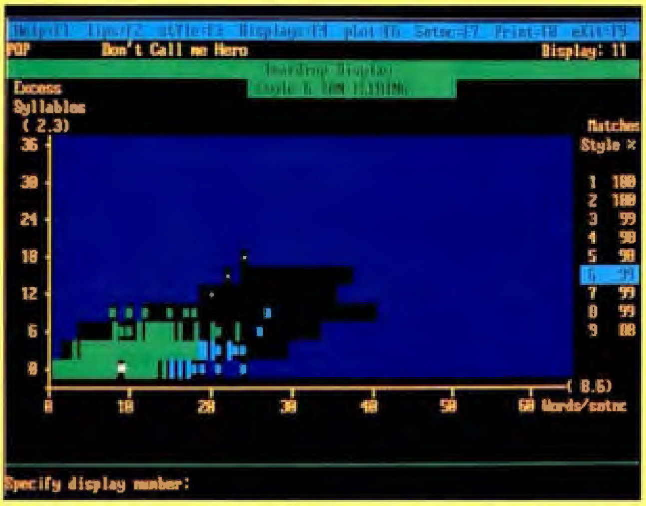
RightWriter interfaces directly with major word processors. Other products require you to save your file to disk, exit the word processor, and then run the grammar and style checker. If you're using WordPerfect, you simply run WPRIGHT instead of WP to start up the program. RightWriter wraps a layer around the word processor, which adds two macros to WordPerfect. Then, when you press Alt-R, WordPerfect saves the file and calls up RightWriter, which creates a marked-up copy of your text. RightWriter automatically returns you to WordPerfect with the marked-up text on-screen. You simply scroll through the document, make your changes, and then press Alt-S to strip out the comments. RightWriter provides similar capability for Microsoft Word, WordStar, MultiMate Advantage II, and several other word processors.

Running RightWriter couldn't be easier. It has no interactive mode, so the interface is simple. You start the software, give it a filename, and pick a writing style. The software writes out a copy of the file with its comments and shows you a readability report (see screen 3). After you edit the commented file, you tell RightWriter to strip the comments out. If you need to tweak any of the grammar

The Corporate Voice for Writing

Some pieces of writing are not meant to be compared with academic references. Science fiction, for example, often has more varied structure than the textbooks allow. Perhaps your company also has an established writing style for your documentation. What you need is a tool for ensuring that new text matches the style of your company—not that of some textbook.

Corporate Voice from Scandinavian PC Systems does exactly that. After you install it, you feed it your existing documents. The software analyzes your sentence structure and builds a style model from your samples. Later, any text you analyze is compared with this model, and the results are shown as graphs and charts. The primary display (see screen A) arranges the sentences of your document according to syllable count and the number of words per sentence. The dark "teardrop" surrounding the colored sentence display reflects the selected style.



Screen A: *Corporate Voice's teardrop display. The colored cluster at the lower left shows the makeup of sentences in Andy Tauber's* Don't Call Me Hero. *The dark "teardrop" region is the model built from Ian Fleming's writing. If Andy wanted his writing to be more like that of Ian Fleming, he would use some longer sentences and longer words. Overall, Corporate Voice considers this sample to be a good match to Fleming's style. Other displays show this information in different forms.*

In typical use, you create a style model, choose that model, and analyze your text. The teardrop display compares your writing style to the style model. Usually, some sentences will fall outside the teardrop area. If you press the F7 key, the deviant sentences change to numbers. You choose a sentence by using the cursor keys. Pressing the Return key displays that sentence at the bottom of the screen.

Another key component of a writing style is how you use words. Corporate Voice refers to common words as *bricks*, to industry jargon as *trade words*, and to unusual words as *mortar*. A separate display compares your use with the chosen style model's use of these words. Other displays show word lists, readability, and general comments.

One important difference between Corporate Voice and other grammar and style checkers is that it doesn't analyze individual sentences. Its primary purpose is to help you tailor your writing style to an established reference. How you correct your grammar is up to you. I found it amusing to compare this article on grammar and style checkers with a selection of past BYTE reviews. I downloaded some text from BIX and built a style model. Analyzing my text suggested that if I wanted it to look more like a BYTE article, I should use more pompous sentences! Fascinating.

Corporate Voice is not a substitute for a good grammar and style checker. Most writers I associate with have one common complaint: When you use a word processor, you begin to rely heavily on your spelling checker to find typographical errors. That's not always enough. A good grammar and style checker will help you find words that are out of place and sentences that may need some help. You'll still need one or both kinds of checkers to catch these simple errors.

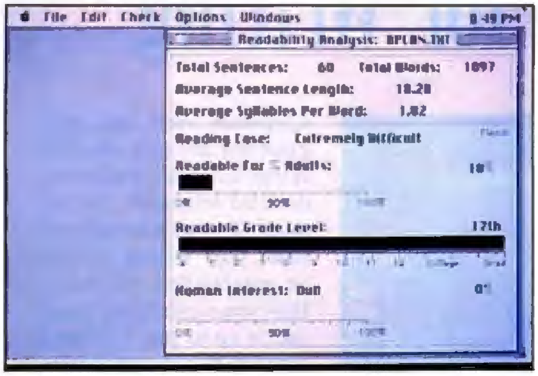
Beyond that, Corporate Voice is a neat tool to help you develop a more consistent writing style. Some people will think it is silly, but some will find it indispensable. If nothing else, comparing your brilliant prose with that of the masters is positively enlightening.

Screen 3: *RightWriter under DOS has no interactive mode but gives you a readability summary after marking up a copy of your text.*

rules, there's a menu choice for that. RightWriter supports most popular DOS and Mac word processor file formats. Tandy DeskMate users can install the DeskMate version and use it directly as a native DeskMate application. RightWriter's comments are usually helpful and well placed. It puts in its share of wrong comments, but they're usually obvious. RightWriter includes a copy of Strunk and White's *The Elements of Style* to help you figure out stuff.

Sensible Grammar

This Mac product has a couple of features that may make it the best choice



Screen 4: *Perhaps the best readability display of all the reviewed products is that of Sensible Grammar for the Mac, which uses descriptive words and bar graphs to clarify the results. In this case, the document was almost impossible to read.*

for some writers. Sensible Grammar's method of presenting readability is second to none. Screen 4 is a sample output from the business plan I used as a test document. Instead of numbers with lots of decimal points, Sensible Grammar gives you graphs with descriptive text. Here, it was right on the mark. The document *is* hard to read and extremely dull.

Sensible Grammar's phrase and word lists are easy to edit. The phrases are grouped by category (e.g., Latin Expressions and Racial Phrases). You have the choice of turning these groups on and off or editing the phrases within the groups. To scan a document, you come up in interactive mode but then choose Auto-Log (to send all the errors to disk) or Auto-Mark (to continue automatically through each error). Auto-Logging to disk turns out to be less than useful. Instead of saving a marked-up copy, Sensible Grammar saves a separate error file, with each sentence identified by number. Correlating the errors to the original text is nigh on impossible.

By default, the package nitpicks at everything. The output I got complained bitterly about every extra space and insisted on turning everything into abbreviations and contractions. It wanted to replace every occurrence of *I have* with *I've* and every occurrence of *hardware* with *hdw*. You can turn off a lot of this stuff. With the annoying comments disabled, I found the product to be genuinely helpful as an interactive checker. For people who don't own big, scary Macs, Sensible Grammar can run on a single 800-kilobyte floppy disk drive and a Mac 512KE or a Mac Plus. The other products either require or work best with a hard disk drive and gobs of memory.

Should "Johns Face" Be Possessive?

I'm sure John would prefer it that way. One of the documents described John's face as wet but said *Johns face was wet*—without the apostrophe. Although some of the products suggested that *Johns* was an improper word, Correct Grammar is the only package that correctly identified that it means *the face belongs to John* and questioned the lack of an apostrophe.

The way that you will use a grammar checker dictates which one you should pick. Whichever one that is, remember that a grammar and style checker won't free you from making decisions. You'll still have to know the difference between homonyms, when to use passive voice, and where to put punctuation. These checkers are handy for helping you locate errors, but you still have to fix them yourself. Just as a paint program won't make you an artist, a grammar and style checker won't make you a professional writer. Finding the mistakes is only half the problem, and that's as far as the checkers go.

Of the Mac products, Sensible Grammar (with some adjustments to its defaults) would make a good interactive checker. Grammatik has interactive and noninteractive modes, and RightWriter requires that you use your own word processor. I lean toward Grammatik Mac because of its flexibility, but I really want to like Sensible Grammar for its readability reports.

In the DOS world, I like RightWriter and Grammatik's approach to integrating with word processors. In a word processor environment, an interactive mode seems unnecessary. I thought that RightWriter's comments were a better fit to the way I write. For ASCII file checking outside of the word processor, Grammatik did a better job than Correct Grammar did of picking out the errors in the test documents. I think that Correct Grammar simply let too many easy errors slip by.

Among the Windows products, there was no contest. The only shipping product in the review was Grammatik, and it supports Ami Pro. (The Correct Grammar beta shows a lot of promise.)

Do you need a grammar checker? It couldn't hurt. Even for writers who spell perfectly, a spelling checker is incredibly useful for catching typos. Unfortunately, a typo can appear as a perfect, valid word, but not be the one you intended. In that case, it's likely that a grammar and style checker will pick it up. In any event, it's an interesting class of products, and working with one is sure to improve your writing—even if you're already an expert. ■

Howard Eglowstein is a BYTE Lab testing editor who previously worked as a senior word processing product designer for MultiMate. He can be reached on BIX as "heglowstein."

COMPANY INFORMATION

Reference Software International
(Grammatik)
330 Townsend, Suite 123
San Francisco, CA 94107
(800) 872-9933
(415) 541-0222
fax: (415) 541-0509
Circle 1110 on Inquiry Card.

RightSoft/MacMillan Computer Publishing
(RightWriter)
11711 North College Ave.
Carmel, IN 46032
(800) 992-0244
Circle 1111 on Inquiry Card.

Scandinavian PC Systems, Inc.
(Corporate Voice)
6 Nelson St.
Rockville, MD 20850
(800) 487-7727
Circle 1112 on Inquiry Card.

Sensible Software, Inc.
(Sensible Grammar)
335 East Big Beaver,
Suite 207
Troy, MI 48083
(313) 528-1950
Circle 1113 on Inquiry Card.

Writing Tools Group, WordStar International
(Correct Grammar)
1 Harbor Dr., Suite 111
Sausalito, CA 94965
(800) 543-3873
(415) 332-8692
fax: (415) 332-8780
Circle 1114 on Inquiry Card.

EEF

ELEX ELECTRONIC FILING - THE DOCUMENT IMAGING SYSTEM

The ELEX Electronic Filing System (EEF) is a hardware/software system designed to reduce the frightening volumes of documents that burden businesses on a daily basis. As paper is eliminated, transactions are made in a fraction of the time required by traditional means, costly storage facilities are reduced, data security and integrity is enhanced, and work quality and quantity is increased. These factors all give companies and individuals the competitive advantage they need to excel in the business environment of the 90's.

Filing vs. Archiving

Document image processing is a new technology which has just begun to evolve. The myriad of hardware devices on the market, and the lack of an industry standard protocol for communicating between them, make the integration of an electronic filing system a formidable task. And without an intelligent software to control all aspects of the storage, management, and retrieval of documents, the filing system will be nothing more than a micro-fiche machine in disguise.

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Open Architecture

EEF is designed as a totally open architecture system. Rather than being a closed package, EEF is composed of building blocks defined by their area of electronic filing functionality. These blocks are not bound to specific hardware/software limitations. As such, they can be combined in a variety of forms on each of the following operating platforms, to achieve optimal satisfaction of an application's specific demands:

- A single user workstation under the **DOS** or the **OS/2** operating system.
- A **local area network** - Novell NetWare 286 and higher or any MS DOS compatible network.
- A **host computer** under the UNIX, VAX/VMS or IBM AS/400 system with a PC connection.

EEF
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Scanner, Fax, Word Processing, OCR, Host Computer, Etc.
Processing
Document Manager, Retrieval Engine, Hyper-Media, 5GL Image Database Application Generator
Output
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The EEF system opens a vast new world of opportunities for you. The possible applications are limitless, and to name a few:

- Automatic Fax Routing
- Work Flow Management
- Banking Signature Verification
- Medical Records Management
- Legal Case Management
- Personnel/Human Resource System
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- Contract Management
- Engineering Department

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The system components are:

Hardware

- Intel workstation with 386 CPU, 8 MB RAM, 500 MB Hard Disk with Disk Caching controller.
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- HP Laser Jet III 300 DPI, 8 PPM printer.
- 19" High-resolution (1664x1200) CRT display.
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The EEF software license including:

- 5 GL Document Imaging Solution Generator for quick implementation of filing problems.
- Generic Work Flow Data and Image management system.
- 20 Hours of Prototyping and Application Support Services.

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SYSTEM

Full Color Comes to LCDs

STEVE APIKI

Photo 1: *The Dolch C-P.A.C. 486-33E handles 256-color VGA modes. It uses a sophisticated LCD controller to coax other colors out of Sharp's active-matrix color LCD panel.*

Photo 2: *The Toshiba T3200SXC's display is simply gorgeous. The backlit LCD, based on active-matrix technology, responds quickly enough to keep up with a mouse cursor.*

Heading out the door with a portable computer used to mean bidding farewell to your color display. It also meant saying goodbye to Windows, CAD, presentation software, and many other application programs that thrive on color—but not anymore.

Toshiba's T3200SXC and Dolch's C-P.A.C. 486-33E portable computers feature color displays that make leaving your desktop CRT a little easier. Both systems have a color LCD that handles all standard VGA modes, from monochrome to 256-color. And each machine's display is stunningly bright and colorful.

Last December, I reviewed Dolch's first C-P.A.C., a 25-MHz 486 system that uses an eight-color Hitachi LCD screen (see Reviewer's Notebook, December 1990 BYTE). Toshiba's and Dolch's newer systems are based on the same technology, but innovations in LCD panel design give these systems better color capability.

Illuminating Color LCDs

The T3200SXC and C-P.A.C. 486-33E use backlit thin-film transistor (TFT) displays. Toshiba is one of a handful of color LCD manufacturers; it incorporates its own panel into the T3200SXC. Dolch uses Sharp's new LCD panel.

The TFT, or active-matrix, display is based on a matrix of liquid-crystal elements. Each liquid-crystal element acts like a shutter: When the element is on, light can pass through; when it is off, the element becomes opaque.

In an active-matrix system, every cell is controlled by a dedicated transistor, which can switch the element on and off rapidly. You need fast screen response to avoid problems such as losing a mouse pointer as you drag it across the screen. Toshiba claims that its display can respond in 20 milliseconds, while Dolch says that its display will switch in under 40 ms. By contrast, passive LCDs require about 300 ms.

In the two systems, the LCD matrix mounts behind a panel with repeating vertical red, green, and blue stripes, each as wide as a single liquid-crystal element. Each pixel is a triplet of different-colored liquid-crystal elements.

By turning the red, green, and blue elements completely on and off, you can get eight colors. To get more colors, manufacturers vary the on and off times of each element so that they appear to be in an intermediate state. This technique gives Sharp's panel eight levels per primary color, or 512 total colors. Toshiba's display boasts 57 levels per primary color, for a total of 185,193 colors.

These numbers represent each display's palette. As with any CRT, you won't see more than 256 colors on-screen when using standard VGA modes. Both palettes are more limited than the standard VGA palette of 262,144 colors.

Dolch C-P.A.C. 486-33E

Dolch didn't stop at the 512-color limit imposed by the Sharp LCD panel. It built

BYTE ACTION SUMMARY

- **WHAT THE DOLCH C-P.A.C. 486-33E AND THE TOSHIBA T3200SXC DO**
  Bring full-color VGA to portable computer LCDs.
- **LIKES**
  The vivid, full-color VGA displays provide bright screens with excellent contrast. The C-P.A.C.'s 33-MHz 486 processor and caching disk drive controller also outran every other portable the BYTE Lab has tested to date.
- **DISLIKES**
  Both systems require AC power to drive their backlit color displays, are relatively heavy, and are considerably more expensive than monochrome machines.
- **RECOMMENDATIONS**
  Either system could replace your desktop machine. Both displays are excellent, but the T3200SXC's provides somewhat better contrast and colors. If your application requires top-end performance as well as color, choose the C-P.A.C; otherwise, the BYTE Lab favors the T3200SXC.
- **PRICE**
  Dolch C-P.A.C. 486-33E base system, $14,995; system as tested, $21,485

  Toshiba T3200SXC base system, $7249; system as tested, $9522
- **FOR MORE INFORMATION**
  Dolch Computer Systems
  372 Turquoise St.
  Milpitas, CA 95035
  (800) 538-7506
  (408) 957-6575
  fax: (408) 263-6305

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  Toshiba America Information Systems, Inc.
  Computer Systems Division
  9740 Irvine Blvd.
  Irvine, CA 92718
  (800) 334-3445
  fax: (714) 583-3437

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SYSTEM CONFIGURATION AS TESTED

	Dolch C-P.A.C. 486-33E	Toshiba T3200SXC
Processor	33-MHz 486 CPU	20-MHz 386SX CPU; 20-MHz 387SX FPU
Memory	8 MB of RAM	5 MB of RAM
Mass storage	420-MB 15-ms SCSI hard disk drive; DTC caching disk drive controller with 4 MB of RAM; 1.44-MB floppy disk drive	120-MB 19-ms Intelligent Drive Electronics hard disk drive; 1.44-MB floppy disk drive
Display	10-inch color active-matrix VGA LCD; 256 simultaneous colors from a palette of 24,389	10-inch active-matrix color VGA LCD; 256 simultaneous colors from a palette of 185,193
Keyboard	84 keys	91 keys
I/O interfaces	One serial port; one parallel port; external keyboard port; monitor port; external SCSI port; three EISA slots	Two serial ports; external keyboard port; monitor port; printer/external floppy disk drive port; one 16-bit slot; one 8-bit half-length slot; one proprietary option slot
Other		Toshiba T24D 2400-bps modem

its display using Chips & Technologies' 82457 flat-panel controller, which adds more apparent colors.

The 82457 uses a sophisticated dithering algorithm to bring the display on the C-P.A.C. up to 29 levels per color, for a total palette of 24,389. The controller also compensates for the shortened display produced by using LCDs at less than full resolution. In text modes, only 400 of the 480 lines are used; this leaves blank areas at the top and bottom of the display. The 82457 interleaves more lines to fill the screen.

Photo 1 shows the C-P.A.C.'s screen at its optimal viewing angle. Unfortunately, the display looks a little washed out from any angle except straight on. Dolch explained that Sharp mounts a polarizing panel at the front of the display, which causes this effect.

Dolch offers its color-display option on several machines, ranging from a $5995 20-MHz 386SX system to the $14,995 33-MHz 486 EISA system that I tested. In all cases, the color display adds $3995 to the price of the system.

Behind the dazzling screen, the Dolch C-P.A.C. 486-33E is a top performer. Even without an external CPU cache, the C-P.A.C. outran the 33-MHz 486-based PS/2 Model P75 on BYTE's CPU benchmarks. With its standard caching disk drive controller and optional 420-megabyte SCSI hard disk drive (the stock system includes a 120-MB SCSI hard disk drive), the C-P.A.C. 486-33E turned in excellent disk and application indexes as well.

The Folding Desktop

Toshiba's latest portable is one of the first systems to offer color-to-go in something smaller than a lunchbox. The $7249 T3200SXC is of the familiar clamshell design that is shared by the other models in Toshiba's portable line. The base model includes the color display.

The only Toshiba-supplied options on the review machine were an external modem and an upgrade from 1 to 5 MB. I also plugged in an optional 387SX math coprocessor (which Toshiba does not sell) for benchmark testing. A monochrome version of the T3200SXC, which comes equipped with a 40-MB hard disk drive, sells for $4399. Besides the brilliant screen, the T3200SXC provides good CPU performance and respectable hard disk speed.

With its palette of 185,193 colors, the Toshiba display is vivid (see photo 2). If there is any flaw, it is that the backlighting is uneven from top to bottom. At most viewing angles, the bottom of the screen appears to be slightly brighter than the top.

Toshiba's color portable performed satisfactorily, although it was slower than Compaq's similarly configured SLT 386s/20 on disk and video tests. The T3200SXC features a very comfortable keyboard and good expandability for its compact design.

Pick a Color

These two machines vary so greatly in performance-determining features, such

From the start, VGA was missing one important thing: Video.

VideoVGA brings high quality, recordable video into the Video Graphics Adapter picture. It's true that all VGA boards allow PC users to display graphic images on their monitors. Great, but then what? The printed hard copies or slides—even at their sharpest—just sat there. All too often, so did the audience. VideoVGA takes you to the next step, which can also be a giant leap for your presentations and training.

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If you can shoot it on video, or can create it with your PC, then VideoVGA lets you record it to videotape or videodisc. You can even overlay graphics on live or recorded video. And because of VideoVGA's advanced encoding, the video output is a high-quality NTSC signal, not a fuzzy substitute. Your audience can see the difference, so don't blur a good message with poor output quality.

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VideoVGA lets you get even more from your software. It's fully compatible with Windows-based presentation and graphics packages, as well as animation, CAD and other VGA software. Whatever you're using to create PC images, you can merge them with video for an extremely persuasive link.

