

# BYTE

A McGRAW-HILL PUBLICATION

Taming  
A Sea of  
Paper

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An insider's look at computing  
in the troubled U.S.S.R.

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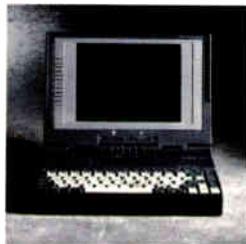
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• Intel 80386SX microprocessor running at 20 MHz.  
**\*\*Commercial Lease Plan. Lease for as low as \$97/month.**  
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You even have anytime, any day access to Dell's innovative automated TechFax line. Just dial-up, and get detailed information from the Dell technical library faxed back to you. On the spot.

And if your problem can't be solved over the phone, a trained service technician will come to you with a solution the next business day.<sup>Δ</sup> All this coverage, including the first year of on-site service, is included in the system price.

Either way, the first year of on-site service is included in the system price.

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# ROAD WARRIOR.

There you are, doing battle far from home. Armed with your powerful new notebook computer. As you prep for the next day's conquest, something unexpected happens.

Suddenly you find yourself stranded in some strange hotel room, with your computer down. And no one will come service it.

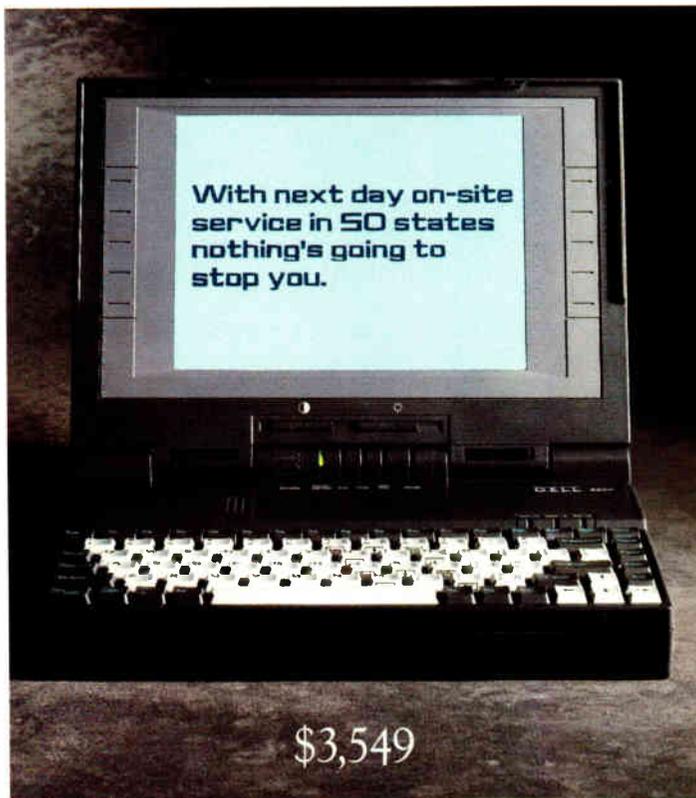
You wake up in a pool of sweat.

Dreams like this make it very easy to choose Dell's 20 MHz 386SX notebook computer over the remarkably overpriced and underserviced Compaq LTE/386s/20.

Because when you buy the Compaq system, this isn't just a bad dream.

It's a real possibility.

**Can you afford  
not to buy the**



Dell System® 320N 386™ SX 20 MHz<sup>3</sup> Lease: \$129/mo.\*\*

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**Dell® 320N?** At a time when everybody is cutting budgets, can anyone afford to spend up to an extra \$2,950?

More importantly, can you afford to go on the road counting on service from a Compaq dealer you've never heard of?

Especially when every Dell system comes with a full gamut of road services. Like a toll-free technical support line that helps users solve 90% of their problems over the phone.

And if you need help in the middle of the night, just call Dell's innovative TechFax line. It automatically faxes back detailed information on your Dell computer. Even to your hotel.

If that doesn't solve it, call for road service. A trained

## THE NEW DELL SYSTEM 320N 20 MHz 386SX AND THE NEW DELL SYSTEM 212N 12 MHz 286.

- Intel® 80386SX microprocessor running at 20 MHz (320N) and the Intel 80C286 microprocessor running at 12 MHz (212N).
  - Standard 1 MB of RAM,\* expandable to 5 MB (on the system board using 1 MB or 2 MB memory modules).
  - 640 x 480 VGA LCD with edgelight.
  - One expansion slot for Dell Data/FAX modem.
  - 6.4 lbs. with battery, dimensions are 8.5" D x 11" W x 2" H.
  - 3.5" 1.44 MB diskette drive.
  - 85-key keyboard with embedded numeric keyboard.
  - 1 serial port and external VGA monitor port.
  - Selectable parallel printer or external 5.25" disk drive/tape backup port.
  - Connector for numeric keypad or 101-key keyboard.
  - Mouse port.
  - Removable and rechargeable battery pack utilizing Dell's "Continuous Power Battery System" (patent pending).
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| 212N: 20 MB, 1 MB RAM* | \$2,399 |
| 320N: 30 MB, 1 MB RAM* | \$3,399 |
- 40 MB available for the 212N.  
60 MB available for the 320N.

# TEN TIMES BETTER!



THE EISA-BASED  
DELL SYSTEM® 433TE.  
**ONLY \$9,649**

\* i486 microprocessor running at 33 MHz with 128 KB external cache.  
\*\*Commercial Lease Plan. Lease for as low as \$348/month.  
330 MB VGA \$9,649  
Monochrome System  
Price listed includes 4 MB of RAM.\* 80, 100, 190 and 650 MB hard drive configurations also available.  
25 MHz systems also available starting at \$6,649.



THE EISA-BASED  
DELL SYSTEM 433E.  
**ONLY \$8,199**

\* i486 microprocessor running at 33 MHz.  
\*\*Commercial Lease Plan. Lease for as low as \$296/month.  
190 MB Super VGA \$8,199  
Color System (800 x 600)  
Price listed includes 4 MB of RAM.\* 80, 100, 330 and 650 MB hard drive configurations also available.  
25 MHz systems also available starting at \$5,749.



THE NEW  
DELL SYSTEM 433P.  
**ONLY \$4,999**

\* i486 microprocessor running at 33 MHz.  
\*\*Commercial Lease Plan. Lease for as low as \$181/month.  
100 MB VGA Color Plus System \$4,999  
Price listed includes 2 MB of RAM.\* 190 and 320 MB hard drive configurations also available.



THE  
DELL SYSTEM 333D.  
**ONLY \$4,199**

 \* Intel® 80386 microprocessor running at 33 MHz with 64 KB external cache.  
\*\*Commercial Lease Plan. Lease for as low as \$152/month.  
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THE NEW  
DELL SYSTEM 325P.  
**ONLY \$2,599**

\* Intel 80386 microprocessor running at 25 MHz.  
\*\*Commercial Lease Plan. Lease for as low as \$97/month.  
40 MB VGA Color Plus System \$2,599  
Price listed includes 2 MB of RAM.\* 80, 100, 190 and 320 MB hard drive configurations also available.  
33 MHz systems also available starting at \$2,649.

If we've said it once, we've said it ten times. You can get a custom-built Dell® computer with better service for \$1,700 to \$16,000 less than a similarly configured Compaq.†

But if you're still not convinced, go to a Compaq dealer and compare what's there with what's here.

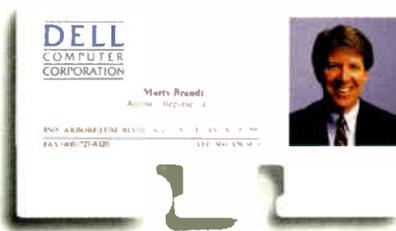
**You make the call, then we make the computer.**

After we finish taking your order, we begin building your computer. Everything from the hottest 386SX notebook PCs to workgroup-sized i486™ network servers.

And because we actually manufacture the computers we sell, each one is custom configured to your specifications. With a virtually limitless number of choices of monitors, hard drives, RAM sizes and peripherals.

Then we run a configured systems check, and ship it to you via two-day air standard. With a 30-day money back guarantee and a one-year limited warranty.

**Support that wins awards, and your confidence.**



For Compaq service, you get the dealer that sold the computer. With Dell service, you get the company that designed and built the computer.

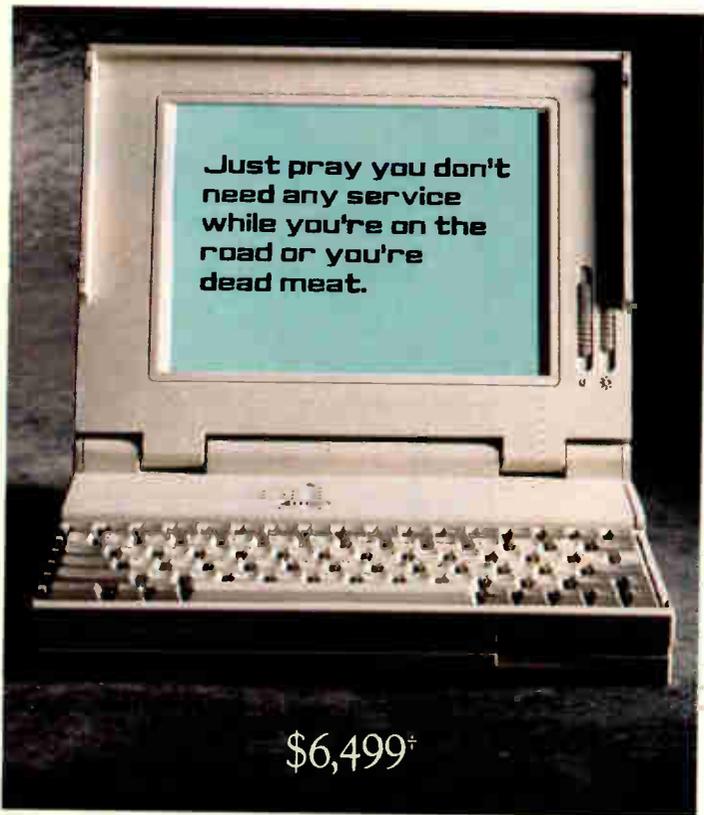
The Dell service and support package has won an unprecedented 8 PC Week Corporate Satisfaction Polls for PCs, laptops and servers. Maybe because the company that supports Dell computers is the same one that makes Dell computers.

Which means you get a technical support

staff that can solve 90% of all problems over the phone. Usually in 6 minutes or less. You also get an electronic bulletin board that lets you see other users' questions about Dell systems. And more importantly, Dell's answers.

§The Dell System includes VGA LCD monitor, 30 MB hard drive, 2 MB RAM. The Compaq System includes VGA LCD monitor, 30 MB hard drive, 2 MB RAM. The Dell System 433TE and 425TE are class A 425E, 433E, 425TE and 433TE) of memory is reserved for use by the system to enhance performance. Can be optionally disabled on 333D, 325D, 333P, 325P, 320N, 212N, 316SX and 210. All systems are photographed with optional extras. All prices are in U.S. dollars. †Leasing arranged by Leasing Group, Inc. In Canada, configurations and prices may vary. Dell and DELL SYSTEM are registered trademarks, and SmartVu is a trademark of Dell Computer Corporation. Intel is a registered trademark and a trade name of Intel Corporation. © On-site service provided by Xerox and may not be available in certain locations. Shipping, handling and applicable sales tax not included in the price. For information on and a copy of Dell's 30-day Total Satisfaction Guarantee, call 1-800-4-A-DELL.

# ROAD WORRIER.



Compaq LTE/386s/20 386SX 20 MHz<sup>†</sup> Dealer prices may vary.

technician will come to your hotel room, or office,<sup>△</sup> the next business day with a replacement system if necessary. And if possible, your hard drive contents will be transferred on the spot. All at no additional cost for the first year you own your computer.

**It's light weight. But it's no lightweight.** Dell's notebook weighs just 6.4 pounds. It measures a trim 8½" x 11" x 2". And it fits in your briefcase like a pad of paper. But technically, this is heavy artillery.

The Dell 320N features a built-in 3.5" diskette drive with

your choice of high-speed 30 or 60 MB hard drives.

The display is a high quality VGA LCD. There's an optional, built-in Data/FAX modem. And a sliding door that lets you easily insert a math coprocessor, RAM modules or the modem without major surgery. (Dell also has the 212N, 12 MHz 286 with a 20 or 40 MB hard drive.)

Even the keyboard shows touches of brilliance. It's a complete 85-key layout. Including the special screen navigation keys (Home, End, Page Up, Page Down and separate Cursor keys) that let you easily navigate even the most spread-out spreadsheet. And every key is engineered for extended travel, to provide the familiar touch of a top-of-the-line desktop system.

**Don't worry. Be happy.** One more thing to consider. When you buy from Dell, you're dealing directly with a company that has won *PC Week's* Corporate Satisfaction Poll for PCs, servers and laptops. Not just once. An unprecedented eight times.

A company that will custom configure any system to meet your needs. And then work with you to custom configure a finance or leasing plan.<sup>◇</sup>

And we back it all with a 30-day no questions asked satisfaction guarantee.

Call today for either of our new notebook computers. And hit the road, equipped with a Dell.

That'll really give the guys with the Compaqs something to worry about.



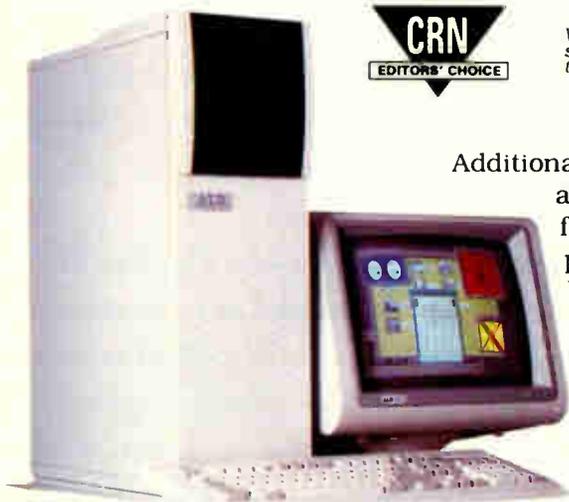
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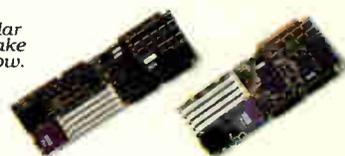


# There's An Double Your

## Introducing The ALR POWERPRO



*With the POWERPRO's advanced modular system architecture, the choices you make today won't limit your options tomorrow.*



**Just Upgrade the CPU!™**

Additionally, all models will be able to accommodate future, faster, processors.

With 49-MBs of possible RAM, twelve expansion slots, and accommodations for up to 2.5-GB of internal stor-

age (up to 10-GB of total storage utilizing an external ALR expansion chassis), the POWERPRO has the expandability needed to keep pace with your future needs. The POWERPRO also incorporates a 32-bit EISA bus, so you'll have maximum compatibil-

ity with cutting-edge enhancement products while enjoying the affordability of today's low-cost "AT" compatible hardware.

**SUPERIOR CACHE**  
The POWERPRO uses ALR's proprietary

Strapping two traditional PCs together won't give you the dual processing power you need to keep pace with today's growing networks and multi-user environments, but the new ALR POWERPRO will. It's the affordable, high-performance alternative to the COMPAQ SYSTEMPRO™.

Whether you need a system for single or multiple users, CAD/CAM, office automation, manufacturing management systems, shared databases or a host of other applications, there's a POWERPRO that delivers. Choose between one or two 33-MHZ i486 processors and up to 1-MB of cache for performance ranging from 14.7 to 40 VAX™ MIPS. Single CPU models can be quickly and easily upgraded to dual processing.



low-cost "AT" compatible hardware.



# Easier Way To Processing Power.

Single or Dual Processing Performance with Prices Starting at \$7495



SMP Certified

PROCACHE scalable cache memory architecture. This mainframe-like read-and-write-back design is more efficient than the standard write-through architecture found on the SYSTEMPRO.

ing, spanning and mirroring — with greater flexibility and higher performance. ALR's SDA protects your data while helping to eliminate hard disk bottlenecks.

## OFF THE SHELF COMPATIBILITY

The SYSTEMPRO-compatible ALR POWERPRO runs off the shelf dual-processing versions of SCO® UNIX™ with SCO MPX as well as Banyan® Vines™ SMP. And it's positioned for use with future dual processing versions of Novell® NetWare™, OS/ 2™ and LAN Manager 2.0™.

Manufacturer Model Name	ALR POWERPRO 486/33 VM 64	ALR POWERPRO 486/33 SMP 512	Compaq SYSTEMPRO 486/33
CPU	Single 33-MHz i486	Single 33-MHz i486	Single 33-MHz i486
# of Processors	1	1	1
Max. # of Processors	2	2	2
Bus Architecture	32-bit EISA	32-bit EISA	32-bit EISA
Memory Cache	64-KB	512-KB	512-KB
RAM Std.	5-MB	17-MB	8-MB
Hard Drive	none	330-MB <18ms	240-MB <19ms
Expansion Slots	12	12	11
Price	\$7,495	\$14,495	\$20,995

More importantly, this scalable architecture allows you to equip the POWERPRO with up to 1-MB of cache.

## ADVANCED DISK PERFORMANCE AND SECURITY

Yet the POWERPRO's performance edge doesn't stop there. Selected models use ALR's SCSI SDA (Software Disk Array) to provide the capabilities of hardware disk arrays — including disk strip-

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Prices based on U.S. Dollars.

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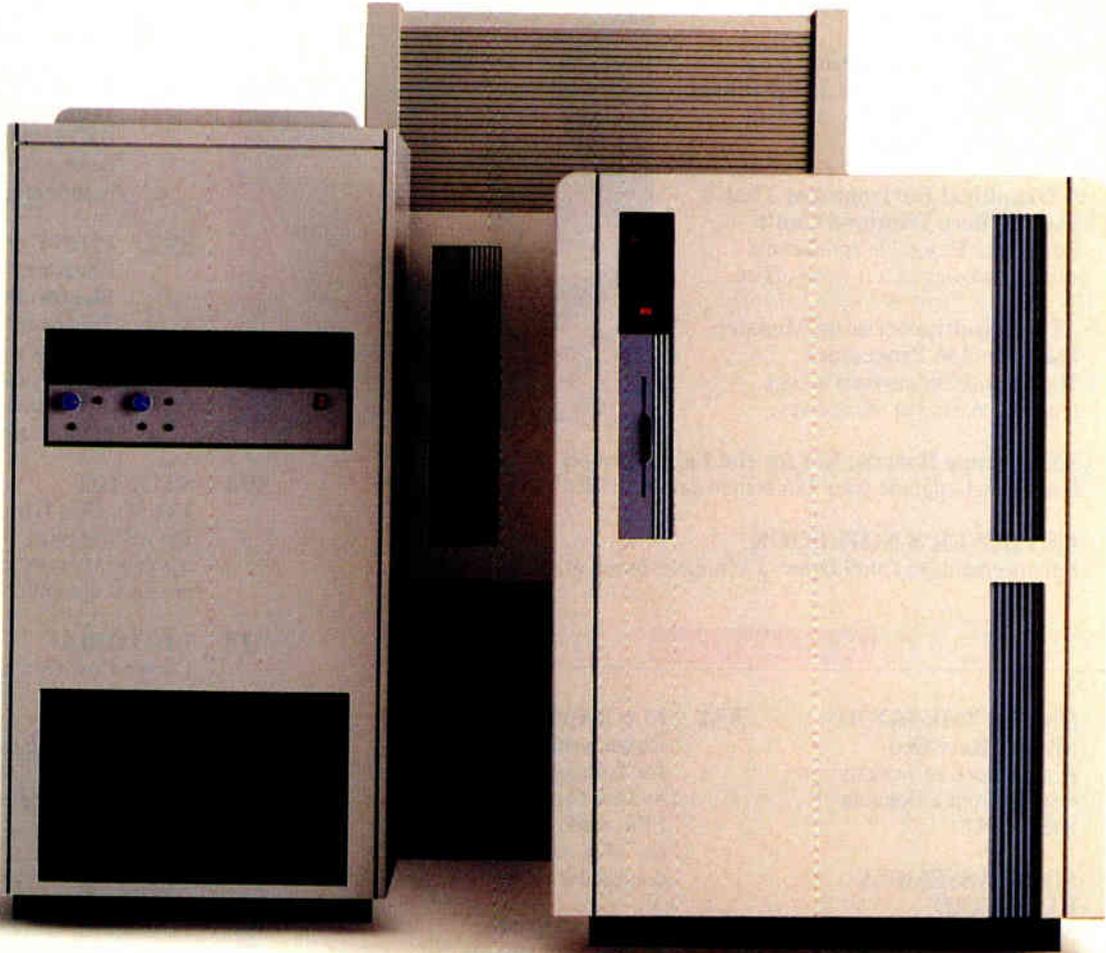
### PROGRAM LISTINGS

- From BIX: Call (800) 227-2983  
From BYTEnet: Call (617) 861-9764  
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# The Joneses.



Check out the benchmarks. When it comes to speed, pure and simple, mainframes are no longer the main attraction.

Introducing the Everex STEP 486/33 and STEP 486/25. Along with the STEP 486*is*, they give you desktop performance that was previously unheard of.

There are two reasons. The first, of course, is the 486™ chip. The other is AMMA™, Everex's proprietary Advanced Memory Management Architecture.

STEP 486/33	34,000 Dhrystones (19.4 MIPS)
CRAY-X-MP/48	17,857 Dhrystones
IBM 3083	16,666 Dhrystones

AMMA uses "write-back" cache technology instead of the "write-through" technologies used in most PC's. The write-back cache was developed for mainframes. Everex was the pioneer in developing it for the PC. And in doing so, opened a whole new dimension in desktop performance.

With AMMA, you can write directly to the STEP 486's cache in nearly all cases. With write-through techniques, on the other hand, you lose most of the performance benefit of the cache.

\*Inquiries from outside the U.S. call 415-498-1111. EVER for EXcellence is a registered trademark and Everex, STEP, STEP 486*is*, AMMA and PDS are trademarks of Everex Systems, Inc. 486 is a trademark of Intel Corp.

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World Radio History

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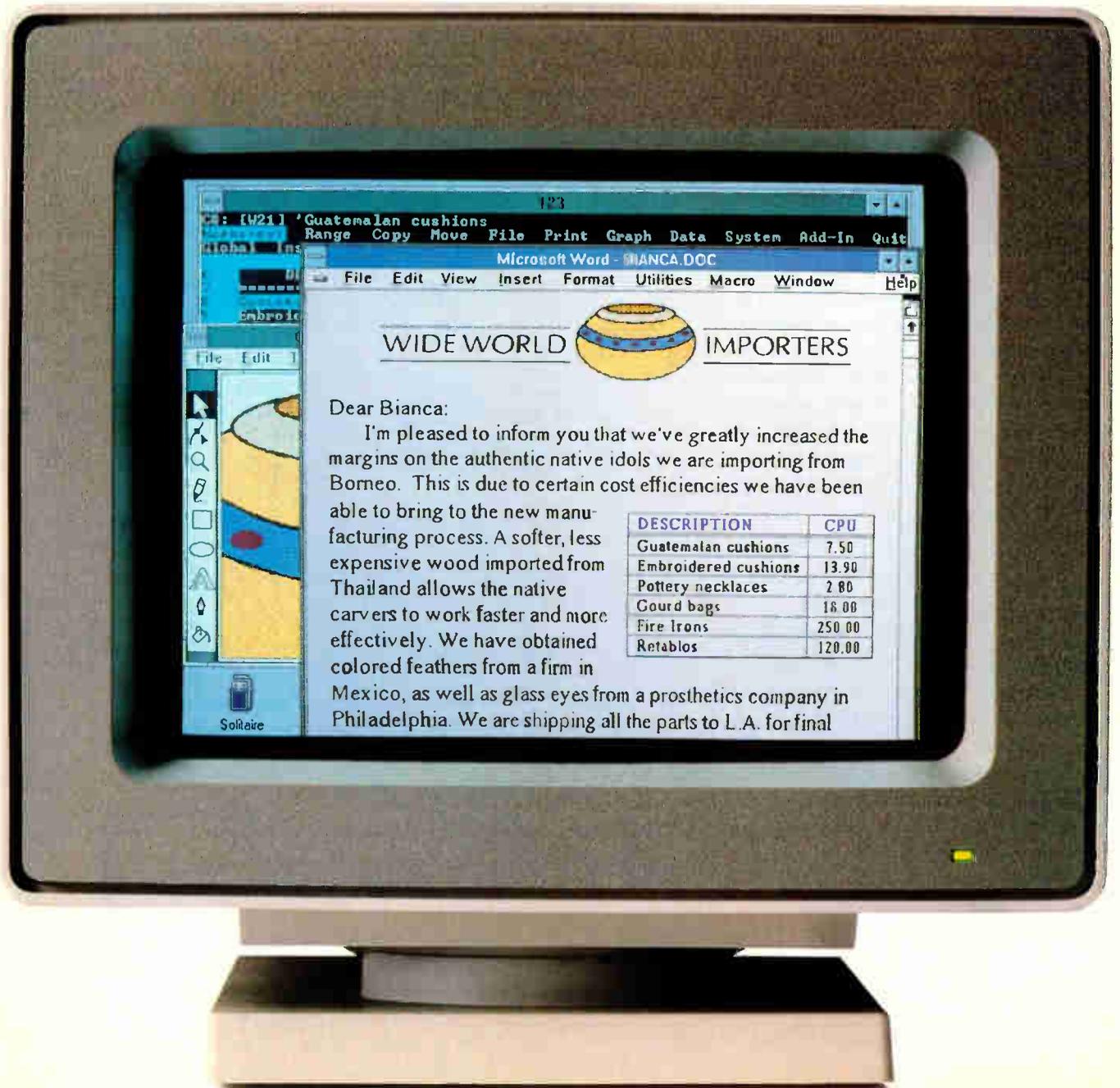
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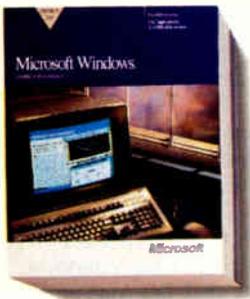
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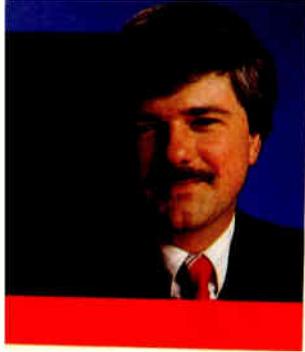
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FRED LANGA

# EDITORIAL

## LOWER-COST DOWNLOADS

**A new BYTE service can save you money when downloading material**

One of the horrors of the early days of personal computing was the—argh!—type-and-run program. I can recall spending too many evenings with a magazine open on my lap, laboriously keying in page after page of code. I'd initially use rulers and pencil marks to try to keep my place on the page; then, with one finger on the screen and another on the page, I'd painstakingly cross-check my typed code against the original. Then, finally, I'd try to run the newly keyed program. It almost never worked the first time. With listings of any length at all, some subtle typo would inevitably creep in, fouling up the listing in whole or in part. What a pain.

With the advent of BBSes and on-line services, the type-and-run program largely died a well-deserved death. Full-blown print listings linger today only in a few publications: those that cater to novices (who may lack modems or the knowledge of how to download software) or, more sadly, publications looking to pad out their editorial ratio with space-filling code.

When BYTEnet and then BIX started in the 1980s, BYTE shifted the bulk of its routine program listings on-line, reserving printed listings only for special cases, and when there was some compelling reason. This worked pretty well: If you signed up for BIX or called the free BYTEnet number, you could download in minutes and with total accuracy code that might otherwise have taken hours to key in. This saved you time, and it gave us more space in the magazine to bring you additional articles.

The only catch was cost. Even the "free" BYTEnet number required that you call Lexington, Massachusetts, to access the BYTEnet host. The long-distance charges could be daunting.

Happily, that catch has been largely eliminated. Starting this month, instead of having to call Massachusetts for BYTEnet, most readers will be able to phone a much closer access point to obtain current BYTE listings for free. This will reduce your phone charges while still giving you error-free, timesaving downloads of program code.

We're able to do this by piggybacking the BYTE listings onto our Demolink service and using Demolink's international communications network.

Now, when you call Demolink, you'll have the option of downloading either the current BYTE listings or Demolink's normal fare, which is free "try before you buy" software offered by a group of major software vendors.

For example, on a recent weekend when I last logged on, Demolink offered free versions of Lotus Magellan 2.0; some Borland software; C-scape (an object-oriented C programming tool) and the Look & Feel screen designer from the Oakland Group; Zortech's multiplatform C++, which is portable to DOS, Windows 3.0, OS/2, extended DOS, Unix, and the Mac; and more.

The list of available software is constantly growing and changing, and it will probably be different when you call. But in all cases, instead of having to write or call to request a demonstration disk (and suffer the usual four- to six-week wait), Demolink lets you instantly download the demonstration software of your choice.

And now, Demolink also gives you access to the BYTE listings.

Demolink is currently available through local calls in the following cities: Chicago (312) 616-1071; Los Angeles (213) 383-9856; New York (212) 797-5620; San Francisco (415) 434-4510; Washington, DC (202) 463-4920; Denver (303) 220-0328; Hightstown, NJ (609) 426-7110; and Toronto, Ontario, Canada (416) 960-3187. Other cities, including European access points, are in the works.

Connecting with Demolink is standard: Using conventional modem settings (8 data bits, 1 stop bit, no parity; 2400 or 1200 bps), you call one of the numbers listed above and enter DEMOLINK at the first prompt. You'll then be walked through a brief sign-on process. After that, you're given a menu of available software and listings.

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We're glad to be able to offer you free electronic listings from more access points at lower telephone costs than ever before. Check out Demolink; we think you'll like it!

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

# “Who would you expect to give you the best compiler for creating Windows applications?”

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## Compare these costs

	Microsoft® C 6.0	Borland C++
C compiler	\$ 495	\$495
C++ compiler	not available	included
Windows programming tools	\$ 495 (SDK)	included
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<b>Total**</b>	<b>\$ 1,140</b>	<b>\$495</b>

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World Radio History

# dFacts Are In.

<b>DATABASE COMPARISON TABLE</b>	<b>dBASE IV version 1.1</b>	<b>Paradox version 3.5</b>	<b>FoxPro version 1.02</b>
<b>EASE OF USE</b>			
Control Center organizes data, queries, forms, reports, labels, applications on <u>one</u> screen	<b>Yes</b>	<b>No</b>	<b>No</b>
Create applications <i>without programming</i>	<b>Yes</b>	<b>Yes</b>	<b>No</b>
Modern pulldown menus for all Design Tools	<b>Yes</b>	<b>No</b>	<b>Limited</b>
Query by Example (QBE) for easy access to information	<b>Yes</b>	<b>Yes</b>	<b>No</b>
Context specific help by menu item	<b>Yes</b>	<b>No</b>	<b>No</b>
<b>PRODUCTIVITY</b>			
Quick Layout for automatic forms, reports <u>and</u> labels	<b>Yes</b>	<b>No</b>	<b>Yes</b>
Application Generator for quick application development	<b>Yes</b>	<b>Yes</b>	<b>No</b>
Automatic code generation for all Design Tools	<b>Yes</b>	<b>No</b>	<b>No</b>
Automatic maintenance of <u>multiple</u> indexes for ordering data	<b>Yes</b>	<b>No</b>	<b>No</b>
Memo fields for notes, letters, descriptions	<b>Yes</b>	<b>No</b>	<b>Yes</b>
<b>POWER &amp; FLEXIBILITY</b>			
Bold, underline, italic, subscript, superscript text for high impact reports and labels	<b>Yes</b>	<b>No</b>	<b>No</b>
User Defined Functions for extending programming language	<b>Yes</b>	<b>No</b>	<b>Yes</b>
Data input validity checking in forms	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
Multi-user transaction processing ensures data integrity	<b>Yes</b>	<b>No</b>	<b>No</b>
Number of file formats imported/exported	<b>7</b>	<b>6</b>	<b>3</b>
<b>INDUSTRY STANDARDS</b>			
#1 Selling, #1 Rated multiuser database; over 3 million users (1)(2)	<b>Yes</b>	<b>No</b>	<b>No</b>
Compatible with dBASE III PLUS data and applications	<b>Yes</b>	<b>No</b>	<b>Yes</b>
Compatible versions for DOS, VAX VMS, Macintosh, SunOS and other UNIX platforms (3)	<b>Yes</b>	<b>No</b>	<b>Limited</b>
Structured Query Language (SQL) integrated with programming language	<b>Yes</b>	<b>No</b>	<b>No</b>

(1) dBASE III PLUS and dBASE IV comprise approximately 55% of PC database systems sold (3 times nearest competitor) according to the most recent report by the market research firm Audits & Surveys (Oct. 1990) (2) Software Digest rated dBASE IV #1 among multiuser databases, October 1990 (3) Versions of dBASE IV are shipping for DOS, VAX, and SunOS. Macintosh and other UNIX Platforms are announced

Based on what our customers tell us, we made a list of some of the most important features to look for in data management software.

Then we compared the new dBASE IV® version 1.1 with two other database products.

As you can see, dBASE IV offers exclusive advantages in

many categories.

For instance, only dBASE IV lets you access all its functions from a single screen. Called the Control Center, this screen lets you manage existing data, and create new tables, queries, reports, forms and labels totally without programming.

When all the facts are on the table, it's easy to see which database software is best.

Of course we aren't the only ones who have come to this particular conclusion.

Software Digest rates dBASE IV version 1.1 the #1 Multiuser Database (Vol. 7, No. 13, Oct. '90).

# Truth Comes Out.

**Software Digest RATINGS REPORT**  
 The Independent Comparative Ratings Report for Selecting IBM PC Business Software

Volume 7 Number 13

## MULTIUSER DATABASE PROGRAMS

Ratings Key: ■ 70-100 ■ 50-69 ■ under 50

Software Digest Rating	Overall Evaluation	Overall Power	Program Name	Version Tested	Performance	Versatility	Error Handling	Ease of Learning	Ease of Use	Memory Requirement	Price	Volume Purchase Agreements	Page
***	70	67	dBase IV	1.1	■	■	■	■	■	450KB	\$795	✓	28
**	6.8	5.1	Paradox	3.5	■	■	■	■	■	640KB	\$995	✓	32
**	6.8	7.1	FoxPro/LAN	1.02	■	■	■	■	■	512KB	\$1,095	✓	30
**	6.4	5.1	DataEase	4.2	■	■	■	■	■	640KB	\$750	✓	26
*	5.8	3.6	R:Base	3.0	■	■	■	■	■	520KB	\$995	✓	34
*	5.7	6.0	Clarion Professional Developer	2.1	■	■	■	■	■	512KB	\$845	✓	24
*	5.7	6.6	Advanced Revelation	2.01	■	■	■	■	■	640KB	\$995	✓	22

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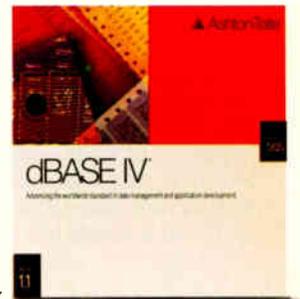
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# LETTERS

## X.400: Theory vs. Practice

Imagine my surprise upon returning from the recently completed CCITT SGVII/Q18 meeting in Geneva to find Steven J. Vaughan-Nichols's "X.400: Standardizing E-Mail" (December 1990) dealing with the precise topic we were discussing (i.e., understanding X.400). As I read the article, I became concerned about the numerous inaccuracies and misconceptions it contains.

For example, the current version of the X.400 series is the 1988 version (i.e., the "blue book"), which has superseded the 1984 version (the "red book"). There is no X.401 or X.410 in the blue book. Furthermore, any speculation that X.410 was ever the "most important member of the X.400 family" is subject to some debate. You can be a perfectly happy user of an E-mail service without caring about the underlying transport protocol mechanism.

The simplistic explanation of the X.500 series of recommendations is hard to reconcile with the rest of the article, because X.500 was introduced in 1988 and certainly provides more than simple name-to-address resolution. The statement that X.500 is a database service is confusing at best.

Finally, X.400 does not define any format for presenting an originator/recipient address visually. Thus, the notion that an O/R address can be presented as "keyword:value" will come as a shock to those representatives at the Geneva meeting who are attempting to define appropriate visual representations. The fact that Vaughan-Nichols's service uses one particular visual representation does not imply that that representation is standardized in the X.400 series. Indeed, there are many parts of the global message-handling environment that are not standardized by X.400. To understand what is standardized in X.400, one must first understand the Open Systems Interconnection stack, and where in that stack X.400 sits.

Bruce Greenblatt  
IBM Corp.  
Roanoke, TX

*What you describe as inaccuracies and misconceptions are really the differences between two views of X.400. Your view is representative of the ivory tower vision of the standard. My article, however, was about X.400's real-world implementations. Behind these positions is a long-standing debate in E-mail circles on what X.400 is and what it should be.*

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*To go into more specific detail, you are quite correct that the "blue book" version of the protocols does not include X.401 or X.410. The subject matter these two standards address has now been incorporated into X.400 and a combination of X.218, X.219, X.228, and X.229, respectively. That's the theory, anyway. In practice, all commercial programs I am aware of are based on the 1984 model. In these implementations, how X.410 is handled is vital to the success of the mail-handling process. That this is transparent to the E-mail user does not in any way undermine the importance of the issues that X.410 addresses.*

*I am puzzled by your trouble with my explanation of X.500. From both E-mail users' and administrators' points of view, X.500 will be an easy-to-access distributed database of E-mail user information. Since yours has been the only criticism of the explanation, I can only assume that the fault lies with your understanding of X.500 directory services.*

*You seem surprisingly ignorant of real-world implementations of X.400. Whether you use X.400 addressing on MCI Mail, Sprint Telemail, AT&T Mail, or the Internet, O/R addresses are presented in one of several versions of a "keyword:value" format. While there are theoretical discussions on how addresses should be represented, the "keyword:value" style is the de facto standard for human-readable addresses in X.400 systems.*

—Steven J. Vaughan-Nichols

## Multiplatform Fans

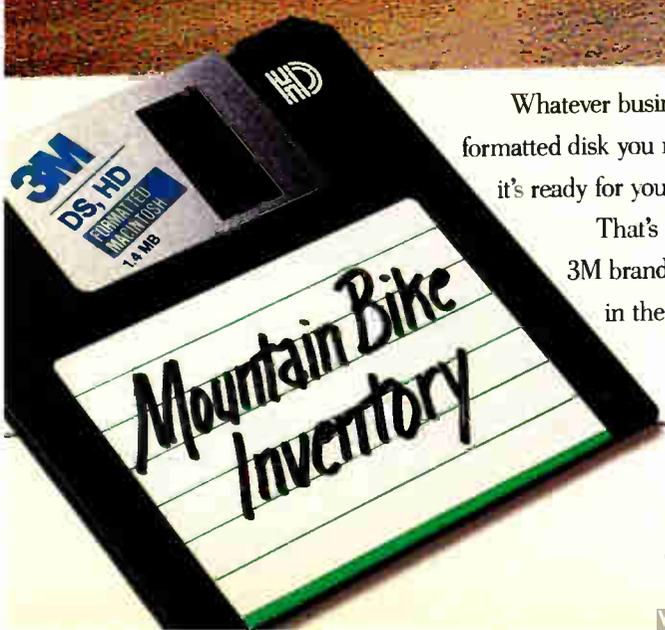
I just finished reading your January issue, and I had to turn on my Amiga, dial up BIX, and thank you for making this the most enjoyable issue in a long while. BYTE's most endearing quality for me has always been its willingness to explore more than just the latest application on the business platform of choice (whatever that might currently be). In January, I found articles on the history of Ethernet, the battle over who invented the microprocessor, a look at Intel's i860 chip, eight articles on AI, and a wonderful article on the Amiga's Exec. I am aware that both BYTE and Jerry Pournelle get a very unfair share of verbal and written abuse from Amiga users [who don't think their platform receives enough coverage]. As an Amiga user and developer since 1985, I'm astounded by this. I would invite those people to count the articles about the Amiga published by all other computer magazines that are not Amiga specific. I'd be very surprised if taken all together they equaled the number BYTE has done.

After seeing the article on the Amiga Exec and a BYTE Award for NewTek's Video Toaster in the same issue, I think you deserve a round of applause. Instead of taking the easy way out and ignoring the Amiga, you report on those aspects you think might interest a significant portion of your readers, in spite of the flak you will most certainly receive.

Dave Quick  
Edina, MN



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As usual, I enjoyed Jerry Pournelle's November column. I really wish he had brought his Amiga out of the spare bedroom and tried to use it to work on Mrs. Pournelle's promotional videotape. I think he'd find it has all the tools needed to do the job. Let me suggest an excellent reference on computer desktop video: *Amiga Desktop Video Guide* by Guy Wright (Abacus, 1990). While aimed at Amiga owners, it really explains the various hardware and software products that can be used in producing desktop video. Keep up the good work, Jerry, but don't relegate that Amiga to the closet just yet.

Gordon R. Zeese  
Albany, GA

*I agree: The Amiga would have done the job, and I should have used it. If Commodore would stop taking marketing lessons from AT&T, they would get some market share; the Amiga is falling a bit behind the very latest PCs, but not far, and is still about the easiest "desktop video" system I know of. They're particularly popular here in Hollywood. Alas, Mrs. Pournelle's program hasn't been ported to the Amiga; I'm working on that, but I have little time. David Joiner has offered to help, though, and he's an Amiga whiz.* —Jerry Pournelle

## QuickBASIC Fix

I wanted to share with Jerry Pournelle and his readers a "solution" to the problem of QuickBASIC 4.5 locking up during the binding process on large programs. As Garry Owens pointed out in his letter (Chaos Manor Mail, September 1990), running large programs from within the QuickBASIC environment will hang your machine during the binding process without issuing any error message.

Pournelle's reply suggested that Owens compile and link from DOS. That will alleviate the binding problem, but QuickBASIC users will not be able to make use of the integrated debugging and testing environment provided with QuickBASIC. I found that you can get around the binding problem by pretending you are going to compile into an executable module. QuickBASIC will bind normally in this mode and then let you select your compile options. At this time, you can cancel the compile process and run from within the QuickBASIC environment without any further binding problems.

I have used this method to develop and test some fairly large applications without any further incidents of the binding problem. As my programs have grown larger and more complex, the next barrier I have found for running large programs from within the QuickBASIC environment is a familiar one—640K bytes.

Carl F. Neer  
Lakewood, CO

*I tried it, and it works. Thanks for the tip!*

—Jerry Pournelle

## Hardworking Mac

What did Bill Calabrese mean by 1 gigabyte of ROM on the last page of his MacRenderMan review entitled "Photo-Realism for Those with Time (and

RAM) to Spare" (January)? Seems like a lot, although the context implies that he is referring to disk space. I'm impressed—any Mac that needs a gig of disk storage is a hardworking Mac indeed!

R. Broome  
Slidell, LA

*I was referring to my disk storage space, which is 1000 megabytes. This size is needed for the animations I create with Dynaperspective, some of which reach 200 megabytes in size. I temporarily store them on my hard disk before I transfer them to videotape. I also have about 100 MB of applications and utilities, plus 200 MB of stored files. CADD files require large hard disk drives, and those seriously considering doing CADD need to purchase the largest storage medium they can afford.*

—Bill Calabrese

## Up to BAT for DOS

In "Alternative Operating Systems, Part 6: FlexOS's Muscle" (January), Ben Smith writes that the FlexOS "script language has the same flow control as DOS .BAT files, with one notable extension: BATCH. The BATCH command allows nested scripts." This "extension" has been part of DOS for at least two versions (3.3 and 4.01), with the CALL command.

Mike Firth  
Dallas, TX

*Good eye! The truth be told, my expertise is in Unix, and I was unfamiliar with the DOS CALL command for .BAT files. Thank you for your correction.* —Ben Smith

## Engineering Trade-Offs

As a software developer, I have to commend Brett Glass on his views about the problems of the software industry and its apparent lack of (or at least insufficient) concern ("A Plea for Software That Works," Stop Bit, December 1990). As Glass pointed out, far too many programs lack the error detection and correction necessary for reliable operation.

Being a devout Turbo Pascal programmer, I agree completely with his comments regarding C—it is not an ideal language for developing large, reliable, maintainable programs by any stretch of the imagination. Yet, many people swear by C, and many more are jumping on the bandwagon.

But for all my agreement with Glass, I have to question a remark of his regarding OS/2. He points out that OS/2 2.0 uses the 32-bit flat memory model and, due to hardware limitations of the 386, cannot check memory references to the exact byte. In fact, a reference can be as much as 4K bytes off without detection. How horrible! Does that mean one program can accidentally overwrite another program running in a different window? Not necessarily. Glass's statement and condemnation are valid only if you assume that the operating system will grant requests for more memory exactly as requested by the application program. Although I'm not certain, I would hope that OS/2 will allocate memory to an application in 4K-byte chunks. Thus, an application can never

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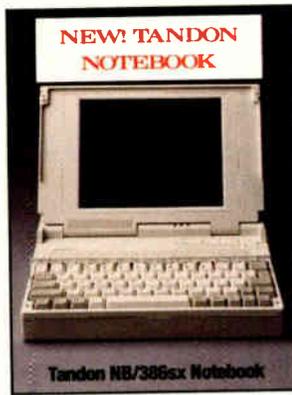
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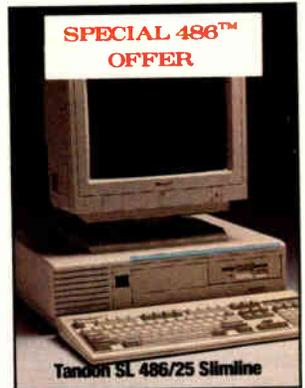
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step outside what the operating system considers its own.

Now, whether 4K bytes is too coarse is another argument entirely. But this coarseness, even if it were reduced to 2 bytes instead of 4096, does not prevent the operating system from ensuring that no application makes reference to a byte of memory that is not its own.

Finally, an important comment of Glass's deserves to be restated. The love affair people have with powerful machines and fast software is hurting the industry. To some extent it is the fault of the press, including the BYTE Lab, for publishing such exacting benchmark tests. Too often the buying public is swayed by as little as a 1 percent or 2 percent performance increase over someone else's box.

The PC market wants unbelievable speed, power, flexibility, support, and reliability, but it does not want to succumb to real-world trade-offs. People must begin to realize that computers are not wonder boxes that are above normal engineering trade-offs. If you want extra reliability, then it will cost you, either in dollars for hardware or in a performance hit in software.

Bill Jurasz Jr.  
Applications Engineer  
Texas Instruments  
Dallas, TX

## Laptop Etiquette

Fred Langa discussed how office decorum and business etiquette should be considered before buying a laptop ("Laptop Troubles and Triumphs," November 1990 Editorial). He specifically mentioned that taking meeting notes on a laptop can cause a commotion. I can confirm that from personal experience.

Last year our office was assigned to attend a series of 14 legislative hearings. The hearings were held throughout the state, and our job was to take notes and keep the executive staff informed. I lent my Toshiba laptop to the effort. The plan was to enter the notes from the testimony into Nota Bene and then use the text-based features of the program to compile the testimony by topic, speaker, and so on.

We were really quite pleased with ourselves until the tenth hearing, when we were told by the legislative staff that the witnesses found my laptop intimidating. Now, I admit that this thing weighs almost 20 pounds, requires a power cord, makes fan noises, and has a screen that creates an orange beacon—but intimidating? I never would have imagined it.

Langa was right—laptop hardware should be selected with more than just price and user-friendliness in mind. When I bought my laptop, my selection criteria were logical and technically correct, but I ignored what turned out to be a major variable—the environment in which the machine was to be used. I'm not talking heat and humidity here; this environment is composed of people who are suspicious of government. When I as a government employee entered this environment with my whiz-bang efficiency equipment, I was perceived as intentionally intimidating rather than efficient. It's a point to ponder.

Paul A. Smith  
Citrus Heights, CA

## DAT Spat

I read Karina Lion's article "DAT's a Solution" (November 1990) with great interest. While all of us in the industry try to present our products and technologies in the best light, her article contains serious misstatements of fact, as well as numerous conclusions that are open to debate. In the interest of accuracy, and in case you are misinformed, I would like to point these out.

1. She makes the statement that digital audiotape and 8-mm tape "store comparable quantities of data." Nowhere in the article, other than the table on page 324, which I will comment on below, does she specify the capacities of DAT drives. Eight-mm tape capacities of 2.5 gigabytes and 5 gigabytes, both in native, or uncompressed, mode, are available today. I know of no DAT products offering more than 1.3 gigabytes today. Sometime this year, DAT vendors promise 2 gigabytes, which will be achieved by using thinner 90-meter tape.

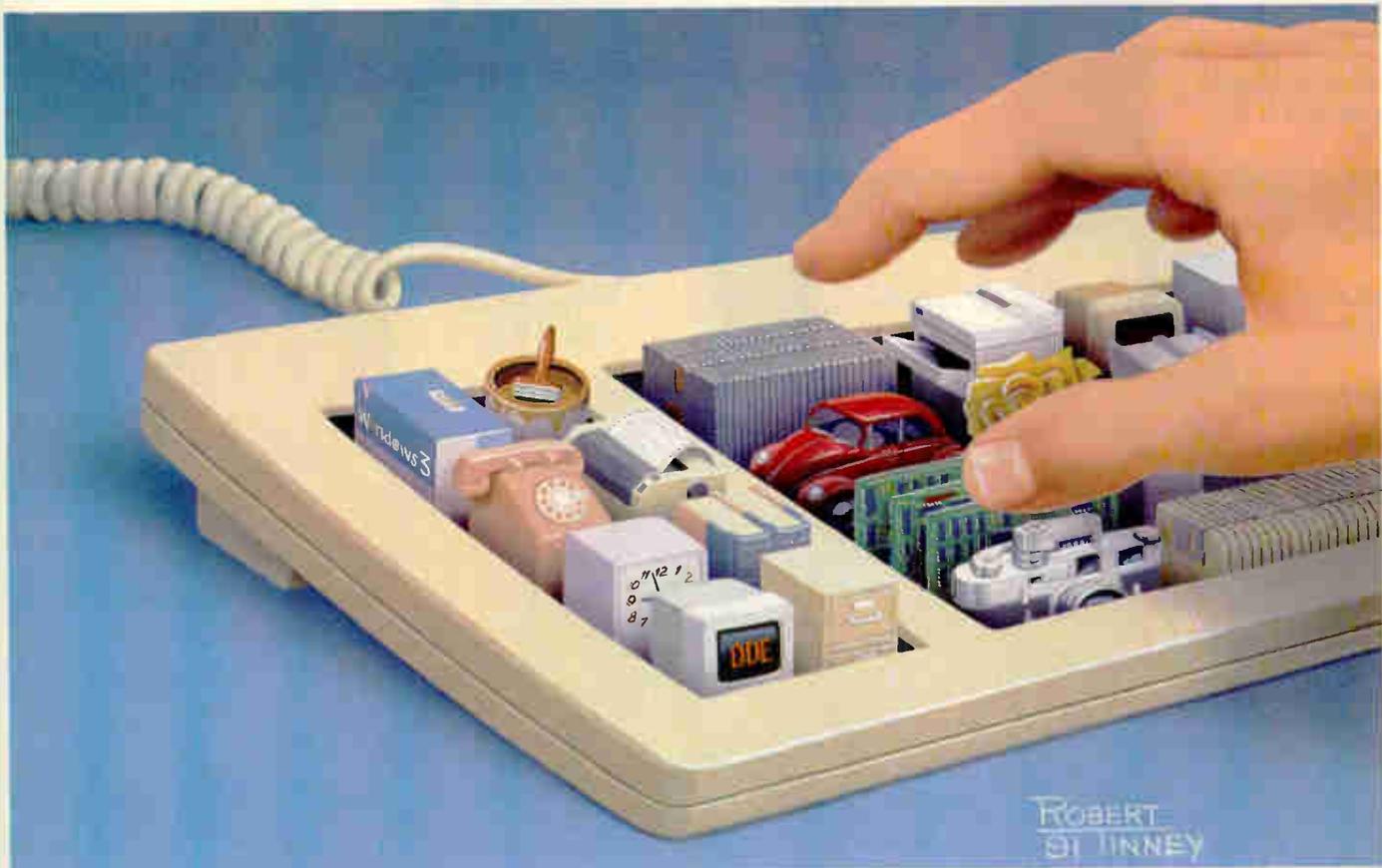
2. Lion's statement that "per megabyte, DAT is cheaper than 8-mm tape storage" is also up for discussion. The end-user price for a data-certified 8-mm cartridge with 2.5 gigabytes of capacity is about \$25, or 1 cent per megabyte. A data-certified DAT cartridge with a capacity of 1.3 gigabytes costs about \$19, or 1½ cents per megabyte. The same 8-mm cartridge can also contain 5 gigabytes if used on the latest 8-mm drives, cutting the cost per megabyte in half.

3. The table on page 324, comparing DAT and quarter-inch tape systems, is misleading at best. It states that the capacity in production of DAT is 2.5 gigabytes. This capacity can be achieved only by assuming a compression ratio of about 2 to 1. The next capacity level of 5 gigabytes also assumes compression and the use of 90-meter tape. By omitting the fact that these capacities require the use of compression, the table is deceiving. The DAT transfer rate of 207K bytes per second is also questionable. Every other DAT vendor specifies a transfer rate of 183K bytes per second for digital data storage format, and transfer rates of from 100 to 140K bytes per second in DataDAT format. I can only conclude that the higher transfer rate that Lion cites is also based on some expected compression ratio.

4. The statement that the 90-degree wrap angle of DAT provides an advantage over the 221-degree wrap angle used by 8-mm tape is certainly questionable. Conventional wisdom among tape designers maintains that a longer tape path provides better tape guidance. The 221-degree wrap provides less tension on the tape, both during normal read/write operations and during high-speed search, while the longer tape path sustains the high level of head-to-tape contact necessary to achieve helical scan's high areal densities reliably. In short, the longer wrap angle provides for gentler, more stable tape handling and reduces the likelihood of tape damage. If the author has any data that proves otherwise, we at Exabyte would like to see it.

5. The discussion on servo and data heads with the accompanying figure 2 is highly misleading. The 8-mm servo implementation allowing for track offset was specifically designed for data storage applications. The DAT servo system was lifted intact from the consumer product, retaining the integral servo/read/write head design but adding a pair of read-after-write heads. The distorted tracks shown in figure 2 are something we have yet to

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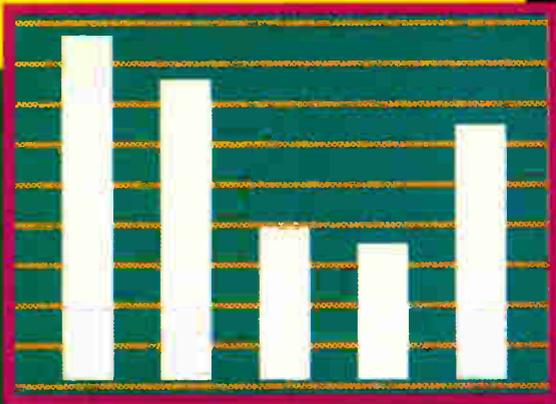
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see in over three years of product shipments, yet the 8-mm servo system, using track offset, would allow all the data on those tracks to be read, while it is highly unlikely that any DAT system could successfully recover the data. This is as much a function of the data format as it is of the servo system. Eight-mm tracks are composed of individual blocks of data, and if an individual block, or blocks, cannot be read, the error-recovery procedures will offset the heads and reread the track to recover the missing block(s). DAT, on the other hand, must read the entire track in one pass, whether on the first attempt or during a subsequent retry, to be successful. In the example Lion used, that appears to be impossible.

6. Finally, regarding the statements that quarter-inch, half-inch, and 8-mm tape employ analog recording methods, while DAT uses digital recording techniques: None of these technologies uses analog recording; they are all digital. In fact, the NRZI data encoding method employed by DAT was developed for, and used by, half-inch tape more than 20 years ago.

Grant Wilcox  
Product Manager  
Exabyte Corp.  
Boulder, CO

*The numbered sections below correspond to the numbered items in your letter.*

1. Since the article was published in November, DAT manufacturers have achieved even higher capacities of storage per cassette than was stated in my article. More than five companies have announced DAT drives with 2.5-gigabyte storage capacity per cassette using data compression. In January, my company, GigaTrend, announced the use of a new 90-meter tape that will enable storage of up to 4 gigabytes of data on a standard DAT cassette; without data compression, a 90-meter tape stores up to 2 gigabytes in native mode. As for the issues of data compression and extended tape, as long as data is backed up efficiently, reliably, and accurately, what difference does it make to the end user?