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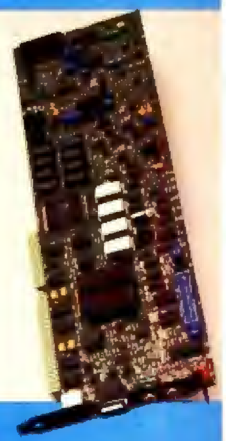

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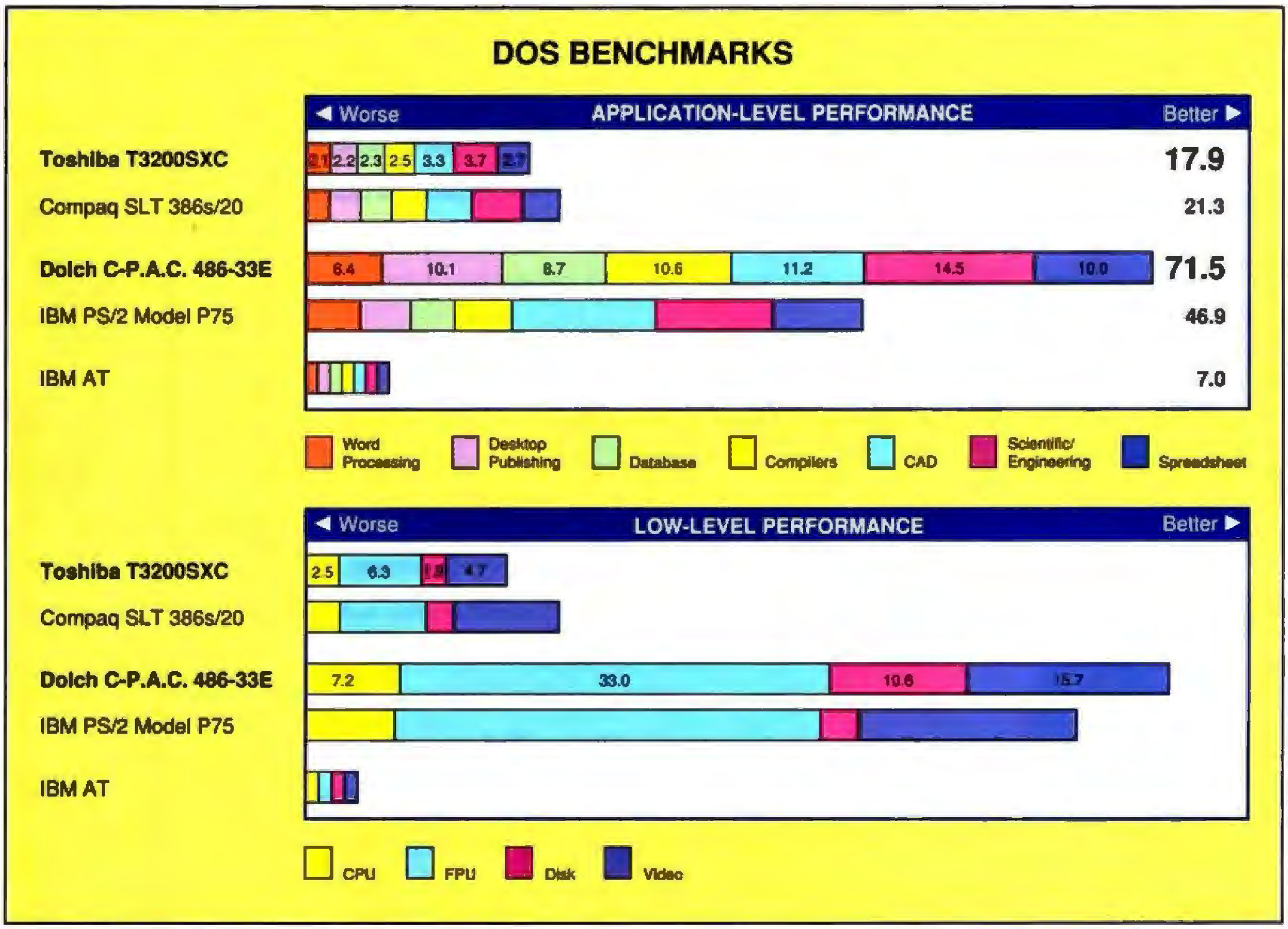

CONVENTIONAL BENCHMARKS

	LINPACK (single) (MFLOPS)	Dhrystones (Dhry./sec.)
Toshiba T3200SXC	0.14630	6047
Dolch C-P.A.C. 486-33E	0.89210	26506
IBM PS/2 Model P75	0.88440	25489
Compaq SLT 386s/20	0.15530	7935
IBM AT	0.02105	2318

For application and low-level benchmarks, results are indexed and show relative performance; for each individual index, an 8-MHz IBM AT running MS-DOS 3.30 = 1. For all benchmarks, higher numbers indicate better performance.

The BYTE low-level benchmark suite identifies relative performance at the hardware level; the application benchmarks evaluate real-world performance by running a standard test suite using commercially available applications. Application indexes include tests using the following programs: Word Processing: WordPerfect 5.0; Desktop Publishing: Aldus PageMaker 3.0; Database: Borland Paradox 3.0 and Ashton-Tate dBase IV; Compilers: Microsoft C 5.1 and Turbo Pascal 5.5; CAD: AutoCAD release 10 and Generic CADD level 3 1 1.5; Scientific/Engineering: Stata release 2, MathCAD 2.5, and PC-Matlab 3.5f; and Spreadsheet: Lotus 1-2-3 release 3.0 and Microsoft Excel 2.1

The BYTE Lab introduced version 2 of the DOS benchmarks in the August 1990 issue (see "BYTE's New Benchmarks: New Looks, New Numbers"). Benchmark results for machines reviewed under previous versions aren't directly comparable. To obtain a copy of the benchmarks, join the listings area of the byte.bmarks conference on BIX or contact BYTE directly.

The 486 C-P.A.C. and SX T3200SXC don't compete with each other in terms of performance. This review's purpose is to evaluate the relative quality of the color LCDs. The graph shows relative performance against comparable machines: IBM's Model P75 486 and Compaq's 386SX-based LTE 386s/20.

as CPU and disk, that the only legitimate point of comparison is the quality of the color LCDs. (Dolch did not have its 386SX system available in time for this review.) Of the two, the T3200SXC has the better display by a hair. Its viewing angle is slightly better, and the contrast is somewhat deeper.

Naturally, the color screens and solid performance of both of these portables invite comparisons with desktop machines. They feature a screen that's flatter than a CRT and just as bright, and they perform like the desktop systems in their class.

But the Toshiba T3200SXC and the Dolch C-P.A.C. also share some of the less desirable traits of desktop systems. Both of these machines are heavy: Toshiba's portable weighs 17 pounds, and Dolch's weighs 18 pounds. In addition, the computers require AC power. Finally, both systems are considerably more expensive than similarly equipped monochrome portables.

But each machine is good enough to make replacing your desktop system worth serious consideration. So if you do a good part of your work on the road, it may be time for you to say goodbye to your desktop machine and look into one of these. ■

Steve Apiki is a testing editor for the BYTE Lab. You can reach him on BIX as "apiki."

PC MAGAZINE
EDITORS' CHOICE AWARD

IDEK

IDEK — THE FIRST COMPLETE FAMILY OF FST COLOR MONITORS

PC MAGAZINE
EDITORS' CHOICE
March 26, 1991
Idek MF-5117

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IDEK's MULTIFLAT Series of 17-inch Color Monitors take full advantage of the remarkable properties of their Flat Square Tubes (FST) to deliver superior resolution and a sharper image that is easier on your eyes. A glimpse at our 17" Color Monitors reveals their matchless over-scanning capability that delivers a crisp, distortion-free display across the entire screen.
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Model	H. Frequency	Dot	Resolution
MF-5117	20 to 50kHz	0.28	1024 × 768
MF-5217	30 to 57kHz	0.28	1024 × 768
MF-5317 (Coming soon)	30 to 80kHz	0.28	1280 × 1280

MULTIFLAT Series (21" Flat CRT Monitors)

Model	H. Frequency	Dot	Resolution
MF-5021	15 to 38kHz	0.31	1024 × 768
MF-5121	21 to 50kHz	0.31	1024 × 768
MF-5221	30 to 80kHz	0.31	1280 × 1280
MF-5321 (A.R.Panel)	30 to 80kHz	0.31	1280 × 1280
MF-5421 (A.R.Panel)	30 to 80kHz	0.26	1600 × 1280

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IDEK Europe (Germany)
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(ULTRA model shown available as option)

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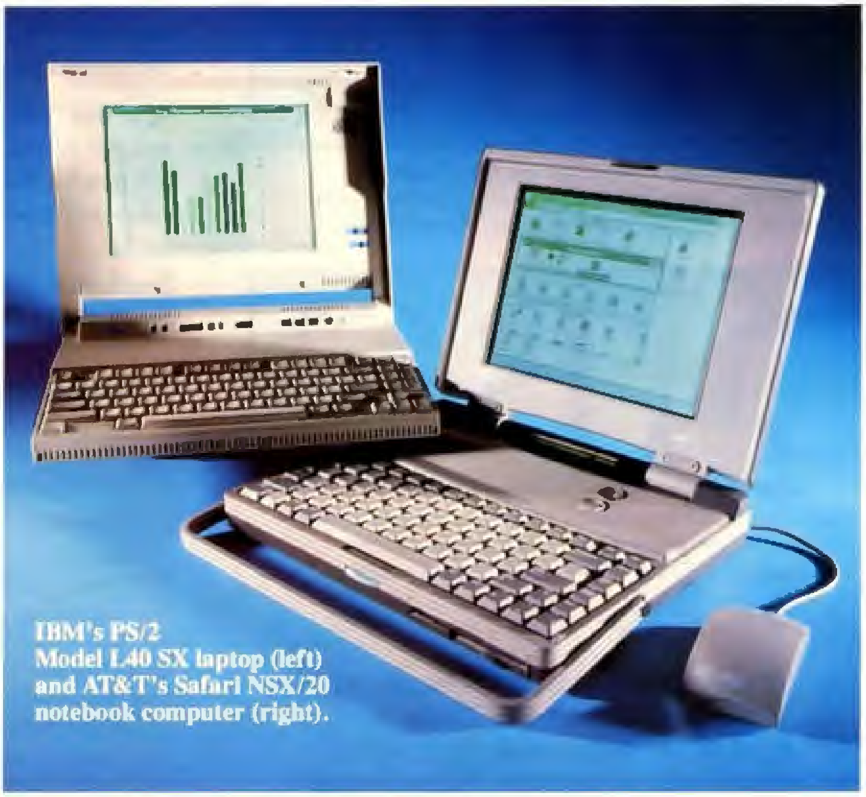
HARDWARE

IBM and AT&T Enter the Fray of 386SX Notebook Computers

ROBERT MITCHELL

IBM and AT&T are not the first vendors to introduce 20-MHz 386SX notebook computers, but each company has brought more than just a famous three-letter moniker to this new class of machines. The AT&T Safari NSX/20's svelte, neofifties design turned a few heads in the BYTE Lab, as did the system's "status-window" LCD panel—a feature it shares with IBM's new PS/2 Model L40 SX. Calling the Model L40 SX a notebook computer is stretching things a bit: The machine measures 12.8 by 2.1 by 10.7 inches. IBM clearly intends the system to compete in the category of 386SX notebook machines, however, and its keyboard makes good use of the extra space.

AT&T sees the Safari NSX/20 extending the reach of its AT&T Mail E-mail service by way of alphanumeric pagers and other wireless communications technologies (see the text box "AT&T's New Air Mail" on page 253). The Model L40 SX is IBM's first foray into a market long dominated by companies like Toshiba and Tandy.


IBM's PS/2 Model L40 SX laptop (left) and AT&T's Safari NSX/20 notebook computer (right).

IBM PS/2 Model L40 SX

If IBM's newest PS/2 is too big to be called a notebook computer, the keyboard is worth every extra inch. The Model L40 SX's full-function and full-size Enhanced AT keyboard boasts 84 keys; the standard 17-key external numeric keypad completes the 101-key arrangement. The 5-degree typing angle and good key response compensate for a short key travel to make this one of the best keyboards I've seen for a machine in this class.

The Model L40 SX's sidelit supertwist LCD screen is disappointing, however. The 10-inch VGA display supports 32 gray scales but suffers from considerable image streaking, and it is difficult to adjust. Competing displays are far better; there's simply no reason today to settle for a display of this poor quality.

The base system comes configured with 2 megabytes of RAM, a high-density 3½-inch floppy disk drive, and a 60-

SYSTEM CONFIGURATION AS TESTED

	AT&T Safari NSX/20	IBM PS/2 Model L40 SX
Processor	20-MHz 386SX; socket for 387SX	20-MHz 386SX; socket for 387SX
Memory	4 MB of RAM	6 MB of RAM
Mass storage	40-MB hard disk drive; high-density 3½-inch floppy disk drive	60-MB hard disk drive; 3½-inch 1.44-MB floppy disk drive
Display	10-inch electroluminescent backlit triple-supertwist VGA LCD; 32 gray scales; status-window LCD	10-inch sidelit supertwist VGA LCD; 32 gray scales; 10 status-window LCDs
Keyboard	82 keys; numeric keypad overlay	84 keys; external numeric keypad
I/O interfaces	Serial, parallel, external monitor, and PS/2 mouse/keyboard ports; AT-bus interface	Serial, parallel, PS/2 mouse, numeric keypad, and external monitor ports; AT-bus expansion connector
Size	12 by 1.8 by 9.5 inches; 7.3 pounds	12.8 by 2.1 by 10.7 inches; 7.7 pounds
Other	Windows 3.00a; DOS 4.01; bus mouse; 2400-bps internal modem; carrying case; handle	2400-/9600-bps data/fax modem

AT&T's New Air Mail

The newest AT&T Mail/EasyLink gateway, which reportedly will be available later this year, will give remote users who have a Telefind alphanumeric pager instant access to their E-mail messages. The pager holds up to 11 510-character messages. You can read messages on a small 16-character display or upload them into the Safari through the serial port and respond to them just as you would to any other AT&T Mail message. Pager users can configure their AT&T Mail mailbox to forward messages to their pager automatically. The system truncates long messages, but your AT&T Mail mailbox can hold a complete copy for you.

AT&T estimates the cost of the service at 75 cents to $1 per message; the pager sells for approximately $350. The service is a joint venture with Telefind (Coral Gables, FL), which routes messages between different paging service areas across the country. If you don't have an AT&T Mail account, you can call Telefind directly to send a short message.

The new service has one drawback: Pagers can only receive messages. AT&T expects to unveil two alternatives in 1992—based on packet radio and cellular technology—that will provide two-way communications for AT&T Mail users who don't have access to the public telephone network.

MB hard disk drive. IBM also throws in an external power supply, a numeric keypad, and a soft carrying case for $5995. The system I tested included an internal 2400-/9600-bps data/fax modem ($695) and an extra 4 MB of RAM ($1995). The system has the usual complement of I/O ports and includes an AT-bus expansion connector for IBM's planned docking station.

Ten status-window LCDs above the keyboard indicate keylock states, disk access, and battery-charge level. Special icons flash when the temperature or humidity exceeds the operating range (41 to 95 degrees or 5 percent to 95 percent, respectively). The icons aren't all intuitive, and some flash too quickly before going black again. Status-window labels would help.

Power management features include setup options for the hard disk drive and the display time-outs, a front-mounted switch that puts the CPU into 2-MHz low-power mode between keystrokes, and a suspend/resume mode similar to that of Toshiba's notebook computers. With this function, you can close the unit and even change the battery, if needed, without having to save files or exit a program. When you reopen the Model L40 SX's cover, however, the computer requires almost 30 seconds to restore operations.

During BYTE's battery-life tests, which disable all power-conservation functions, the system's nickel-cadmium battery lasted 1 hour, 54 minutes—far shorter than the times of the AT&T Safari, Compaq LTE 386s/20, and Toshiba T2000SX machines. With a recharge time of 10 hours, you'll want IBM's 4-hour quick charger ($219) and an extra battery ($129).

The Model L40 SX performed at about the middle of the pack in BYTE's low-level and application-level benchmarks. (For more information on the Compaq and Toshiba notebooks, see "No-Compromise Notebooks with 386SX Power," June BYTE, and "Perfectly Portable," February BYTE.)

AT&T Safari NSX/20

The Safari NSX/20 earns praise for more than its appearance; AT&T has loaded the standard configuration with 2 MB of RAM, a 40-MB hard disk drive, a mouse, and a 2400-bps V.42/MNP level 5 modem. AT&T also preinstalls DOS 4.01, Windows 3.00a, Windows Productivity Pak, and AT&T Mail Access Plus. If you send in the product registration forms, AT&T will send you a carrying handle and slipcase.

Given all these features, it's not surprising that the Safari sells for $5399—on a par with the Texas Instruments TravelMate 3000. The machine I tested included a proprietary 2-MB memory card ($795) that slides right into the side of the unit.

BYTE ACTION SUMMARY

- **WHAT THE IBM PS/2 MODEL L40 SX AND THE AT&T SAFARI NSX/20 ARE**
  Unique new competitors in the 386SX notebook computer arena.
- **LIKES**
  Fans of IBM's clicky Enhanced AT keyboard will love the Model L40 SX's 84-key keyboard and external numeric keypad. The Safari's display is outstanding; it's one of the few LCDs that work acceptably with Windows 3.0.
- **DISLIKES**
  You may find the Model L40 SX's display quality unacceptable.
  The Safari's keyboard is a bit stiff for touch-typing.
- **RECOMMENDATIONS**
  The Safari's display makes it an excellent, but expensive, machine for running Windows 3.0.
  For other applications, competing machines that BYTE has reviewed offer good displays and comparable or better performance for less money.
- **PRICE**
  Model L40 SX base system, $5995; system as tested, $8685;
  Safari base system, $5399; system as tested, $6194
- **FOR MORE INFORMATION**

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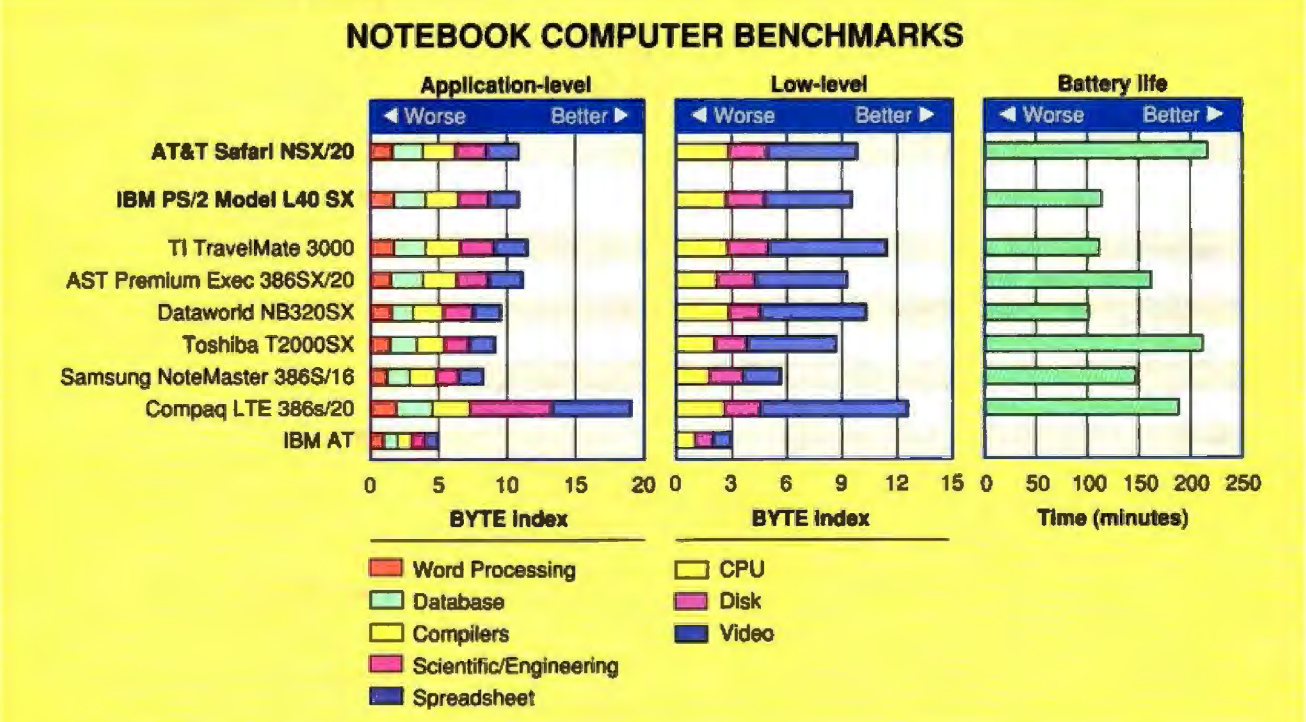
The system's full-travel keyboard feels less responsive and somewhat stiff compared with the looser, clicky keyboard of the Model L40 SX; the Model L40 SX's is faster for touch-typing. The Safari's 82-key layout doesn't match that of the Model L40 SX but is quite good for



The notebook computer benchmark suite includes a battery-life test, the standard low-level benchmarks, and a modified version of the standard application-level benchmarks. We run the battery-life test with all power-conservation functions disabled. Results of the battery-left test are in minutes. For all other benchmarks, the results are indexed and show relative performance; for each individual index, an 8-MHz IBM AT running MS-DOS 3.3 = 1.

For details on the notebook computer benchmarks, see "From the Testing Notebook," page 152, February BYTE.

a notebook computer. It includes 12 half-size function keys; arrow keys in an inverted-T configuration; and separate PageUp, PageDown, Home, and End keys. The Fn key controls keylock status and the embedded numeric keypad, toggles the machine into sleep mode, brings up the setup menu, and toggles the display to inverse video or to an external monitor.

The Safari notebook's trump card is its 10-inch triple-supertwist Sharp VGA LCD screen. Electroluminescent backlighting, 32 gray scales, and a wide viewing angle make for an outstanding display that easily equals that of the TI TravelMate 3000. The Safari drives an external monitor at a resolution of up to 800 by 600 pixels by 16 colors.

The system's status-window LCD has icons for power-source and battery-charge state, keylock status, and floppy disk and hard disk access. Its other icons include an envelope that appears when you have E-mail waiting and an owl that closes its eyes when you put the Safari into sleep mode.