2. It is deceptive to claim that the Exabyte cartridge is "about \$25 per cartridge." When we at GigaTrend called Exabyte to verify this, we were told by the direct sales department that a minimum order of 2.5-gigabyte cartridges put the individual cartridge price at \$40. Additionally, in checking with two Exabyte OEMs, we learned they are charging \$60 for a 2.5-gigabyte cartridge, not \$25. Since GigaTrend and other DAT makers are charging \$36 for a 2.5-gigabyte cartridge (using data compression), DAT is still cheaper by far.

3. The capacity of DAT drives in production is currently 2.5 gigabytes. In the first quarter of this year, the capacity of DAT drives in production using extended tape will be over 4 gigabytes per cassette. DAT at capacities of 2.5 gigabytes using compression was formally announced by GigaTrend in July 1990. Likewise, the use of extended tape in DAT has been known since November 1990. Industry analysts have been publishing announcements about extended DAT tape from five vendors since September 1990. Therefore, the 2.5-gigabyte DAT cassette capacity listed in the table was an established fact.

On August 9, 1990, I demonstrated GigaTrend's 2.5-gigabyte TurboDAT and a 207K-byte-per-second transfer rate at a press conference. This transfer rate was achieved during an actual demonstration of the product,

not an "expected" compression ratio, as you claim.

4. The following excerpt from an article entitled "The Case for DAT" published in the July 1990 issue of Digital Desktop explains why the Exabyte theory of a longer tape path is incorrect:

"The 8mm format uses a tape wrap of 221° around a drum as opposed to DAT's shorter wrap of 90°. The DAT wrap angle has less contact with the recording tape and therefore creates less friction and requires fewer complicated mechanical parts to insure proper alignment. Given a similar drum size and speed, more surface contact with a tape will create more potentially damaging heat on the surface of the tape. Additionally, a 221° wrap leaves 8mm tape unguided for approximately three inches, which is just under the entire circumference of a DAT drum. Because of the mechanical requirements, a nominal 221° needs about 360° of actual wraparound. This is not possible on the same horizontal level. 8mm tape must descend one level below the horizontal tape path and return, in order to achieve this actual wraparound.

"There is stress and strain both in a vertical and horizontal direction on the tape using 8mm. Typically, worn edges are indicative of this type of wrap. Conversely, 4mm puts less strain on the tape by deviating only slightly from a straight vertical tape path with a 90° wrap. Also, a pure horizontal alignment level is maintained through electronic tracking, preventing any stretched edges on the tape."

5. Although the servo/read/write head of DAT for computers is based on the audio version of the drive, Japanese electronics manufacturers, not to mention Hewlett-Packard and GigaTape outside Japan, have modified the design for computer storage to achieve performance levels that are as yet unparalleled by 8-mm tape.

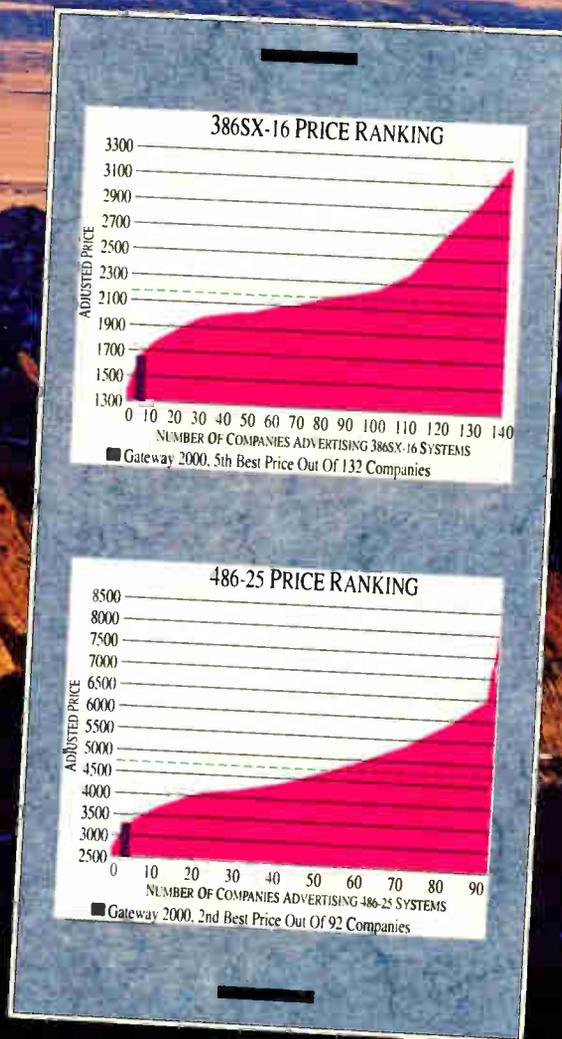
When the servo/read/write functions of DAT are performed by the same heads, there is absolutely no chance of alignment deviations. The combination of the tracking mechanism plus DAT's three levels of error checking and correction enables error recovery that is statistically even higher than 8-mm tape.

6. The analog recording method referred to in my article references the recording of tape filemarking. In this case, Exabyte uses an analog method called "physical" filemarks. Conversely, GigaTrend and other DAT manufacturers use logical filemarks, which is a digital method of tape filemarking.—Karina Lion

## FIXES

- The current telephone number for Micron Technology (December 1990 State of the Art section) is (208) 368-4000.
- The correct telephone number for Monolithic Systems Corp. (December 1990 State of the Art section) is (800) 525-7661.
- Leading Edge (January Ask BYTE) is a subsidiary of Daewoo Telecomm.
- The correct address for Microsoft Press (January Ask BYTE) is Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052.

# You Find The Best Values In The Most Unusual Places...



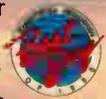
 **GATEWAY2000**

*"You've got a friend in the business."*

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We custom-build each Gateway 2000 computer to customer specifications. We'll gladly provide you with a quote on your configuration. 386 and 486 are trademarks of Intel Corporation. Due to the volatility of the DRAM market, all prices are subject to change. Prices do not include shipping.



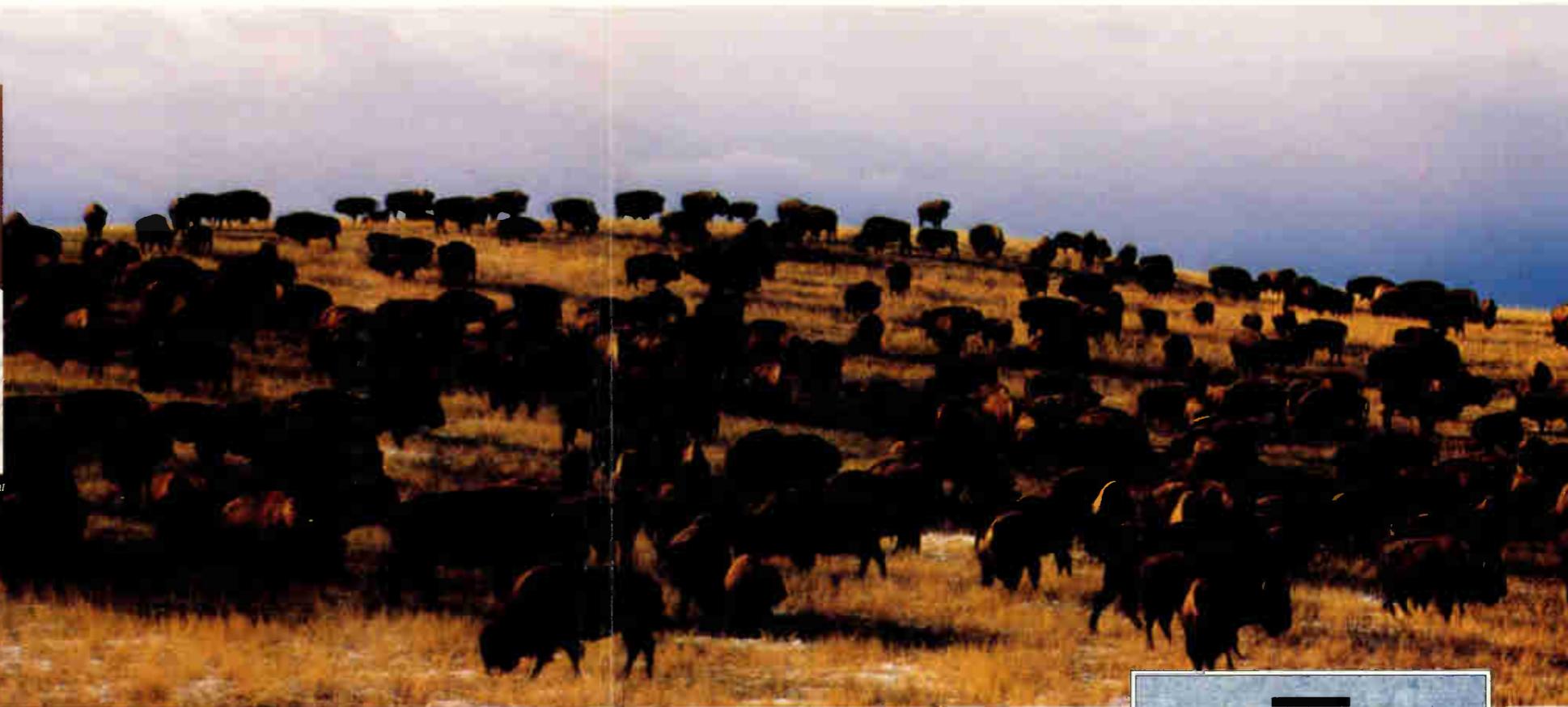
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# ...Like South Dakota, Where Gateway 2000 Customers Saved \$10,747,179 In One Month.

"We asked an independent research firm to do a study for us," said Ted Waitt, Gateway 2000 President. "I wanted to see an unbiased, direct comparison of features and prices from the manufacturers who advertise in the Computer Shopper. The results were astonishing," he exclaimed, "even to me. Ranked by best price, Gateway 2000 was the only major direct marketer at the top of the lists. The other 'big guys' in the direct market field were so far down in the rankings I couldn't even find some of them. Get a copy of the study and see for yourself."\*



Ted Waitt, Gateway 2000 President



Computer buyers who purchased Gateway 2000 systems in January saved an average of \$697 per system. This figure comes from a comparison of 132 computer manufacturers' advertised prices in the January 1991 issue of Computer Shopper. That means Gateway customers shared a total savings of \$10,747,179 on 15,427 systems in one month alone.

No matter where you look, that's the best value you're going to find in this industry.

## Providing The Best Value Starts With Values

"Whenever I'm asked," continued Ted, "why Gateway 2000 is so successful, my answer is: value. When you buy a Gateway 2000 computer, you're getting the best price, best

quality and features, best service, all from a very strong, healthy company. That's value. Then I'm asked how we provide value," Ted remarked, "and the answer is almost the same. It's values. The values of the people at Gateway 2000 give our product its value," said Ted. "People who grow up in the Midwest value frugality, quality, resourcefulness, hard work, strength, and most of all, integrity and honesty in all dealings with other people. Providing value in our products starts with these values."

## We Value Quality

Only the highest quality components go into a Gateway 2000 computer. Midwestern pride in workmanship and quality is demonstrated by

every one of nearly 100 skilled assembly technicians. These technicians build your complete system one at a time.

## We Value Strength

A company's strength is measured by its balance sheet. As independent sources will confirm, Gateway 2000 has an enviable balance sheet coupled with strong growth. Inc. Magazine listed Gateway as the second fastest-growing private company in America during 1990. Financial strength is crucial to you. What good are warranties, guarantees or promises of lifetime technical support if the

company that sold you the computer goes out of business?

## We Value Integrity

Integrity is the fundamental value without which any organization is doomed. At Gateway 2000, you'll find integrity throughout the company, most visibly in sales and customer support. Gateway salespeople honestly represent the company and its products. Each person you deal with in customer support, during and after the sale, has a personal commitment to make sure you're completely satisfied.

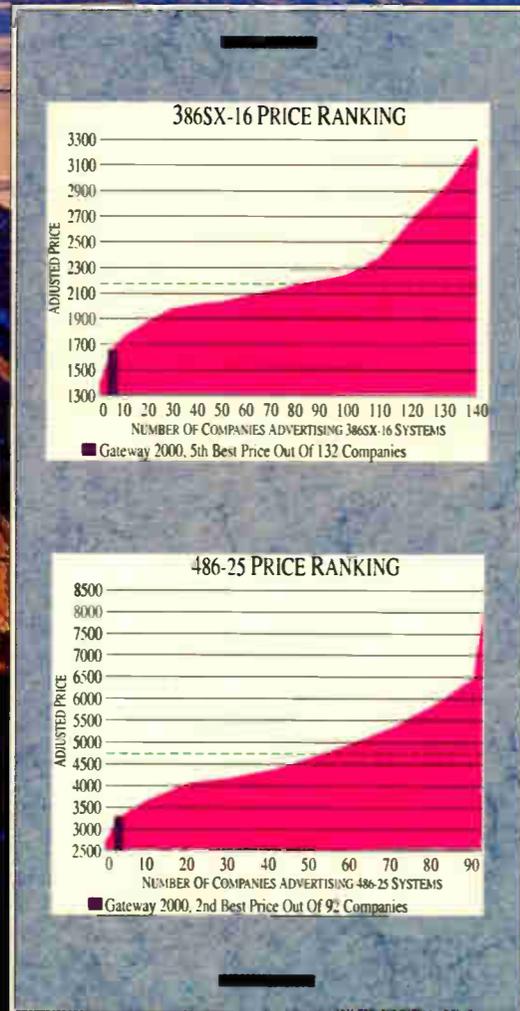
## We Value You

Gateway customer Robert C. True, Jr. writes: "We on the East Coast have become so accustomed to surly, uninformed and disinterested...staff, that working with your group may have induced an element of 'Culture Shock.' Every person in your organization operates as if there is only one customer in the world - the one they are talking to at the moment."

"You've got a friend in the business" is more than a slogan. It's our way of life here at Gateway.

\*Call our toll-free number for your free copy of this informative study of computer industry prices.

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## Intel Winds Up the i486 Clock to 100 MHz

Intel engineers have an experimental i486 running at 100 MHz, the company disclosed at the recent International Solid State Circuits Conference. The chip is a long way from a commercial product—Intel still hasn't banged the kinks out of the 50-MHz i486—but it does point toward Intel chips of the future. It's also a step toward the chip maker's goal of a 100-million-transistor microprocessor running at 250 MHz and delivering 2 billion instructions per second.

Intel says that it has achieved this increase to 100 MHz by using a combination of new techniques. First, the chip is implemented in 0.8-micron CMOS, instead of the current 1-micron CMOS. This alone makes the chip smaller and faster. More important, Intel has moved to a three-level metal design instead of a two-level design; this reduces gate interconnect distances and further speeds up the chip. Intel developed new CAD tools for laying out the chip on a three-level process to fully utilize the third layer.

One unusual feature of the new chip is that the clock has been implemented using a phase-locked loop. This allows the clock to operate more tightly and thus faster than previously. Clock skew has been reduced, and the setup time is now 1.5 ns, down from 3.0 ns; the hold time is 1 ns, down from 2.5 ns; and the overall output valid time is 7.5 ns, down from 9 ns. However, this design has its drawbacks. It relies heavily on the power signal coming in. Intel says that the PLL can lock on and operate fully in the time it takes the processor to power up. If the PLL couldn't do this, then serious system errors would occur. The major side effect is that the chip can't use a standby mode. Since the chip also uses 8 W of power at 100 MHz, it will not be very useful in laptop or notebook systems, as power consumption will be high and no power-saving standby mode can be implemented.

Intel engineers say that they have fabricated the chip and tested it. It operated at frequencies of up to 100 MHz at 5 V and at room temperature. Intel expects that any processors it manufactures using such high speeds would be part of a multichip or multipackage module rather than used in a traditional circuit board design.

Intel admits that many problems remain before this technology can be used in a commercial design. RFI noise could be a severe problem. Intel's John Crawford said that by isolating the high-speed elements of the design on a module, this could be minimized, but he confessed that it is a problem Intel has not fully addressed. A standard heat sink with good airflow will be adequate to cool the processor, he said.

A computer system based on this design would be heavily dependent on the performance of the cache, Crawford said. Intel designed the part with the use of a secondary cache in mind. Crawford acknowledged that the chip won't be quite three times as fast as the 33-MHz i486 but didn't think that the degradation would be significant.

—Owen Linderholm

## OS Shuffle Has Developers Dizzy

The spin doctors have been working overtime at Microsoft. The software giant and its sometimes-partner IBM reshuffled their operating-system responsibilities last year, with Microsoft

keeping OS/2 3.0; there has since been widespread talk that Microsoft was neglecting OS/2 to design industrial-strength Windows. Then the *Wall Street Journal* reported that Microsoft is "dropping

## NANOBYTES

IBM made its fortunes in proprietary systems, but a senior executive says Big Blue will "be the most open company in the business." Senior vice president C. Michael Armstrong acknowledged in his UniForum keynote speech



that such a statement would be met with skepticism, but he claimed that IBM is committed to being the leader in open systems.

"There are no illusions at IBM," Armstrong said. "Open systems are the future, and IBM's future is in open systems." That means support for POSIX, XPG3, ISO, and ANSI compliance, he said, but most of all, it means Unix.

Unix makes for good business, IBM officials are finding. The company recently issued sales figures for its RISC System/6000 workstation, saying sales have tallied \$1 billion.

All signs point to Apple finally releasing System 7.0 next month. At the recent MacApp Developers Association conference, Apple announced four tools for use with System 7.0, the major new operating software for the Mac, including release 3.0 of MacApp, the object-oriented development system. MacApp 3.0 will let software designers incorporate System 7.0 features into their applications. Letting the tools out the door indicates that the operating software is pretty stable. Plus, Apple likes to give its faithful developers a little something at the annual developers' conference, which is slated for May. This year, it's likely that they'll get a shiny compact disc containing System 7.0.

# NEWS

## MICROBYTES

OS/2," an incorrect assumption that further confused developers and users.

Contrary to the "inaccurate speculations," Microsoft says that it will not abandon OS/2 to focus on 32-bit Windows. The company maintains that it is still working on a portable version of OS/2 called OS/2 3.0 (or OS/2 NT, for new technology) and that it is still working on OS/2 applications.

"We will have a high-end and a low-end operating system offering, while having a single mainstream programming interface for developers," a Microsoft staff member said. That interface is now the Windows 3.0 API (for application programming interface) but will eventually be the Win32 API, he said.

This "new-technology" operating system, targeted for client/server situations and multiprocessor systems, will

incorporate what is being called Win32, an API in which 32-bit Windows programs can run directly under OS/2 3.0. Microsoft officials insist that OS/2 3.0 is not taking a back seat to Windows, but that it is rather a product for users who need something stronger than DOS. Although some industry insiders say that Microsoft is adding the Presentation Manager API only to appease IBM, a Microsoft representative said that "the PM subsystem has always been part of the product plans for OS/2 3.0."

An IBM official said that the Windows-or-PM scenario just confuses the issue. "It's not a question of user interface. It is a question of which operating environment will give you what you need. The choice is Windows on DOS, which is fine for personal applications, or the advanced capabilities of OS/2." So

### OPERATING-SYSTEM SCORECARD

*With all the rumors and reshuffling, it's hard to keep track of what's what in the world of DOS-descendant operating environments. As it stands right now, here's what Microsoft and IBM have in the works.*

#### MICROSOFT

##### OS/2 3.0

- Portable to other processors
- Runs Windows programs, courtesy of Win32
- Small-kernel architecture
- Supports at least four APIs: DOS, 16-bit Windows, 32-bit Windows, and POSIX
- Currently a prealpha project

##### Win32

- Lets 32-bit Windows programs run under OS/2 3.0
- Part of the OS/2 2.0 system kernel
- API set will be hosted on DOS and OS/2 3.0
- To be the "single mainstream programming interface"

##### Binary Compatibility Layer (BCL)

- A feature of OS/2 2.0
- Allows well-behaved Windows applications to run directly, without having to be recompiled for 16-bit segmented Windows programs

##### Windows Libraries for OS/2

- Allows developers to relink Windows 3.0 programs to run under OS/2 1.2, 1.3, and 2.0
- Combines functions of the BCL and the System Migration Kit
- Includes libraries that map Windows APIs to Presentation Manager APIs
- Version 0.9 was released in February

##### DOS 5.0

- Tiny, leaving more memory for applications
- DR-DOS-like memory management
- Due any month now

##### DOS 6.0

- Will have Installable File System, which can track and maintain links between documents

#### IBM

##### OS/2 2.0

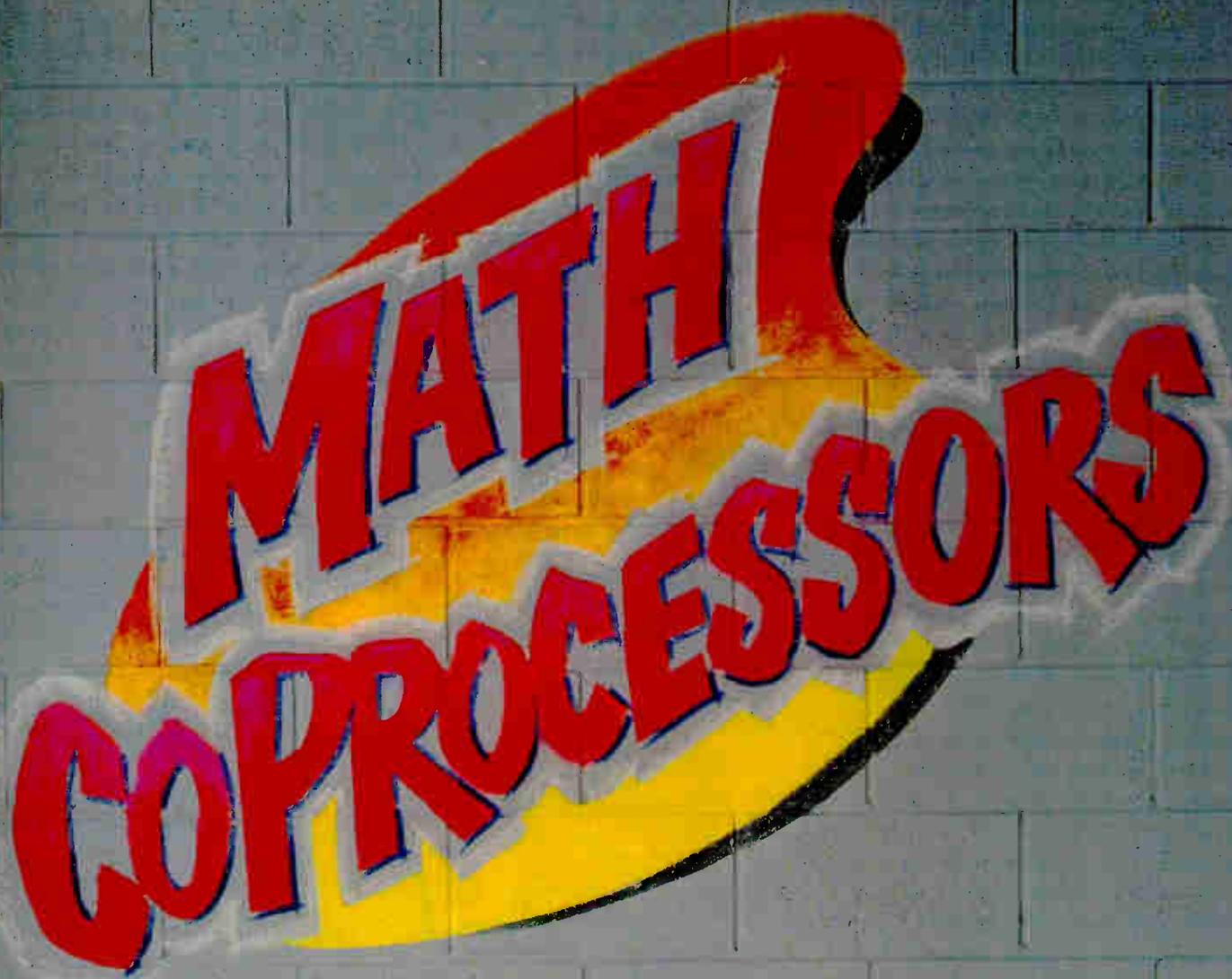
- The 32-bit version will support future 32-bit Presentation Manager programs
- Also supports 16-bit PM programs
- Multiple DOS compatibility boxes
- Will be able to run Windows applications (without DOS box), possibly with a BCL
- Slated to be ready sometime this year

## NANOBYTES

Novell says that it is nearly ready with the NetWare Loadable Modules that will allow DOS, Windows, Mac, OS/2, and Unix computers to share information and resources transparently. The new NetWare 3.11 will let users install the software that they need to run Mac and Unix clients with NetWare servers. The Mac NLM will support AppleTalk Phase 1 and 2 and will let Mac users access NetWare resources through the Mac network-client interface. NetWare NFS, Novell's implementation of Sun's Network File System, will let NetWare 3.11 give native file and print services to Unix clients. Novell also disclosed recently that it has incorporated in the core operating system a TCP/IP implementation to allow multivendor internetworking with environments that support TCP/IP. The company also has a GOSIP-compliant file transfer implementation that links NetWare with the OSI environment.

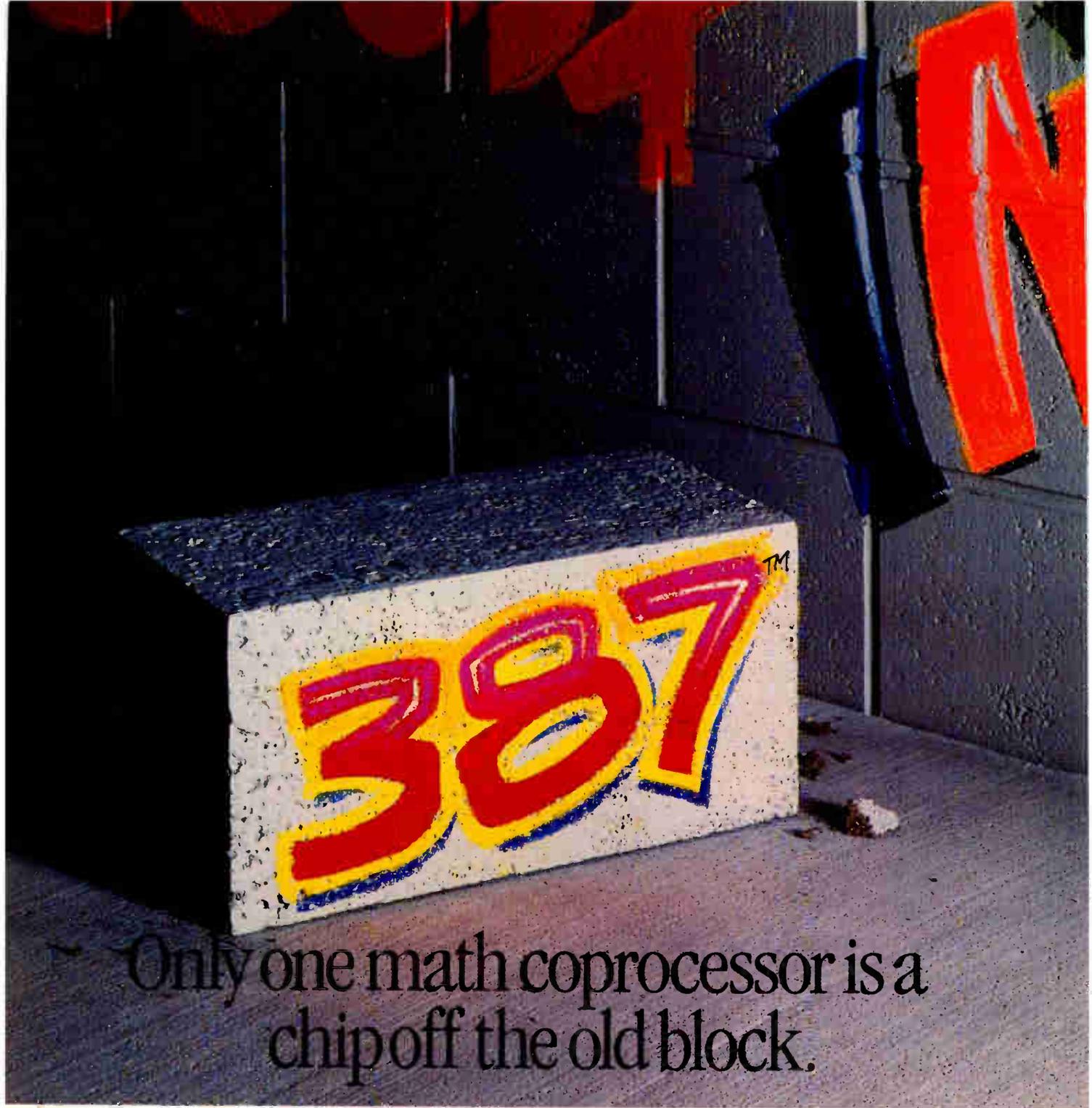
Responding to "an emotional firestorm," Lotus withdrew its MarketPlace CD-ROM databases from the market. Marketplace: Households, a Mac-based database of individuals (i.e., potential consumers), contained information (name, address, age, gender, marital status, income, dwelling type, purchasing propensity, and "lifestyle") of about 120 million Americans. It did not include home telephone numbers, nor was it possible to search for individual names. However, critics charged that a mass-marketed CD-ROM database could facilitate **abuses of privacy** by making consumer data easier to access and harder to control.

MarketPlace was a topic of discussion on BBSes around the country, and about 30,000 people called in to have their names removed. "While we believe that the actual data content and controls built into the product preserved consumer privacy, we couldn't ignore the high level of consumer concern," Lotus president Jim Manzi said.

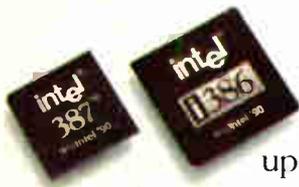


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Circle 140 on Inquiry Card (RESELLERS: 141).

World Radio History

# NEWS

## MICROBYTES

will IBM do Windows? In a recent internal memo on how to deal with questions about operating-system strategy, IBM said that it "is evaluating where Windows fits in the range of solutions available to our customers."

OS/2 3.0 is currently in the prealpha stage; sources say that it won't ship before 1992. Microsoft officials confirm that they've ported it to certain unnamed RISC machines; sources say that those machines are the IBM RISC System/6000 and computers based on the MIPS R3000 and the Intel i486 with the i860.

Many developers say that they think

Microsoft and IBM are still sending mixed signals. The perceived dispute between Microsoft and IBM is "damaging our ability to market products," said one. "We are facing a nightmare."

So what should developers do? That "depends on the technical and marketing requirements of their product," says Cam Myhrvold, manager of developer relations at Microsoft. "If people want to target the largest graphical desktop market, it is clear that Windows is the volume leader," he says. For the server marketplace, it's OS/2.

—Martin Heller and D. Barker

## Hitachi Claims Superconducting BIPS

**A**lthough the media hubbub over superconductivity has faded, research continues to bring the technology closer to the world of useful computing. Scientists at Hitachi recently revealed details of a superconducting microprocessor that is capable of running at 1 billion instructions per second (BIPS).

The prototype chip has a 4-bit architecture with 1K bit of on-board memory and 500 bits of ROM. At 7 mm square and with only thousands of devices rather than the usual millions, this microprocessor is obviously only the first step along this development track. The de-

signers employ low-inductance chip-to-chip connections. They say that these connections reduce the effects of AC-power cross talk on the I/O signals and let the device operate at clock frequencies of around 1 gigahertz. The Hitachi team claims that power dissipation is only 50 mW, but the need for cryogenic cooling (the current device works only when kept in liquid helium) negates the overall advantage. The fact that the prototype works at all indicates that superconducting processors will have a role to play in the future of computer technology.

—Andy Redfern

## Apple Breaks the Printer Cost Barrier

**T**hat headline might sound like one of those "headlines you'll never read," but Apple has in fact come out with two very price-conscious printers. One is a \$1299 QuickDraw-based device called the Personal LaserWriter LS. The more novel model is an ink-jet printer, called the StyleWriter, that prints at 360 dpi. This machine retails for \$599.

Canon's new StyleWriter, based on its bubblejet engine, is made in Japan for Apple; however, Apple has redesigned almost every aspect of the machine. Because this QuickDraw-based unit has a resolution of 360 dpi, it can generate gray-scale images that look better than those from a LaserWriter. A model that was shown to BYTE took about 2 minutes to put out a page, however.

The StyleWriter accepts compressed information from the Macintosh via high-speed serial communication, but it decompresses each band of information as it comes over and prints it. This means that the Mac is held up from further work until the page is finished. Still, to many

users, that is an acceptable compromise for a printer of this price.

The new LaserWriter LS was designed to print a full page of text and graphics using only 512K bytes of memory. The printer driver software compresses the page image information and passes it to the printer, which decompresses it while printing in bands. This printer also uses a serial connection and clocks the serial port of the Macintosh at a much higher rate than it normally operates at. Apple representatives said that it effectively operates at 900,000 bps. Unlike the StyleWriter, the LaserWriter LS receives the whole page from the Mac before decompressing and printing. Both printers are being shipped with TrueType and TrueType fonts.

Mac Classic buyers have been hesitant to buy a laser printer when it costs twice as much as their computers. But now, the StyleWriter means that you can have a fully functional Mac and a laser-quality printer for a street price of about \$1700.

—Owen Linderholm

## NANOBYTES

Even Microsoft chairman **Bill Gates** agrees that people are confused about his company's intentions regarding operating systems. "We're confusing the market, that's for sure," he told a group of press and financial analysts. But there was nothing confusing about his attitude toward a competing operating environment. After being asked whether Microsoft's Object Linking and Embedding technology will do what Hewlett-Packard's NewWave already does, Gates said, "No, no, no, that's wrong. NewWave doesn't do anything."



While some people doubt that PCs can gain an edge over traditional workstations, **Interactive** president Dennis Peck thinks otherwise. In a couple of years, he said in a recent interview, the huge **Unix market** will be split between RISC (mostly, he thinks, SPARC) and Intel-based Unix. Intel's i586 chip, expected later this year, and the i686 will give Intel a lock on a vast number of desktops. Enhancements from Interactive, such as the high-priority effort to improve ease of use and administration through graphical applications, will keep Interactive the leading choice for Intel V.4, Peck said.

In an effort to help deal with **environmental disasters**, the **National Oceanographic and Atmospheric Administration** has launched a Macintosh program that provides quick access to **information on chemical compounds**, identifies areas that might be affected by toxins, plots the course of emissions into the air, and even analyzes possible accident scenarios. In addition, the **Cameo II** program can help communities and businesses prepare detailed contingency plans for emergencies.

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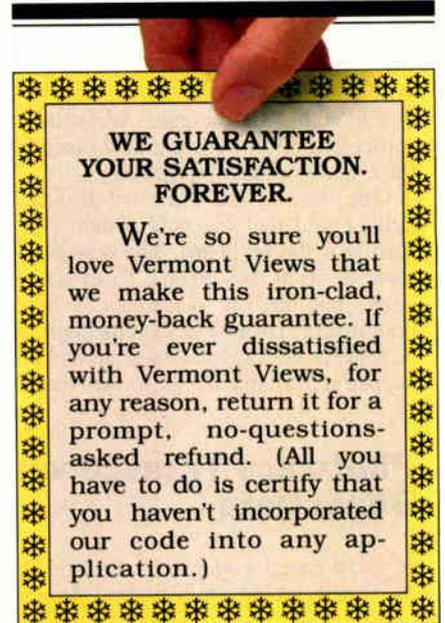
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## Has IBM Finally Gotten Its Portable Right?

IBM may finally have shaken the curse of its ill-fated Portable PC. The company was expected to have brought out by now its new laptop that is based on the 20-MHz 386SX processor.

According to people who have seen it, the new system is very similar to the Compaq LTE 386s/20. It features a 60-MB hard disk drive, a 3½-inch floppy disk drive, 2 MB to 18 MB of memory, and a VGA LCD screen. According to sources familiar with the new machine, the L40 SX weighs 7½ pounds.

One user at the Harvard Business School said that the new system's best feature is the keyboard. The keys do not travel as far as they do on a Toshiba notebook, but the key placement is better than that on Toshiba or Compaq laptops, he said. In addition, an external numeric keypad is available for those who like the

feel of a full keyboard.

The new notebook incorporates a "fuel gauge" that indicates the power remaining in the system's battery. The system that was used at Harvard also includes a 2400-bps modem and 9600-bps fax modem, but it was not clear whether this fax modem will be included as standard when the machine is released.

As we were going to press, the price of the L40 SX was still a matter of speculation, but sources and published reports estimate the cost will be near \$6000. With mail-order SX notebooks dipping down below \$2500 and a new wave of Far East notebooks on the way, sales of the L40 SX could depend on its price. It is a fairly safe bet, however, that IBM will choose a list price close to that of the Compaq LTE (\$6499).

—Rich Malloy

## Photonics Transceiver Lets Hand-Held Systems Beam Data

Pen-based computers and wireless networking are a natural fit. One of the companies putting the two together is Photonics (Campbell, CA), which has prototyped a diffuse infrared transceiver that allows a mobile unit to be part of a network without a physical connection.

The transceiver has a range of approximately 30 feet. Photonics plans to provide repeater stations to carry the signal even farther than that. Photonics and GO Corp. recently demonstrated the equipment. They attached two GO systems to the Photonics transceivers and used the systems to hook into a stationary transceiver attached to its network with Ethernet and token-ring connections. They then demonstrated a remote Structured Query Language access to a Mac over a wireless link using software from TechGnosis. The transfer took a couple of seconds, but it was successful.

GO's PenPoint hardware can recognize network connections on its own. Users will be able to walk into a room and establish a network connection almost immediately. This could foreseeably allow instant networks of pen-based systems in meetings, or automatic data transfer from a mobile unit to stationary, central corporate units. These connections and transfers can happen automatically without user input, the moment a user returns to the base office.

Photonics president Dick Allen said that the new technology in its infrared transceiver will be capable of supporting Ethernet networking in the future at speeds of up to 10 Mbps. The current version can transmit at 1 Mbps. The Photonics scheme uses its own error-correcting method and does not require the retransmission of data, Allen said.

—Owen Linderholm

## New AppleTalk Code Will Let Macs Tap Unix Services

Macintosh and Unix system users should soon be able to share services. Apple Computer and AT&T said that they will jointly develop a specification to standardize internetworking between Macintoshes running AppleTalk and Unix systems that are running

System V release 4.

At the heart of the deal is agreement on an application programming interface that will allow Unix developers to write software that takes advantage of file-sharing, client/server, and other AppleTalk network services. Source code that

## NANOBYTES

IBM recently demonstrated a working prototype of a **4-pound portable terminal** designed to work with the Motorola/IBM Ardis packet-radio network. The unnamed machine will be announced later in the year, IBM said. It's based on a 286 CPU and runs DOS in ROM but is mostly intended for connection to host systems via 3270 emulation.

The ruggedized device has a full keyboard and a backlit LCD screen but no hard disk drive or floppy disk drive; instead, it has a slot for credit-card-size IC cards. Both an RF modem and a standard modem for connecting to land lines are built in. The portable terminal will enter field testing this summer, and IBM said it will be "competitively" priced with Motorola hand-held RF terminals.

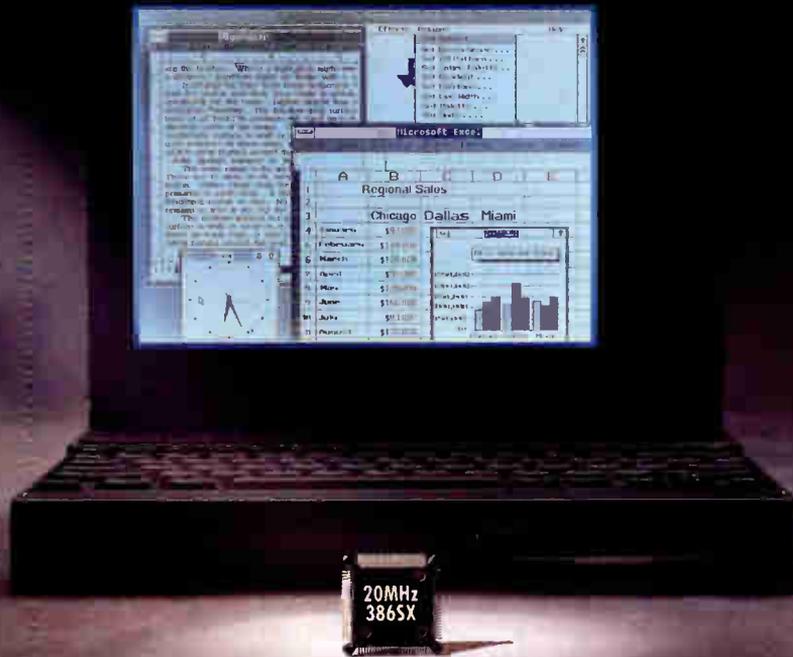
Developers who want to create new applications for **pen-based computers** will have to start thinking in a brand new mode. Robert Carr, vice president of GO Corp. and one of the designers of PenPoint, advises developers to forget about cursors, mice, and other aspects of the traditional user interface. **Dan Bricklin**, veteran programmer and vice president of **Slate**, says you don't have to be a "superprogrammer" to design pen-based applications, "but you do need to know C." Slate says that its PenApps development environment will let people write complete applications in a few weeks, while the Data Access Architecture will let them easily integrate the PenApps application with even proprietary databases. At a recent Boston Computer Society meeting, Bricklin used the PenApps tools on GO's 286-based machine to build a forms application from scratch. His demonstration was aimed at developers who want to quickly design forms applications.



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# NEWS

## MICROBYTES

follows the API should be portable across hardware lines, as long as the target system provides services compatible with the API.

Apple has agreed to implement the new AppleTalk API in the next release of its Portable AppleTalk source code, available under an Apple licensing program. This API will let Mac users run Unix applications, such as E-mail, from

within the AppleTalk environment. (To do that now, they must run a TCP/IP protocol stack.) Pacer Software has ported the protocol to a variety of Unix systems, including System V release 4 for the NCR System 3000. The AppleTalk specification will be distributed by both Apple and AT&T sometime this quarter, the companies said.

—Tom Yager

## C&T Develops Multiprocessing Design; Alternative to C-Bus

**A**ttempting to provide an alternative to Corollary's C-Bus Intel-based multiprocessing architecture, Chips & Technologies (San Jose, CA) has developed its own multiprocessing platform called M/PAX.

M/PAX and its Corollary counterpart both support multiple processors in a single chassis, communicating with each other over a proprietary bus. But M/PAX's main advantage is the bandwidth of its interprocessor data channel, or Multi-Processor Interface; the MPI is a 128-bit-wide bus that passes messages between processors. M/PAX calls for an additional level of cache, beyond the i486 internal cache, to reduce the total traffic

between the processors and to the shared memory pool. Up to four memory controllers can be present in an M/PAX implementation, permitting multiple simultaneous transfers.

Chips & Technologies provides the interface circuits needed for the system, processor, and memory modules. A company representative claimed that M/PAX has a significant performance edge over Corollary's C-Bus and said that the SCO MPX extensions to Unix work with both C-Bus and M/PAX. The same representative said that one drawback is that M/PAX may not support as many total processors as C-Bus.

—Tom Yager

## Compaq Now Offers a Little Help for Its Friends

**C**ompaq has changed its ways and started offering product support directly to end users. The computer maker is also classifying its dealers according to its ability to sell and service complex networked systems.

The moves are an effort to satisfy customer demands for better support than has traditionally been available through the dealer channel—especially for complicated multivendor systems—while sparing Compaq the expense and political fallout of establishing a direct sales force to serve corporate buyers.

For the benefit of customers seeking "advanced connectivity solutions," Compaq will identify a subset of its authorized dealers who have the training and facilities necessary to sell and service products such as the Compaq SystemPro running Novell NetWare.

The end-user support will include a toll-free hotline that will be available to any Compaq customer seeking information about accessories, upgrades, or basic system configuration; and a paid service, called the Compaq Telephone Support

Agreement, that will provide high-level system support and problem solving.

Compaq's new free customer support center is open Monday through Friday, 7 a.m. to 7 p.m. Central time, and you can contact it at (800) 345-1518. The center will offer answers to simple questions about hardware configuration and setup, operating systems, and BASIC language programming, as well as problem diagnosis, the company says. Sales information about upgrades, options, and dealer locations will also be provided.

For more sophisticated information, especially concerning networked systems, Compaq will sell a telephone support contract through its dealers for \$3000 per year. The fee covers 10 "support incidents" during the year; each request for support (assuming it merits high-level attention and cannot be solved via the free hot line) will be assigned a case number and a supervising engineer. Compaq specialists, in conjunction with engineers from network vendors, will work on the problem until they solve it.

—Andy Reinhardt

## NANOBYTES

**NCR** expects to introduce its **notepad computer** based on GO Corp.'s new PenPoint system in the third quarter of this year. The portable system will likely be based on a 386-class CPU. The NCR notebook will support handwriting recognition and mouse functions even when running standard DOS programs. NCR's pen can be a pointer, or, with a click of a button, it will emulate a keyboard; DOS programs won't know or care how the text was entered because characters written on the pad will be forwarded to the keyboard buffer.

**Apple Computer** has made a few adjustments to its **Macintosh Portable** and knocked \$1000 off the price, but it couldn't keep the weight down. The biggest change is backlighting for the active matrix LCD, which makes it easier to read in a variety of lighting conditions. You can turn the backlight on or off, which is good because when it's on, the power consumption goes way up.

So that users will be able to run System 7.0 when it arrives, Apple has raised the standard amount of RAM it puts in the Portable, now offering 2-MB and 4-MB models. The Portable with 2 MB of RAM and a 40-MB hard disk drive is now \$4199; with 4 MB of RAM and a 40-MB hard disk drive, it's \$4699. Mac users we interviewed said they think the price is still too high, but at least Apple is moving it in the right direction. Others said that they're waiting to see the notebook-size computers expected from Apple later this year.

**AT&T's** new Unix System V Graphics Platform (developed by Quest Systems) gives a nod to a rival user interface. The software bundle comes with either the **Open Look** or **OSF/Motif** graphical user interface layers. This is the first sign that AT&T's competitive stance in the GUI arena is softening, or perhaps it's just a realistic response to market acceptance of Motif.

ANNOUNCING

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## Apple Asks for Airspace for Data Communications Service

**P**aving the way for wireless networking, Apple Computer has petitioned the FCC for permission to establish a "Data Personal Communications Service." Using 40 MHz in the 1850- to 1990-MHz bandwidth, the service would transmit data at 10 Mbps over short distances (less than 150 feet). Such a service could replace wired LANs within a workgroup. Users would send data between desktop systems or use "portable computers equipped with miniature, nonoptimum antennas." Apple officials say that they can't develop this new technology until the FCC "allocates sufficient bandwidth."

Apple has filed the petition to "put a stake in the ground," said Bill Stevens, manager of the Advanced Technology Group team working on wireless LAN technology. "What we are proposing is

an unlicensed service with each transmitter containing a call that is specific to that transmitter for identification," Stevens said. "Also, we proposed that the service operate in a 'listen-before-talk' manner. This means a battery-powered device would not have to use continual power to maintain connectivity."

Apple notes in the petition that it has done tests in different buildings, using frequency ranges of 900, 1900, 2400, and 5800 MHz and several modulation schemes.

The proposed service would be open to other manufacturers who want to "connect services to the nonstationary user," Stevens said. One of those other manufacturers is likely to be General Magic, the Apple-funded company developing what it calls "personal communicators."

—Larry Loeb

## Interactive Takes New Direction as Publisher of Unix System V Release 4

**S**hedding its role in distribution, AT&T's Unix System Labs (USL) has signed Interactive Systems (Santa Monica, CA) as "a principal publisher of System V release 4 for Intel platforms." Intel, which is currently marketing its own port of Unix V.4, said it will turn its V.4 business over to Interactive.

Under this new arrangement, USL will do the Unix development, aided by Intel, and turn a finished product over to Interactive. Interactive will then package it and offer optional added value (like OSF/Motif and Ported NetWare), as well as handle distribution and support.

The ramifications could be far-reaching. In gaining endorsements from both AT&T and Intel, Interactive will position its packaged version of V.4 as the obvious choice—instead of the one from rival The Santa Cruz Operation—for Intel-based systems. At least until AT&T selects its next "principal publisher."

Interactive appears to be moving away

from developing operating systems. Instead, the company will use its software development talent to produce add-ons to System V.4, as well as new applications software. Interactive's parent company, Kodak, mandates one such application. Kodak has been investing heavily in its Photo CD technology, which basically converts photo prints into high-resolution digitized images on a compact disc. Kodak will market players and printers to accompany this technology, but Interactive is already well along in developing Unix imaging software that can expand the capabilities of the Photo CD.

The company has just started shipping its Ported NetWare package, an implementation of Novell's Portable NetWare for Unix. Ported NetWare operates on any 386 or 486 system running Interactive Unix 2.02 or higher. The company has also added a menu-driven utility for Unix-oriented administration.

—Tom Yager

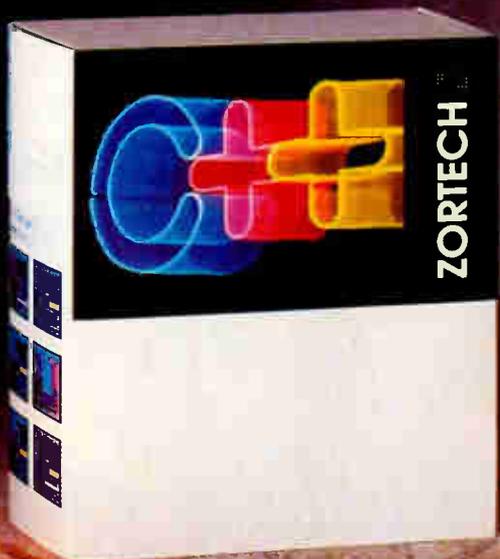
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## NANOBYTES

**3Com** (Santa Clara, CA) has demonstrated the "first commercially available implementation of the Intermediate System-to-Intermediate System (IS-IS) routing protocol for OSI networks." IS-IS is a draft standard for intra-domain routing on OSI networks. Support for this capability is included in a new version (2.0) of 3Com's NetBuilder Router software, which also has routing capabilities for Novell IPX and DECnet Phase IV. 3Com's routers now support all the major routing protocols, which also include TCP/IP, XNS, and OSI.

**DVI** meets the Mario Brothers: Although aimed at computer graphics and imaging systems, Intel's Digital Video Interactive technology will show up in a new generation of video games slated to hit arcades next fall. **Data East USA** (San Jose, CA) will bring out four games that use Intel's i750 digital video processors. "Over the past few years, arcade video games have lost some of the technological edge over home entertainment systems," says Joseph Keenan, president of Data East USA. "DVI technology returns that advantage tenfold and makes immediately available a highly advanced multimedia computer technology that will be found in arcade systems long before its entry into the home marketplace." Data East will supply Intel with the video for the games.

A new program introduced at UniForum will let Unix users include **any type of text or binary data** in E-mail messages. The first product from **Alfalfa Software** (Cambridge, MA), called **Poste**, provides for multipart messages consisting not only of text but user-defined *enclosures* as well. These enclosures can contain text, images, fax transmissions, and digitized sound. Users or third-party developers can add new types as technology advances, Alfalfa says. Poste is a graphical application with an OSF/Motif interface. It's likely to cost \$395.



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\* Source: MS-DOS, C++ Compilers. A comparison by the Ladd Group. (c) 1990

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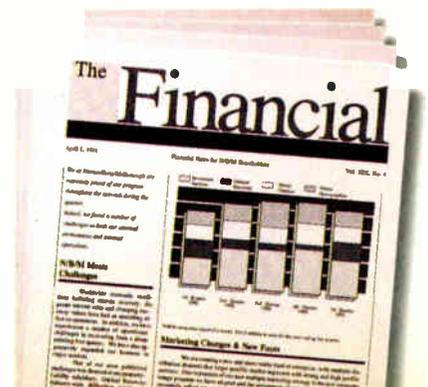
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**A technology called Rushmore boosts FoxPro's performance by orders of magnitude**

Sufficiently advanced technology, it's been said, cannot be distinguished from magic. So it is with Rushmore, the code-named patent-pending data-retrieval magic at the core of FoxPro 2.0. Rushmore enables the new version of FoxPro to wield huge sets of records at speeds that are utterly shocking. Certain basic operations run two orders of magnitude faster than under FoxPro 1.0, itself the performance

leader among dBASE-compatible programs. For good measure, Fox has tossed in interactive menu and screen generators, a Structured Query Language (SQL) query facility, a project manager, a 32-bit extended-DOS version, application programming interface (API) libraries for C and assembly programmers, a collection of handy new user-interface objects, and a host of useful language enhancements. If you hear an unusual noise this spring, it may be the sound of the earth shaking. Even in an industry accustomed to upheaval, FoxPro 2.0's debut should score high on the Richter scale.

I maintain a small suite of applications under FoxPro/LAN 1.0, so my first order of business was to test these under version 2.0. The beta copy I used had no multiuser support, so I ran it on a LAN in single-user mode. (Fox says both single-user and LAN versions will ship in the second quarter of this year.) Other than that, everything checked out beautifully.

The Rushmore technology made its presence known in cases where my programs use SET FILTER TO to deliver subsets of records in response to the BROWSE command. Under version 1.0, subset BROWSEs tend to crawl. Only users with fast machines can really benefit from this otherwise marvelously useful access idiom. With 2.0, my programs could BROWSE filtered subsets with no perceptible strain. Almost unbelievably, that held true when I moved from my 4-megabyte 20-MHz 386 to a lowly 640K-byte 10-MHz 286. The world's full of such machines—I've got to support a number of them myself—and FoxPro's newfound ability to wring performance out of modest hardware is a godsend. Thanks to Rushmore, a new fine-grained segment loader (which replaces 1.0's overlay system), and a smaller root segment, low-end machines get a new lease on life.

## Let FoxPro Write the Code

Although version 1.0's FoxView/FoxCode tool set gave savvy programmers a big head start on building rich user interfaces, you had to learn a rather obscure meta-language to use the tools. I've heard it's a good system for interactively designing and automatically generating programs, but I've never had time to master it. For me, database programming is a quick-and-dirty af-

fair to which I devote a few odd hours stolen from official duties. Under 1.0, the quick-and-dirty solution was to lean heavily on the BROWSE command and avoid custom user interfaces.

What will my next generation of FoxPro applications look like? Take a look at photo 1. After I got the hang of the new screen builder, I was able to whip up a simplified working version of that program in under 2 minutes. How? FoxPro wrote most of it—including code to open database files, set relations, and place and activate interface objects. All I did was interactively build the interface and supply a few lines of code. "Scary," said one colleague who watched the demonstration.

Like FoxPro 1.0's report builder, the new screen builder supports mouse-driven positioning of text and database fields. It also handles new interface objects: text buttons, radio buttons, check boxes, scrollable lists, and multiline text fields. With these objects, programs written with FoxPro can now sport the exemplary character-mode graphical user interface (GUI) of FoxPro itself.

As with the report builder, there's a "quick" option that dumps fields and their names onto the screen to give you a head start on the design. You can select sets of objects, and group and ungroup them. (These conveniences also carry over to 2.0's report builder; 1.0's report builder didn't support multiple selection or grouping.) Double-clicking on an object brings forward a dialog box that you use to specify the object's behavior. In some cases, you won't even need to do that. The default behavior may be just what you want, as was true for most of the fields shown in photo 1. Note in particular the checkboxes, which map directly to logical (true/false) fields in the database.

## The Automatic GUI

In other cases, though, you will need programmatic control. All the interface objects become statements (variants of the @...GET command) in the program that FoxPro writes. These statements can have clauses that execute when the corresponding object receives or loses the input focus, and they can transmit the data that they solicit to variables or database fields. The screen builder prompts you for these clauses and variables, and it then stores the code that you supply in

### THE FACTS

**FoxPro 2.0**  
(price not set at press time)

**Fox Software**  
134 West South Boundary  
Perrysburg, OH 43551  
(419) 874-0162  
fax: (419) 874-8678  
Circle 1060 on Inquiry Card.

a FoxPro database.