From the setup screen, you can set time-outs for the hard disk drive, keyboard, and display or turn off power to the modem and I/O ports. The CPU automatically steps down into 2-MHz sleep mode during periods of inactivity. Changes made in the setup screen take effect only after you reboot the machine. The Master Control utility lets you adjust the power management functions on the fly from a menu or from the command line. You can, for example, write a batch file that enables power to the modem before it runs AT&T Access Plus and then shuts it down when you exit the application. The utility also provides extensive display controls and a video "fast mode" that expands video memory to dramatically improve performance.

The system runs on two nickel-cadmium batteries that bring the total system weight to just 7.7 pounds. The dual nickel-cadmium batteries held out for 3 hours, 37 minutes in the BYTE battery-life benchmarks, edging out the Toshiba T2000SX's nickel-hydride battery by a few minutes. A full recharge takes 6 hours; AT&T plans to offer a 2-hour fast charger. The Safari performed on a par with the Model L40 SX on the BYTE benchmarks. We did not enable the video fast-mode setup option, because AT&T warns that it may not be compatible with all applications.

Choosing a Machine

The IBM PS/2 Model L40 SX's excellent keyboard just can't compensate for its inadequate display, short battery life, and high price. Compare the Model L40 SX ($5995) to the similarly equipped Safari ($5399), the Toshiba T2000SX ($4298), and the superfast Compaq LTE 386s/20 ($4799).

The AT&T Safari NSX/20 makes a good, but expensive, machine for Windows 3.0 and AT&T Mail users. I'd choose it over the smaller and slightly faster TravelMate 3000 ($5499), which has a comparable display but a shorter battery life. Otherwise, you may want to consider the Compaq LTE 386s/20 or Toshiba T2000SX. Both have good keyboards and displays and good battery life—and sell for less than the Safari. ■

Robert Mitchell is a technical editor for the BYTE Lab and specializes in system evaluations. You can reach him on BIX as "rob_mitchell."

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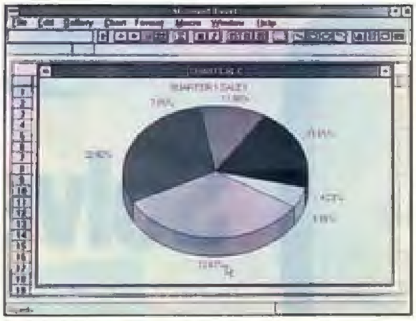

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JONATHAN AMSTERDAM

TAKING EXCEPTION TO C

Ordinarily, C doesn't provide exception handling; here's how you can add it

Hope for the best and prepare for the worst. Not a bad motto for programming. But living up to it can mean a lot of convoluted code. Your job is easier and your source code simpler if you have some form of exception handling.

In programming terms, an exception is any interruption in the normal flow of a program. Common exceptions are division-by-zero, stack overflow, and disk-full errors, and I/O with a file that isn't open. The quality of a program depends on how completely it checks for possible errors and deals with them. Code used for trapping errors can be excessive, and it certainly gets in the way of the readability of the normal program flow. Exception handling lies outside the code for normal operations. Many languages (e.g., PL/I, Ada, and a proposed new version of C++) have it built in. Even though C doesn't have exception handling, you can implement the concept in your C programs.

The Yikes Syndrome

At one time or another, you've probably been the victim of your own wishful thinking. For example, you'd like to read something from a file, so you write:

```
FILE *f;

f = fopen(filename, "r");
read_stuff(f);
fclose(f);
```

This works fine, until you try to open a file that doesn't exist, or that you don't have read permission for, or that has any other problem. Then, fopen returns NULL, and your program dies ignominiously. Yikes!

It's clear what's happened. You didn't want to take the time to check for errors, so you engaged in a bit of wishful thinking: Nothing will go wrong with *my* program. Of course, you should have written something like the following:

```
FILE *f;

if ((f=fopen(filename, "r"))
      == NULL)
{
      fprintf(stderr,
        "Could not open file %s\n",
        filename);
      exit(1);
}
else
{
      read_stuff(f);
      fclose(f);
}
```

continued

That's closer to being correct (though you don't check for errors while reading or closing the file), but it's cumbersome, it's ugly, and it obscures the "normal," nonerror case that was expressed so clearly in the original code. Worst of all, you have to type in all that extra code every time you do anything that could potentially result in an error.

Here's one way out, at least for this example. Write your own version of fopen to do the error checking:

```
FILE *file_open(char *fname,
    char *type)
{
    FILE *f;

    if ((f=fopen(fname, type))
      == NULL)
    {
      fprintf(stderr,
        "Could not open file
          %s\n",
          fname);
      exit(1);
    }
    else
      return f;
}
```

Since file_open is guaranteed to return a valid file pointer if it returns at all, you can now safely use the original code, replacing fopen with file_open.

This is a reasonable solution for quick-and-dirty programs that can easily be rerun if they fail. But in many other situations, you'll want to do something more polite than exiting: You may want to enter another filename, or try a different filename from a list, or simply proceed, ignoring the error.

It's not feasible to write a version of file_open for each possibility, but, on the other hand, it's painful to have to put in the error-checks all the time. If fopen were the only place where this problem came up, it would be no big deal. But the same issue crops up with file I/O, dynamic memory allocation, arithmetic (overflow and division by zero), and elsewhere. The problem is how, in the face of all these potential errors, to write clean code that checks for errors and handles them flexibly.

Exception Handling

You can have an exception-handling mechanism for C by combining C's nonlocal goto feature with some clever macrology. But first, to get an idea of what a good exception-handling facility looks like, consider Ada. In Ada, you could write your file like this:

```
f: IN_FILE;
begin
    OPEN(f, filename);
    read_stuff(f);
    CLOSE(f);
exception
    when NAME_ERROR = >
      PUT("Filename error");
      - maybe ask user for
      - another filename
    when DEVICE_ERROR = >
      PUT("Device error");
      - do something
        appropriate
    when others = >
      - do something here
end;
```

Here's how it works: If no exceptions are encountered while the code is executing between begin and exception, then execution continues after end. If an exception does occur, then control transfers to the code (i.e., the exception handler) after exception, where appropriate action is taken depending on the kind of exception. After the exception handler is run, execution continues after end. Ada defines several kinds of exceptions for file, numeric, memory allocation, and other errors. I've shown a couple to give you the gist. (Ada also allows you to define your own exceptions.)

You can see that Ada's exception-handling mechanism clears up one problem: You can now separate the normal execution path from the error checking. Programs are easier to read, because the error-checking code has been relegated to the status of a footnote, instead of cluttering up the main program text. But are programs any easier to write? Don't you still have to write error-handling code wherever you think an exception may happen?

No, you don't. Say you were writing a quick-and-dirty program and decided to leave off the error checking:

```
f: IN_FILE;
begin
    OPEN(f, filename);
    read_stuff(f);
    CLOSE(f);
end;
```

You would *not* get a "Bus error–core dumped" message if an error occurred during OPEN. Instead, the program would abort with a message like "Unhandled exception: NAME_ERROR"—not an ideal message, but it beats dumping core.

Ada avoids generating a bus error, because it never calls read_stuff with an invalid file. Instead, OPEN notices the error and raises an exception. In Ada, when an exception is raised, it propagates up the call stack looking for a matching exception handler. If it doesn't find one, the program aborts with an "Unhandled exception" error message.

Because a raised exception searches the entire call stack, it's not necessary to put exception handlers everywhere an error might occur. For instance, if the main body of your quick-and-dirty Ada program looked like this:

```
begin
    - do normal processing
exception
WHEN NAME_ERROR = >
    PUT("I'm sorry, but");
    PUT("something was wrong");
    PUT("with the name of a
         file.");
WHEN others = >
    PUT("I'm sorry, but");
    PUT("an error occurred.");
end
```

you would at least have a program that apologized before it died. The exception raised by OPEN would propagate to OPEN's caller, then to the caller of that procedure, and so on, until it reached the handler.

You should now be convinced that exceptions are a pretty good solution to the error-handling problem. They factor out normal processing from error processing; they allow flexible treatment of errors, since handlers can contain any code; and they reduce the amount of error code that needs to be written, because handlers occur only at certain crucial places in a program. So, how do you do it in C?

Exceptions in C

Exception handling in C looks and works much like it does in Ada. You will be able to write code like:

```
WITH_HANDLING {
    f = file_open(filename,
      "r");
    read_stuff(f);
    file_close(f);
} ON_EXCEPTION {
    fprintf(stderr,
"Error while reading file
      %s\n",
      filename);
    exit(1);
} END_HANDLING;
```

Exceptions will propagate up the call stack looking for handlers. If none are found, you will receive an "Unhandled

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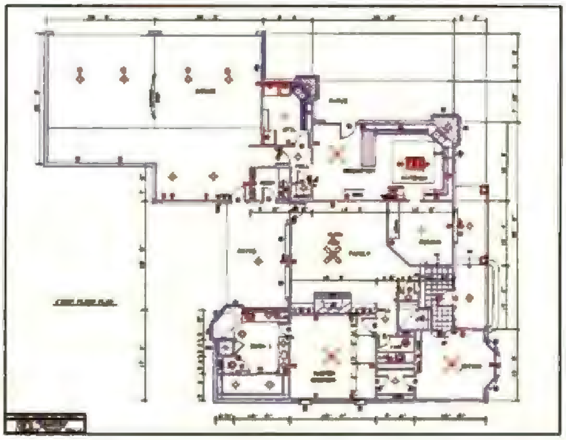

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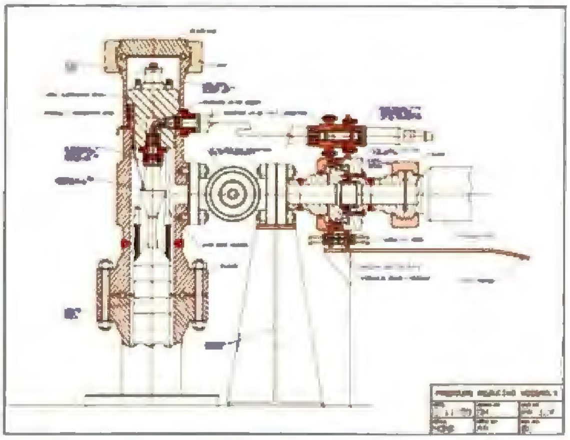

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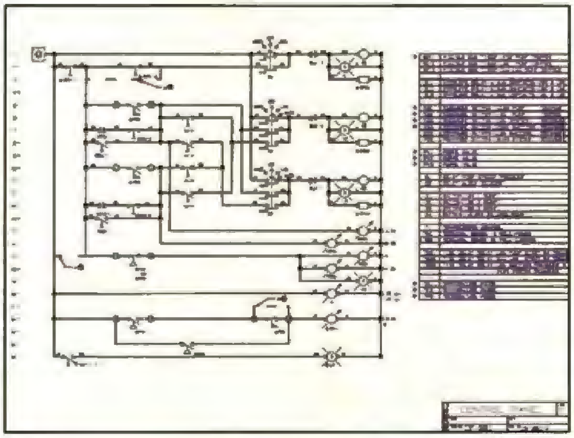

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Listing 1: *You can distinguish between different kinds of exceptions using standard C constructs. This code prints a message in response to the error type.*

```
WITH_HANDLING {
  f = file_open(filename, "r");
  read_stuff(f);
  file_close(f);
} ON_EXCEPTION {
  if (theException == FileOpenError)
    fprintf(stderr, "Error opening file %s\n", filename);
  else if (theException == FileReadError)
    fprintf(stderr, "Error reading file %s\n", filename);
  else if (theException == FileCloseError)
    fprintf(stderr, "Error closing file %s\n", filename);
  else
    reraise();
  exit(1);
} END_HANDLING;
```

exception" message. Note that the example uses `file_open` and `file_close`, which you must write. The `file_open` statement looks like it did before, but instead of exiting, it raises an exception:

```
FILE *file_open(char *fname,
    char *type)
{
    FILE *f;

    if ((f=fopen(fname, type))
      == NULL)
      raise(FileOpenError);
    else
      return f;
}
```

You can distinguish between different exceptions. In the code after `ON_EXCEPTION`, the global variable `theException` is set to the exception that occurred. You use standard C constructs to examine it.

The code in listing 1 prints a message and dies if the error is a file error but leaves processing of other exceptions to other handlers by using the `reraise` function to raise the exception again. A `raise` or `reraise` that occurs within a handler is not trapped by that handler but proceeds to the next one up on the stack. To declare an exception, you declare a global variable using the `exception` data type and give it a string value:

```
exception FileOpenError =
    "File open error";
```

In fact, exceptions are just strings, and `exception` is equivalent to `char *`. Using numbers for exceptions would allow the use of `switch` statements in exception handlers but would require a mapping between numbers and strings. If exceptions *are* strings, that mapping is automatic. Note that the equality checks are no more expensive for your exceptions than they are for numbers, because you are comparing the addresses of the strings and not their contents.

Implementation

There are two problems in implementing the mechanism just described: You have to devise a way—ideally, a portable way—of searching the stack for exception handlers, and you have to introduce the `WITH_HANDLING` syntax into C. You solve the first problem with C's `setjmp` mechanism and the second with macros.

C provides a powerful and portable mechanism for nonlocal control-flow in the form of two procedures: `setjmp`, which marks a point to which control can return, and `longjmp`, which jumps to that point. Here's how these functions might be used for the file-error example:

```
#include <setjmp.h>

jmp_buf jb;

read_file(char *filename)
{
    FILE *f;

    if (setjmp(jb) == 0) {
      f = file_open(filename,
        "r");
      read_stuff(f);
      file_close(f);
    } else {
      fprintf(stderr,
"Error while reading file
        %s\n",
        filename);
      exit(1);
    }
}

FILE
*file_open(char *fname,
    char *type)
{
FILE *f;

if ((f=fopen(fname,
      type)) == NULL)
    longjmp(jb, 1);
else
    return f;
}
```

If you are unfamiliar with the `setjmp` mechanism, you will probably find this code confusing. The call to `setjmp` saves information about the current state of the computation in the global variable `jb`, whose type `jmp_buf` is declared in the `setjmp.h` header file. The `setjmp` procedure then returns 0. If `file_open` discovers an error, it executes `longjmp` with the same `jmp_buf` `jb`. The weird part is that `longjmp` causes `setjmp` to return *again*—this time with `longjmp`'s second argument, 1, as a return value. Hence, the error-handling code in `read_file` will be executed. If `longjmp` is never executed, `setjmp` behaves normally, and the error-handling code is skipped.

As should be clear, the `setjmp` mechanism goes a long way toward solving the problem: It allows you to portably "unwind" the stack to an earlier point. But `setjmp` is too low-level. You have to declare a `jmp_buf` for each distinct use of `setjmp`, and C gives you no way of stacking these `jmp_buf`s to allow the kind of repeated unwinding that `reraise` needs. Also, `setjmp` is dangerous. Nothing prevents you from calling `longjmp` with an invalid `jmp_buf`—one that was established by a `setjmp` whose procedure has already returned. The result of doing this is unpredictable and probably fatal. Like `goto`, the `setjmp` mechanism is too powerful. You can view exception handling as a kind of structured `setjmp`.

Taming by Stacking

You can begin taming `setjmp` by developing a way to stack `jmp_buf`s. The idea is that each time you want to invoke `setjmp`, you create a new `jmp_buf`, push it onto the stack of `jmp_buf`s, and then call `setjmp`. A call to `longjmp` uses the top `jmp_buf` on the stack and then pops the stack. This method correctly implements the desired semantics for exceptions, since `longjmp` will go to the most recently established handler.

Here's one way of implementing the `jmp_buf` stack:

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```
jmp_buf
  jb_stack[MAX_JB_STACK_SIZE];
```

An array will work fine, and it's easy, but it makes me ill at ease. I dislike arbitrary limits, and MAX_JB_STACK_SIZE is an arbitrary limit. How big should it be? 10? 20? What if I have a recursive procedure that establishes a handler on each call? Now how big should it be?

Instead of using a fixed-size stack, you can use a linked list with this structure:

```
typedef struct jbr {
      jmp_buf jb;
      struct jbr *next;
    } jmp_buf_rec;
```

Whenever the program needs a new stack element, it must allocate one; when it's through with the element, it should free it. The stack can grow as big as memory allows, but it is mildly annoying that the program needs to allocate and free these jmp_buf_recs all the time. And malloc and free are not the fastest functions in the world. Although it's not a big deal, it would be nice if you could avoid that sort of allocation, especially since jmp_buf_recs are going to be parceled out in a stack discipline with the last one allocated being the first one freed. If only you could find a stack on which you could do the allocation...

How about the C stack? Why not thread the linked list of jmp_buf_recs right through the stack that C uses to save local variables and other function-call information? It sounds grungy and implementation-dependent, but it isn't at all. You simply make each jmp_buf_rec a local variable, like so:

```
jmp_buf_rec *cur_rec = NULL;

f()
{
    jmp_buf_rec jbr;
    ...
    push_jbr(&jbr);
    ...
    pop_jbr();
}

push_jbr(jbr);
jmp_buf_rec *jbr;
{
    jbr->next = cur_rec;
    cur_rec = jbr;
}

pop_jbr()
{
    cur_rec = cur_rec->next;
}
```

The global variable cur_rec points to the top of the stack, push_jbr adds a record to the stack, and pop_jbr removes a record. C automatically allocates the storage for the records.

A remaining annoyance is that the local variable jmp_buf_rec is at the beginning of the function, separated from the pushing and popping. You won't be able to write a WITH_HANDLING form, but you must declare the jmp_buf_rec.

A seldom-used C feature provides the solution: Declarations may occur inside any block (i.e., any open brace). Instead of declaring the variable at the top of the function, you create a block in the middle and declare it there, next to the push.

```
f()
{
    ...
    /* start a new block */
    {
      /* create the record */
      jmp_buf_rec jbr;

      push_jbr(&jbr);
      ...
      pop_jbr();
    }
}
```

Note that you must close the block after the pop. You can rewrite the read_file function as shown in listing 2.

All you have to do is package this method in a more palatable syntax using macros. In listing 2, the lines marked with a 1 constitute the WITH_HANDLING macro, those that have a 2 constitute the ON_EXCEPTION macro, and the crucial close braces are taken care of with END_EXCEPTION. (The macros are defined, so that multiple statements between them do not need to be surrounded by braces—but I do so as a style quirk.) The actual definition of WITH_HANDLING (shown in listing 3) differs from the above: First, the jmp_buf_rec variable begins with an underscore to minimize conflict with a programmer's variables; second, theException is set to NULL in case it had been set by a previous raise.

The last important piece of the implementation is raise:

```
void raise(ex)
exception ex;
{
    jmp_buf_rec *jbr;

    if (cur_rec == NULL) {
      fprintf(stderr,
"Unhandled exception: %s\n",
          ex);
      exit(2);
    } else {
      theException = ex;
      jbr = cur_rec;
      pop_jbr();
      longjmp(jbr, 1);
    }
}
```

If the stack of jmp_bufs is empty, raise exits the program; otherwise, it sets theException, pops the stack, and longjmps to the top jmp_buf.

This concludes the implementation. The entire code is shown in listings 3 and 4. As you can see, it's quite short—88 lines in all. I haven't written versions of fopen, fgets, malloc, and so on that raise exceptions on error, but they are easy to write.

Three Key Ideas

The exception-handling system is a nice example of how to take a low-level feature—in this case setjmp—and make it convenient and palatable by exploiting some simple but powerful ideas. Following are the three ideas I've used:

The C stack. If your allocation pattern mirrors the function-call pattern of your program, you can use C's automatic stack allocation to do your work for you.

Internal blocks and local variables. By setting up a block inside a function and declaring variables within it, you can keep the different parts of a mechanism in one place, paving the way for matching macros.

Matching macros. Macros that occur in matching pairs (e.g., WITH_HANDLING and END_HANDLING) beef up C's already-powerful macro facility.

This third idea is so important and useful that I want to provide two more examples of it. First, I haven't yet discussed three macros in listing 3: UNWIND_PROTECT, ON_UNWIND, and END_UNWIND. These provide an interface to the exception-handling mechanism that allows for cleanup code to be executed even if a procedure exits abnormally. Again, file handling is a good illustration. Say you want to open, process, and close a file, but you are not interested in catching errors. However, you do want to be sure that the file is closed, whether or not an exception occurs. You can do this by writing the following:

```
UNWIND_PROTECT {
    f = file_open(filename);
    process(f);
} ON_UNWIND
    fclose(f);
END_UNWIND;
```

continued on page 332

DICK POUNTAIN

THE TRANSPUTER STRIKES BACK

In 1985, Inmos launched the T414 transputer, the world's first microprocessor built for parallel processing. The concept was simple: Put a CPU, some memory, and four fast DMA/serial-communications links onto a chip, and then hook many chips together and make them work in parallel. Ganging up conventional microprocessors in this fashion inevitably leads to a communications bottleneck as the chips contend for control of the bus. With transputers, you can be sure that computation power and communications bandwidth remain roughly in balance as the network grows, since each extra chip adds a bit of both.

Implementing the concept required what was then state-of-the-art silicon technology. In its heyday, the 20-million-instruction-per-second T414 was the fastest 32-bit microprocessor on the market, and its 2-million-floating-point-operation-per-second cousin, the T800 (launched in 1987), held a similar honor for a while. Recently, however, new RISC and CISC processors from Sun, Mips Computer Systems, and Intel have obliterated this performance edge; for example, Intel's 860 easily outruns the T800, and some parallel computer vendors have switched to the 860 despite its conventional bus-based communications (see "Personal Supercomputing with the Intel i860," January BYTE).

Now Inmos strikes back with the IMS T9000, the first of a new generation of transputers. Once again pushing fabrication technology to its limits, Inmos has come up with a design that delivers 200 MIPS and 25 MFLOPS (at 50 MHz) and features greatly improved communications technology. Even better, while the T9000 uses CPU caching and superscalar parallel execution of multiple instructions (as does the 860), it doesn't require supersmart compilers or assembly language wizardry. Code compiled for older transputers should run on the T9000 at near-optimal speed.

A new, superscalar packet-switching version of the Inmos transputer—the T9000—should give RISC chips a run for their money

Equally revolutionary is the T9000's new packet-switched "virtual" communications system, which takes the responsibility for routing messages from the programmer's code and moves it to fast hardware, where it belongs. This innovation promises communication delays of only a few microseconds, even across networks containing 1000 or more processors. By contrast, routing done in T800 software exhibits delays of hundreds of milliseconds.

The T9000 is built on a 180-square-millimeter die and incorporates 2 million transistors. For comparison,

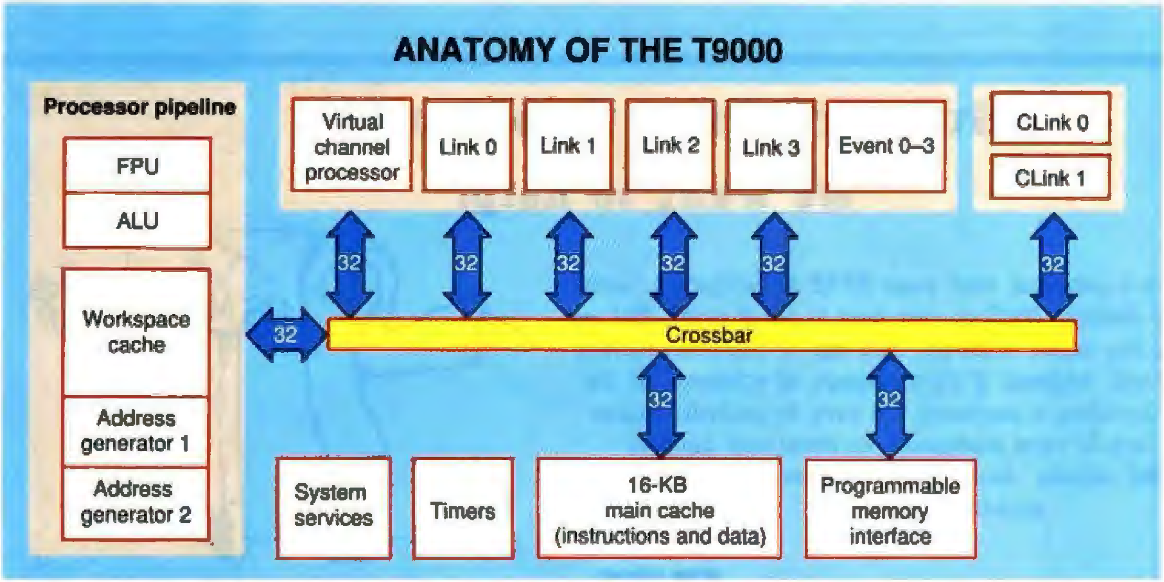

Figure 1: *With four independent data paths, Inmos's T9000 can compute and communicate simultaneously at high speeds.*

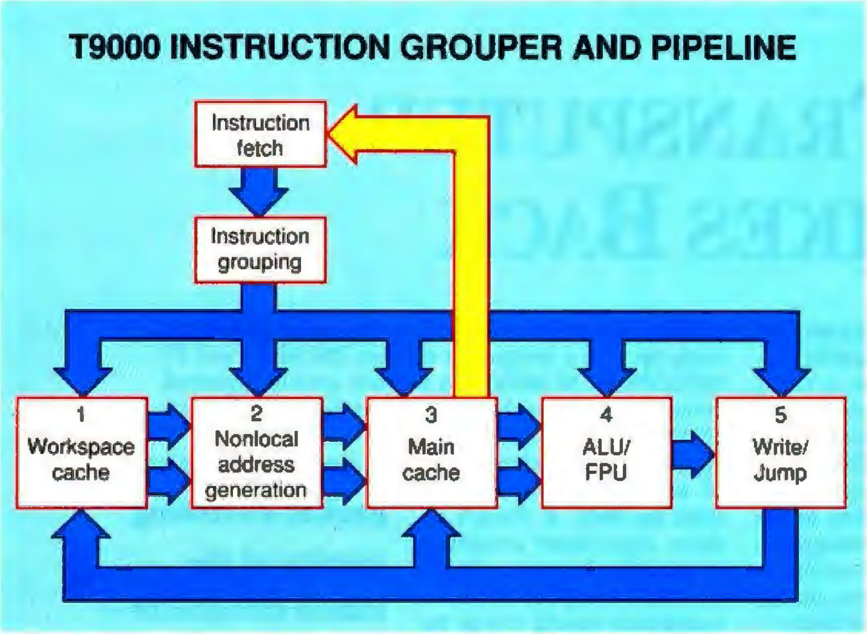

Figure 2: *The grouper automatically fills the five-stage pipeline.*

Intel's 486 and 860 each have about 1 million transistors. Inmos is using a new submicron CMOS fabrication process that employs three metal layers and tungsten plugs for interconnection. NEC recently announced a similar process (see Microbytes, May BYTE).

The T9000's Anatomy

The main functional units on the chip (see figure 1) are the 32-bit-integer processor core, a 64-bit FPU, 16 kilobytes of CPU cache memory, four serial-communication-link engines, a virtual channel processor (VCP), and a programmable memory interface (PMI). There are also two on-chip timers, four pairs of event channels for synchronizing internal processes with external events, and two control links that allow control signals to be sent between T9000s independently of the data links. The control links facilitate error handling, network configuration and analysis, bootstrapping, and resetting. An on-chip phase-locked loop generates all the high-frequency clock signals needed by the chip's subunits, so the chip needs only a single 5-MHz external clock signal.

Running down the center of the chip like a spine and connecting all these subunits together is a crossbar switch that controls four completely separate 32-bit data paths. These paths connect four subunits—the CPU, the VCP, the PMI, and the process scheduler—to the four banks of the main cache. Without multiple data paths, the T9000 couldn't achieve the bandwidths that it needs. The 200-MIPS CPU needs an instruction and data bandwidth of some 600 megabits per second to keep it busy, while the VCP needs to be fed at a rate of 120 Mbps when communicating with other chips on all four links. The 16-KB cache is organized into four banks of 4 KB, each with its own 32-bit address and data buses. The crossbar arbitrates and switches the buses among the subunits in such a way that all four cache banks can be accessed simultaneously in every cycle, providing a total cache bandwidth of 800 Mbps. Both the CPU and the VCP have multiple ports into the cache memory; the CPU has three read ports and one write port. This architecture lets the T9000's CPU compute at a peak rate without reducing the communications bandwidth (and vice versa).

The main cache holds data and instructions. Each of its banks maps one quarter of the T9000's 4-gigabyte address space using 256 four-word lines, each with a 26-bit fully associative tag. One of these lines is always kept empty, to be filled with four words from memory whenever a cache miss occurs. The cache then chooses another line at random to become the new empty line; if this line is dirty (i.e., its contents have changed), it is immediately written back to memory, a stratagem that Inmos calls "early write-back."

You can program the T9000 cache to act as 16 KB of on-chip memory, for embedded applications with no external memory system, or as a hybrid with 8 KB of cache and 8 KB of on-chip memory.

CPU Pipeline and the Instruction Grouper

Like previous transputers, the T9000 uses a stack-based CPU architecture. Three 32-bit registers called Areg, Breg, and Creg act as a push-down hardware stack for expression evaluation. Most instructions implicitly look for their operands on the stack; for example, add takes the top two stack items and leaves their sum on top of the stack. The FPU also uses a three-stage stack with 64-bit registers called FAreg, FBreg, and FCreg, but it is the CPU that transfers floating-point values (whose addresses are formed on the CPU stack) between memory and the FPU stack.

There are three other registers: Next Instruction, Operand, and Workspace Pointer. The Next Instruction register is just the program counter, but on the T9000, it works through a 32-instruction fetch-ahead buffer and a pipeline.

The Operand register is where instructions and operands are constructed. To reduce code size, the transputer family employs a frequency-encoded instruction format. Single-byte op codes select the most common operations, while multibyte op codes formed with special prefix codes select unusual ones.

The Workspace Pointer points to the block of local variables in on-chip memory, which form the workspace for the current process. Transputers use an on-chip process scheduler for multitasking, a function that operating-system software usually performs. Because there is so little state to save for each process, the context-switching time for the transputer scheduler is less than a microsecond.

The T9000 is even more efficient than previous transputers, thanks to a separate 32-word buffer, called the workspace cache, that holds the 32 most-recently accessed local variables. The workspace cache is triple-ported, allowing two reads and one write per cycle, and it writes through to the main cache. Most of the time, local values can be accessed entirely within the CPU, effectively in zero cycles, without reference to

INSTRUCTION GROUPING FOR a[i+1] := b[j+15] + c[k+7];

In a single cycle, the T9000 executes an entire group of instructions.

Operation	Meaning	Pipeline stage
Group 1		
ldl j	Load local *j*	1
ldl b	Load local address of *b*	1
wsub	Calculate address of *b*[*j*]	2
ldnl 15	Load value of *b*[*j*+15]	2, 3
Group 2		
ldl k	Load local *k*	1
ldl c	Load local address of *c*	1
wsub	Calculate address of *c*[*k*]	2
ldnl 7	Load value of *c*[*k*+7]	2, 3
add	Add top two stack values	4
Group 3		
ldl i	Load local *i*	1
ldl a	Load local address of *a*	1
wsub	Calculate address of *a*[*i*]	2
stnl 1	Store into *a*[*i*+1]	2, 5

external memory or even to the main cache. Because the workspace cache is a circular buffer that doesn't need to be flushed during context switches or external interrupts, it imposes no interrupts.

The workspace cache is actually the first stage of a CPU pipeline that lets the T9000 issue several instructions per cycle. This so-called superscalar architecture appears in several other advanced microprocessors, most notably the Intel 860. By judiciously choosing the right instructions, the T9000 can execute several instructions in parallel.

Figure 2 illustrates the T9000's five-stage pipeline structure. Within a single clock cycle, the first stage (the workspace cache) can fetch two local variables, thanks to its triple porting; the second stage can compute two addresses for nonlocal variables or array elements; the third stage (the main cache) can load two nonlocal variables; the fourth stage can execute an ALU or FPU operation; and the fifth stage can perform a conditional jump or a write to memory. Many arithmetic instructions have been sped up enormously compared to the T800; for example, an integer multiply now takes two to five cycles (compared to 38 for the T800), and a 64-bit floating-point multiply takes three cycles (compared to 27 for the T800).

A problem with previous superscalar designs was that the ordering of instructions, crucial to efficient pipelining, was left to the programmer or the compiler

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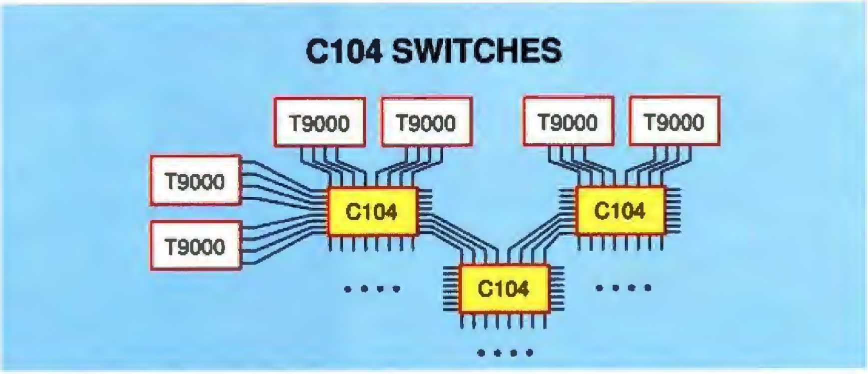


Figure 3: *The C104, with 32 links, can route 16 simultaneous conversations. It uses worm-hole routing and has a switching latency of just 700 nanoseconds.*

writer. Either way, tricky hand- or machine-generated code was needed to optimize instruction order for the pipeline. Smart compilers have been slow in arriving for the Intel 860, and that's been inconvenient for would-be developers.

Inmos's engineers chose a different strategy. The T9000's pipeline contains a hardware instruction grouper that automatically sorts the instruction stream into groups that can most efficiently execute together; the CPU actually executes one group per cycle. Consider this complicated assignment between array elements:

```
a[i+1] := b[j+15] + c[k+7];
```

The T9000 can execute this assignment in just three cycles by grouping the instructions, as shown in the table. The grouper can even cram in a couple of instructions from other surrounding routines at the same time; for example, the first group in the table does not use stages 4 and 5, so earlier instructions could occupy these stages.

Thanks to the grouper, compilers for the T9000 do not need to be supersmart, and code compiled for older transputers will run efficiently (typically 10 times faster than on a 20-MHz T800). This entire pipelining and caching system is transparent to the programmer, who just sees something that works like a T800, but faster.

Memory Interface and Protection

The PMI unit on the T9000 generates all the timing signals needed by DRAM-based memory systems, including multiplexed row/column addresses, refresh, and page-mode accesses. You can connect up to 8 megabytes of DRAM directly to the chip without any extra logic, and you can connect larger amounts with just some address and data buffers. The PMI automatically uses page-mode access for reads and writes from the same row address when page-mode DRAM is connected to it, so the T9000 can transfer a

whole cache line without resetting the row address. If 64-bit-wide DRAM is connected, the PMI will read an entire 16-byte cache line in two memory operations rather than four.

The PMI divides the total memory space into four banks (not necessarily the same as those allocated by the main cache), providing separate timing and decoding for each bank, and it sets the bus width to 8, 16, 32, or 64 bits. You can easily design mixed memory systems containing, say, DRAM, video RAM, ROM, and memory-mapped peripheral devices.

The transputer family was conceived primarily to support the model of concurrent processes communicating over channels, but there are other models of parallel computation, one of the most popular of which is shared memory. Shared-memory systems have an advantage when huge amounts of data need to be moved between processors. The T9000's PMI has a set of signals that control access to the memory system by external devices. System programmers can use these to implement shared-memory systems (or to control DMA-based coprocessors, such as graphics engines). Caching can present a problem for shared-memory systems, since one processor may write to a location that invalidates another processor's cache contents. The T9000 handles this situation by means of instructions that flush the caches when a synchronized shared-memory transfer takes place.

Also new with the T9000 is hardware support for shared resources, whether they be peripherals, such as printers, or processes running on a network server. A server automatically queues requests sent over several channels by clients. The server issues a `grant` instruction to connect the head of the queue to the resource when it becomes free. On older transputers, you had to handle this sort of shared access much less efficiently by using the `alt` instruction to poll all waiting channels.

The T9000 supports a degree of memory protection, although it falls short of full demand-paged virtual memory (that is slated for the next-generation chip in the mid-1990s). The protection scheme lets the T9000 check and translate addresses for four regions of memory that are sized independently. An operating system could treat these regions as stack, heap, code, and data spaces. You can implement the scheme within programs by launching special *P-processes* (via the `go-protected` instruction), each under the control of a normal parent process called a *supervisor*. A P-process can read from all regions but can only write to or execute code from regions for which it has permission to do so. Illegal access attempts by a P-process can trigger a hardware trap that returns control to the supervisor process (as does an error condition or the execution of a privileged instruction). After certain write traps, the supervisor can extend the size of a region and then restart the P-process. That's one way to implement dynamically allocated stacks.

Virtual Channels and Routing

The T9000, like its predecessors, has just four serial-communications links, although, at 100 Mbps each (in both directions), they are five times faster than in the T800. Older transputers communicated by a simple point-to-point byte stream. Programs were limited to just

eight channels per chip, and if you needed any more, you had to write explicit (and very tedious) code to multiplex your messages down these channels. The T9000's VCP changes all that. It's a packet-switching controller that chops messages up into 32-byte packets, with headers containing addressing information. The VCP interleaves packets from different processes down the same physical link, just the way Tymnet does, and these packets get reassembled at their destinations. Effectively, there's a continuous channel. Your programs can use as many of these "virtual channels" as they need, limited only by the maximum bandwidth of the links and your performance criteria.

Packet switching lets the VCP make far more efficient use of the links than the old transputers could. While any particular virtual channel is idle, messages from other processes can keep the same link busy. If one process sends a long message, shorter messages from other processes can be sent concurrently on the same link without waiting for the first to finish. The receipt of every packet is acknowledged by a return packet consisting of an empty header, and the sending process remains blocked until its last packet has been acknowledged. However, other processes can use the link while the blocked process waits, so the blocked process cannot monopolize the link.

For applications that use mainly nearest-neighbor communication (e.g., image processing), you can use T9000s by just connecting their links directly together. For programs that need more distant communication via a switched network, there is now a more efficient alternative: the T9000's companion routing chip, the IMS C104.

The C104 is a fast 32 by 32 nonblocking crossbar switch that can rapidly connect any one of its 32 links to any other. The topological possibilities are almost limitless. You could connect all four links of eight T9000s to a single C104, or to one link of 32 T9000s, or you can gang up C104s (see figure 3) to form even more complex topologies. You can also use the C100, a protocol conversion chip, to connect older transputers to the C104.

Implemented in the same advanced VLSI technology as the T9000, the C104 can have up to 16 messages passing between pairs of its links simultaneously, so for reasonably simple networks it has a negligible effect on the communications bandwidth. Its switching latency is typically 700 nanoseconds per chip traversed.

Unlike some routers, the C104 does not buffer whole messages or even packets, which would require a large amount of memory. Instead, it uses so-called worm-hole routing, where only the header of a packet is buffered on the chip. A routing decision is made according to the address information in the header, the crossbar is set, and then the body of the packet flows continuously through the chip from input to output. The header may well arrive at its destination before the tail has left the sender. As the tail of a packet passes through the network, the path closes up behind it, like a worm crawling through sandy soil.

The routing algorithm you use with the C104 is based on an interval-labeling scheme. You label each T9000 in the network with a unique address number, and every C104 stores the range (i.e., interval) of destination labels available. The C104 can then switch a packet to the correct link by making a single comparison, something like 6 ≤ header < 13. The label values are stored into C104 registers at boot time, using the T9000's control links.

Interval labeling is faster and requires far less on-chip memory than storing a full routing table, but it only works if the network is labeled in certain ways. Fortunately, there is always at least one complete labeling for any network, and a known algorithm that will find it. For many popular network topologies, including trees, grids, and hypercubes, there is a labeling that's guaranteed not to cause deadlock.

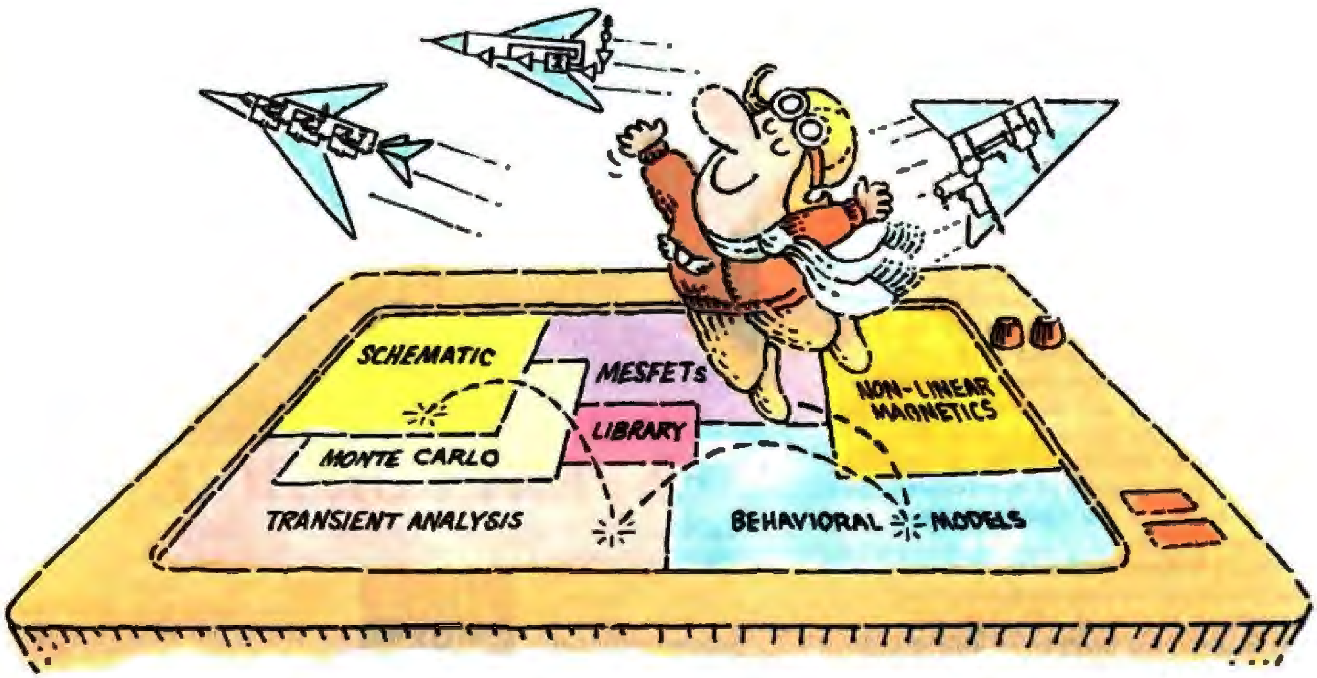
The C104 has several modes of operation that let you tune the performance of the network. In general, with single message headers, you won't know what actual route a particular message will take; however, you can tell the C104 to apply multiple headers, which get stripped off at each switch, to explicitly specify a route. Hot spots can arise if an application algorithm routes too many messages through the same switch; another C104 mode can eliminate hot spots by routing each message in two stages, via a randomly chosen "halfway house."

Building on a Solid Foundation

The T9000 displays the same elegance and rigor in its design as the original transputer and delivers far more power and flexibility. Like its predecessors, it could serve as a stand-alone workstation CPU, as a component for parallel supercomputers, or as an embedded real-time controller. Yet it begs for new uses; for example, the T9000 has enough communications bandwidth to capture digital TV or ISDN data streams in real time and still perform several computations on each datum. For more processing, you can add more T9000s in a scalable way. In applications such as real-time three-dimensional rendering for virtual reality, or as a color laser printer or fax engine, the T9000 should have a dramatic impact on the cost/performance ratio.

Unlike its predecessor, though, the T9000 is not entering the market cold. There is now a worldwide base of transputer expertise; software development tools such as ANSI C, C++, and Occam; and plenty of program code that will run straightaway on the new chip. With engineering samples of the T9000 due by the fourth quarter of this year, 1992 just might be the year of the transputer. ■

Dick Pountain is a BYTE consulting editor based in London. You can contact him on BIX as "dickp."



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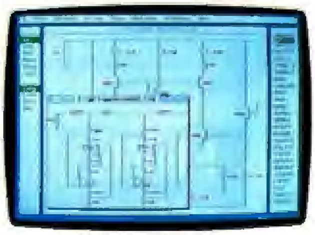
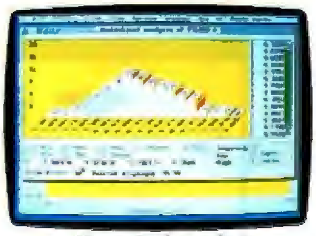


Schematic editor



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BARRY NANCE

KEYS, TREES, AND FONTS

This month's freebies let you capture keystrokes, manage directories, and preview typefaces

If computers are supposed to save time by automating repetitious tasks, why do they hold us hostage by making us press the same keys over and over again? I've often seen people fill the keyboard buffer with type-ahead keystrokes, then wait impatiently to enter more.

This month, Software Corner highlights a utility called Stuffit. Created by Terje Mathisen of Norway, documented by Roedy Green of Canada, and tested by BIX members worldwide, Stuffit plays back scripts of keystroke information into your applications.

You can use Stuffit to run lengthy file-conversion utilities over a weekend, to activate your tape backups after you go to bed, to reboot your computer at midnight, or to create canned demos of your software. During software development, you can use Stuffit to maintain *test suites* of situations and replay them to ensure that your software behaves properly. Use your imagination to create your own uses of Stuffit that save you time and effort.

What Makes Stuffit Special

Stuffit is different from other keyboard macro programs. First of all, it comes with source code, so you can add features and options if you want. Stuffit is also free; Mathisen only asks that you enjoy his software. This utility can watch the screen and respond decisively to prompts as they appear. The keyboard remains fully functional the entire time for additional manual input or correction.

Stuffit works with intractable programs that throw away keystrokes or bypass DOS. It can use your computer's clock to wake up your computer at any time of the day and run programs. Stuffit is able to handle large scripts (up to 64 kilobytes). And it lets you generate more keystroke combinations than many other keyboard buffer-stuffers.

You specify keystroke information on the command line or in a separate file of keystroke commands. By intermixing keystroke commands (which can include ASCII codes and their scan code equivalents), elapsed time commands, time-of-day commands, delay factors, and prompt strings, you make your computer work for you even when you're not there to baby-sit it.

Stuffit's hardware requirements are simple: You need a PC and less than 2 KB of RAM. If you want to change Stuffit, you'll need TASM, the Borland assembler product.

How It Works

When you press a key, a hardware interrupt (09 hexadecimal) occurs in the PC, and a keystroke code (scan code) is deposited in a buffer by the BIOS. When you release the key, the same interrupt occurs, but the BIOS doesn't do much with the information. When DOS or an application reads the keyboard, it's actually asking the BIOS, with a software interrupt (16h), to retrieve keystrokes from this buffer. Based on your commands, Stuffit pretends it is the BIOS hardware-interrupt handler and sneaks keystrokes into the buffer when appropriate.

I think you'll find that Stuffit becomes an oft-used item in your utilities toolbox . . . one with an international flair! ■

UNIX/Ben Smith

Plant a File Tree on Your Screen

Most Unix GUI-based file managers have a way of displaying a graphical map of the file tree. But if you are just running a character-based interface to your Unix machine, you have to build the map in your mind.

For those of us who prefer to see the map of subdirectories rather than just imagine it, there is `vtree` by Jonathan Bayer of Rockville Centre, New York. He has added to the work of David Hayes and Doug Gwyn (the developer of a library of "nearly-POSIX-compliant" directory-access routines) to produce a simple program that generates several different styles of file-tree maps.

One output format creates a graphical tree (very much like the MS-DOS file management programs). Another format uses simple indentation and reports on disk-block usage. Unlike the Unix utility du, this program ignores duplicate inodes that are created by links. It is often the little things that we appreciate the most.

MAC/Tom Thompson

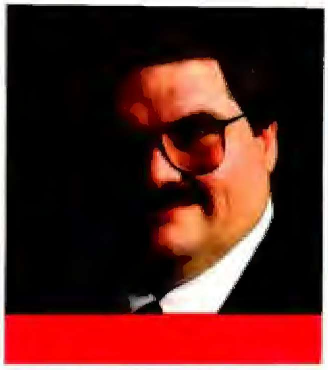
Preview Typefaces with Font Cascade

Apple's System 7.0 lets you have your cake and eat it, too. It supports TrueType, Apple's font-outline technology that displays or prints typefaces in any point size, and Adobe Type Manager, an INIT/cdev combo that performs the same feat with PostScript Type 1 fonts. What could be better?

Well, how about an easy, inexpensive way to view these typefaces in very large sizes? Enter Font Cascade, a utility written by Mike Gleason. It allows you to display TrueType or PostScript typefaces in any size from 5 to 127 points. You can examine either currently installed typefaces or open suitcase files (files containing multiple typeface families).

Unfortunately, you can't print these views. However, if you need a good hard look at a typeface throughout a range of sizes for that special project, Font Cascade provides a low-cost solution. Font Cascade is shareware. If you use it, the author asks that you make a small donation to the Salvation Army.

Editor's note: *Software Corner programs are available in a variety of formats. See "Program Listings" on page 5 for details. We solicit your contributions for this column. If you've written a program or utility that you think others might find useful, let us know. We'll pay $50 for any program we use. Write to: Software Corner, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*



DON CRABB

NEW FRONTIERS

From a user's point of view, one of the most aggravating omissions of some GUIs is their inability to let you handle simple and complex user tasks as you can with DOS command or Unix shell scripts. The Mac is a solid offender in this regard. Even though Apple Events provide some of the System support for an AppleScript language, there isn't one yet. You can automate your actions to some extent by using Apple's simple MacroMaker utility, or you can buy a fancier macro system like CE Software's multifunction QuicKeys 2.2 or Tempo II from Affinity Microsystems.

However, such macros miss the whole point of going through the System's internal services. As long as your macros have to use the same GUI to make things happen (e.g., who's got the mouse-click?), they'll be slow and ultimately hampered, no matter how cleverly they are implemented. No, you still need a real scripting language (à la Unix) so you can build and run batch and shell files with speed, without having to know the idiosyncrasies of each application you want to control or automate.

Yes, Apple Events and InterApplication Communication (IAC) give developers the System services to make user scripting happen, but it's taken a third party, Dave (ThinkTank) Winer and his UserLand Software, to make user scripting first happen on the Mac. Thank you, Dave. Frontier's scripting environment goes on sale in October, and it does pretty much what I've been wanting Apple to do all along with AppleScript.

Here's how Frontier works: It lets you create Desktop menus and link them to scripts that can run just about anything you want. Want to automate disk backup to a network server? No problem with Frontier. You build the Desktop menu and use the integrated scripting language to control the network file server. You could build your own custom menu to handle everyday tasks such as file copying, renaming, or deleting; window cleanup and redisplay; application launching; or any other daily utility function that would benefit from an automated assist. Click on your custom menus, and the scripts behind them run off and do all the stuff. This is especially handy for setting up your machine to work in a variety of custom ways.

You could, for example, write a script that sets parameters and launches applications (with memory usage reset each time) for several kinds of jobs: writing the annual report or summarizing the results of your latest research, for example. In both cases, your custom script opens the required applications and files. You could even build a special shutdown script and wire it to a menu that would safely close all the open environments and then power down your Mac.

Frontier scripts can be more sophisticated than batch files, though. You customize them as much as you can a Unix shell script—using variables, selection structures, and loops—so that the actions they perform are anything but dumb. Nor are they GUI-limited, as a macro facility is. Because Frontier understands IAC, it can also poke itself into any IAC-compliant application to make complex file sharing happen using compound documents. In fact, Frontier may be just the thing that most users and some developers need to make some sense out of IAC as they become more familiar with System 7.0.

The Frontier scripting language resembles a C language made less formidable. UserLand has thoughtfully dropped some of the sparse syntax and exotic extensions that make C programming so hard to learn. If you can learn HyperTalk, you can certainly learn FrontierScript. And there is no reason why FrontierScript can't be ported over to other GUIs (e.g., Motif, NextStep, Windows, Presentation Manager, or Open Look). If that were to happen, UserLand could do more for unifying these disparate GUIs than anything we've yet seen.

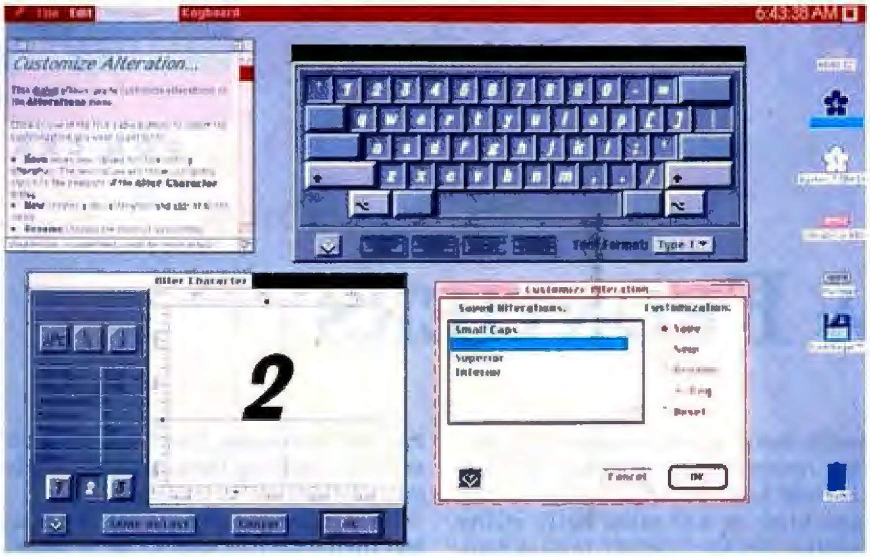
I was impressed with the IAC Toolkit, and from what I've seen so far of prerelease versions of Frontier, this is yet another hit product from Dave Winer. It also makes me wonder why Apple didn't come up with the idea sooner. It would be a natural extension to System 7.0.

Software of the Month: ColorStudio and FontStudio

Now that System 7.0 is finally out the door, a slew of vendors have gotten their acts together and updated their applications to take advantage of some of System

A few new programs make it easier to script and manage fonts

ILLUSTRATION: KENTON NELSON © 1991



The FontMonger application from Ares Software can edit or convert fonts.

7.0's slickest features: Balloon Help, Publish/Subscribe to a live scrapbook, IAC, and TrueType.

One such vendor that you don't hear that much about (even though it tends to dominate the graphic-design software market with a complete line of high-powered products) is Letraset. I've been looking at two of its System 7.0-aware products, ColorStudio 1.5 and FontStudio 2.0, and I like what I've seen.

ITEMS DISCUSSED

ColorStudio 1.5 .... $995
FontStudio 2.0.................... $595
Letraset Graphic Design Software
40 Eisenhower Dr.
Paramus, NJ 07653
(201) 845-6100
fax: (201) 845-4708
Circle 1151 on Inquiry Card.

FontMonger $99.95
Ares Software Corp.
P.O. Box 4667
Foster City, CA 94404
(415) 578-9090
fax: (415) 378-8999
Circle 1152 on Inquiry Card.

Frontier
(price not set at press time)
UserLand Software
490 California Ave.
Palo Alto, CA 94306
(415) 325-5700
fax: (415) 325-9829
Circle 1153 on Inquiry Card.

ColorStudio is one of the best color imaging programs you can buy. It takes the power of color imaging and adds PostScript drawing capabilities to come up with a very easy-to-use graphics color prepress tool. These prepress capabilities extend to direct handshaking with color systems (e.g., those made by Crosfield and Scitex America) and other devices through nine-track tape drives.

You also get some customizable paint tools (e.g., pen points and fill patterns) and default or custom color control for things like color palettes, RGB/CMY color correction curves, CMYK (cyan, magenta, yellow, black) separation corrections, and printer settings. There's also 8-bit full-density masking (which uses the alpha-channel information for a 32-bit video board), the ability to work directly with gray-scale and color scanners, and support for lots of file types (i.e., PICT, TIFF, Encapsulated PostScript [EPS5 or DCS], TARGA, and RIFF). RIFF is ColorStudio's proprietary format that provides for automatic compression of images.

ColorStudio 1.5 also adds capabilities that make it easier to integrate the software with other graphics and color products you might be using. It works with scanner drivers for Photoshop, for example. This makes it much easier to use ColorStudio and Photoshop together on the same scanned images.

You also get better virtual file management with ColorStudio 1.5. Virtual files are the stock-in-trade of any serious Mac color program, since you don't always have the physical RAM necessary to hold a single image. Virtual files are used to store image data (which can balloon to 32 megabytes in size) in excess of what can be accommodated in RAM. Some imaging programs require that a single volume be used for their virtual files. ColorStudio 1.5 not only builds separate virtual files for the image, it also creates an Undo file, a Scrap [Clipboard] file, and a floating Copy file. ColorStudio spreads these files across multiple volumes (but not across networked volumes, a flaw that Letraset should correct, since many Mac installations have moved to Ethernet) and keeps track of them from session to session. That's real virtual file management.

FontStudio 2.0 is a Letraset utility that combines an outline font editor, a bitmap font editor, and a kerning window so you can create high-quality printer and screen fonts. It supports Type 1, Type 3, and TrueType fonts, and it can convert from one font format to another. It also works with Adobe Type Manager (ATM) and the TrueType rasterizer to produce clean bit maps from the outline algorithms. My only gripe with FontStudio is that it costs too much—$595.

Tip of the Month: FontMonger

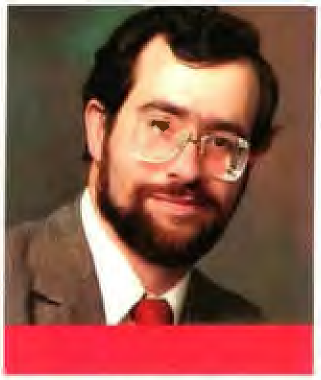
However, if all you need is font format conversion (and not creation or extensive editing), I've got a bargain for you. Give FontMonger from Ares Software a try. It can convert among Type 1, Type 3, and TrueType fonts just like FontStudio. But it costs only $99.95.

FontMonger even works with Illustrator files and FreeHand drawings saved as EPS files. FontMonger is especially nice when you convert some Type 1 fonts to TrueType so you can load them into your System 7.0 System Folder. It also works great on those skanky Type 3 fonts you have accumulated and turns them into Type 1 fonts (for use with ATM) or TrueType fonts (see the screen shot).

My only complaint with FontMonger isn't something that Ares Software can do much about. Here's my beef: Why on Zambodia didn't Apple include this utility with System 7.0? As it is, managing different fonts under System 7.0 is anything but clean. Thank you, Ares. ■

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 contacted on BIX as "decrabb."

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



DAVID FIEDLER

LET ME DOWN GENTLY

In February 1990, we experienced a three-day power failure due to an unexpected blizzard. It was quite an adventure, with the entire family (including our snakes and lizards) sleeping in the living room near the wood stove, cooking our meals on the barbecue, and burying our frozen food in the snow (which only partially worked). Luckily, it was over a weekend, and no articles were due at the time, but my computer being completely inaccessible left me with a scary feeling of isolation, since a great deal of my interaction with people in the Unix world is via modem.

This past winter, things were a lot better. While we didn't get snow, we did get some rain (a welcome event in water-starved northern California), which caused a number of relatively brief power blackouts and brownouts. And Para Systems sent a Minuteman AT650 standby uninterruptible power supply (UPS), so I could find out if it would do what it was supposed to do: keep a Unix system running, but shut it down gracefully if it was necessary.

Actually, I had been hoping for both the rain and the power interruptions so that I could test the UPS under actual Fiedler conditions. After plugging in my Unix system and charging the UPS, I pulled the AC plug several times. The result: nothing. At least, that's what happened to the computer; Unix kept running merrily along, even through a modem session.

I had heard tales about UPS systems that worked fine with the older analog power supplies and their huge capacitors but failed on the digital switching power supplies used in most modern computers. The explanation I heard was that any power interruption of 6 milliseconds or longer that occurred at a particular point of the power cycle could cause a problem. In any case, I needn't have worried, since the Minuteman is rated to switch to internal battery power in just 1 ms. It's kind of fun to see your computer up with the plug out of the wall or when all the lights in the house are dead!

Let's Talk About Power

You're probably familiar with Para Systems' line of products if you've looked into UPS technology at all. I remember Para as one of the first manufacturers to make a reasonably priced line of products specifically for microcomputers, and its logo (a silver android with a laser gun) is nothing if not spectacular. What I didn't realize was that its technology includes overvoltage protection as well as undervoltage—a comforting thought, since our location regularly experiences AC line voltages higher than average.

Some classic technologies solve problems with power and typesetting

When it is not running on battery power, the Minuteman provides RFI and electromagnetic interference filtering and three-stage surge protection on the AC line. When the AC voltage goes sufficiently off specifications to cause the UPS to kick in, the Minuteman generates its power as a sine wave that it synchronizes to the AC sine wave, so your computer won't know what happened.

The Minuteman AT650 has another nice feature. Using a software package called Network Manager U/X by Minuteman, you can interface the UPS directly to your computer system. Current Unix systems supported include the AT&T Model 3B2; IBM RT PC and RISC System/6000; Sun 3, Sun 4, and Sparcstation; and any ISA hardware running AT&T Unix 386, SCO Xenix, or SCO Unix.

The software sets up what security people would call a *supervised connection* to the UPS via a serial port, which means that if the connection is disturbed for any reason, the software is alerted immediately. This lets the UPS notify the software when AC power has been lost or regained (it also means it ties up a serial port).

The software, in turn, sends messages to users or the system administrator at such times. After an initial 10-second delay, it also begins a timed shutdown of the Unix system. At any point until Unix shuts down, the shutdown will be halted if AC power is restored.

Finally, the software is supposed to be able to shut down the UPS after Unix is halted, based on a delay built into the UPS, although I was unable to get this to work. This would be a good feature for unattended operation to prevent the batteries from running down too far. Did I mention that you can change all the messages, the shutdown script, and the delay before final shutdown?

In spite of some minor installation

problems, the Minuteman works just fine, polling the serial port at 2400 bps once per second. The Minuteman, with software, makes a useful package when you can't afford to stop working.

The Textual Revolution

To many computer users, the ability to produce high-quality text from their machines began only recently, with the introduction of programs such as Ventura Publisher and PageMaker. But to Unix users, this capability is old stuff, having begun with `nroff` and `troff`, which date back to the mid-1970s.

Also well known to longtime Unix users was the relative rarity of the one particular typesetter you needed to work with `troff`, as well as the slowness of the process of getting output. These, too, have changed. AT&T completely rewrote both programs in the last decade, making them more flexible, device-independent, and portable.