In the case of the “next/prev/first/last/quit” text-button object shown in photo 1, I told FoxPro to store the user’s choice in a variable called choice. Then, to the object’s VALID clause (which FoxPro calls when the user pushes a button), I attached a DO CASE statement mapping button choices to appropriate FoxPro commands such as SKIP, GO TOP, and QUIT.

FoxPro turns these code snippets into procedures that have machine-generated names such as \_PX201XDY7. Not too handy a string to search for in your text editor, but then the .PRG file FoxPro writes only looks like source code. It’s actually intermediate object code not meant for human consumption. The idea is that you’ll access \_PX201XDY7 only through the screen builder, and you’ll only need to think of it as “that thing right there on the screen.” It’s a matter of preference, I guess, but that bothers me a bit. I believe that naming is a key programming discipline.

Of course, there is a simple workaround. Just have \_PX201XDY7 call a routine in a procedure file, which you can name according to your own conventions. That way you can also retain the use of your own text editor—another matter of strong personal preference.

Quibbles aside, the key point here is that you’re only responsible for what happens when the user makes selections. FoxPro automatically generates code to manage the event-driven framework in which selections can occur.

Although it’s character-based, FoxPro presents a full-blown GUI with much of the attendant complexity. As many Mac, Windows, and now Unix programmers are discovering, there’s no advantage in managing the event loop yourself when the machine can do it for you. Life’s too short, and there are so many interesting things that you can be using the GUI to accomplish. Version 2.0 buys you the time to make those things happen.

### Menu Builder and Project Manager

Although I had learned how to program cascading pull-down menus under FoxPro 1.0, it’s a technique I’ll be happy to forget. Version 2.0’s menu builder does it for you. You interactively build and test a menu tree and then link its leaves to commands or, more typically, programs generated by the screen builder.

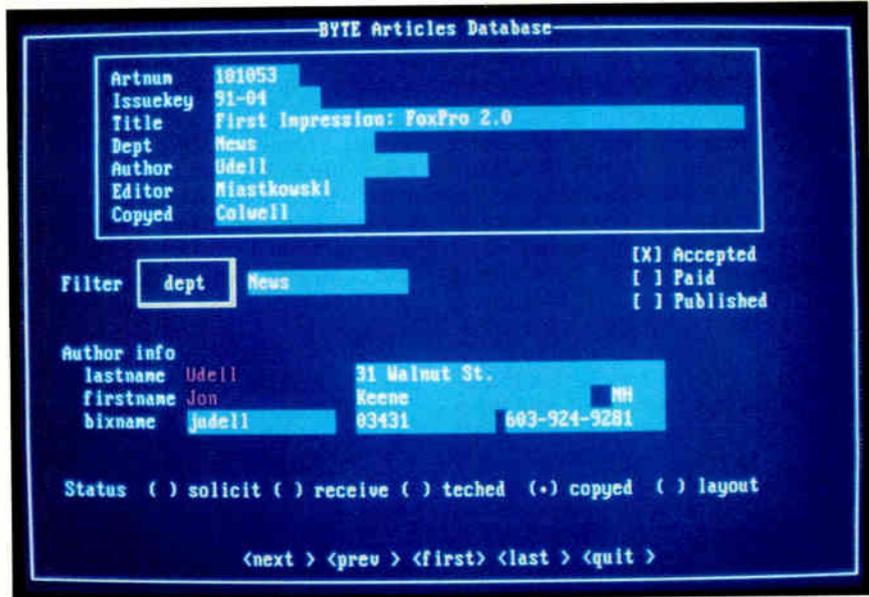


Photo 1: With FoxPro 2.0’s interactive screen builder and code generator, even part-time programmers can get professional results.

There is a “quick” option here, too. It duplicates the FoxPro system menu, which you can then restrict or modify as necessary. Menu items can now have checkmarks that convey binary status: A subsequent choice is available or it isn’t; a switch is on or off. Like the screen builder, the menu builder provides for global initialization and cleanup. When you select one of these options, FoxPro presents an editing window in which you can write code to create or destroy global variables, arrays, and database configurations. The cleanup section is also a place where you can write functions and procedures. These you do name yourself, although you can’t edit them except by way of the menu or screen builder.

Both the screen and menu builders use FoxPro databases (.SCX and .MNX files, respectively) to store the information that drives their respective code generators, which in turn produce .PRG files (which in turn compile to .FXP files). The new SQL facility produces .QRY files (which also compile to .FXP files). And, as before, the report and label generators crank out .FRX and .LBX files. An application may easily require many files of each of these types.

Thankfully, FoxBase 2.0 can help you sort out this alphabet soup. If you can swallow one more three-letter convention—.PJX, the project file—you can forget all the rest. You create a new project file, add the pieces of your application, and voilà: instant organization. Double-

clicking on a file listed in the project manager opens the file and launches the appropriate tool: text editor, or screen, menu, report, or query builder.

The project manager keeps track of dependencies and, when you ask for a rebuild, refreshes only outdated files and their dependents. The Info dialog box remembers the date of the last build. It also lists variables, procedures, and functions by module and notes whether each identifier was defined or referenced in that module—a very handy feature.

I found the project manager helpful not only for developing programs, but also for casual interactive use. While exploring the SQL facility, for example, I used it to group a set of queries into a manageable collection.

### And Then the SQL

FoxPro 1.0 sorely lacked an interactive query tool. Version 2.0’s query tool (see photo 2) plugs that gap. Like many SQL front ends, it walks you through the selection of databases and fields and the specification of join conditions, functions, and qualifying expressions. You can look at the generated SQL code at any time. For interactive purposes, you typically save queries—each one an instance of 2.0’s new SQL-oriented SELECT command—in .QRY files that the project manager associates with the query tool. Alternatively, you might save them in .PRG files for use by programs. Of course, you can also write SELECT

# NEWS

## FIRST IMPRESSIONS

statements yourself and run them from the COMMAND window or from within programs.

SELECT, unlike other FoxPro commands, opens databases on demand. The query optimizer may use available indexes or create temporary ones on the fly. SELECT relies on Rushmore and, in fact, is the only way you can bring Rushmore to bear on multitable retrievals.

Although still in rough form when I saw it (no HAVING or UNION clauses, no descending ORDER BY, query optimizer still unfinished), FoxPro's SELECT appears to be both fast and flexible. Queries that I have used with other SQL products ran snappily on small databases and came up with the right answers. You can dump results right into a .DBF file, which you can then further manipulate using all of FoxPro's interactive and programmatic tools.

SELECT is still evolving. One tantalizing feature on the to-do list is support for FoxPro functions in the SELECT statement. I don't know what SQL purists will say, but FoxPro developers certainly will be drooling over the possibilities inherent in that hybrid.

### Rush Me More Records

The development tools and SQL facility so engaged me that it was several days before I got around to stress-testing Rushmore in earnest. As I've said, my programs' filtered BROWSEs flew where before they had crawled. But these pro-

grams used puny 1000- to 2000-record (1- to 2-MB) databases.

Nothing prepared me for what happened next. I doubled the size of a database again and again and again. At 8000 records, I brought FoxPro 1.0 down to its knees. BROWSE, with a filter, ground to a halt while the file server's disk took a beating. But 2.0 didn't even break a sweat at 8000 records, and it was the same story at 16,000 records and at 32,000 records—what was by now a 12-MB database.

I stopped there because I would have had to clear more space on the server to double the database again—and because I was stunned. BROWSE was still rapidly scrolling through filtered sets of records, the disk was chittering quietly, and I was walking around my office looking for mirrors, wires, trapdoors—anything that might explain this prodigious trick.

Where does it end? I didn't have a million-record database at hand (or space to create one), but I'm no longer inclined to doubt claims that 2.0 will handle such a thing with ease. Fox has simply built a better mousetrap. How, exactly, remains a mystery. The official story is that, by some means, Rushmore optimizes index expressions in the FOR clause of a number of FoxPro commands, including—another 2.0 first—BROWSE FOR. Commands like

```
BROWSE FOR state = "MA"
and city = "Cambridge"
```

or

```
SORT FOR fee > 300
and dept = "Reviews"
```

are fully optimizable if indexes exist for city, state, fee, and dept. However, the command

```
LOCATE FOR fee > 300
and "stein" $ author
```

is at best partially optimizable, since no index can exist for the second part of the FOR expression (which tests for the occurrence of "stein" in author). By the same token,

```
REPORT FOR "stein" $ author
```

is not optimizable at all.

### Indexes, Indexes

Some of Rushmore's prowess, but by no means all of it, flows from FoxPro 2.0's compact index files. Version 2.0 can read and write standard FoxPro .IDX files but prefers a new compact format. These new .IDX files are much smaller. In the case of one 2.5-MB 2000-record database, an index that took 440K bytes under version 1.0 shrank to 50K bytes under 2.0. Smaller indexes confer obvious benefits—less disk traffic, more index data in memory. However, although Rushmore greatly appreciates compact indexes, it does not depend on them.

Building on the new compact index technology, FoxPro 2.0 introduces another great convenience: .CDX files that hold multiple compact indexes. When one of these index files shares the name of the database, it's a *structural index*; FoxPro silently opens it whenever you open the database. Because compact indexes are so small, you can index most or all of the fields of a database in less space than it used to take to index just one field—and still use up just one DOS file handle.

Structural indexes take almost all the hassle out of keeping lots of indexes. Seize the opportunity; Rushmore will put them to good use. When you need to refer explicitly to individual indexes within a .CDX file, you use a *tag name*. The SET ORDER TO and INDEX commands now have TAG clauses that accept tag names. Note, however, that you may need to rethink how you use the SET ORDER TO command. Although Rushmore likes having indexes available, it prefers that none of them controls the order of the database.

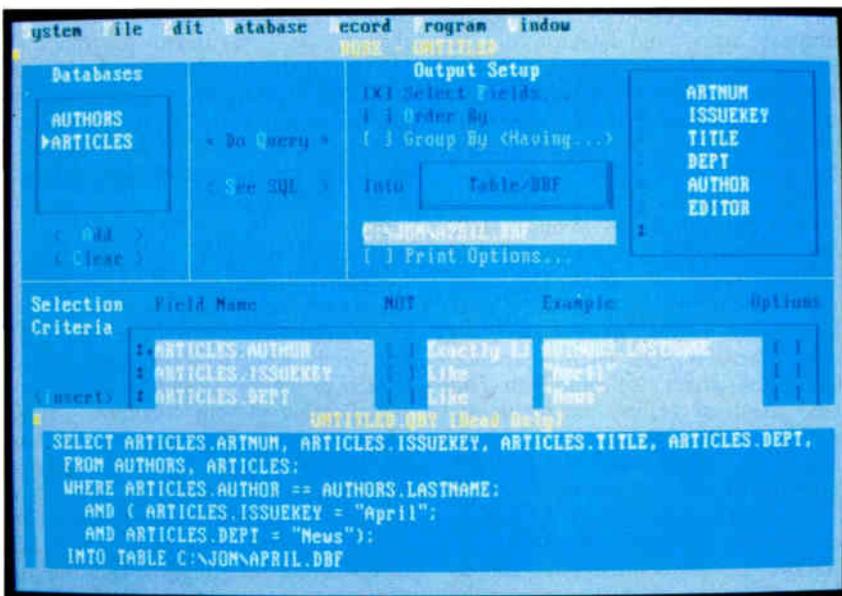


Photo 2: The RQBE (relational query-by-example) window makes FoxPro 2.0's new SQL-style SELECT command accessible to beginners.



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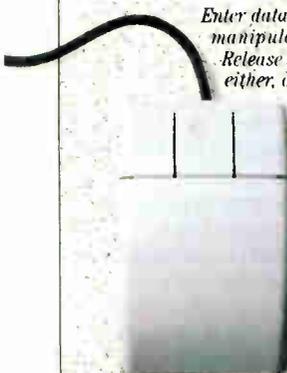
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1,331,601	3,789,665
5,734,905	16,249,604
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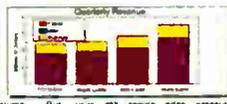
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**Revenue by Product**  
Material collections increased over the year. Plastics continue to bring in the most revenue and profit for the company. Prices for aluminum are still very soft and while we're continuing to collect more glass, markets for the raw materials are still in their infancy.

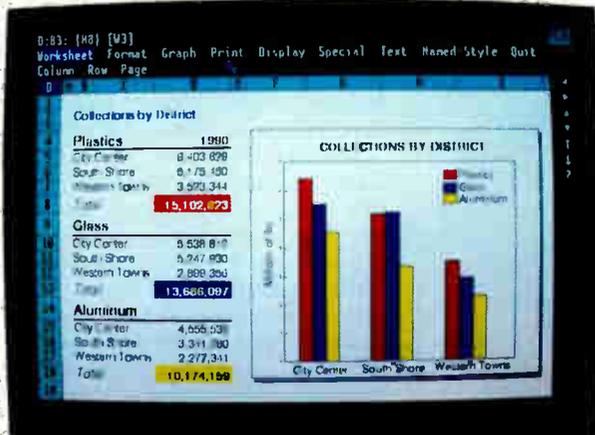
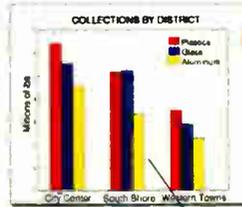
Revenue	Q1	Q2	Q3	Q4	1990
Plastics	1,926,783	1,981,024	2,379,337	2,808,581	9,105,125
Glass	1,700,504	1,862,135	1,896,430	2,800,904	8,032,753
Aluminum	1,146,864	1,192,022	1,496,421	1,601,783	5,432,080
<b>Total</b>	<b>\$4,786,173</b>	<b>\$5,028,180</b>	<b>\$5,772,188</b>	<b>\$7,089,430</b>	<b>\$22,341,038</b>

The graph at the right details our revenue by waste material for the four quarters of 1990. The revenue increases show that communities are building their recycling programs beyond just collecting plastics. Revenue from aluminum and glass have increased as their programs have gained volume. But, we're still seeing price pressure as the supply of recyclable materials continues to exceed the demand. We need to look for ways to expand our markets and increase the use of recycled materials.



**Collections by District**

Plastics	1990
City Center	8,403,859
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Western Towns	3,523,344
<b>Total</b>	<b>21,106,603</b>



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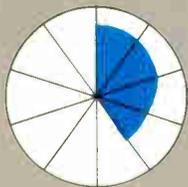
World Radio History



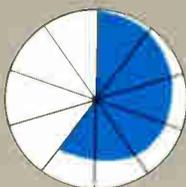
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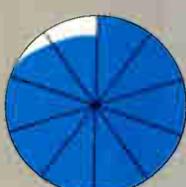
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### .DBF to the Max

There's tons more to say about FoxPro 2.0. The extended (32-bit) version, which Fox will bundle with all versions of the product, ices the performance cake. The Watcom-compatible API libraries should yield powerful FoxPro extensions; one third-party developer has used them to create a command that displays images stored in memo fields.

The new SET SKIP TO command enables BROWSE to navigate a pair of tables while preserving a one-to-many relationship. You can now redimension arrays on the fly, sort and search them, and insert and delete elements. The TEXT...ENDTEXT command can evaluate functions and expressions. New IMPORT and EXPORT commands support a variety of database and spreadsheet file formats. Reports can create and use variables. Pop-up programs can have scroll bars. And the list goes on.

Is it perfection? Not quite. FoxPro still tends to deliver unhelpful error messages like "Invalid expression" and "Type mismatch." The debug and trace tools are excellent, but you shouldn't need to deploy them to unravel simple problems such as these. Smarter diagnostics would be a big help. Also, the documentation is still mainly organized alphabetically by command and function. A more topical, technique-oriented approach would help new or occasional users to exploit FoxPro's power effectively. Fox says the shipping version of 2.0 should show improvements on both these fronts.

Delivering common applications to Mac and PC clients on a LAN is a problem that I face, and FoxPro 2.0 doesn't help yet. But I'll be watching for the Mac version that's now on the drawing board. (It should ship, along with a Windows version, later this year; there's no word yet on a Unix version.)

An early experiment with FoxBase+ and FoxBase+/Mac failed because AppleTalk was unable to handle the traffic. Rushmore's startling efficiency just might change that. Alternatively, Fox confirms that there's a server version even farther out on the horizon, which would also provide a venue for tackling unresolved issues such as transaction integrity and data dictionary support. Either way, FoxPro 2.0's highly developed character GUI should ensure that FoxPro applications will port readily to other platforms. I can hardly wait. ■

*Jon Udell is a BYTE senior editor at large. You can reach him on BIX as "judell."*

# A Lean, Mean SCSI-2 Machine

STAN MIASTKOWSKI

## Hewlett-Packard's Vectra 486/33T file server tames the temperamental SCSI

I've always liked Hewlett-Packard and its products. While too many companies in the PC industry hide behind torrents of marketing hype as they roll out more yawn-provoking products, HP quietly works on developing well-engineered, cutting-edge products. It's a company where engineering excellence and overall quality is highly prized, and the Vectra 486/33T is a prominent case in point.

As its name implies, the 486/33T is based on an i486 microprocessor running at 33 MHz. No real surprises there—HP's had a 25-MHz system for a while now. In the step up to the top-of-the-line 33-MHz 486, the company decided to eschew the ISA bus for the higher speed and bandwidth of the EISA bus. In this, HP has

joined numerous other top-shelf PC makers. But unlike many others, HP uses the EISA bus to full advantage to deliver a fast machine with disk capacities and speeds matched to the needs of heavy multitasking and multiuser applications. Both the specifications and the size of the 486/33T testify to this use. The system is similar to a small refrigerator, measuring 8½ inches wide by 20 inches deep by 24 inches high, and it tips the scales at 60 pounds.

### Delving into Disks

With a machine designed for heavy use (HP claims that it'll easily handle 200 LAN users or 100 Unix users), the company ran smack-dab into the problems associated with today's standard Intelligent Drive Electronics (IDE) and ESDI hard disk drive systems. An HP engineer told me that with the two-to-four-drive limit on hard disk drives and the limited bandwidth of the ISA bus, the "disk system was the key bottleneck."

HP decided that SCSI was the way to go. It was a decision that was not taken lightly. The existing SCSI standard has been far from standard. SCSI devices have always offered the promise of easily connected multiple drives and fast throughput, but they have seldom delivered on that promise. There's a confusing (and often incompatible) tower of SCSI Babel, with proprietary device drivers from different manufacturers. Getting a single SCSI device to work can be an interesting exercise—never mind the nightmare scenario of getting several SCSI devices to work together.

### Enter SCSI-2

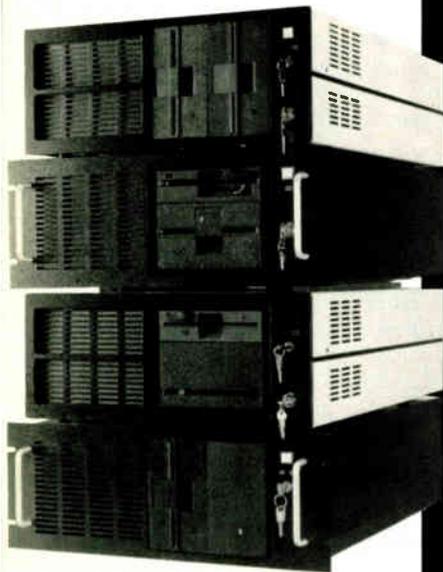
SCSI-2, the next-generation SCSI specification now in its final phases of approval from ANSI, offers much more in the way of compatibility and throughput. The details of SCSI-2 (whose specification runs to some 600 pages) are too involved to get into here, but suffice it to say that HP engineers felt confident that SCSI-2 finally delivered on the promise of SCSI, and that it was a logical solution for the applications that the 486/33T is designed for.

Developed by Adaptec, the hard disk drive controller in the 486/33T uses Intel's proprietary BMIC (for Bus Master Intel Corp.) chip to achieve high data transfer rates. On the bus side, it can deliver data in bursts of up to the maximum



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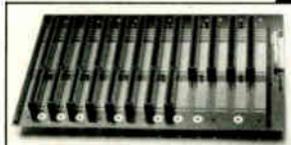
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# NEWS

## FIRST IMPRESSIONS

33-megabyte-per-second bandwidth of the EISA bus. On the disk side, it's capable of handling the 10-MBps transfer rate of the "fast SCSI" specification that's integral to the SCSI-2 specification. That's largely academic right now, since the fastest existing SCSI drives can handle only 5 MBps. Later this year, 10-MBps drives are expected to become available, and an HP spokesperson told me that the company will eventually offer them as an option.

The proof is in the performance, so I ran preliminary benchmark tests on the 486/33T (which was equipped with a 670-MB SCSI-2 drive). The tests showed that the system/controller combination is no slouch, to put it mildly. With a preliminary BYTE Lab disk I/O benchmark index of 4.2, the 486/33T is the fastest system tested to date. The only system that

comes close is the much more expensive Compaq Deskpro, with a disk I/O index of 3.8.

### Traveling in Packs

Although I was only able to test the 486/33T with plain-vanilla DOS 4.01 and a single hard disk drive, the real promise of the bus-mastering controller and SCSI-2 drives lies in multitasking operating systems (e.g., Novell NetWare and OS/2) and multiple drives. In situations like these, the more drives the better. That's because intelligent SCSI-2 devices can dynamically disconnect and reconnect themselves to the bus. In a multitasking environment, the controller and drives in the 486/33T can handle streams of multiple data transfers, with one drive disconnecting itself from the bus and getting data while other drives

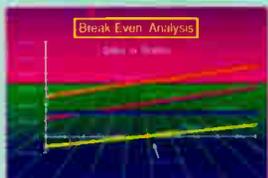


*The HP Vectra 486/33T is solidly designed for full-time heavy-duty use and EISA expandability. The processor is located on its own daughterboard.*

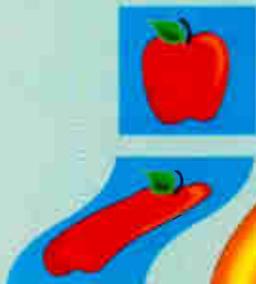
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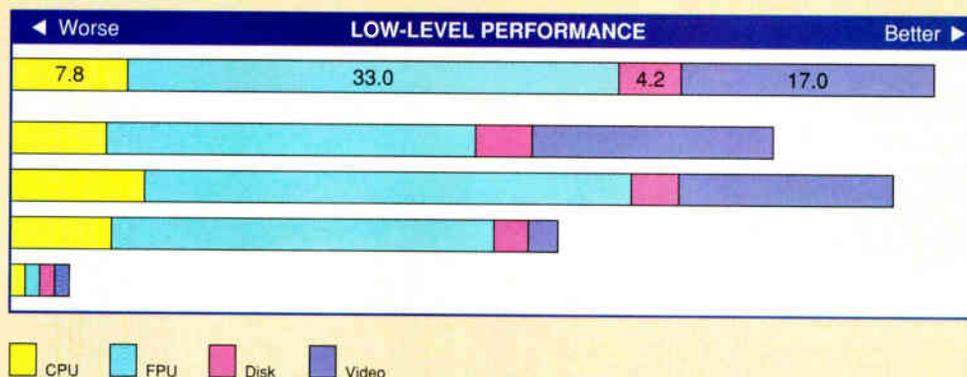
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### DOS BENCHMARKS



Preliminary BYTE Lab benchmark results show that the HP Vectra 486/33T's integrated design pays off in impressive numbers. While the CPU and FPU benchmarks are comparable to competing systems, the disk I/O and video benchmarks are the fastest the BYTE Lab has measured to date. Results are indexed and show relative performance; for each index, an 8-MHz IBM AT=1.

handle other data requests. At Boston's NetWorld show in February, HP demonstrated the 486/33T hooked to a large network and handling 26 gigabytes of mass storage. We've come a long way from the single, slow MFM drives of early PCs.

#### Getting It Together

Although the SCSI-2 controller/drive combination is the shining star of the 486/33T, it's not the only outstanding feature. In fact, it's obvious that all the individual components of the system are fine-tuned to maximize performance. It's a far cry from the "assorted parts and pieces" approach that too many PC manufacturers opt for these days.

The 486/33T's video system is far from being an also-ran; the standard HP Super VGA graphics board delivered a benchmark index of 17.0; once again, it is the fastest that the BYTE Lab has measured to date. The system supports 800-by-600-pixel noninterlaced resolution and interlaced resolution of 1024 by 768 pixels. Although this machine is designed as a file server, it's clearly also a perfect choice for graphics-intensive CAD applications.

As far as the rest of the 486/33T's vital statistics are concerned, it has eight 32-bit EISA slots (with five free in the standard system). To keep the data moving, the unit uses a custom HP memory controller with a 128K-byte external memory cache. Also, 4 MB of zero-wait-state RAM is standard, and you can expand the memory to a maximum of 64 MB.

The processor and its associated circuitry are on a daughterboard that plugs into a proprietary slot on the motherboard, offering the intriguing possibility of future upgrades. HP has spared nothing in the design; the i486 is shielded in its own metal cage, and if the i486's built-in math processing isn't good enough for you, there is a slot for a Weitek WTL4167 coprocessor.

Every individual component of the 486/33T shows that it has been designed for full-time, 24-hour-a-day, heavy-duty use. Even the keyboard and mouse cables are heavy duty. The overall "fit and finish" of the system is superbly solid. And for the security conscious, there is a pair of keyed locks that can lock up the entire system.

#### Pricing Performance

You would expect the 486/33T to be expensive, and it is, especially when compared with today's crop of garden-variety clones from companies large and small. Nevertheless, I was surprised. HP has always priced its systems at a premium, and for good reason. But the 486/33T's pricing heralds a new era for HP. It is aggressive, especially when compared to comparable high-end systems such as the Compaq Deskpro.

The 486/33T starts at a relatively paltry \$9499 for a system without a hard disk drive and controller. If you don't want (or need) the speed and capacity of the SCSI-2 system, there's a system with a 170-MB IDE drive for \$11,249. Add SCSI-2, and complete system prices start

at \$14,449 with the Adaptec bus-mastering controller and a 440-MB hard disk drive. In addition, a system with a 670-MB hard disk drive is available (the system I tested); pricing wasn't available at press time. But why not go for the top? With a 1-gigabyte SCSI-2 drive, the system retails for \$17,799. For a system with this type of speed and capacity, that's an unbeatable price/performance deal. The Vectra is also available in a 25-MHz EISA incarnation, at about \$2000 less. With the introduction of the Vectra 486/33T, HP has retained its engineering edge while signaling that it is fast becoming a marketing force to be reckoned with. ■

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

#### THE FACTS

##### HP Vectra 486/33T

Model 1 (no hard disk drive), \$9499; Model 170 (170-MB IDE hard disk drive), \$11,249; Model 440 (440-MB SCSI-2 hard disk drive), \$14,449; Model 1000 (1-gigabyte SCSI-2 hard disk drive), \$17,799.

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World Radio History

## The LaserJet IIISi: Hewlett-Packard's Flagship Printer

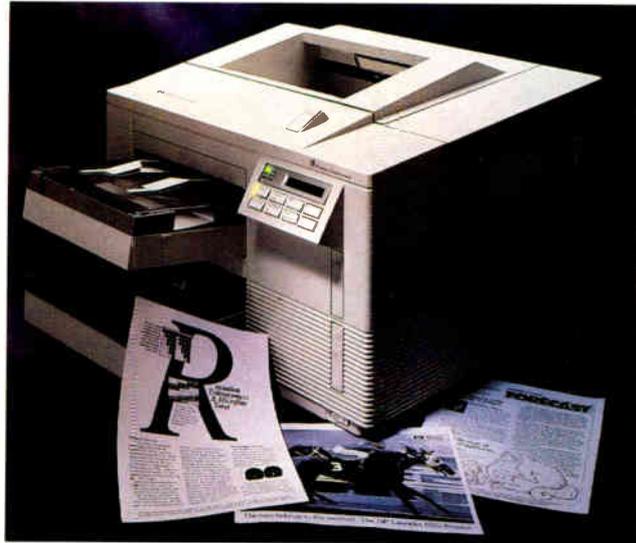
**A**t 106 pounds and built like a small washing machine, Hewlett-Packard's new top-of-the-line LaserJet IIISi hunkers down like a printer that means business. It does. Fast, accurate, capacious, network-aware, and smoothly bilingual, the IIISi will surely become a mainstay of the corporate LAN.

At the heart of HP's behemoth rumbles a new Canon engine that pounds out 17 pages per minute. The brain is an Advanced Micro Devices (AMD) 29000 controller that executes HP's Printer Command Language 5 and (optionally) Adobe PostScript—both at a brisk clip. The PostScript option doesn't come in a cartridge; it installs as an integral component. Switching between the two languages is a snap. You can shift gears at the control panel, from an application, or by means of network queues (the best technique).

Like the LaserJet III and IID, the IIISi employs HP's resolution-enhancement technology. Scanning an image in bands, at full speed, the resolution-enhancement subsystem adjusts dot sizes and locations to clarify features and create an apparent resolution better than the nominal 300 dots per inch. It's magic, in other words, but magic that really works.

I printed a Corel Draw sample illustration (the grasshopper) on a LaserWriter IINT and on the IIISi. The HP printer finished first by a long shot, and it also produced noticeably cleaner curves and subtly smoother gradations of texture. (Note, in fairness, that the IIISi had 5 megabytes of RAM versus the LaserWriter's 2 MB, so the performance gap isn't solely attributable to the AMD processor.)

In the IIISi, resolution enhancement works hand in hand with a new "microfine" toner featuring extremely



### THE FACTS

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small (and therefore more precisely controllable) particles. The "all-in-one" cartridges cost \$169, but they last for 8000 pages; that works out to a very attractive 2 cents per page.

Printer performance on a LAN, as HP likes to point out, depends on a series of pipelined activities: preparing the job, shooting it across the network to a spooler queue, despooling it across the network again to the printer, forming the image, and committing it to paper. Why yoke a hot-rod controller and print engine to a parallel interface that can't keep them adequately stoked with data?

To eliminate the spooler-to-

printer bottleneck, HP offers optional network interface cards for 3+Open and NetWare. Available in Ethernet and Token Ring flavors, these adapters come with despooling firmware that sucks data from queues at network speed. Advantages are threefold: The data moves faster, the server does less work, and the printer, freed from its 10-foot leash to the server, can be located wherever convenient.

I tested the Ethernet adapter on a NetWare 2.15 LAN. Installation is dead simple: You pop out the parallel/serial interface board, pop in the network adapter, tell NetWare there's a new queue server, and tell the IIISi that it is that

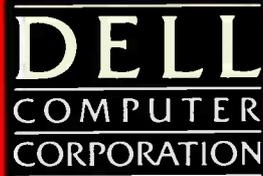
new queue server. The difference is noticeable. When I printed a PageMaker document using the parallel interface, text-only pages printed instantly, while pages heavy with illustrations lingered for a few seconds. With the Ethernet connection, the graphics pages came out nearly as fast as the text pages.

Despite Ethernet's performance advantage, however, the parallel interface turned out to be best for our environment. Although BYTE's NetWare and Unix LANs share the same Ethernet cable, there was no way for Unix workstations to access the IIISi when it was directly connected to Ethernet. The firmware in the printer's network adapter communicates only with NetWare queues to which Unix has no access. Threatened with a riot in the Unix lab, whose staff had quickly grown fond of the new printer, I reverted to our standard solution: parallel cables feeding into an electronic switch.

Although the IIISi is plainly a more capable PostScript printer than the LaserWriters on BYTE's Mac LAN, I was not able to bring the Mac users into the fold. HP won't have an AppleTalk interface option until sometime this fall. It's not clear, as yet, how the IIISi would play in mixed Mac/PC LAN environments. NetWare for Mac users could presumably access an AppleTalk-configured IIISi from PCs, but it would have to settle for AppleTalk speed—and Unix users would again be left out in the cold. Ideally, the printer would accept multiple network connections and switch among them. Let's hope some entrepreneur will rise to the challenge posed by the IIISi's lone I/O slot.

A departmental printer had better be able to handle a lot of paper intelligently. The IIISi shines here, too. For starters,

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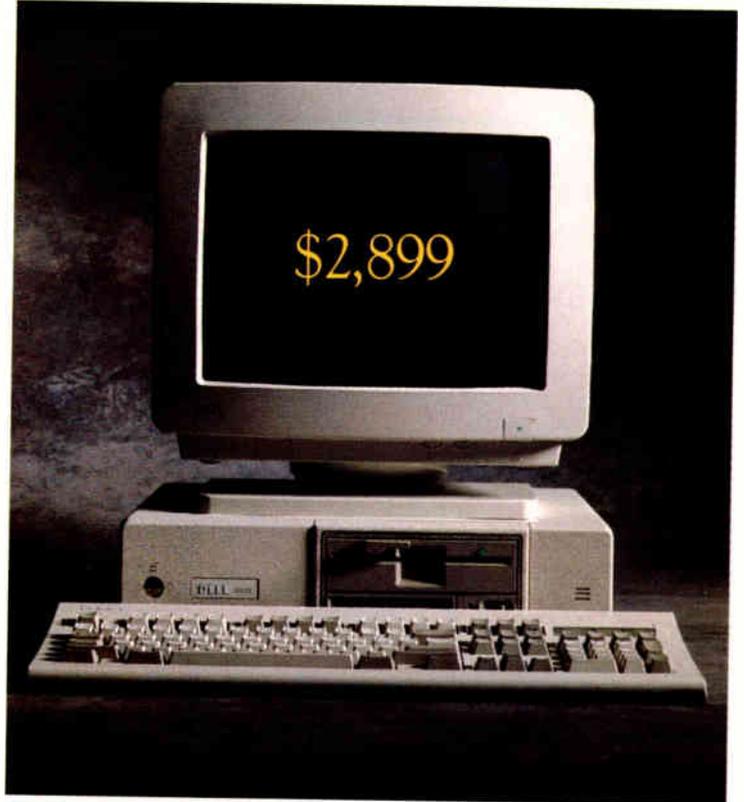
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\*The Dell system includes VGA Color Plus Monitor, 80 MB hard drive, 2 MB RAM. The Compaq system includes VGA Color Monitor, 60 MB hard drive, 2 MB RAM. \*Performance Enhancements: Within the first megabyte of memory 96 KB of memory is reserved for use by the system to enhance performance. Can be optionally disabled. All systems are photographed with optional extras. All prices and specifications are subject to change without notice. Dell cannot be responsible for errors in typography or photography. †Source: From the Compaq Computer Corporation price list effective October 15, 1990. \*\*Payment based on 36-month, open-end lease. ‡Leasing arranged by Leasing Group, Inc. In Canada configurations and prices may vary. Dell and Dell System are registered trademarks of Dell Computer.

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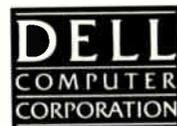
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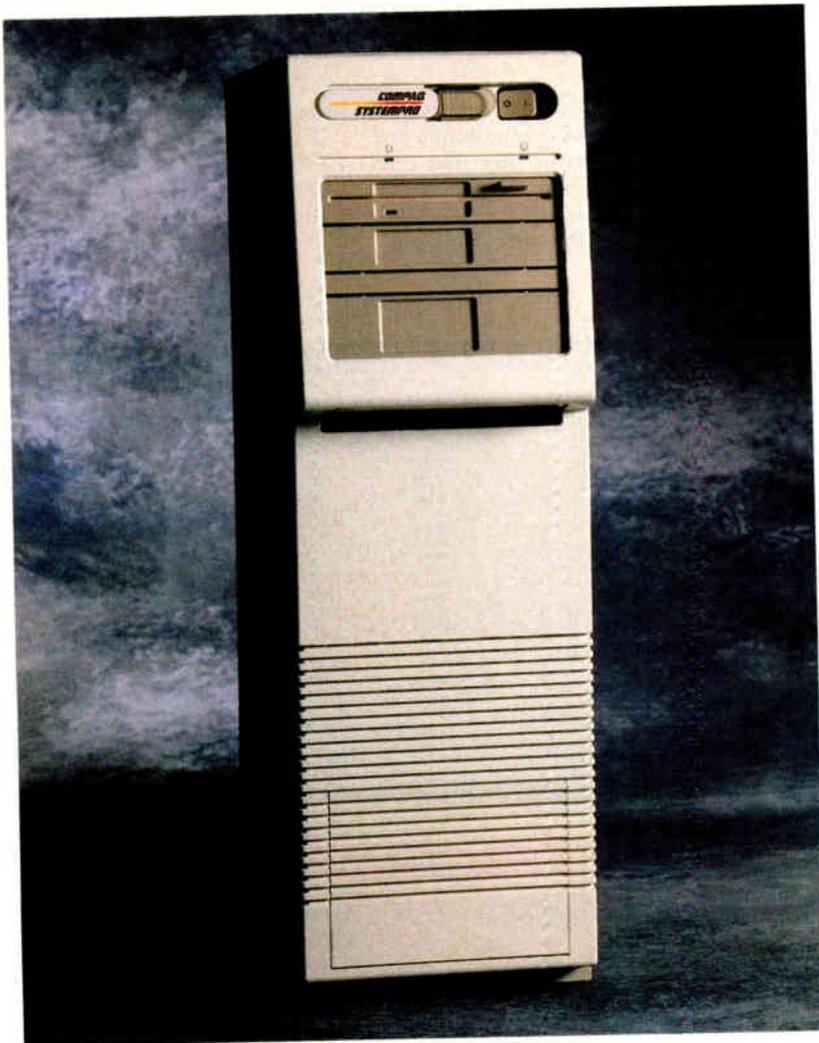
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it accepts two 500-sheet trays. After years of refilling piddling quantities of paper, I found it enormously satisfying to load a thousand pages at a crack. I reserved the lower

tray for letterhead—another luxury if your users have had to share a single tray and perform gymnastics to use letterhead. Then there's the duplex (two-sided-printing) option,

and a job offset feature that staggers jobs in the output bin for easy separation. The tray full arm on top of the output bin helps stack paper neatly. Everything works to mini-

mize shared-printer chaos.

I tip my hat to Hewlett-Packard. The IIISi is a marvelous—and surprisingly affordable—piece of work.

—Jon Udell

## BeckerTools 2.0 Makes Doing Windows a Breeze

The Windows 3.0 version of BeckerTools reminds me of the old college trick of squeezing as many people as you can into a phone booth. The panel that runs down the left side of the screen is chock full of minute icons. You can't tell what the individual graphics are, but you can find out what they do by scrolling the mouse over them and reading what they are at the bottom of the screen. I thought this was an overuse and abuse of the concept of icons.

But those funny little icons are the only thing I didn't like about BeckerTools 2.0. The program is designed to do for Windows 3.0 what Central Point Software's PC Tools Deluxe and the Norton Commander do for DOS. Once you get hooked on such a package, it's hard to switch.

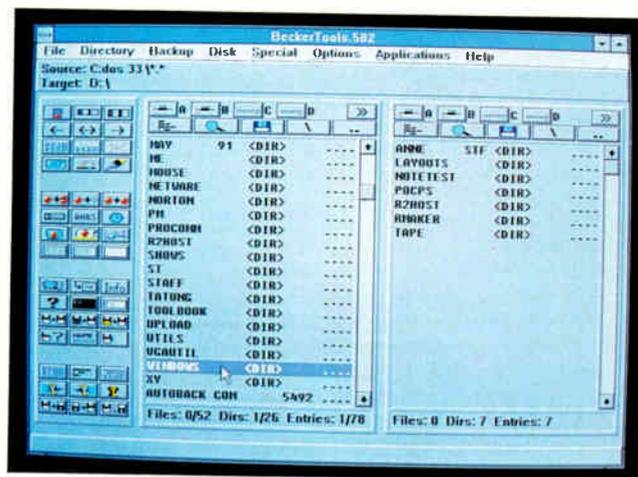
I've never gotten hooked on Windows 3.0. I've found myself working in it awhile and then popping out to do DOS-level stuff like copying to disk, formatting floppy disks, and editing with my word processor. There have been many

complaints about File Manager in Windows 3.0, and I guess my experience shows that it's not all that useful.

BeckerTools seems more developed than File Manager, although they both have the standard file and disk management functions (e.g., Copy, Delete, Rename, Select Files, Find File, Edit Text, and Format). BeckerTools makes it easier to perform these functions, not because of the tiny icons, but because you can point and click on almost anything you want to do. Launching an application is as simple as clicking on the application, pulling down the applications menu, and selecting Launch.

The interface is similar to Norton Commander's split screen, which is my personal favorite. It took me no time at all to get accustomed to the source and target window concept. You can also activate the pull-down menus for the Windows 3.0 look and feel.

BeckerTools 2.0 provides over 200 functions for disk and file management. In the tradition of DOS utilities, it



### THE FACTS

**BeckerTools 2.0**  
\$129.95

**Requirements:**  
A DOS system running  
Windows 3.0.

Abacus  
5370 52nd St. SE  
Grand Rapids, MI 49512  
(616) 698-0330  
fax: (616) 698-0325  
**Circle 1179 on Inquiry Card.**

also offers functions like undelete, file editing, disk verifying, file archiving, and a screen dimmer. BeckerTools has three levels of features: beginning, intermediate, and advanced. The only differences are in the number and sophisti-

cation of the features you can access.

Installation of BeckerTools 2.0 was a breeze. Basically, you just install it and move the little icon into position in the Windows Toolbox.

—Anne Fischer Lent

## The First "What You See Is All You Get" Notebook

If the Supernote 386SX had a color LCD and a modem, I would be tempted to push my desktop machine into the trash can. This 6½-pound notebook from Twinhead has a 16-MHz 386SX processor, and it comes with a 40-megabyte hard disk drive, a sidelit electroluminescent 32-shade VGA

LCD, 2 MB of RAM, and a 3½-inch 1.2-MB floppy disk drive. Times have changed since the trusty old Model 100 was born.

Of course, the prices have changed, too. But look at what you get for a list price of \$3495. With the exception of no color and no room for add-

in gizmos, you get good desktop performance in a truly notebook-size case (11 by 8¾ by 2 inches). If you simply must communicate and network, you can use an external "portable" modem or Ethernet box offered as extra-cost options.

The Supernote 386SX has a

socket for an 80C387SX coprocessor, a parallel printer port that can double as an external floppy disk drive connector (the Supernote automatically figures out what's connected to that port), two serial ports, and a 15-pin connector to drive an external VGA monitor (the LCD and

the external VGA monitor cannot operate simultaneously because of BIOS limitations). Software provided includes MS-DOS 4.01 and two floppy disks full of utilities and drivers. The keyboard is full-size and has a nice feel, although the cursor arrangement took some getting used to.

Twinhead's own chip set, a single chip and one support chip, disguises itself as a 386SX. The TH4100 chip has about 85,000 transistor equivalents and is the size of a postage stamp. The TH4009 support chip is about "the size of a dime, only square," according to John Bryan of Twinhead's marketing department. The motherboard is about 4 inches square (as is the VGA board), and surface-mount technology is used. If you want the maximum of 4 MB of RAM, you have to specify it when you order your system because it also is surface-mounted.

The main glitch I had with this supposedly ready-to-ship unit was that the power management system had a hiccup and started to beep annoyingly after about 45 minutes to announce that the batteries were low. With a claimed running time of 2½ to 3 hours, the warning was a bit premature. Twinhead assured me that it would fix the problem before shipping. To meet this publication deadline, however, the company simply disabled the battery-monitoring circuitry on my unit.

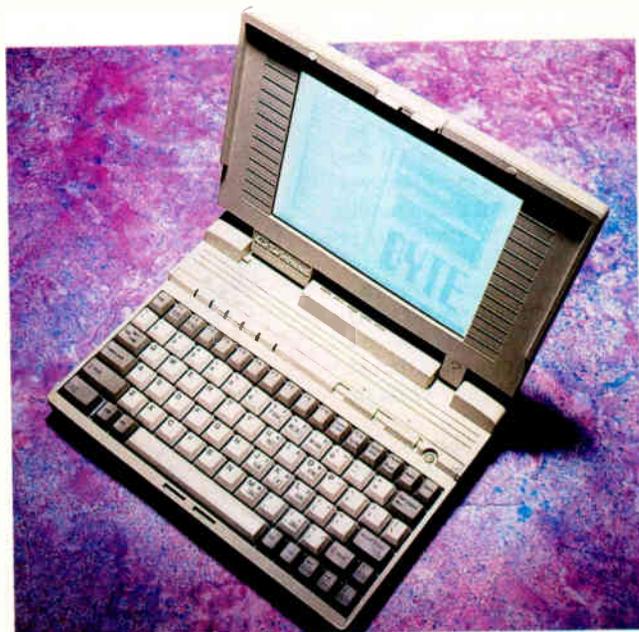
Battery capacity is always a concern, so I set out to test it. The power management system enables you to adjust independently the length of time before the LCD blanks and the hard disk stops spinning. Defaults are 5 minutes for the screen and 1 minute for the hard disk. I wrote a batch file that changed directories, displayed the contents of each, and kept repeating itself. This way, the Supernote 386SX screen and hard disk would have no rest.

After recharging for the 1 hour and 45 minutes specified, I started the machine and ran it until it died, which took 2 hours and 20 minutes. Not bad for nonstop computing. A properly operating power management system would have alerted me earlier in stages, according to the manual, by sounding a beep and by changing the power LED's color from green to amber and then to red.

The only other problems were inconsistencies in the user's manual that state, for example, that you can have up to 8 MB of RAM, that the Chips & Technologies NEAT chip set was used, and that the keyboard Ctrl/Alt— sequence would toggle the microprocessor between 8 and 16 MHz. (You can toggle via a setup screen, however.)

While the price is in line with similarly configured SX notebooks (see "The Tandon NB 386sx Notebook," March BYTE), the inability to add anything to this system is a serious drawback. It's a nice system, however, and is well made. So if you don't plan on expansion, the Supernote 386SX could be just the ticket.

—Gene Smarte



#### THE FACTS

**Supernote 386SX**  
\$3495

**Options:**

4 MB of RAM (installed by manufacturer), \$199;  
5½-inch 1.2-MB floppy disk drive, \$249; spare nickel-cadmium battery pack, \$99.

Twinhead Corp.  
1537 Centre Pointe Dr.  
Milpitas, CA 95035  
(408) 945-0808  
fax: (408) 945-1080  
**Circle 1180 on Inquiry Card.**

## Pointing to a Portable Future

**M**ice are nice, and they are more and more of a necessity in the graphical-user-interface-crazy world of today's PCs. There are, however, problems mating mice with laptop or notebook computers. Have you ever tried to use a mouse with a laptop on an airplane tray? There just isn't any room.

Great technological minds think alike, and three major mouse makers have concurrently come out with add-on mouse products designed to eliminate the adventure of using a mouse with a laptop. Actually, *pointing device* is a

more accurate moniker than *mouse*, since Microsoft's **BallPoint**, Appoint's **Thumbelina**, and Logitech's **TrackMan Portable** are all variations on a theme: a miniature trackball. Although all have similarities, each also has a quirky individual personality.

BallPoint is intriguing. It's evident that Microsoft spent a huge amount of time studying the ergonomics of pointing devices. The company supplied us with a photo of the scores of designs it rejected, some of them unusual indeed. The final design looks deceptively

simple at first glance. Microsoft decided that actually attaching BallPoint to the computer is essential to its usability.

BallPoint comes with several sets of adapters that let you easily hook it to virtually any laptop or notebook computer. We tried it with a half-dozen different computers, with no problems at all, attaching it to the left, right, and front of the keyboard.

Clever thumbscrews ensure that you cannot overtighten them and damage your computer, yet you can easily remove BallPoint. (It comes

# NEWS

## FIRST IMPRESSIONS

with a small padded case for portability.)

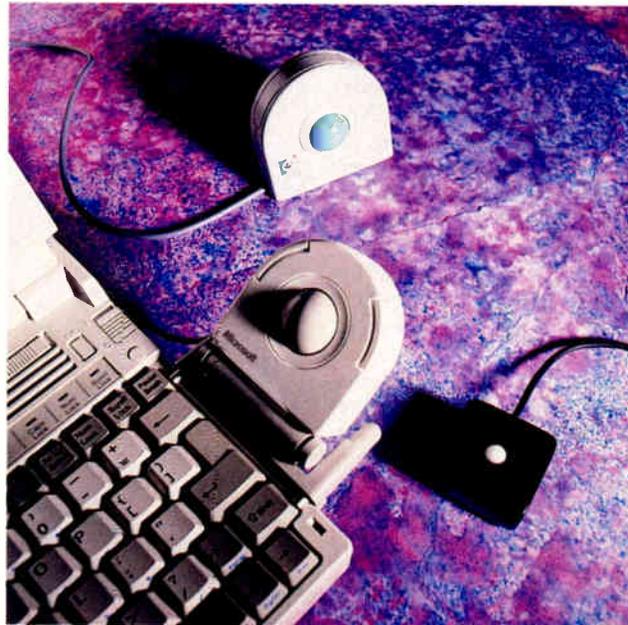
BallPoint has four click stops that let you use it at angles of 0, 30, 60, or 90 degrees. We liked the 30-degree setting best, but that's purely subjective. The trackball in BallPoint is relatively large for the size of the unit and is easy to control. It comes with a software utility that lets you control the sensitivity and the orientation direction of where the ball tracks.

The interestingly named Thumbelina is—as its name implies—tiny. Measuring 1½ inches square and only ¾ inch high, Thumbelina also uses a tiny (⅜ inch) trackball. In general, the larger the trackball, the better the control, but Thumbelina is an exception to this.

The finely tuned friction mechanism that holds the ball allows a surprising amount of control with minimal thumb movement. Where are the buttons? The entire top of the case clicks down. Clever.

The early Thumbelina prototype we used didn't have a way of attaching to a keyboard. An Appoint spokesperson said a rudimentary attachment kit (probably Velcro) will be shipped with the final version. Most users, however, will probably use Thumbelina as is. It's small enough to stuff into the smallest space.

The Logitech TrackMan Portable is essentially a tiny trackball device that you hold in one hand and operate using the thumb on the ball and the index finger to press the main button. You can remove the



button and switch it to the other end of the curve, as you also can switch the connector cable, which comes out of the end of the curve that is opposite the button. Switching these around lets TrackMan Portable operate as either left- or right-handed.

The trackball takes up the center of the face of the semicircle, and on either side of it are the second and third buttons. These are almost impossible to reach while operating the device when it is held in one hand. We found it more comfortable to rest the straight side of the semicircle on a flat surface with the hand curved over the top, thumb resting on the trackball, and index finger on the main button. In this position, your wrist is supported, and TrackMan Portable is ex-

remely easy to use. While it is possible to use the device when it is held up in the air in one hand, this is tiring and also makes it harder to reach the second and third buttons.

These three products are only the beginning of what's likely to be an avalanche of laptop-specific pseudorodents. From looking at the first three, it's not hard to see that the choice will be difficult—and highly personal. Of the three, we liked Thumbelina best for its daring innovation and low price. It's also the only one of the three that has a Mac-specific model. But at the same time, BallPoint is elegant, and TrackMan Portable is most attractive. Some advice: Try before you buy.

—Stan Miastkowski  
and Owen Linderholm

### THE FACTS

**BallPoint** (center)  
\$175

*Requirements:*  
Serial port or PS/2  
mouse port.

Microsoft Corp.  
One Microsoft Way  
Redmond, WA 98052  
(800) 426-9400  
(206) 882-8080  
fax: (206) 883-8101  
**Circle 1181 on Inquiry Card.**

**Thumbelina** (bottom)  
\$99

*Requirements:*  
PC version: Serial port  
or PS/2 mouse port.  
Mac version: Apple  
Desktop Bus port.

Appoint  
1332 Vendels Cir.  
Paso Robles, CA 93446  
(800) 448-1184  
(805) 239-8976  
fax: (805) 239-8978  
**Circle 1182 on Inquiry Card.**

**TrackMan Portable** (top)  
\$149

*Requirements:*  
Serial port or PS/2  
mouse port.

Logitech, Inc.  
6505 Kaiser Dr.  
Fremont, CA 94555  
(800) 231-7717  
(415) 795-8500  
fax: (415) 792-8901  
**Circle 1183 on Inquiry Card.**

## A High-Resolution Duo for Eye Relief

A few years ago, the 640-by-400-pixel resolution of a VGA setup seemed incredibly sharp. But in the interim, the waters of choice have been muddied by a flood of (often conflicting) graphics stan-

dards. There are several different varieties of so-called Super VGA, Texas Instruments Graphics Architecture (TIGA) for that company's powerful 34010 and 34020 graphics processors, and

IBM's recently announced Extended Graphics Array (XGA).

Nearly lost in the confusion is the 8514/A, which IBM introduced along with VGA back in 1987. There were, however,

a few problems. Its 1024-by-768-pixel resolution was sharp but interlaced, which often resulted in a discernible and bothersome flicker. Also, not only were 8514/A cards expensive, but unlike with VGA,

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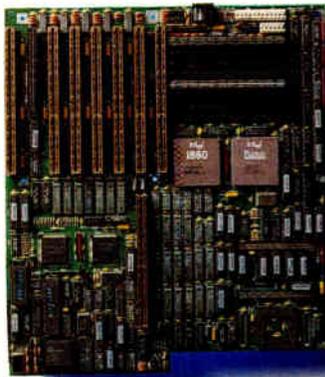
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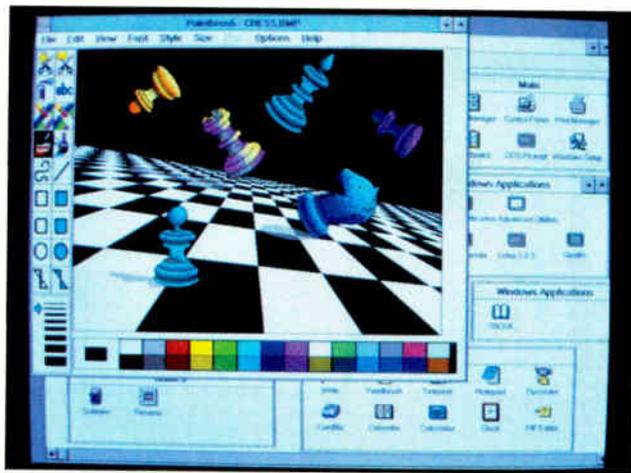
IBM refused to release its technical details, insisting that companies write 8514/A drivers to an adapter interface, which limited its applications.

Several companies have gone through the not-inconsequential process of developing register-level 8514/A clones. The latest is ATI Technologies' 8514/Ultra, a reasonably priced board with a few tricks up its sleeve. The first is that it gives a *noninterlaced* resolution of 1024 by 768 pixels. In addition, it adds a 70-Hz refresh rate for a truly rock-steady, flickerless, and sharp image.

Getting the 8514/Ultra up and running is a bit more complicated than just plugging in the board and turning it on. The board does feature a very clever design that lets you use it with either a standard ISA bus or the PS/2 Micro Channel bus. Just move the connector and flip it over. Although the 8514/Ultra is available with an integrated VGA board, the one I tested was designed to be used with an existing VGA board. A jumper cable connects between the 8514/Ultra and the "feature connector" that's on the top of all VGA boards. There's also a terminator plug that plugs into the VGA card.

The 8514/Ultra has a set of software utilities that largely automate the process of the board's installation. The utilities search for a free memory location for the board and set the on-board EPROM to that address. They also fine-tune the board's output for your particular monitor.

When it's started in a text-only mode, there's definitely a different "look and feel" to the screen. Characters are denser, sharper, and easier to read. However, to get to the power of the board, you need to use graphics. I changed my Windows 3.0 setup from VGA to 8514/A. The difference was striking. The 1024- by 768-



1024 by 768 pixels shows a new graphics perspective.

pixel desktop brings a whole new dimension to Windows. Sure, individual icons and characters are smaller, but they're easier to see and give you lots of capability to customize the desktop to your own particular preferences.

Unfortunately, I wasn't able to test what ATI is touting as one of the biggest features of the 8514/Ultra, the Crystal Font technology that gives real-time font-scaling capabilities to Windows 3.0. ATI claims it gives an effective on-screen resolution of nearly 300 dots per inch. But no matter what I did, I couldn't get it to work on my computer. Windows 3.0 just kept locking up.

ATI promised to send me an updated version of the pre-release software that I was using, but I didn't get it.