One of the earliest programs to take advantage of the new `ditroff` (device-independent `troff`) is `devps` from Pipeline Associates. While `ditroff` comes standard with AT&T's Documenter's Workbench (DWB), you can't do much with it unless you have an output driver. Pipeline's `devps` is essentially a filter for `ditroff` that outputs PostScript, which is the de facto standard for typesetting on both laser printers and typesetters. It supports (and includes) a number of downloadable fonts, as well as merging of Mac graphics into documents, special macros for enhancing text, and programs that handle labels and envelopes.

Using `devps` is the most inexpensive way I know of getting PostScript output from a commercial program, especially if you have `ditroff`. It is reasonably priced, especially when you consider it's offered as source code only. I've been using it for years.

If you don't have `ditroff`, you can get it, and the other programs in DWB, as part of the comprehensive `eroff` package from Elan Computer Group. Elan has done a great deal of bug fixing and enhancements on DWB. The complete package includes `nroff`, `ditroff`, `tbl`, `eqn`, `pic`, `grap`, a number of complete macro packages, and more.

Included with `eroff` are drivers for both PostScript and LaserJet printers, with automatic smart-font downloading and compression for LaserJet printers and the ability to insert native printer code into a document. You can insert bitmap, MacPaint, TIFF, Sun raster, and PCX files into documents, and the text will automatically flow around them. You even get an ASCII previewer, so you can get an idea as to what the finished page will look like. An optional X Window System-based previewer is available for more exact work. Elan's `eroff` is available for dozens of different platforms.

Even more inexpensive products are available, such as the shareware `jetroff` from PC Research (available on BIX and from most FTP sites), which connects `ditroff` output to the LaserJet. Cheaper than this is free, which describes programs like `troff2lj`, `thack` (`troff` to PostScript), and Ghostscript (a free PostScript interpreter). You can get these free programs via Demolink and BIX (see page 5), from major archive sites, or from UUNET. There's something for every budget on Unix! ■

COMPANY INFORMATION

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David Fiedler has been a consultant and writer on Unix topics for over a decade and has started several Unix publications. His company, InfoPro Systems, produces corporate image and marketing videos for high-tech firms. You can reach him on BIX as "fiedler."

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486

Moby Brick is only about the size of a ream of copy paper and weighs 8.9 lbs. (4 kg.), yet it packs full desktop power with a 33 MHz 486 processor and up to 32 MB of RAM. The new 486 is twice as fast as the 33 MHz 386 and includes a built-in numeric coprocessor.

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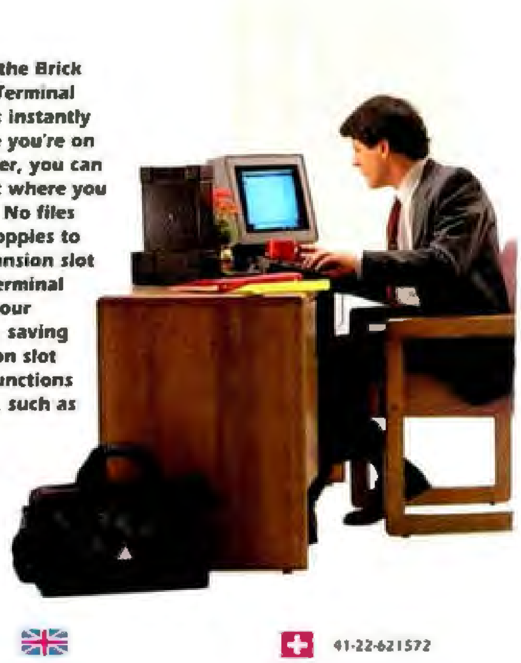

8:35 a.m. Drop the Brick into its Docking Terminal and everything is instantly connected. Since you're on the same computer, you can immediately start where you left off at home. No files to transfer, no floppies to switch. The expansion slot in the Docking Terminal can be used for your network adapter, saving the internal option slot in the Brick for functions you need off-site, such as a fax board.

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fast, quiet, stylish desktop at each of your regular destinations, such as your home and office. The optional Docking Terminal provides instant hook-up of all cables as well as a second, 16-bit 3/4 length expansion slot. The matching VGA LCD display module (available in August) turns Moby Brick into a portable, go anywhere solution. The LCD features a 64 gray scale controller and the latest Sharp thin film, super twist, backlit LCD technology.

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17" (43.18 cm) 1024 x 768 non-interlaced color SVGA monitor (shown above)

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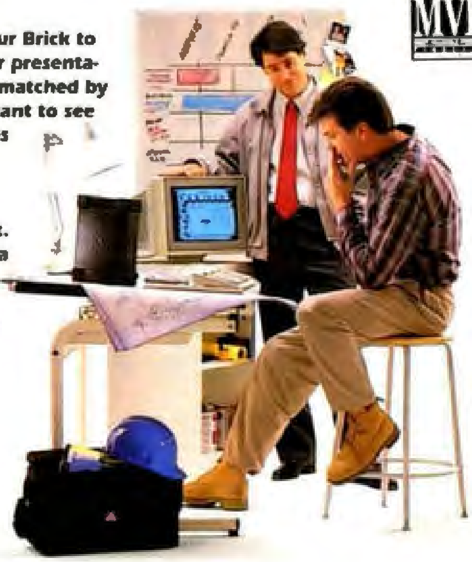

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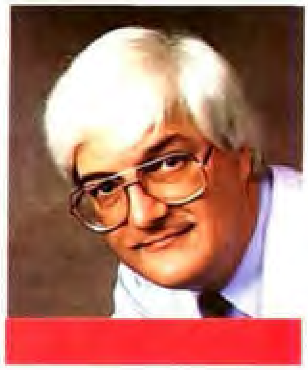


BARRY
NANCE

LAN Tune-Up

My company's LAN had grown sluggish over the last year. I watched with concern as the number of users and the number of files on the server increased and performance began to slow. People were complaining about performance. Something had to be done.

Soon after I started my search for the performance bottleneck, I found that LAN performance depends on a complicated set of variables. There is always a bottleneck somewhere on a LAN; the LAN is no faster than its slowest component. Is your network like greased lightning? You're lucky; it means that your slowest component is itself acceptably fast. Mine wasn't, and I had to identify and replace that component.

Finding a bottleneck on a LAN is a black art. You'll get advice like "Put a faster hard disk drive in the server," "Switch to Token Ring," "Switch to Ethernet," "Switch to NetWare," or "Switch to OS/2 LAN Manager." What if you take someone's advice and find that performance doesn't change? The part you replaced wasn't the bottleneck. You've wasted time and money.

Here's how I identified the cause of our performance problem. You can use the same techniques to make your LAN faster, spending your dollars wisely in the process.

Performance Factors

When you run an application that resides on the file server and that in turn reads and writes files on the server, a flurry of activity takes place. COMMAND.COM first looks in each of your path directories for the executable file. This searching of server directories causes a dialogue of LAN messages. For each directory, your workstation sends a "Find File" request message, and the server sends back a response. The executable file loads into your workstation's memory via another series of LAN messages, usually in 512- or 1024-byte chunks.

Once loaded, the program issues open, read, write, and close requests that become LAN messages sent to the server. The server responds to each request with an "OK" or a "Here's the data" message. On NetBIOS-based networks, the receiver separately acknowledges each message. On NetWare networks, though, the acknowledgment and the response message are one and the same.

The server has to manage a queue of requests from the many workstations on the LAN, and the queue can become quite long at times. If you also use the server for printing, the print jobs may keep the file server busy reading and writing spool files, thus delaying other file service requests and requiring the file server to devote some time to managing the shared printers. In addition, workstation and server messages (both for file service and print spooling) may have to cross one or more bridges, which creates another delay.

The upper-layer network software (e.g., NetWare's NETx.COM) filters each file and print request and creates one or more message records that it hands to the lower layer (IPX.COM). This layer in turn gives the request message to the network device drivers. Through an 8-, 16-, or 32-bit slot, these drivers tell the network adapter to send the request to the server. When it can use the LAN cable, the network card sends the request. At the server, the network support software hands the request up through more layers of support code before the network operating system finally processes it. If the request can't be satisfied from server memory (i.e., the RAM cache), the server waits for the hard disk to rotate into position to access the data.

The response travels back to the workstation through the support software, server network adapter, LAN cable, workstation network adapter, and workstation support software. A 250-kilobyte executable file that uses 512-byte message packets requires the interchange of more than 500 requests and 500 responses just to load the program. (Larger packets cause less overhead.) If many people try to use the file server at the same time, it becomes a Grand Central Station for LAN traffic and file requests.

Your network's bottleneck might be at the workstation, in the network device drivers or TSR programs, or in the network adapter. Or the transmission rate of the LAN itself might be the bottleneck.

At the server, you have several suspects. The server CPU may not be executing the network software quickly enough. The network software may not

A nuts-and-bolts look at how to solve performance problems

ILLUSTRATION: KENTON NELSON © 1991

be efficiently coded. Too little RAM in the server for file-caching purposes means that the server must frequently take the time to access the hard disk drive. The server may spend an inordinate amount of time acting as a print server. Perhaps your server's overhead would be less if you could configure it to use larger packets.

Could the speed of the bus be throttling you back? Or perhaps the server and the network adapter have trouble communicating through a confining 8-bit slot. The network adapter may not contain enough RAM to buffer all the LAN messages. Are your bridges slowing things up? The list of potential bottlenecks is a long one, and the interactions that can occur between components complicate the picture further.

Network analyzers can be useful, but they can't give you simple answers.

By the Numbers

I spent some time after hours with my company's LAN to get baseline performance figures without interference from other network traffic. I then repeated my time trials on a busy afternoon. I wanted to isolate the different components with a series of controlled experiments that would reveal the bottleneck, even if only through implication.

I first inventoried the network; I categorized the applications, the workstations (by CPU type, CPU speed, and type of network adapter), and the servers (by CPU type, CPU speed, amount of memory, hard disk speed, number of files on the server, and type of network adapter). You'll want to do the same inventory of your LAN.

I was fortunate to have the use of two network analyzers: a Network General Sniffer and a Novell LANalyzer. Both helped show huge amounts of detail about the LAN traffic, but I found that it took a huge effort to understand that detail. Network analyzers can be useful, but be aware that they can't give you simple answers like "You need a faster hard disk drive in your server."

Did I have a workstation, server, or LAN bandwidth problem? The workstations are a mix of 286 and 386 machines, and I knew from both the complaints and the afternoon time trials that the type of the workstations didn't matter. Response times were uniformly slow for all users. (If only certain workstations were affected, I would have concentrated on finding a pattern among the workstations in terms of their CPU horsepower, type of network adapter, or applications. Or I would have noticed that all the complaints were from workstations attached to a bridge.)

The Sniffer and the LANalyzer told me that network load varied between 20 percent and 45 percent. (A traffic load greater than approximately 70 percent would have pointed to the 4-megabit-per-second bandwidth of the Token Ring as

the problem.) The general nature of the performance problem led me to focus on our primary file server.

My time trials consisted of a few simple batch files. In 10 iterations, I copied a 1-megabyte file from each type of workstation to and from the file server. Again in 10 iterations, I copied 1000 different 1-KB files, from 20 different directories, to and from the server. I measured the effect of the server RAM cache by repeating the file copies after having rebooted the server (i.e., empty cache). Alone and in combination with the file copies, I printed a 100-page report of fairly dense material. I timed each operation by itself in the late evening, when there was no other traffic on the LAN, and during peak use one busy afternoon.

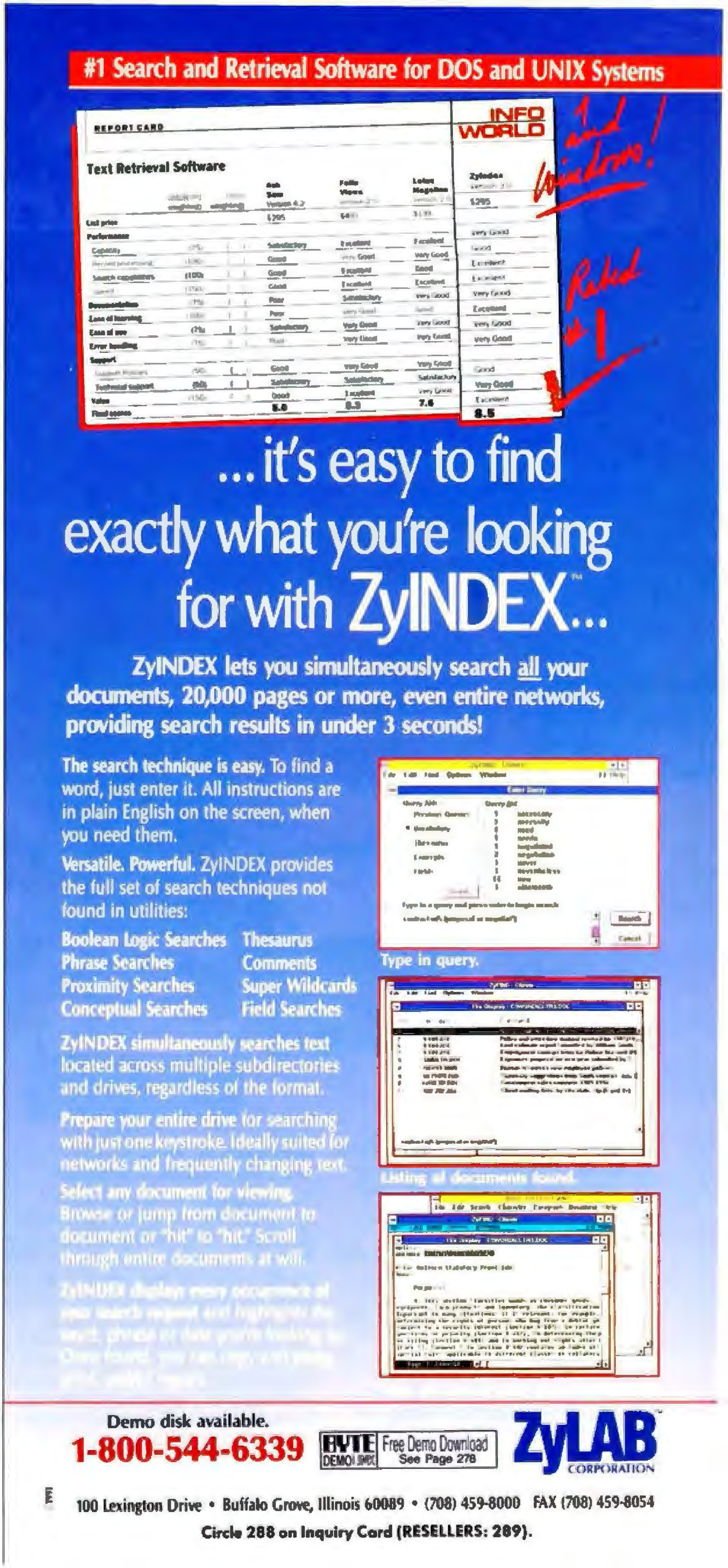
The primary file server handled 10 MB of 1000 files just as quickly as it did 10 MB of the single larger file. The server RAM cache made a difference, but not a big one. Concurrent printing and file access didn't slow things down much. These results told me that the head-movement time of the server hard disk drive is not a serious problem, the hard disk drive itself is probably not the bottleneck, and the file server isn't affected too much by print spooling. Yet, even with no one else on the LAN and with the RAM cache enabled, throughput stood at only 80 KB per second.

The network adapter in the file server, a first-generation IBM Token Ring card with 8 KB of shared RAM and an 8-bit data path, became the focus of my attention. To confirm my suspicions, I used the network analyzers to send pure message traffic (no file access involved) to the server's network adapter. Again, I did tests after hours and during peak use in the afternoon. I had found the culprit. The server's old 8-bit IBM Token Ring card responded to pure message traffic at about the same rate as the entire server did to file service requests.

We have a faster Token Ring card on order. We also plan to install more memory in the file server, but I'm sure the network card will make the difference. ■

Barry Nance does R&D and technical-support work for Insurance Software Systems, a software development company in Hartford, Connecticut. He is also the author of Network Programming in C *(Que Publishing, 1990) and is the IBM Exchange editor on BIX, where you can reach him as "barryn."*

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



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MARTIN HELLER

HEDGING YOUR BETS

My crystal ball is getting cloudy. Actually, it has been cloudy for years, but my glasses were so dirty that I didn't notice. I'm speaking, of course, of the future of OS/2. When OS/2 was announced in 1987, I jumped on the bandwagon with both feet. At the time, though, Microsoft was telling developers to write for Windows first—so I did. Windows has been good to me over the last few years, while OS/2 has given me frustration after frustration.

Rumor has it that OS/2 2.0, as finally released by IBM, will be what the world has been waiting for: a real multitasking system that can run 32-bit Presentation Manager applications, 16-bit PM and character-mode OS/2 applications, Windows applications, DOS applications, and even DOS device drivers. I'd like to see it, but I haven't so far. (The Microsoft Software Development Kit version of OS/2 2.0 that I have seen is interesting, but it's nowhere near what IBM seems to be promising.) Meanwhile, developers like me are faced with a big decision: How do we develop software that won't need to be rewritten for every new operating system and user interface?

GUIs Galore

It's not just Windows and PM out there, either. I'm talking about writing a single application that will run on any GUI and both look and feel like it was lovingly handwritten for that platform. Not just on DOS and OS/2 machines, either: on Macs, on Amigas, on Atari STs, on your choice of Unix. This may sound like a pipe dream, but if you have a small software development company, you can't afford to rewrite your code for each platform.

Until recently, people bet the company on one platform. If they lost the bet, they started over on another platform and hoped that the next time around they'd last long enough to get out of debt. There has to be a way to hedge that bet.

My strategy so far, by happy accident, has been to write for Windows and cross my fingers. I told you about the Microsoft System Migration Kit last year. I was able to make it work on toy programs but not on real programs. The successor to SMK is called Windows Libraries for OS/2, but I'm in no hurry to try it. I expect that I'll be able to relink my Windows programs to run as OS/2 PM programs with a few days' work, but none of my customers is interested in OS/2. I think that will change as IBM pumps money into marketing OS/2. But when it finally changes, the WLO 0.9 I have now is likely to be obsolete.

What to do if you plan to develop software for different platforms—and don't like taking risks

If I were really serious about writing for multiple platforms, I'd practice code segregation. Unfortunately, it takes more discipline than I can muster. Windows code permeates both EnPlot and Room Planner, my two Windows programs. To port them at the source code level, I'd have to write macros to convert the easy stuff, subroutines for the harder stuff, and gruesome `#ifdef` blocks for the worst cases.

Cross-Platform Libraries

You can write for multiple platforms quite easily if you're starting to design an application now. One easy way is to use a multiplatform library. I've found two that seem to work: XVT (XVT Software, Boulder, CO) and C++/Views (CNS, Eden Prairie, MN).

XVT, a C library for Windows, Mac, PM, Motif, and character screens, requires you to write to the XVT application programming interface rather than to any of the system APIs. Optionally, you can make your resources device-independent by writing them in a universal resource language, which XVT can translate into native resources. The XVT API is no harder to learn than any of the system APIs. XVT introduces relatively little additional overhead for the distance it gives you from system details. The XVT documentation is quite clear, with useful (and often omitted) information like "how to stay out of trouble."

I was initially skeptical of a library that tries to provide a least common denominator for five targets (including character mode). However, XVT raises the common denominator by making almost all functions "work" in some fashion on each platform, although, in some cases, "working" might mean doing nothing.

C++/Views is a class library that targets the same platforms as XVT. There

ILLUSTRATION: R. KENTON NELSON © 1991

the similarity ends. C++/Views implements a Smalltalk-like Model View Controller paradigm, complete with its own notifier, object class hierarchy, browser, and dialog box code generator. It isn't Smalltalk, which is both good and bad; it *is* object-oriented out the ears. If you want a device-independent library, the choice between XVT and C++/Views will depend heavily on how well you like the latter's object-oriented approach. Subjectively, C++/Views seems to have a bit more overhead than XVT and to require a bit more adaptation from unregenerate C programmers like me.

I should also mention a library you can use to port Windows programs to DOS. MEWEL (Magma Software Systems, Millburn, NJ) can take you from Windows to character-mode DOS quickly, since it emulates Windows at the API function and message levels. It won't help you with graphical applications—just with programs that use Windows for the Systems Application Architecture/Common User Access user interface. MEWEL is also useful if you want to learn Windows programming but aren't ready to leave DOS quite yet.

Code-Writing Prototypers

Another fairly painless way to write system-independent applications is to use a multiplatform code generator. Two that I've found to work tolerably well in their Windows versions are CASE:W Corporate Edition (Caseworks, Atlanta, GA) and WindowsMaker Professional (Blue Sky Software, Las Vegas, NV). Both products let you design programs largely by pointing and clicking; unfortunately, neither takes you 100 percent of the way to a shippable program. You're still going to have to write your own core routines, and you may also have to tweak the generated C code, which could destroy much of the benefit of using an application generator in the first place.

I haven't found application generators much of an advantage for writing straight Windows applications. They're not any faster for me than cloning existing code and doing global edits. However, they're certainly a big help to novices, and I can see that they offer a big advantage when you need to hedge your bets. You don't have to rewrite your user-interface code for a new platform—just regenerate it with another version of the tool. If you can keep your own code routines free of system-dependent user-interface code, you'll have it made.

If you don't like writing C, a multiplatform application language may suit you better. Smalltalk is substantially the same on every platform; specifically, programs written in Smalltalk V (Digitalk, Los Angeles, CA) for Windows and PM are source code compatible. (Versions for other platforms are coming soon.) Smalltalk has one of the nicest prototyping and development environments available (it's right up there with Lisp), but your first exposure to Smalltalk might be something of a shock if you're used to C. Be prepared for new concepts. Also, you'll have to learn the original contexts of terms you might have thought came from C++: object, class, message, and method.

Don't expect your final Smalltalk applications to be small or especially fast; do expect to produce them a lot faster than you could have in C.

Object/1 (MDBS, Lafayette, IN) also comes in Windows and PM flavors. The source code between the two versions is about 80 percent compatible, and the balance can be translated more or less automatically. Object/1 feels like a Smalltalk environment with C++ syntax. Its browser and incremental compiler are quite handy for interactive development, but the final speed and size of Object/1 applications can leave something to be desired. One special strength of Object/1 comes from its heritage. MDBS is a company built on high-performance databases, so Object/1 knows all about interacting with databases. A decent relational database, TBL, comes with the package; in addition, Object/1 can access MDBS IV and Structured Query Language Server databases.

A final possibility to explore is ToolBook (Asymetrix, Bellevue, WA), although this presents something of a problem. ToolBook 1.0 for Windows and PM are quite compatible. But the current version 1.5 of ToolBook for Windows has enhancements that might not reach the PM platform very quickly. Asymetrix reports a 40-to-1 sales ratio between ToolBook for Windows and ToolBook for PM, and there is little interest in spending more money on a weak-selling PM version.

I'm not sure that you would want to restrict yourself to ToolBook 1.0 commands on the Windows platform, but it might be worthwhile to maintain source-level compatibility. Then again, ToolBook PM sales might pick up after IBM starts selling OS/2 with vigor. I wish this crystal ball would clear.

New Toys

My Windows application of the month is DesignView (Premise, Cambridge, MA). It's technical and maybe not for everybody, but it's a program that makes engineers and designers weep for joy: a drawing program with data-driven variational geometry. This means that you can sketch a mechanism; add some dimensions, equations, and constraints; and let DesignView crank out solutions and draw the correct geometries.

Variational geometry is the technology that made Cognition's design package attractive to mechanical engineers and designers at $50,000 to $100,000 a seat. Unfortunately, that sort of pricing turned out to be prohibitive, and Cognition ended ignominiously. Premise sells DesignView for under $1000, and it does most of what Cognition's system was supposed to do.

Recently, I was inspired by the article "Caching Cards Speed Data Access" (January BYTE) to see if I could get any performance improvement in Windows and OS/2 with a hardware disk cache versus a software cache. Distributed Processing Technology (DPT) lent me a SmartCache controller with 4.5 megabytes of RAM for my computer's ISA bus and ESDI hard disk drives. The SmartCache gives me twice the disk performance I got previously with my best software cache tuning and a WD1007A controller. (Note that the software caches gave a performance boost of three times over the bare controller; the hardware caching controller gives a performance boost of six times.)

It's a pricey solution, but the performance benefits are obvious. OS/2 suddenly seems much lighter on its feet, and Windows no longer crawls when you overcommit memory. DPT will get the SmartCache back only by prying it out of my cold, dead fingers.

By the time you read this, DOS 5.0 should be shipping for real. Right now, I'm running the fifteenth release candidate; it's not going to be long before a version "goes gold." Run, don't walk, to your local software dealer for a DOS 5.0 upgrade package—it is by far the best version of DOS yet in terms of speed, available RAM, and reliability. And if you use Windows, that goes double. ■

Martin Heller develops software and writes about computers, despite a Ph.D. in physics and having worked, literally, as a rocket scientist. His book Advanced Windows Programming *will appear this fall. You can contact him on BIX as "mheller."*

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

ASK BYTE

Paper Tiger Redux

I currently store 100 to 200 legal documents a day on microfilm. I would like to store these documents on my PC using imaging. What are the most reliable imaging methods used? What are the best methods of storage and retrieval? What is the difference between optical character recognition (OCR) and intelligent character recognition (ICR)? What are the processing speeds and cost factors for the different methodologies?

Richard Hagner
Littleton, CO

Boy, have we got an issue for you! The April BYTE thoroughly explores the topic of document image processing. You'll find a number of excellent articles in our State of the Art section. These articles will give you background information as well as some very practical planning considerations.

You must first decide how you want these documents stored. If you need to keep only an image of the documents, you simply scan them in and save them to disk using a structured system of directories and files. OCR offers additional benefits. You'll need considerably less disk space, and you can establish convenient search-and-retrieval mechanisms.

OCR converts printed text into an electronic form. The end result is a file that you can load into a word processor or text-retrieval program. You can then use a program like Folio Views to enable full-text indexing and search navigation. ICR is a type of OCR that uses advanced methods to discern text (e.g., comparing scanned words to known good ones and reviewing words in context).

There is a wide range of OCR products available, depending on your needs and your budget. The software-only products are inexpensive (typically ranging from $400 to $1000), but they're also slower and less reliable than hardware-assisted technologies. Even with a software system, you'll have to dedicate a microcomputer and a scanner to the job, not to mention lots of disk space.

More demanding jobs call for a hardware solution. Many hardware products (e.g., Caere's Parallel Reader, Calera's CDP 9000, and the Kurzweil K5200 from Xerox Imaging Systems) do a fine job, but the prices are steep. The Product Focus in the April BYTE, "Tame the Paper Tiger," looks at the current state of the desktop OCR market. We tested a range of products and made some buying recommendations. The Resource Guide in the April issue lists a number of companies offering high-end systems that let you digitize, store, and retrieve documents.—S. D.

Causing a TIFF

I have many applications that produce PostScript output. It would be nice if I had a PostScript-to-Encapsulated PostScript (EPS) conversion program. Then, I could use a Word for Windows macro to insert the PostScript commands in my Word documents and get a reasonable idea of what the finished product will look like. Do you know of any such program? Is there a more straightforward way to paste PostScript (from non-Windows applications in many cases) into my Word documents?

Samuel L. Park
Alexandria, VA

You can place a standard (unenhanced) EPS file into Word for Windows, but you will not be able to view it on the screen. I think there is a better way. You can use UltraScript PC from QMS to convert the PostScript files to TIFF format. You can then place the TIFF file into your Word document.

This will give you much more flexibility. You can view the placed file on-screen. You can resize it (remember to preserve the aspect ratio by keeping the Shift key depressed when you grab and drag a frame handle). You can store it in compressed TIFF format to save some disk space, and you can select different resolutions from the UltraScript configuration menu. The product costs $195, but you can probably find a better price through mail order or from a dealer. For a dealer in your area, call (800) 627-1967. To buy directly from QMS, call (800) 635-3997.—S. D.

Segments? Arrggh!

I am taking an 8088 assembly course. When I was working on my program assignment (see listing 1), I found a problem that neither the instructor nor the teaching assistant could explain.

I think that a segment should begin at an address divisible by 16. But this is not always the case. When I trace my program with Debug, I find that the data segment begins at the word boundary right after the code segment. I see the same thing in all my programs, even if I use Debug, Turbo Debugger, or CodeView.

Edgar Wu
Garland, TX

You inadvertently answered your own question. The data segment is being loaded directly after the code segment, aligned to the nearest word. Your code fills up only 13 bytes in the last code paragraph (1B9D:0010), so the linker adds a zero to align to the nearest word and starts the data in the next physical memory address (1B9D:001E or 1B9E:000E).

The DS register value is then set to the first paragraph that contains data, and the linker resolves the address to point to the beginning of the actual data. You're right, the hardware requires that physical segments start at paragraph boundaries. Your mistake is in assuming that the assembler was putting your data at the beginning of a physical segment. And that's because of your `.code` *and* `.data` *directives.*

The abbreviated directives you used specify a handful of parameters. Besides the segment name and class, `.code` *and* `.data` *specify word alignment. To get alignment on physical-segment boundaries, you need to specify that specifically. Replace your* `.data` *directive with _DATA*

Listing 1: *In the small model,* `.code` *and* `.data` *segments don't necessarily have to start at physical-segment boundaries.*