The 8514/Ultra is slick and fast, using ATI's proprietary graphics processor, which the company claims is up to 10 times faster than the IBM 8514/A board. Of course, you need a monitor that handles what the board is putting out. I hooked it up to the Nanao FlexScan 9080i, a 16-inch monitor from a company whose name isn't exactly a household word, although it's been making monitors for other companies for many years. The 9080i is a state-of-the-art microprocessor-con-

trolled monitor that handles everything the 8514/Ultra can put out. It also conforms to the Swedish VLF (very low frequency) emission standards for some peace of mind on the health front.

The monitor also has a few neat and unique features. I could hook up video from two computers to the 9080i and switch between them. And it also has a switch that let me toggle between color, amber, and white-on-black displays.

The combination of a high-resolution card and a high-resolution monitor brings new usability (and comfort) to many applications. But it also isn't cheap. The combination that I tested added a hefty \$2728 to the price of my PC. But for those who spend hours in front of their computers day in, day out, a combination like this one is more than just an eyesaver—it's virtually a necessity. ■

—Stan Miastkowski

### THE FACTS

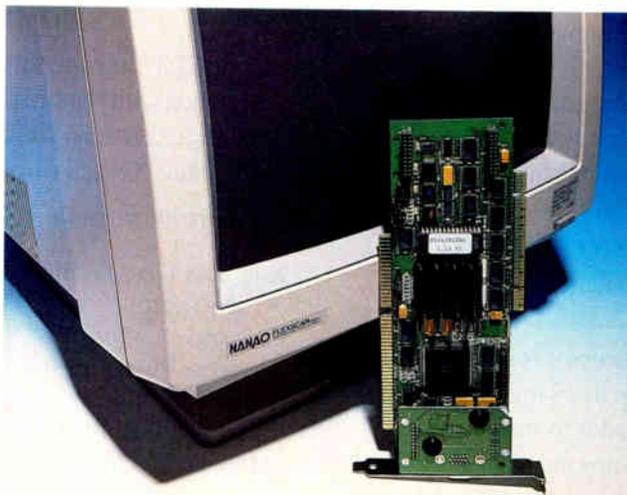
**8514/Ultra**  
with 512K bytes of RAM, \$599; with 1 MB of RAM, \$799

*Requirements:*  
IBM AT, PS/2, or compatible with a VGA board.

ATI Technologies, Inc.  
3761 Victoria Park Ave.  
Scarborough, Ontario,  
Canada M1W 3S2  
(416) 756-0718  
fax: (416) 756-0720  
**Circle 1184 on Inquiry Card.**

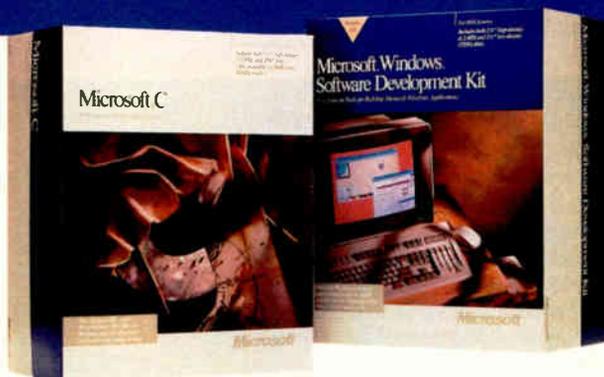
**FlexScan 9080i**  
\$1929

Nanao USA Corp.  
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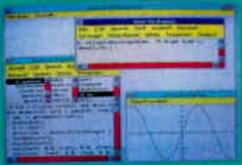
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### Reason Enough for a Desktop System

**R**eason Technology's new 486 desktop system incorporates 4 MB of RAM, 8K bytes of cache RAM, an 80-MB hard disk drive, and an 80387 coprocessor. It also has 1.2-MB and 1.44-MB floppy disk drives.

The small-footprint system uses a 1024- by 768-pixel Super VGA controller in concert with a 14-inch Super VGA color monitor. Additionally, it has one parallel and two serial ports, eight expansion slots, and five disk drive bays.

**Price:** \$3995.

**Contact:** Reason Technology, 290 Coon Rapids Blvd., Minneapolis, MN 55433, (612) 780-4792; fax (612) 780-4797.

**Circle 1287 on Inquiry Card.**

### Power to Go

**B**itwise has packed a desktop of power into its 23-pound, 486 EISA portable computer. The company says its 33-MHz Model 433E/VP is fully compatible with 286 and 386 operating systems.

The 433E/VP features 8K bytes of cache RAM, an integrated math coprocessor and a socket for a Weitek WTL4167, a Conner Peripherals 212-MB hard disk drive with 64K bytes of cache, two 5¼-inch drive bays, and a third drive bay for a 3½-inch drive. The system includes three free full-length slots.

The unit's video consists of a VGA gas-plasma flat-screen display with 16 levels of gray. It uses an Ahead VGA Wizard video adapter and has an external



*Reason Technology's 486 desktop computer is power packed into a small footprint.*

monitor port that lets it display on two screens simultaneously.

**Price:** Basic model, \$12,995.

**Contact:** Bitwise Designs, Inc., 701 River St., Troy, NY 12180, (800) 367-5906 or (518) 274-0755; fax (518) 274-0764.

**Circle 1288 on Inquiry Card.**

### A True 386 Laptop

**T**he LP-386C laptop from Fora uses Intel's 386 chip and incorporates an optional expansion chassis. According to the company, this gives the system

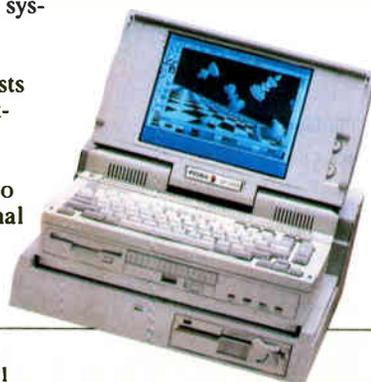
the expansion capacity of a desktop in addition to its portability.

With 2 MB of RAM, which is expandable to 8 MB when the unit is slipped into its expansion chassis, the LP-386C includes a parallel and a serial port, a proprietary slot for an internal modem, and ports for an external VGA monitor and a floppy disk drive. The unit's backlit LCD double-supertwist VGA screen supports up to 32 levels of gray. Its 14-pound weight includes a detachable, rechargeable nickel-cadmium battery and an AC adapter.

**Price:** \$4995; expansion chassis, \$9500.

**Contact:** Fora, Inc., 3081 North First St., San Jose, CA 95134, (800) 367-3672 or (408) 944-0393; fax (408) 944-0392.

**Circle 1289 on Inquiry Card.**



*With an optional expansion chassis, Fora's LP-386C becomes more than a portable.*

### Traveling Companions

**R**andom's Companion and Companion Plus portable computers, with a proprietary operating system and firmware, feature a built-in 2400-bps V.22bis modem. The units also have an RS-232 port, serial and parallel ports, and built-in MNP level 5 software. The Companion Plus also offers word processing and communications capabilities, the ability to capture sessions and take a snapshot of the screen, and 65K bytes of non-volatile RAM. Each model weighs under 4 pounds.

**Price:** Companion, \$1295; Companion Plus, \$1595; optional memory for Companion Plus, \$400.

**Contact:** Random Corp., Northland Blvd., Cincinnati, OH 45240, (800) 553-6773 or (513) 825-0880.

**Circle 1290 on Inquiry Card.**

### 486 Memory and Performance

**A** 33-MHz 486 computer designed for CAD/CAM, database, and server use, Cheetah's Model 433D features 8 MB of 35-ns DRAM, expandable to 16 MB. The unit includes an intelligent caching hard disk drive controller with 512K bytes of RAM, expandable to 20 MB. The proprietary Bus Cycle Machine provides concurrent I/O processing, full 32-bit write operations to I/O devices, and elimination of wait states while writing to I/O devices.

**Price:** \$15,223.

**Contact:** Cheetah Computer Systems, Inc., 7075 Flying Cloud Dr., Eden Prairie, MN 55344, (612) 943-8690; fax (612) 943-8331.

**Circle 1291 on Inquiry Card.**

### Traveling in the Express Lane

**T**he Data Express comprises a receiving frame that fits into a 5¼-inch half-height disk drive slot or into a stand-alone expansion chassis of a PC, workstation, or VMEbus system. Within this frame is a drive carrier that acts as a removable drawer and contains a 3½-inch hard disk drive with a storage capacity of 450 MB. The device supports peripheral interfaces such as Intelligent Drive Electronics, ST506, SCSI, and ESDI.

The transportable design of the unit gives system users the flexibility of sharing a single workstation. Additionally, removing and locking up the drawer is an easy way to ensure that your sensitive data remains secure. The Data Express has the advantage of letting you collect data at several remote sites and process it at your convenience at a central location. The product line includes the ruggedized, shock-mounted Data Commuter and the Data Silo, a SCSI peripheral expansion cabinet that accepts 3½- or 5¼-inch half-height tape drives, hard disk drives, removable drives, and optical drives.

**Price:** Data Express, \$315; Data Silo, \$440; Data Commuter, \$1395.

**Contact:** Kingston Technology Corp., 3023 South Harbor Blvd., Santa Ana, CA 92704, (714) 435-2600; fax (714) 545-2176.

**Circle 1292 on Inquiry Card.**

### In Touch with McKey Mouse

**I**n Touch Systems has added a mouse option to its Magic Wand Keyboard. Called the McKey Mouse,



*The Data Express from Kingston provides flexibility as well as transportability.*

the Microsoft-compatible mouse requires no strength or dexterity on the part of the user, enabling quadriplegics to use software such as Windows and PageMaker.

You use McKey Mouse by touching keys on the 12-ounce Magic Wand Keyboard. Features include left and right click, double-click, drag, chord click, and 11 speed settings.

**Price:** Magic Wand Keyboard with McKey Mouse, \$1590; McKey Mouse as an upgrade, \$349.

**Contact:** In Touch Sys-

tems, 11 Westview Rd., Spring Valley, NY 10977, (914) 354-7431.

**Circle 1293 on Inquiry Card.**

### Output Continuous Forms

**A** continuous-form laser printer with a speed of 16 ppm is available from Output Technology. The LaserMatrix 1000, Model 3, is Hewlett-Packard compatible and features a 3½- to

9½-inch adjustable tractor feed. Its emulations and interfaces include HP LaserJet Series II, IBM Proprinter II, and Centronics parallel and RS-232 serial interfaces. When used with standard bar coding software, the printer can produce bar code symbologies.

**Price:** \$5995.

**Contact:** Output Technology Corp., East 9922 Montgomery Dr., Spokane, WA 99206, (800) 468-8788 or (509) 926-3855; fax (509) 922-4742.

**Circle 1294 on Inquiry Card.**

### Nonglare Color Monitor

**A** 14-inch Ultra VGA analog color monitor with a 250-mm by 190-mm nonglare, dark-tinted display is available from Amazing Technologies. With a palette of unlimited colors, the Model CM8484EX has a built-in text switch that gives you the flexibility to adjust the text color to amber or green from the normal white on black.

The monitor's 0.28-mm dot pitch display has an interlaced display resolution of 1024 by 768 pixels. In support of VGA, Super VGA, and 8514/A video standards, the monitor has a dual horizontal scan frequency of 31.5 and 35.5 kHz and a vertical scan frequency of from 50 to 70 Hz.

**Price:** \$579.

**Contact:** Amazing Technologies Corp., 5980 Lakeshore Dr., Cypress, CA 90630, (714) 826-9680; fax (714) 826-9681.

**Circle 1295 on Inquiry Card.**

### Computer-Controlled VCR

The Selectra/Panasonic AG-1960/RS computer-controlled VCR is controllable from any personal computer through an RS-232 port. Among other capabilities, the unit automatically records computer graphics and animation sequences on videotape, brings motion video to the computer to combine with other multimedia elements, and turns your computer into a controller to create finished multimedia presentations or image databases on videotape.

**Price:** \$2195.

**Contact:** Selectra Corp., P.O. Box 5497, Walnut Creek, CA 94596, (800) 874-9889 or (415) 283-1670; fax (415) 284-2117.

**Circle 1296 on Inquiry Card.**

### DSP Board with Options

The AC5-AO floating-point digital signal processor board, based on AT&T's DSP32C floating-point DSP, is available from Communication Automation & Control. The 50-MHz board comes with daughterboards and software development tools.

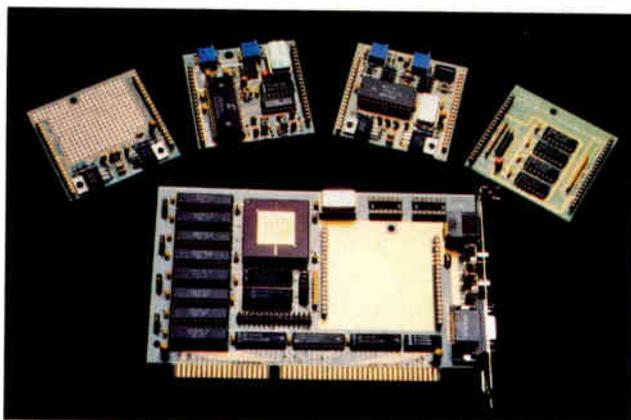
With a peak performance of 25 MFLOPS, the AC5-AO uses an I/O-mapped ISA bus host interface. It includes 64K bytes of zero-wait-state static RAM, expandable to 256K bytes. Daughterboards available for the AC5-AO are the DBCS5339, a dual-channel audio-band data acquisition card; the DBT7525, a single-channel voice-band I/O card; and the DBSERIAL, a buffered serial interface card. Software support includes a C compiler, assembler, linker, and simulator; a window-based debugger; and a library of trigonometric functions.

**Price:** AC5-AO board, \$1195; daughterboards, \$95 to \$295; C compiler package, \$1495; assembler package, \$495; debugger, \$395. **Contact:** Communication Automation & Control, Inc., 1642 Union Blvd., Suite 200, Allentown, PA 18103, (215) 776-6669; fax (215) 770-1232.

Circle 1297 on Inquiry Card.

### Universal Frequency Counter

The Model PC-10 Universal Frequency Counter drop-in board for the PC uses Windows 3.0 as its control panel for displaying the frequencies. The board's operating range is from 10 Hz to 2.4 GHz.



The AC5-AO floating-point DSP board has a 2.5-Mbps ISA bus data transfer rate.

The PC-10 has on-board RF amplifiers and switchable prescalers to operate as a stand-alone high-frequency RF counter. The board can also send frequency data to a communications receiver for instant tuning and listening to radio signals it has detected.

**Price:** \$335. **Contact:** Optoelectronics, 5821 Northeast 14th Ave., Fort Lauderdale, FL

33334, (800) 327-5912 or (305) 771-2050; fax (305) 771-2052.

Circle 1298 on Inquiry Card.

### Cache in Static RAM

The Atto Cache ci, a 64K-byte static RAM cache, increases Mac IIci performance by 40 percent to

70 percent, according to Atto Technology. The Atto Cache ci stores frequently used data in 25-ns SRAM, holding it until the 68030 processor requests it. The unit plugs into the 120-pin cache connector on the Mac IIci.

**Price:** \$279.

**Contact:** Atto Technology, Inc., Baird Research Park, 1576 Sweet Home Rd., Amherst, NY 14228, (716) 688-4259; fax (716) 636-3630.

Circle 1299 on Inquiry Card.

### Monitor and Control the Temperature

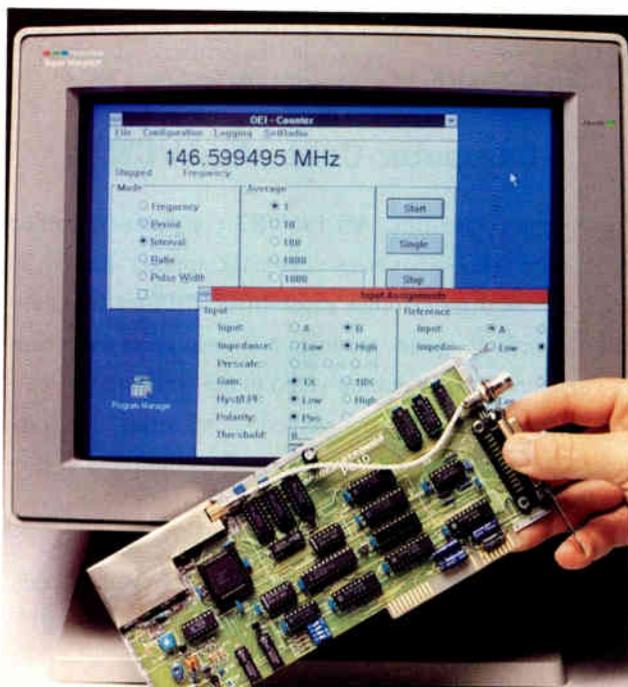
Keithley MetraByte's DAS-Temp 32-channel, 12-bit temperature-measurement board measures up to 200 samples per second. For use with the IBM PC XT, AT, and compatibles, the board has a minimum temperature resolution of 0.1°C and is accurate to within 0.1°C.

Working within a temperature range of from -25°C to 105°C, the DAS-Temp includes three levels of software: a pop-up package that lets you use the board without programming, a high-level device driver, and a callable driver. You can manually or automatically calibrate the board. According to MetraByte, DAS-Temp is extremely noise immune.

**Price:** \$399.

**Contact:** Keithley MetraByte Corp., 440 Myles Standish Blvd., Taunton, MA 02780, (508) 880-3000; fax (508) 880-0179.

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Optoelectronics' PC-10 Universal Frequency Counter uses Windows 3.0 for instrument control.



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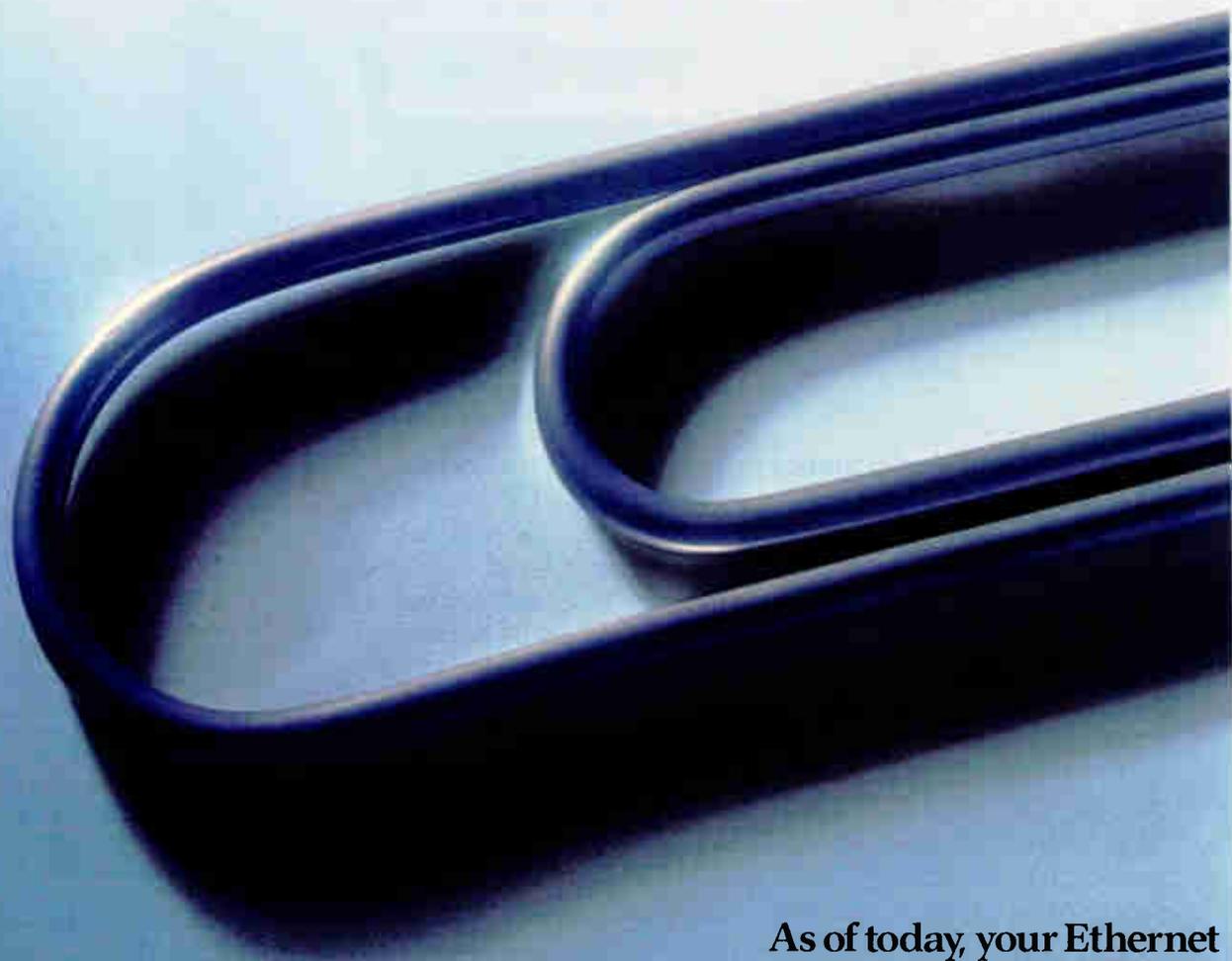
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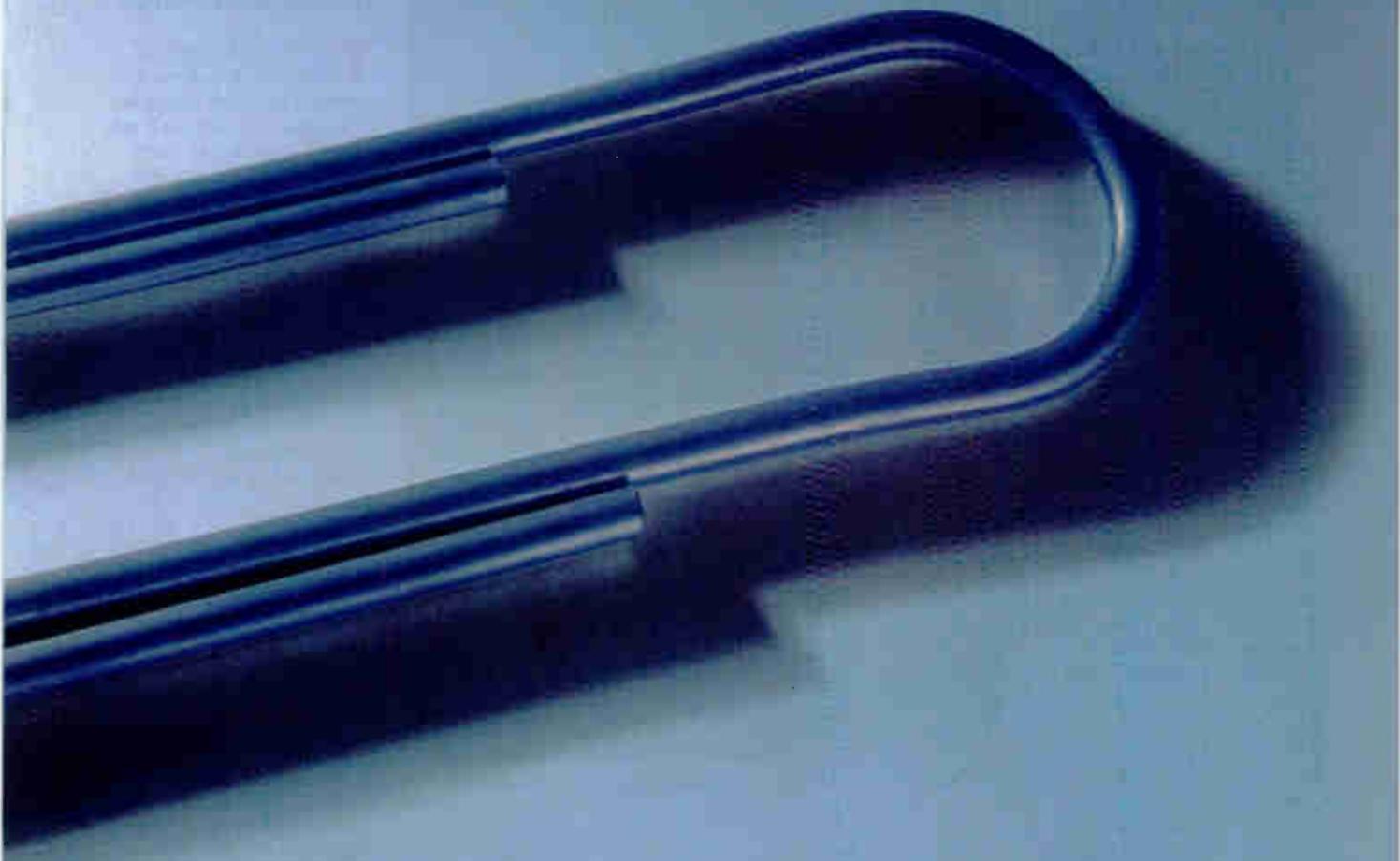
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## Stargazing with Your PC

The StarScape IIA, IIB, and IIC charge-coupled device (CCD) cameras constitute First Magnitude's new line of ultralow-light-level digital imaging devices. The PC-compatible cameras, for use in astronomy, medicine, and remote sensing, include a camera head, a controller board, cabling, and software.

The StarScape IIC, for amateur astronomers, has a thermoelectrically cooled CCD with a 14-bit A/D converter and offers a choice of a 590- by 490-pixel monochrome or a 250- by 250-pixel color CCD. The StarScape IIB, also thermoelectrically cooled, and the StarScape IIA (liquid nitrogen cooled) use a 16-bit A/D converter. They are available with 590- by 490-pixel CCDs or optional 1024- by 1024-pixel CCDs.

**Price:** IIC, \$9500; IIB, \$12,900; IIA, \$13,900.  
**Contact:** First Magnitude Corp., 519 South Fifth St., Laramie, WY 82070, (307) 745-3744.

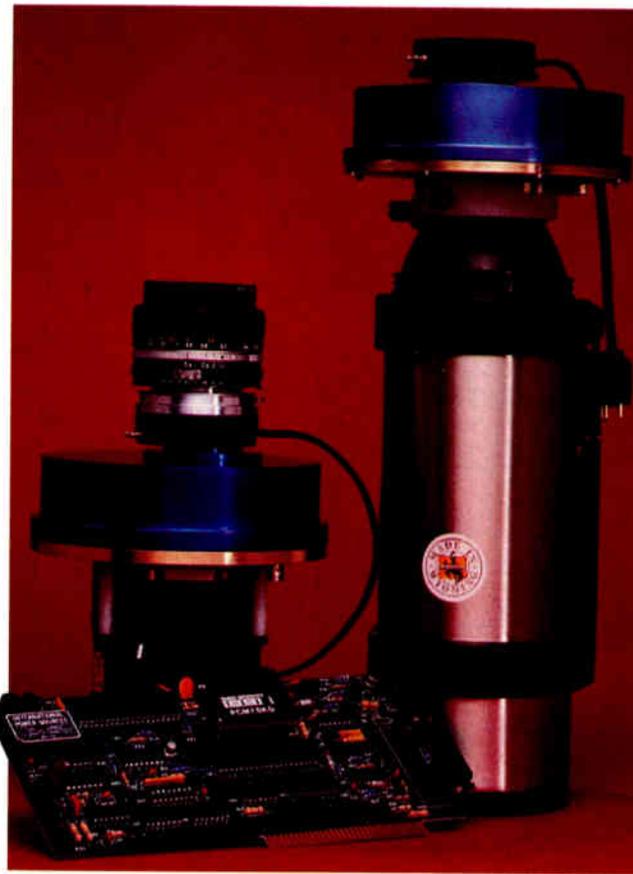
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## Wall Outlet Surge Suppressor

A single-outlet, wall-mounted surge suppressor, the Electra Guard EG3C plugs directly into any



The Electra Guard EG3C.



First Magnitude's PC-compatible StarScape CCD cameras.

standard grounded electrical outlet. The EG3C responds within 1 ns of an overvoltage, surge, spike, or transient. Rated for use at 120 V AC and 15 amps, its hybrid circuitry enables it to clamp voltages as low as 345 V and protect from surges of up to 6000 V.