```
        dosseg
        .model small
        .code
MAIN    proc
; Point DS to our data segment
        mov     ax,@data
        mov     ds,ax
; Display a message on-screen
        mov     ah,9
        mov     dx,offset PROMPT
        int     21h
; more stuff
        mov     ah,8
        int     21h
        sub     al,32
        mov     dl,al
        mov     ah,2
        int     21h
; Exit to DOS
        mov     ax,4c00h
        int     21h
MAIN    endp
        .data
PROMPT  db      'Type a lowercase letter :$'
        .stack 100h
        end MAIN

AX=1B9E  BX=0000  CX=0250  DX=0000  SP=0100
BP=0000  SI=0000  DI=0000
DS=1B9E  ES=1B8D  SS=1BA1  CS=1B9D  IP=0005
NV UP EI PL NZ NA PO NC
1B9D:0005 B409          MOV     AH,09
-t
AX=099E  BX=0000  CX=0250  DX=0000  SP=0100
BP=0000  SI=0000  DI=0000
DS=1B9E  ES=1B8D  SS=1BA1  CS=1B9D  IP=0007
NV UP EI PL NZ NA PO NC
1B9D:0007 BA0E00        MOV     DX,000E
-dds:0
1B9E:0000  2C 20 8A D0 B4 02 CD 21-B8 00 4C CD 21
           00 54 79    , .....!..L.!.Ty
1B9E:0010  70 65 20 61 20 6C 6F 77-65 72 63 61 73
           65 20 6C    pe a lowercase l
1B9E:0020  65 74 74 65 72 20 3A 24-00 00 00 00 00
           00 00 00    etter :$........
```

SEGMENT PARA PUBLIC 'DATA' (and add the supporting statements) to get the results you want.—H. E.

The Big Red Switch

Is it better to leave my personal computing equipment on or off? In schools and businesses, PCs are often left on indefinitely. At home, however, they are usually turned off when not in use.

I have an IBM AT with a hard disk drive and a color monitor. I use this system several hours a day. If I turn off the power, there is less wear on the hard disk drive and fan motor bearings. Also, less dust is circulated throughout the chassis. I also save about 48 cents per day on power.

If I keep the power on, the electronic components are kept at a fixed temperature, and the system doesn't need to reboot. Additionally, I understand that hard disk drive read/write heads "float" over the magnetic disk on an air cushion caused by the spinning disk. Is my hard disk drive more vulnerable to damage from being bumped when the disk is not spinning? Should a hard disk drive be parked when off?

William Snyder
Rochester, NY

You've correctly identified all the problems involved. Your last question is the easiest: Yes, you should park your hard disk drive every time you turn it off. Remember that some hard disk drives park themselves, and others require a special parking procedure. Look through your owner's manual or contact the manufacturer before trying some public domain drive parker. Using the wrong software can damage your drive.

When to turn your machine on and off is quite another thing. The PC community is about evenly split on this. I suggest the following:

If you decide to leave it on all the time, invest in a really good *surge suppressor, line conditioner, or uninterruptible power supply. Power surges and noise can really wipe out a machine, and they always seem to happen when you're not there. If possible, unplug the machine if you're expecting lightning storms.*

Some folks suggest turning the machine off as soon as you're through, regardless of how soon you expect to use it again. Others suggest turning it off if you're leaving for more than an hour. I think both of those are extreme, and I suggest if you're going to turn it off, wait until you're through for the day.

I belong to the "leave it on" camp and have stuff powered on 24 hours a day. My Compaq Plus ran that way for seven years before losing the hard disk drive and power supply. My current 386 machine has been running for four years, with a five-year-old hard disk drive. So far, so good.—H. E.

Davong, Anyone?

I recently acquired an old Davong tape backup system for my IBM XT. Unfortunately, it didn't come with a user's manual, software, or cassettes. Is Davong still around, and, if so, what is its current address?

Yariv Nachshon
Hamburg, Germany

Davong? Wow, there's a name from the past. The company vanished from sight sometime in 1984 or 1985, and no one's heard from it since. Global Computer Supplies ((516) 625-6200) remembers Davong, listing two of Davong's drives in its media compatibility list. You didn't say which Davong model you have. The Davong EXT1 uses DC600AD cartridges, and the Davong DSI/U620T uses DC300XLP cartridges. Both cartridge types should be available from any good computer-supply house.

If you don't have the software and manuals, you've got a problem. While some early tape drives mimicked floppy disk drives, most didn't, and they required special software. Without the software, you may have just bought yourself a fancy paperweight. Maybe a reader has an old copy he or she could send you?—H. E. ■

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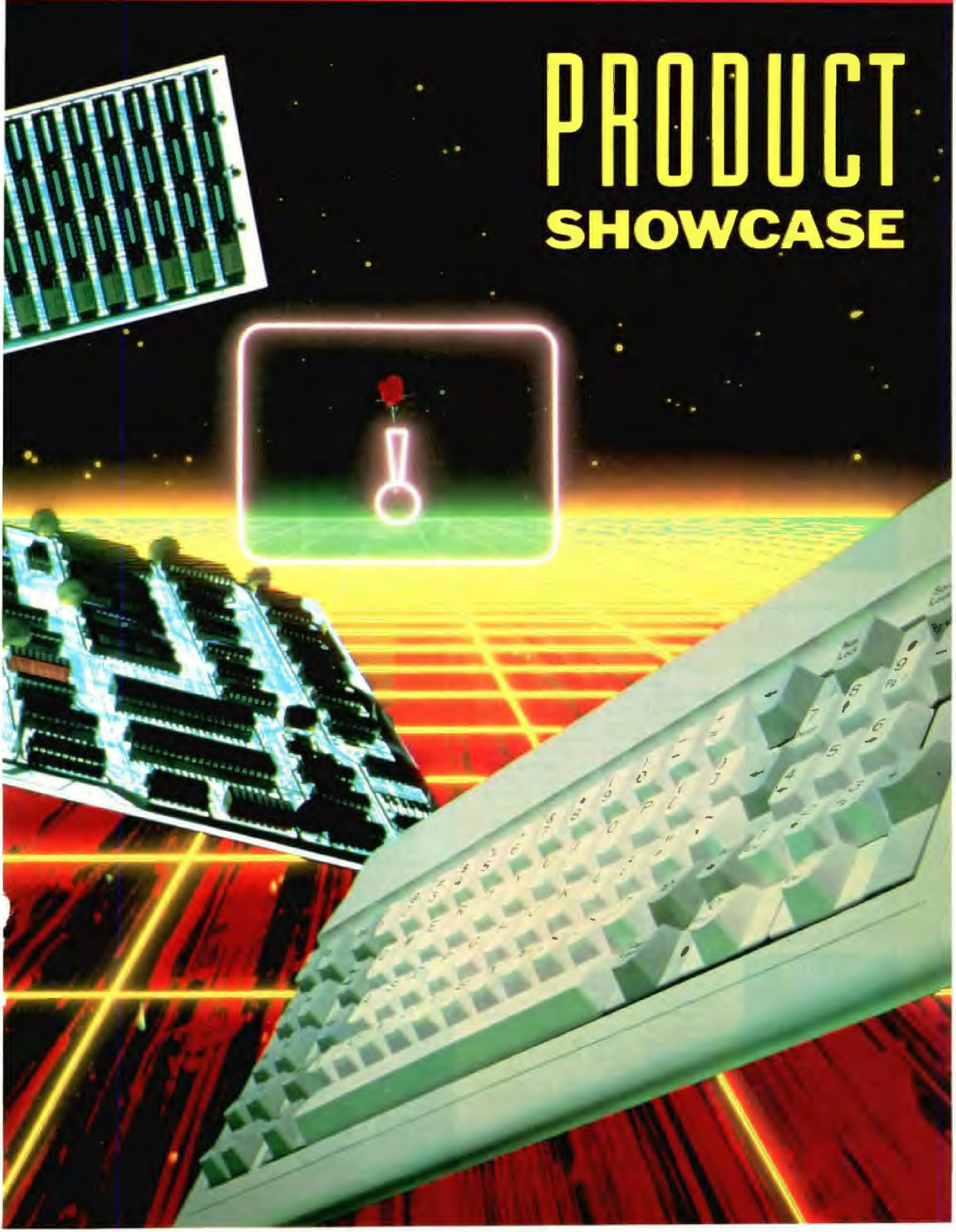

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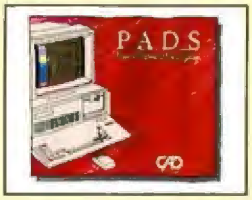

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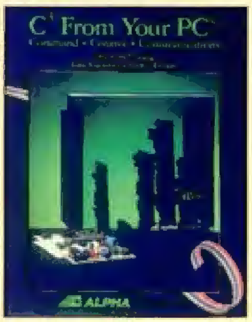

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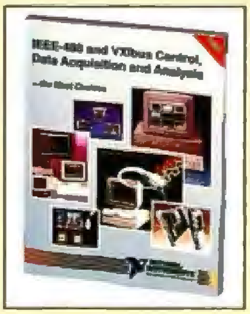

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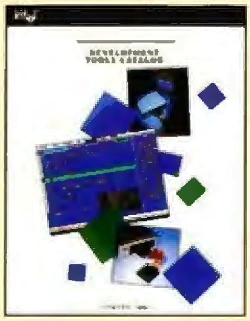

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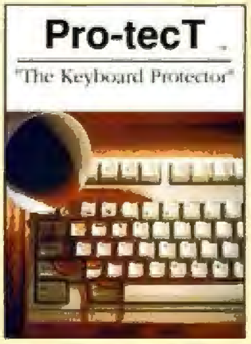

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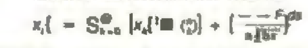

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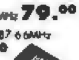

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MODEL	MEMORY ADDED	COMPAQ EQUIV. PART#	YOUR COST
DESKPRO 286	512K KIT	113012-001	89.00
DESKPRO	1MB MODULE	118688-001	79.00
286N, 386N	2MB MODULE	118689-001	149.00
386SX/20	4MB MODULE	118690-001	398.00
DESKPRO	1MB BOARD	108069-001	370.00
386/16	2MB BOARD	108069W71	340.00
	1MB KIT	108071-001	128.00
	4MB BOARD	108070-001	990.00
	4MB KIT	108072-001	318.00
DESKPRO	1MB BOARD	113633-001	180.00
386S	4MB BOARD	113634-001	380.00
	1MB MODULE	113646-001	104.00
	4MB MODULE	112534-001	279.00
DESKPRO	1MB MODULE	113131-001	98.00
386/20 25, 286E	4MB MODULE	113132-001	238.00
DESKPRO	1MB BOARD	113644-001	158.00
386/20E/25E	4MB BOARD	113645-001	348.00
DESKPRO	2MB MODULE	115144-001	148.00
386/33 486/25	8MB MODULE	116561-001	899.00
SYSTEMPRO	32MB MODULE	116568-001	8498.00
PORTABLES			
PORTABLE	512K KIT	107331-001	38.00
III	INTFC BD	107808-001	99.00
	EXP BD	107811-001	199.00
	2MB KIT	107332-001	128.00
SLT/286	1MB MODULE	110235-001	158.00
	4MB MODULE	110237-001	649.00
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	1MB BOARD	117081-001	138.00
	2MB BOARD	117081-002	178.00
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386/20	INTFC BD	107707-001	88.00
	4MB BOARD	107653-001	698.00
	4MB EXT BRD	107654-001	799.00
SLT/386S	1MB MODULE	108303-001	194.00
	2MB MODULE	108304-001	334.00

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DESCRIPTION	150NS	120NS	100NS	80NS	70NS
64X1	1.20	1.80	1.99		
64X4	1.95	2.35	2.45	3.95	
256X1	1.80	1.65	1.95	1.99	2.95
256X4		3.95	4.45	5.95	6.95
1MEGX1		4.75	4.95	5.45	5.95

TOSHIBA MEMORY

TOSHIBA MODEL	MEMORY ADDED	TOSHIBA EQUIV. PART #	YOUR COST
PORTABLE 2000SX	1MB BD	PC14 PA8311U	188.00
T1000SE & XE/LE	2MB BD	PC14 PA8312U	278.00
PORTABLE T1200XE	2MB BD	PC13 PA8306U	168.00
PORTABLE T1600	2MB BD	PC8 PA8302U	158.00
PORTABLE T3100E	2MB KIT	PC9 PA8341U	188.00
PORTABLE T3100SX	2MB BD	PC15-PA8308U	158.00
	4MB BD	PC15-PA8310U	298.00
PORTABLE T3200	3MB BD	PC6-PA7137U	278.00
PORTABLE T3200SX	2MB KIT	PC12-PA8307U	158.00
	4MB KIT	PC12 PA8309U	398.00
PORTABLE T5100	2MB BD	PC7 PA8301U	168.00
DESKTOP T8500 OR PORTABLE T5200	2MB KIT	PC10-PA8304U	168.00
	8MB KIT	PC10 PA8313U	998.00

ZENITH MEMORY

ZENITH MODEL	MEMORY ADDED	ZENITH EQUIV. PART #	YOUR COST
Z386/33/37E/25/20	1MB MOD	ZA3800ME	78.00
	4MB MOD	ZA3800MK	389.00
Z386/25/33	1MB MOD	ZA3600ME	78.00
	2MB MOD	ZA3800MG	148.00
Z248 Z286LP Z386SX	2MB MOD	Z-605-1	148.00
TURBO SPRT 386,386E	1MB KIT	ZA3034ME	258.00
	4MB KIT	ZA3034MK	868.00
SUPER SPRT	2MB KIT	ZA180-64	199.00
SX	2MB KIT	ZA180-86	199.00
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IBM PS/2 MODEL	MEMORY ADDED	IBM EQUIV. PART#	YOUR COST
PS/2 25/286	512K KIT	30F5348	39.00
30-286, 50Z & 55 SX, 65SX	2MB KIT	30F5360	124.00
PS/2 50Z & 55SX, 65SX	1MB SIMM	6450603	59.00
	2MB SIMM	6450604	109.00
55SX & 65SX	4MB MODULE	34F2933/87F9977	209.00
50, 50Z, 55SX & 60, 65SX	2 8MB BOARD	1497259/6450609	349.00
PS/2	1MB SIMM	6450603	59.00
70-E61, 061 121	2MB SIMM	6450604	109.00
PS/2 70-A21 AX1 BX1	2MB SIMM	6450608	119.00
PS/2 80-041	1MB MODULE	6450375	98.00
PS/2 80-111 121 31 321	2MB MODULE	6450379	149.00
80-A21, A31	4MB MODULE	6451060	279.00
PS/2	2 8MB BOARD	645605 OR	378.00
ALL 70s & 80s	2 14MB BOARD	34F3077 OR	389.00
	4 16MB BOARD	34F3011	519.00
90 95 & 975	1MB	6450902	188.00
	4MB	6450128	419.00

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DESCRIPTION	120NS	100NS	80NS	70NS	60NS
256X9 IBM	9.00	14.00	19.00	20.00	30.00
1MEG X 8 APPLE		57.00	59.00	71.00	79.00
1MEG X 9 IBM		39.00	49.00	59.00	74.00
4MEG X 9 IBM			219.00	249.00	319.00

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HPII & IID	2MB MODULE	33444B	138.00
	4MB MODULE	33445B	228.00
HP3 & IIID	1MB MODULE	33474A/B	98.00
HPIIP	2MB MODULE	33475A/B	138.00
	4MB MODULE	N/A	238.00
CANON LBP4	1MB MODULE	N/A	199.00
CANON LBP	1MB MODULE	N/A	98.00
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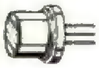
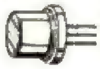


- Output: 3 mW (max.)
- Current: 85-100 mA
- Op. Volt.: 2.3-3.0V
- Wavelength: 670NM
- Lens Required
- Data Sheet & Application notes inc.

STOCK # LS9200 PRICE $49.99

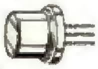
Laser Diode (visible red)



- Output: 5 mW (max.)
- Current: 65-100 mA
- Op. Volt.: 1.75-2.2V
- Wavelength: 780NM
- Lens Required
- Data Sheet & Application notes inc.

STOCK # LS022 PRICE $19.99

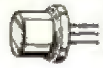
Laser Diode (visible red)



- Output: 4 mW (max.)
- Current: 20 mA
- Op. Volt.: 2.3-3.0V
- Wavelength: 670NM
- Lens Required
- Data Sheet & Application notes inc.

STOCK # SB3200 PRICE $89.99

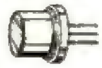
Laser Diode (visible red)



- Output: 5 mW (max.)
- Current: 60 mA
- Op. Volt.: 2.3-3.0V
- Wavelength: 670NM
- Lens Required
- Data Sheet & Application notes inc.

STOCK # LS9211 PRICE $69.99

Laser Diode (Infra-red)



- Output: 3 mW (max.)
- Current: 85-100 mA
- Op. Volt.: 2.3-3.0V
- Wavelength: 820NM
- Lens Required
- Data Sheet inc.

STOCK # SB1053 PRICE $9.99

Collimator Pen (Infra-red)

- Output: 2.5 mW (max.)
- Current: 90-150 mA
- Op. Volt.: 2.2-2.5V
- Wavelength: 820NM
- Data Sheet inc.

STOCK # LB1052 PRICE $39.99

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- Output: 3.5 mW
- Wavelength: 670NM
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27C16	3.99	3.79	3.41	27128A	4.79	4.55	4.09
2732	4.19	3.98	3.58	27C128	4.79	4.55	4.08
2732A-2	3.79	3.60	3.24	27256-20	5.29	5.03	4.53
2732A	3.69	3.51	3.16	27256	4.79	4.55	4.09
2732A-4	3.19	3.03	2.73	27C256	4.29	4.08	3.67
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27C32	3.79	3.60	3.24	27C512	5.99	5.69	5.12
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4116-250	.59	.56	.50	41256-80	2.79	2.65	2.39
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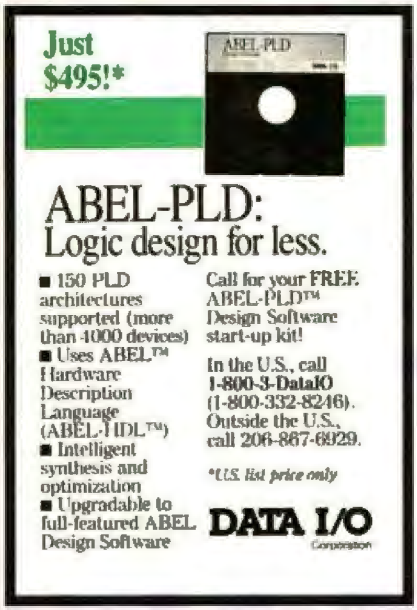

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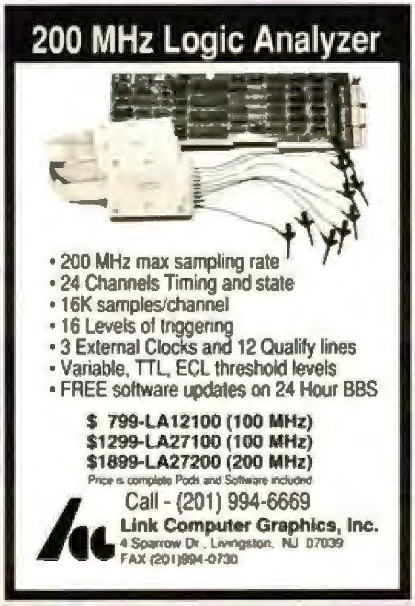

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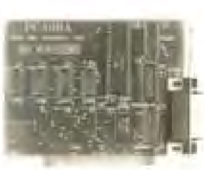

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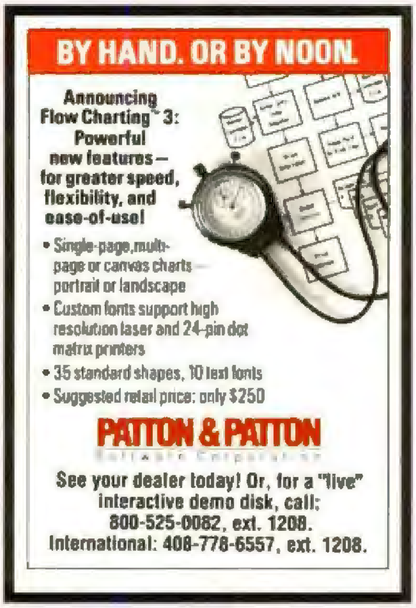

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Joanne Dow, Exchange Editor

amiga.user	Exchange ideas, solve problems, compare notes
amiga.sw	Amiga programming and developer issues
amiga.hw	Amiga hardware design, use, and hookup
amiga.arts	Artistry using the Amiga
amiga.int	Developing for the international Amiga
amiga.special	Special guests and events
amiga.dev	Commodore's conference for developers

■ IBM Exchange

Barry Nance, Exchange Editor

ibm.pc	The venerable PC
ibm.at	The AT series and workalikes
ibm.ps	The PS/2 series
ibm.os2	OS/2 operating system
ibm.dos	PC/DOS & MS/DOS operating systems
ibm.os.386	Alternative 386 operating systems
ibm.utils	Utility software for IBM computers

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ibm.repairshop	Garage and Tune-up Shop
ibm.new.prods	New products for IBM computers
ibm.exchange	IBM Exchange clearinghouse
ibm.listings	Index to program files in the Exchange
ibm.other	Apps, printers, modems, etc.
microsoft	Products from Microsoft

■ Writers' Exchange

Wayne Rash, Jr., Exchange Editor

desktop.pub	Using microcomputers for publishing
elfquest	Find out about things elven with Richard Pini
journalism	Reporting and writing news
journalism.pro*	Interaction for working press only
lexicon	About words
marketing	Promos, sales, public relations and high tech
new.writers	Getting started in the writing business
poetry.prose	Writing both types of English
sf	Science Fiction, Star Trek, and fantasy fans
sfwa*	Science Fiction Writers of America
tech.news	Discuss Microbytes, product reports, items
word.processor	Word-processing programs
writers	The original writers conference
write.fiction	How to write fiction
writers.pros*	Interaction for professional writers only
writers.talk	Conversations with professional writers

■ Macintosh Exchange

Dr. Larry Loeb, Exchange Editor

mac.apple	The word from Cupertino
mac.business	Macs in the office
mac.desktop	Publishing with a Mac
mac.external	Information from all over
mac.hack	Technical information about the Mac
mac.hypercard	Using the HyperCard programming environment
mac.news	Up-to-the-minute information
mac.novice	For beginners
mac.products	Listings of new hardware and software
mac.sandbox	For off-hours fun

■ Tojerry Exchange

Jerry Pournelle, Exchange Editor

tojerry	Messages for and from Jerry Pournelle
chaos.manor	Computing at Chaos Manor
astronomy	A star party for amateur astronomers
contact	Science fiction meets science
disasters	Natural and man-made disasters
education	Computers in American classrooms
mathematics	Talk about high-level mathematics
sciences	Scientific programs
space	Space exploration and development
technology	New technologies and their impact

*Please Note: Membership in this conference is limited to pre-screened specialists only.

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Listing 2: *The C stack is used to hold pointers to the* `setjmp` *structure.*

```
read_file(char *filename)
{
  FILE *f;

  {
    jmp_buf_rec jbr;          /* 1 */
    push_jbr(&jbr);           /* 1 */
    if (setjmp(jbr.jb) == 0) /* 1 */
      {
        f = file_open(filename, "r");
        read_stuff(f);
        file_close(f);
        pop_jbr();             /* 2 */
    } else {                   /* 2 */
        fprintf(stderr,
          "Error while reading file %s\n",
          filename);
        exit(1);
    }                          /* 3 */
  }                            /* 3 */
}
```

Listing 3: *Header file for exception-handling system.*

```
/* A general-purpose exception-handling system for C
    by Jonathan Amsterdam, 1991 */
#include <setjmp.h>
typedef char *exception;
typedef struct jbr {
    jmp_buf jb;
    struct jbr *next;
    struct jbr *self;
  } jmp_buf_rec;

#define WITH_HANDLING {jmp_buf_rec_jbr; \
                   push_jbr(&_jbr); \
                   if (setjmp(_jbr.jb) == 0) {theException=NULL;
#define ON_EXCEPTION  pop_jbr();} else {
#define END_HANDLING  }}
#define UNWIND_PROTECT WITH_HANDLING
#define ON_UNWIND     pop_jbr();}}
#define END_UNWIND    if (theException != NULL) reraise();

extern exception theException;

void raise(exception);
void reraise(void);
```

This differs from using the `WITH_HANDLING` macros, in that the code after `ON_UNWIND` is executed in normal and exceptional cases. As you can see from the macro definitions, it's not difficult to get this behavior.

Second, as another, more interesting example of matching macros, consider `WITH_OPEN_FILE`:

```
read_file(char *filename)
{
    WITH_OPEN_FILE(f, filename,
        "r")
      process(f);
    ON_FILE_EXCEPTION(f)
      if (theException ==
        FileOpenError)
      fprintf(stderr,
"could not open file %s\n",
        fname);
      else
      ...
    END_OPEN_FILE;
}
```

It opens, it closes, it even lets you handle exceptions if you want to. The implementation is built on `WITH_HANDLING` and is, again, quite simple:

```
#define WITH_OPEN_FILE(fp,\
    fname,mode) \
{ \
    FILE *fp; \
    WITH_HANDLING \
    if ((fp=fopen(fname,\
        mode)) == NULL) \
      raise(FileOpenError);

#define ON_FILE_EXCEPTION(fp) \
    if (fclose(fp)==EOF) \
      raise(FileCloseError); \
    ON_EXCEPTION

#define END_OPEN_FILE \
    END_HANDLING}
```

The Bad News

This article has three points. I discussed the first two: Exception handling is a good thing, and you can capture most, but not quite all, of it in C. Now it's time to address the third point.

There are two significant places where this C mechanism for exception handling falls short of Ada's method. The first is that Ada's exceptions search the stack for the first *matching* handler, not just the first handler. In Ada, if an exception `E1` is raised and the handler

```
exception
    when E2 = > ...
end;
```

is encountered, it will not be executed, and the search up the stack will continue. In the C version, there is no way for `raise` to tell which exceptions are handled by a handler, so it simply goes to the first exception. Therefore, it's important for handlers to have `else reraise()` if you don't want them to handle all exceptions.

The second deficiency of the mechanism is more serious. Consider this code, which allocates a pointer to an integer by using a memory allocation routine that raises an exception when memory is exhausted:

```
/* this code is dangerously
                    wrong! */
int *alloc_int()
{
    WITH_HANDLING
      return
        allocate(sizeof(int));
    ON_EXCEPTION {
      if (theException ==
          OutOfMemory)
      {
        fprintf(stderr,
"Out of memory!\n");
        exit(1);
```

```
      } else
         reraise();
    } END_HANDLING;
}
```

The problem would become apparent if you expanded the macros. If allocate returns normally, the pop_jbr contained in ON_EXCEPTION is not executed, so the top jmp_buf on the stack is invalid. Because pop_jbr has to be executed, you must *never* leave a WITH_HANDLING form except by falling through. The return, break, continue, and goto statements are dangerous inside a WITH_HANDLING form. You must write alloc_int thus:

```
int *alloc_int()
{
    int *ip;

    WITH_HANDLING
      ip = allocate
           (sizeof(int));
    ON_EXCEPTION {
      if (theException ==
          OutOfMemory)
      {
        fprintf(stderr,
"Out of memory!\n");
        exit(1);
      } else
        reraise();
      } END_HANDLING;
    return ip;
}
```

I don't know of a fully portable way around this weakness in the exception-handling scheme presented here. As a partial solution, I've made each jmp_buf_rec point to itself (through its self field). The raise statement checks this pointer before doing a longjmp. If the jmp_buf_rec has been corrupted, it's unlikely that it will still point to itself, but this is far from foolproof. You could also check the stack depth of a jmp_buf_rec, but this check requires nonportable knowledge about the stack organization. In any case, other function calls may have reextended the stack past the point of the invalid jmp_buf. Because the Ada exception mechanism is built into the compiler, it's not subject to this problem.

Listing 4: *Code file for exception-handling system.*

```
/* A general-purpose exception-handling system for C
    by Jonathan Amsterdam, 1991 */
#include <stdio.h>
#include "exhandle.h"

exception theException = NULL;
jmp_buf_rec *cur_rec = NULL;

push_jbr(jbr)
jmp_buf_rec *jbr;
{
  jbr->next = cur_rec;
  jbr->self = jbr;
  cur_rec = jbr;
}

pop_jbr()
{
  if (cur_rec == NULL) {
    fprintf(stderr, "Attempt to pop empty exception stack\n");
    exit(1);
  } else
    cur_rec = cur_rec->next;
}

void raise(ex)
exception ex;
{
  jmp_buf_rec *jbr;

  if (cur_rec == NULL) {
    fprintf(stderr, "Unhandled exception: %s\n", ex);
    exit(2);
  } else {
    theException = ex;
    jbr = cur_rec;
    if (jbr->self != jbr) {
      fprintf(stderr, "Corrupted exception stack\n");
      exit(2);
    }
    pop_jbr();
    longjmp(jbr, 1);
  }
}

void reraise()
{
  raise(theException);
}
```

Extensions

Despite its problems, the exception-handling facility presented here is useful. But there's room for improvement:

1. Unix implementations of C allow you to trap certain errors, called *signals*. These errors typically include division by zero and floating-point overflow, as well as user interrupts (Control-C's). To trap a signal, you first call signal with the signal name and a function:

```
signal(SIGINT, handle_interrupt);
```

Here, handle_interrupt will be called whenever you type Control-C. Incorporate signals into the exception system.

2. You can't pass back any information when you raise an exception—raise accepts only an exception (i.e., a string). You're forced to use global variables. Extend the exception facility to allow exceptions with arguments. (C's varargs mechanism may be useful here.) If you succeed, you'll have improved on Ada—its exceptions cannot have arguments.

3. The exception semantics follows that of Ada in not allowing execution to be resumed at the point of error. Other languages (e.g., Mesa and Common Lisp) allow exception handlers to return to the point of the raise. Write an exception system with this type of semantics. It will look quite different from the one I've described. ■

Jonathan Amsterdam is a graduate student in computer science at MIT and lives in Cambridge, Massachusetts. He can be reached on BIX c/o "editors."

HUGH KENNER

Bicycles for the Mind

A collection of corporate case studies examines the question, "Why can't Johnny compute?"

Steve Jobs (yes, the SJ you're thinking of) "read a *Scientific American* article back in the 70's [about] various animal species and how they use energy. In a list of about 67 animals, ranging from cheetahs to tortoises, humans came somewhere in the middle. Not too impressive. But then they put the human on a bicycle and humans moved to the top of the list. Steve told me he thinks of the computer as a bicycle for the mind."

That's Mark Edmiston, former chairman and CEO of *The Cable Guide*, recounting a talk with Jobs. *The Cable Guide* is the nation's sixth largest magazine, thanks to its ability to exist in 500 separate monthly versions, including the one I get in Athens, Georgia. ("Other magazines do regional editions, where they have the basic magazine and then insert pages. We actually lay out the magazine from front to back in 500 different ways.") Only computerization makes that possible. Moreover, it's only the CEO's hands-on use of computers that lets him hold the enterprise together.

The CEO, hands-on? Mr. Big himself? Aren't computers just clack-clacks for the steno pool, file systems for the accounting cubicles? Not according to Mary E. Boone, whose book *Leadership and the Computer* (Prima Publishing, 1991, $24.95, ISBN 1-55958-080-1) offers 16 case studies of CEO hands-on expertise. Most executives, she concedes, don't use them, mainly because they don't know what they're missing. But her sample of the ones who do is persuasive.

Here's a worldwide law firm (1200 attorneys in 11 offices across the U.S., plus offices in Tokyo, Geneva, Hong Kong, London, Paris, Riyadh, Brussels, Taipei, and Frankfurt), which is based in, of all places, Cleveland. "Clients must be convinced that they are receiving top-notch, cost-effective service, even though many of their attorneys are far removed from the client's location. And the right resources must be accessible to every remote office." That's done by "electronic document exchange, computerized research, computerized dockets, and desktop publishing." Also, "Because all the offices are linked, the network allows us to just ignore geography."

Yes, yes. But in addition, the firm eschews committee management. It keeps one man at the top, a managing partner, who can make decisions fast. There have been only five such managers since the firm was founded in 1913. The present one, Richard Pogue, uses his computer to keep those 1200 attorneys productive and happy.

E-mail, for instance. "We have a rule in our firm that the managing partner is accessible to any partner or lawyer" (even, in practice, to any secretary). Phone? The person you want is never in. Paper? It goes to the do-it-later heap. No, E-mail.

Another thing about keyboard-and-screen: It frees up psyches. At the University of Texas–Austin, I once visited a poetry seminar run by John Slatin. Some 30 students sat around a large room, each at a terminal, exchanging comments on the day's assignment and on one another's comments. Any teacher knows how efforts to cause oral "discussion" will activate—at most—four articulate people, the rest sitting dumb. But keyboard participation that morning was close to 100 percent. It was eerie; all of them in the same room, looking not at one another but at monitors, and typing things they wouldn't venture to utter. (Later, everyone received a printout of the hour's interactions.) In that light, think of CEO Pogue getting input from secretaries: "They wouldn't ever call me up. But they feel comfortable sending me a message."

Skip to Boone's eighteenth chapter, "The Barriers Holding Executives Back." Isn't "executive computing" an oxymoron like "airline cuisine"? For instance, "I can't type." That tends to mean, "Typists are paid to type. I'm not." One answer is, "Hunt and peck!" Another is, "Learn!"

Another objection: "It's too hard to learn," which underrates the learning ability of anyone smart enough to have become a CEO in the first place. Here Boone observes that too many systems underrate users and cumber them with help screens. A simplistic interface can reinforce the prejudice that computers are merely tools for toilers. "It's easy to blow up balloons, but executives don't sit around in offices doing that. Executives don't do things because they are easy; they do things because they produce results." And, "If executives view the computer as a convenience, they perceive the payoff as relatively low."

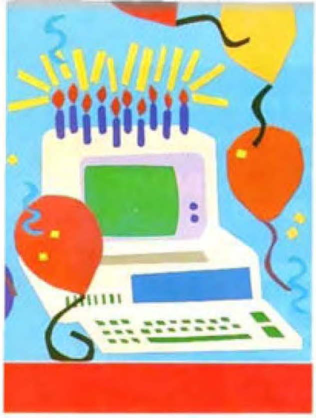
Those are wise words. And—quoting Debbi Fields, president of 600 successful cookie stores—software should be "user-easy, not user-friendly," analogous to something the user already knows. Hence, "No graphic interface, no icons, no mice, no things that people don't use. We prefer form-based systems." (So take that, Mac!)

Meanwhile, here's the president of Aetna Life (44,000 employees): "I used to think managers who wrote their own stuff on-line were wasting their time. They're not. It actually takes less time than sitting there staring at your secretary, or dictating to your machine. Very few people, and I am not one of them, can dictate on complicated issues with any precision. The stuff comes out like James Joyce." So President Compton punches his own keyboard, and Aetna thrives. Who knows, he may eventually conserve enough time to *read* James Joyce. ■

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. He writes for publications ranging from the New York Times *to* Art & Antiques. *His recent books include* Mazes *and* Historical Fictions. *He can be contacted on BIX as "hkenner."*

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

Circle 6 on Inquiry Card (RESELLERS: 7).



STOP BIT

KENNETH M. SHELDON

YOU'VE COME A LONG WAY, PC

At BYTE, we use manufacturers' press releases to gather information, but we never print those releases. That's because press releases sometimes contain several times the minimum daily requirement of hype and jargon, instead of details about what the product is, what it does, and how much it costs. (Call us picky.)

However, we're about to make an exception to that rule, for two reasons. First, the following press release is among the few that could arguably be called historically significant. Second, it's 10 years old; we figure the statute of limitations has run out on this one.

Ten years ago this month, the world's leading manufacturer of large computer systems released its first microcomputer. Here is what the press release said:

> *NEW YORK, August 12*—IBM Corporation today announced its smallest, lowest-priced computer system—the IBM Personal Computer.
>
> Designed for business, school, and home, the easy-to-use system sells for as little as $1565. It offers many advanced features and, with optional software, may use hundreds of popular application programs.

The release went on to describe some highlights of the new system, including "up to 262,144 characters of user memory (16,384 standard)." For those impressed by large numbers, keep in mind that 16,384 characters is 16 kilobytes. Well, it sure seemed enough at the time. IBM's current top-of-the-line desktop system, the PS/2 Model 90, comes standard with 8 megabytes of RAM.

A decade after its debut, the influence of the IBM PC is undeniable and universal

Then there was the "high-speed, 16-bit microprocessor. . .operating at speeds measured in millionths of a second." The chip was an Intel 8088, which has 16-bit registers but an 8-bit data bus—a design that saved a few dollars on every PC and made it somewhat easier for manufacturers to design add-in boards. The 8088 ran at 4.77 MHz. Remember when that seemed like "high-speed"? Recently, Intel announced that it had managed to crank up the speed of the great-great-grandchild of the 8088 (i.e., the 486) to 100 MHz.

For graphics, the new system was "capable of displaying 256 characters in any of 16 foreground and 8 background colors" and had "graphics in 4 colors." To get those colors—in fact, to get any graphics whatsoever—you had to buy an optional graphics card, an arrangement that opened the door for an eventual avalanche of various add-in products.

The announcement accompanying the PC's debut boasted that the IBM PC was "compact." Well, it was certainly smaller than IBM's System 370 mainframe. Nowadays, you can buy a laptop computer that weighs less than the IBM PC's keyboard.

Interestingly, the press release reflects that the IBM PC was originally intended for use in the home as well as in the office.

One of the photographs accompanying the press kit showed two tykes lying on their living room rug, playing MUSIC.BAS on their PC. They could also have been playing DONKEY.BAS, an arcade game—written by Microsoft chairman Bill Gates—that was included with the system. And prominently included in a list of applications software available for the new system was Microsoft's version of the classic Adventure game.

Of course, Microsoft also supplied an "advanced disk operating system" for the computer, which IBM called PC-DOS. Just to be safe, IBM also provided CP/M-86 and UCSD p-System as optional operating systems for the PC. According to the release, "These two systems should provide users with the opportunity to transfer hundreds of widely used applications to the IBM Personal Computer with minimal modifications." Needless to say, not that many application programs were transferred via those systems, but countless new programs were written using the optional BASIC compiler, and the chairman of Microsoft now owns several small nations.

Looking back, it's easy to poke fun at the capabilities of the original IBM PC. We do so with gentle affection. Although it was challenged by systems like the Macintosh and high-powered RISC machines, the PC spawned a breed of computers that remains the undeniable leader among small computers around the globe, and we're pleased to celebrate its birthday.

Sadly, that celebration cannot be shared by the man who led the development team for the IBM PC. Don Estridge, president of IBM's Entry Systems Division, was killed in a plane crash in August 1985. (The name "Entry Systems" tells you something about corporate IBM's original view of the PC's place in its product lineup.) Congratulations, Don, wherever you are. You done good. ■

Kenneth M. Sheldon is BYTE's senior editor for the Features and Hands On sections. He can be reached on BIX as "ksheldon."