**Price:** \$9.95.  
**Contact:** Intermatic, Inc., Intermatic Plaza, Spring Grove, IL 60081, (815) 675-2321.

**Circle 1302 on Inquiry Card.**

## Communication with a UPS

American Power Conversion has added three uninterruptible power supplies to its Smart-UPS line.

The 900-, 1250-, and 2000-VA units protect multiple servers or CPUs, intelligent hubs, multiple workstations, telecommunications equipment, and minicomputers.

The new Smart-UPS units are designed to let network managers communicate with the UPS to diagnose problems that may be a result of faulty power. Features include an internal control language, a replace-battery indicator, and site wiring fault indicators.

**Price:** Smart-UPS 900, \$999; Smart-UPS 1250, \$1299; Smart-UPS 2000, \$1999.

**Contact:** American Power Conversion, P.O. Box 278, 132 Fairgrounds Rd., West Kingston, RI 02892, (401) 789-5735; fax (401) 789-3710.

**Circle 1303 on Inquiry Card.**

## Windows 3.0 Quick Reference

The Quick Reference Card for Windows 3.0 provides the most frequently needed programming reference information. Sized to be easily accessed, the card includes the correct spelling of all Windows procedures, which parameters to use, the order in which to use them, and the spelling of manifest constants.

**Price:** \$14.99.

**Contact:** Cooper Software, Inc., 3523A Haven Ave., Menlo Park, CA 94025, (415) 364-9150.

**Circle 1304 on Inquiry Card.**

## Put the Emphasis on Pointing

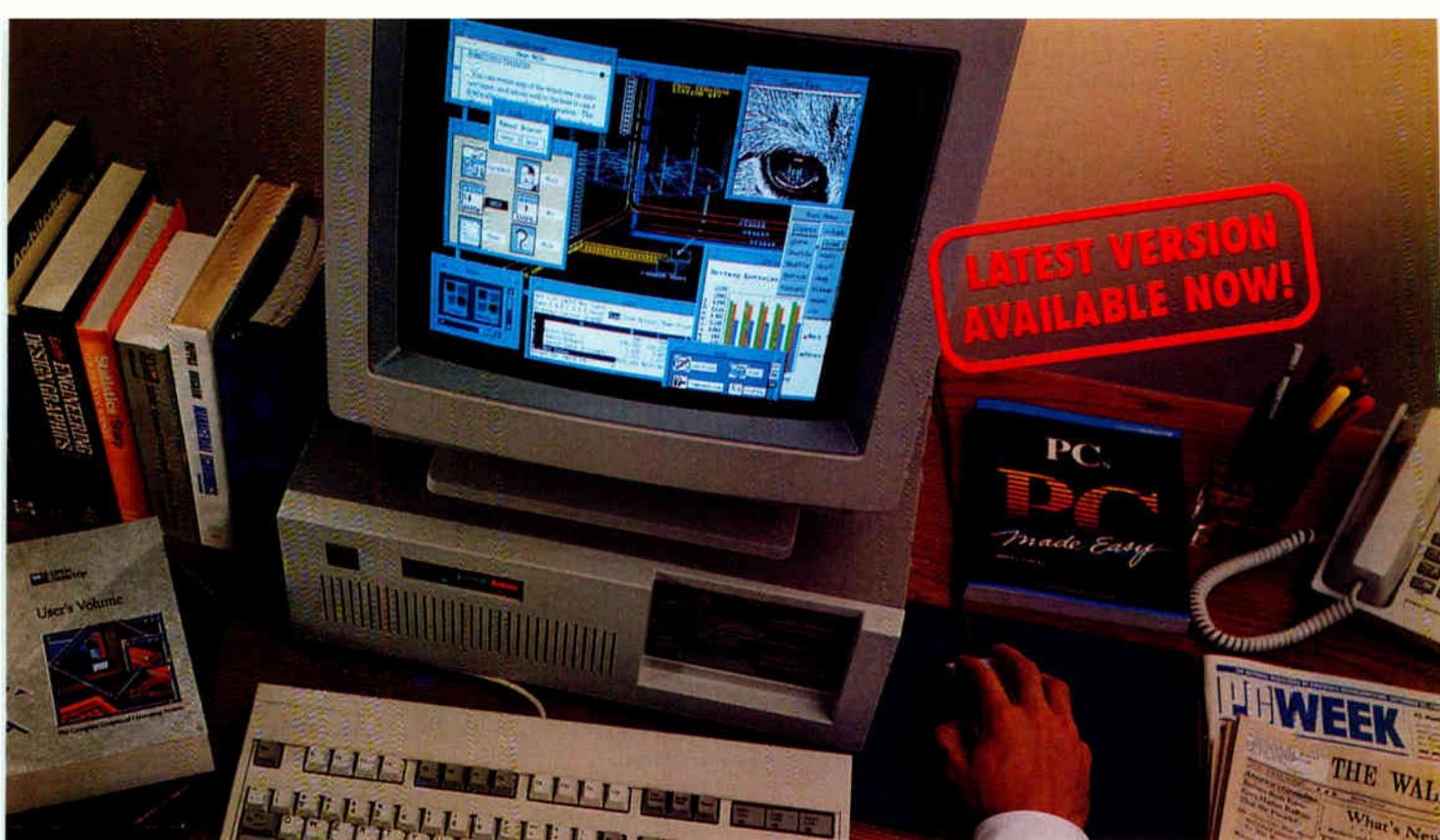
The Emphasis laser pointers are available in two models: the Professional and the Executive. Constructed from brass and aluminum, the pointers are visible in all normal office lighting at ranges of up to 150 feet and are clearly visible against a light projector screen, according to the manufacturer. Both models are 8½ inches long and weigh 5½ ounces with two AA batteries installed.



**Price:** Professional, \$219; Executive, \$249.

**Contact:** The Layman's Laser Co., P.O. Box 58770, Seattle, WA 98138, (800) 258-2202 or (206) 439-7894.

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### A Pocket Modem for Your Laptop

**A**cton's 2400MNP-P pocket-size modem incorporates MNP level 1 to 5 error correction and data compression. Designed for use with laptop computers, the 2400MNP-P runs for up to 4 hours on a 9-V battery; it has transmission speeds as high as 4800 bps over a standard phone line.

The roughly 4¾- by 2½- by 1¼-inch modem connects to your computer's RS-232 serial port and to the telephone line via a standard RJ-11 jack. The modem features automatic dialing, re-dialing, and answering, as well as full call-progress monitoring. It also supports serial, binary, and asynchronous connections.

**Price:** \$459.

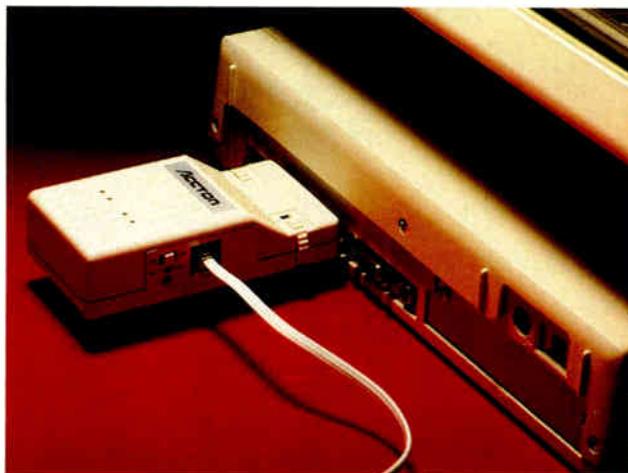
**Contact:** Accton Technology Corp., 46750 Fremont Blvd., Suite 104, Fremont, CA 94538, (415) 226-9800.  
**Circle 1306 on Inquiry Card.**

### Versatile Ethernet Adapters

**T**wo Ethernet adapters designed for the Mac IIsi and Mac SE/30 have been introduced by Compatible Systems. EtherDS is a direct-slot Ethernet adapter for client applications; EtherVHP is optimized for server applications.

The EtherDS has 16K bytes of memory, a 16-bit on-board data path, and a 16-bit direct slot interface. The EtherVHP includes 32K bytes of memory, a 32-bit on-board data path, and a 32-bit direct slot interface. Both adapters are available in standard coaxial or 10Base-T twisted-pair versions.

**Price:** EtherDS, \$395; EtherVHP, \$595.



*The 2400MNP-P pocket modem from Accton.*

**Contact:** Compatible Systems Corp., P.O. Drawer 17220, Boulder, CO 80308, (800) 356-0283 or (303) 444-9532; fax (303) 444-9595.  
**Circle 1307 on Inquiry Card.**

### Three Share a Line Automatically

**S**martMax II, a fax/phone autoswitch from MaxTrek, makes it possible for a fax, a phone, and a computer modem to share a single telephone line. The unit automatically routes the calls.

The Model 6000 and the Model 6500 do fax/phone switching; the 6500 also has an auxiliary port for such uses as a computer modem or a credit card terminal. Features of the SmartMax II include a sentry mode for nighttime operation, a programmable ring count for additional switching options, and the power to handle multiple extension phones.

**Price:** Model 6000, \$199; Model 6500, \$249.  
**Contact:** MaxTrek, Inc., 23210 Bernhardt St., Hayward, CA 94545, (415) 785-6282; fax (415) 785-6657.  
**Circle 1308 on Inquiry Card.**

### One-Board Ethernet Graphics

**U**nited Networks has begun marketing GrandSlam Ethernet/VGA, an adapter that combines the capabilities of Ethernet hardware and Super VGA graphics on a single board. The 16-bit adapter uses Fujitsu's EtherStar chip.

The GrandSlam Ethernet/VGA has 512K bytes of memory and includes a 64K-byte RAM buffer. It supports up to 256 colors at resolutions of 800 by 600, 640 by 480, or 640 by 400 pixels and a 70-Hz refresh rate. The adapter also supports thin and thick Ethernet cabling and is available with jumper-selectable remote boot PROM for diskless workstations. The company is planning a Micro Channel architecture version of the adapter.

**Price:** \$695.  
**Contact:** United Networks, Inc., 2178 Paragon Dr., San Jose, CA 95131, (408) 436-2800; fax (408) 436-2807.  
**Circle 1309 on Inquiry Card.**

### Network Multimanager

**T**he CMS 910 Dial Management System monitors and manages high-speed dial-up communication networks. The multi-user, multitasking network management system uses a Unix-based PC with a window- and menu-based graphical interface as a central site-control platform. The CMS 910 lets you do such tasks as monitoring your network's performance, conducting tests and diagnosing problems, and compiling operational statistics and reports while the system continues to work in the background.

**Price:** CMS 910 system software with SCO Xenix 2.23/286, \$3500; six-port controller card with cabling, \$1700; VA1690 chassis, \$2195.

**Contact:** Racal-Vadic, 1708 McCarthy Blvd., Milpitas, CA 95035, (800) 482-3427.

**Circle 1310 on Inquiry Card.**

### Phone from Your Computer

**T**he TE 158 Telephone Control Card provides complete computer control of a telephone call. Its capabilities include automatic dialing, line connect and disconnect, call-progress detection, and Touch-Tone encoding and decoding. You can use the TE 158 to dial out and send messages with tones and as an answering machine.

**Price:** \$190.  
**Contact:** Alpha Products, 242 West Ave., Darien, CT 06820, (800) 221-0916 or (203) 656-1806; fax (203) 656-0756.  
**Circle 1311 on Inquiry Card.**

# Take Our Course In C And The First Lesson You'll Learn Is In Economics.

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PC WEEK

C's power, and portability make it the language of choice for software developers. Unfortunately, learning C can be a very costly proposition. Classroom instruction is, in a word, expensive. And many C video courses carry hefty price tags.

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Yes, that's right. The Complete C Video Course includes our famous C compiler (it runs on any MS-DOS machine) with linker, library manager, full graphics library and on-line help. It's the choice of professional programmers everywhere for fast code, fast development and fast debugging.

```
#include <stdio.h>
#define NAMLEN 15
#define NUMMARK 4
struct person
{
    char name[NAMLEN];
    int mark[NUMMARK];
};
```

## Learn C in as little as two weeks

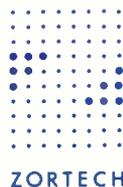
Speaking of speedy, with The Complete C Video Course you can learn C in only two weeks.

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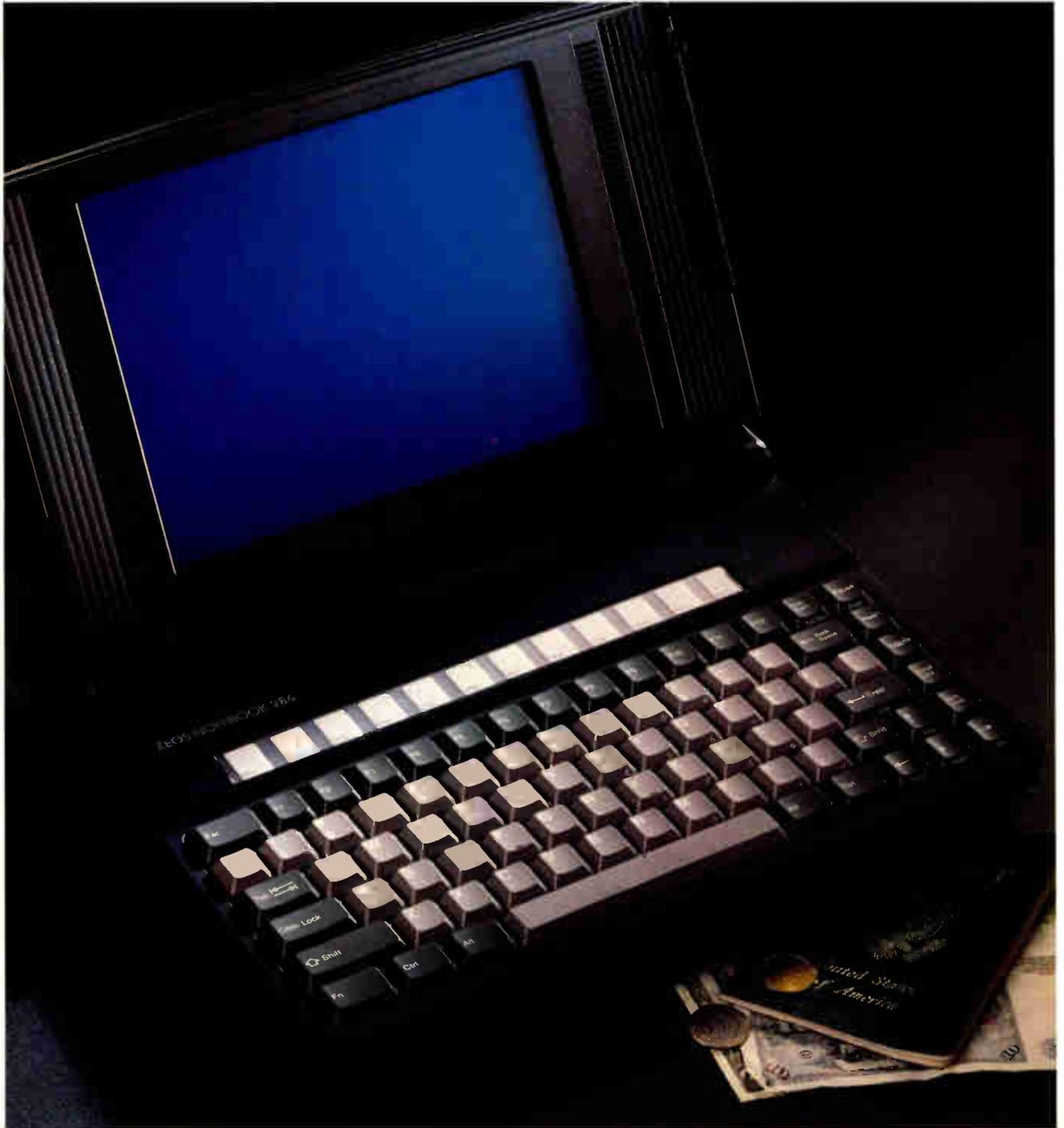
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"In the unending battle to become the most functional notebook for the most attractive price, there's a new king of the hill—the Zeos Notebook..." *PC Magazine*. What did they like most?

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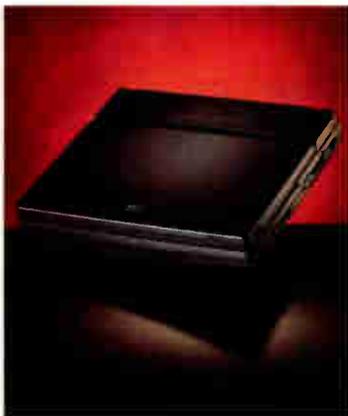
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### The Next Microphone

**M**icroPhone II for Next computers takes advantage of the Next graphical interface and uses scripting for you to automate your communications activities. For example, you click once on an E-mail icon to instruct the program to access a remote mail service and automatically transfer mail.

MicroPhone II uses file transfer protocols to communicate with BBSes, on-line services, and mainframes. It can transmit text, files, pictures, and sound to another Next, a Macintosh, or a PC. **Price: \$395.**

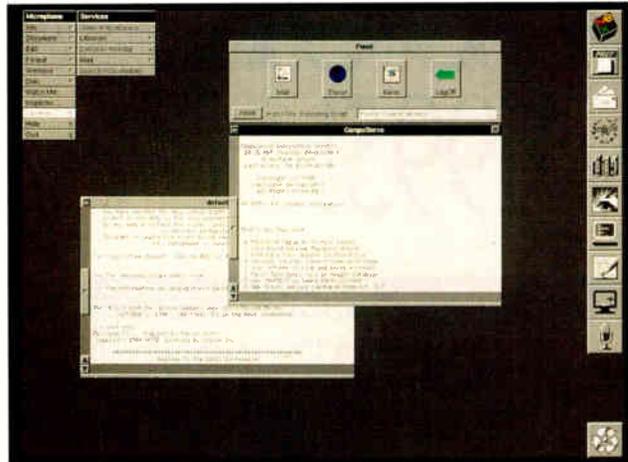
**Contact:** Software Ventures Corp., 2907 Claremont Ave., Suite 220, Berkeley, CA 94705, (415) 644-3232; fax (415) 848-0885.

**Circle 1312 on Inquiry Card.**

### MainLaning Ethernet

**M**ainLan Ethernet, an Ethernet peer-to-peer network system, transmits program-sharing, file-sharing, printer-sharing, and E-mail data at 10 Mbps on PCs. The system requires 30K bytes of RAM in conventional PC workstations and 15K bytes of RAM in workstations using expanded memory. With additional software such as MacLan by Miramar Systems, MainLan Ethernet can connect Macintosh computers into the network.

Compatible with NetWare and NetBIOS, MainLan Ethernet also runs network versions of Microsoft Windows, WordPerfect, Lotus 1-2-3, dBASE III, and Paradox. MainLan Ethernet is available as a starter pack, supporting connection of



*MicroPhone II for Next computers uses scripting to let you automate your communications.*

two PCs. The pack includes software, two Ethernet cards, 16½ feet of coaxial cable, Novell NetWare drivers, and a user's manual. Packs supporting an additional PC apiece are available.

**Price:** Starter pack, \$499; additional pack for one PC, \$199.

**Contact:** US Sage, Inc., 2005 Tree Fork Lane, Suite 113, Longwood, FL 32750,

(800) 999-6770 or (407) 331-4400; fax (407) 331-4406.

**Circle 1313 on Inquiry Card.**

### Miniature Interface Converter

**R**ad's MIC-232/485 miniature interface converter connects terminals and computers that have dif-

ferent interfaces. The unit, which operates asynchronously over two or four wires, connects the RS-232 interface with the RS-485 multipoint interface. It operates at data rates of up to 38,400 bps.

The MIC-232/485 operates on low power from the RS-232 data and control signals. Used as a short-range modem, the device lets you connect a single computer or terminal with an RS-232 interface to one or several terminals with an RS-485 interface. It has a transmission range of from 3¼ to 6½ miles, depending on signal speed.

**Price: \$200.**

**Contact:** Rad Data Communications, 151 West Passaic St., Rochelle Park, NJ 07662, (201) 587-8822; fax (201) 587-8847.

**Circle 1314 on Inquiry Card.**

### A Sun-Touched Apple

**S**unTops 3.0, for Sun workstations, provides a seamless link for file transfer and printer sharing between the workstations and Macs and PCs. Version 3.0 supports AppleTalk Filing Protocol's shared environment extensions, as well as AppleTalk Phase II. Additionally, it provides transparent routing between AppleTalk Phase I and Phase II, and it lets you print to any serially attached laser printer without using third-party products.

**Price:** For Sparcstations, \$1295; for other Sun workstations, \$1395.

**Contact:** Sitka Corp., 950 Marina Village Pkwy., Alameda, CA 94501, (415) 769-9669.

**Circle 1315 on Inquiry Card.**

### Joining Apple and Ethernet

Two cards and three adapters make up Apple's new line of plug-and-play Ethernet products. You can use all of them in any existing Ethernet environment, according to Apple.

The Ethernet LC Card brings Ethernet capability to the Mac LC computer. The Ethernet NB Card is an intelligent NuBus card for Mac II computers.

The Ethernet Cabling System includes the Ethernet Thin Coax Transceiver, the Ethernet Twisted Pair Transceiver, and the Ethernet AUI Adapter. These adapters connect the cards to any industry-standard Ethernet medium.

**Price:** Ethernet LC Card, \$199; Ethernet NB Card, \$424; adapters, \$175 each.

**Contact:** Apple Computer, Inc., 20525 Mariani Ave., Cupertino, CA 95014, (408) 996-1010.

**Circle 1316 on Inquiry Card.**

# BYTE

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Toshiba's

PAGE 127



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\*PC Magazine service and reliability survey ranked Plus Development #1. September 25, 1990.

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1. Typical application access time using DMA mode. 2. As measured by a Perfmeter on a Compaq Deskpro 386. © 1990 Plus Development Corp. Plus Hardcard II XL is a trademark of Plus Development Corp. Other product and company names are trademarks or registered trademarks of their respective holders.

World Radio History

# Recycle

Everyone wants more productivity out of their computers.

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Over 1,000,000 users multitask their programs with DESQview.

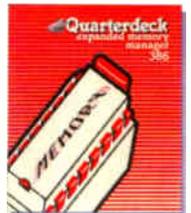
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Break the 640K barrier in DOS—or in Windows 3.0—and give your DOS programs up to 130K more room within the first megabyte of memory, plus another 96K of video memory, in some instances.

QEMM takes buffers, network drivers, TSRs and other memory-using utilities and moves them into idle areas between 640K and one megabyte.

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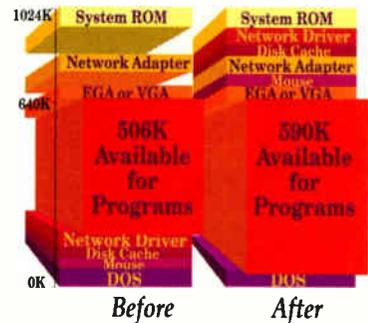


Number one.

QEMM 386 is incorporated into DESQview 386 to provide the optimum operating environment for productivity oriented users of 386, 386SX and i486 PCs.

QEMM 50/60 is designed to work in IBM® PS/2™ Model 50 and 60 PCs with specific IBM adapter boards.

QEMM is the #1 selling utility according to distribution sources. In fact, it was the number one selling software package in the PC industry in April, May and June 1990.



These are some of DESQview's most recent awards

These are some of QEMM's most recent awards

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# your PC

## Manifest Gives You in-Depth Knowledge of Your PC



Our newest utility is Quarterdeck Manifest, the best way to discover everything you ever wanted to know about your PC. Manifest shows you around 'under the hood', pointing out how memory is used, comparing memory speeds, and indicating how you can gain more room for your programs to work.

It can point you to as much as 130K of additional RAM your programs can use. It shows you which memory areas are faster. It even helps you compare add-in memory board performance.



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*Manifest has been quick to win recognition*

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Once you know where you can move those memory-hogging utilities, GRAM lets you do it. It even works on 8088, 8086 and 80286 PCs with EMS 4.0 or EEMS memory boards.

GRAM and Manifest help you get every last 'K' out of the hardware you own.

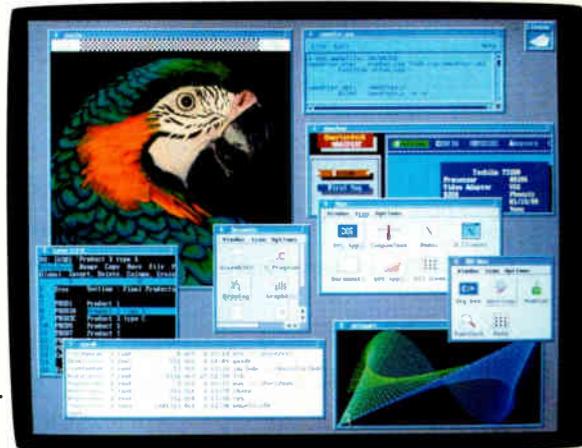
In fact, all our products are designed to give you more productivity out of the system you already have, whether it's an 8088, 8086, 286, 386SX, 386, or i486.

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Our mission is to protect your investment. Whether your PC is 8 years old or fresh out of the box, our products make it more versatile, more flexible; and help deliver performance dividends from your computer investment. Our products help fine-tune your PC which helps you do your work better, which makes you look good.

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# Quarterdeck

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World Radio History

### Rational Adds Support for Microsoft C 6.0

Instant-C 4.1 integrates an incremental compiler with an editor and debugger and adds compatibility with the Microsoft C 6.0 compiler. Version 4.1 lets you develop applications with more than 100,000 lines of source code and use the Microsoft compiler to produce the final program.

The program includes source-level debugging; interactive C expression evaluation including macros, cross-referencing, and browsing; and single or partial program execution. It supports programs of up to 16 MB using Rational's DOS extender technology. **Price:** \$795.

**Contact:** Rational Systems, Inc., 220 North Main St., Natick, MA 01760, (508) 653-6006; fax (508) 655-2753.

**Circle 1271 on Inquiry Card.**

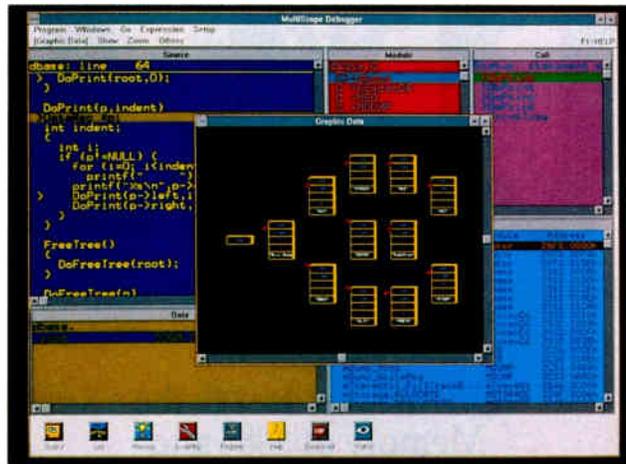
### Put a Mac Face on FORTRAN Code

Users of AppMaker's application generator can now generate code for use with the Language Systems FORTRAN compiler. AppMaker, which previously supported only C and Pascal, lets you develop user interfaces without having to learn all the details of the Macintosh Toolbox.

**Price:** FORTRAN Tools for current AppMaker owners, \$100; bundled with AppMaker, \$295.

**Contact:** Language Systems Corp., 441 Carlisle Dr., Herndon, VA 22070, (703) 478-0181; fax (703) 689-9593.

**Circle 1272 on Inquiry Card.**



*MultiScope's Graphic Data Window lets you display a graph of simple or complex data structures. Arrows represent records, pointers, and values. You can zoom in on an item for details.*

### MultiScope Debuggers for DOS

The MultiScope Debuggers for DOS provide a Microsoft Windows and standard character-mode interface for debugging DOS applications. The package supplies DOS Virtual Machine capability, remote debuggers, and post-mortem debugging. When hosted under Windows or the character-mode interface, the CodeView-compatible debugger provides the extended memory and 386 and i486 services needed for debugging large DOS applications. With the Windows DOS VM capability, you can run the DOS application in a virtual DOS window side by side with the MultiScope debugger, eliminating switching between the application screen and the debugger. For character mode, a VCR remote control interface stays on top of the application.

Monitor Execution Dump-BC, a TSR program included with the debuggers, tells you what source line results in a hang or crash. MED-BC flushes out the offending source line, and the TSR's MED portion dumps the contents of computer memory into a file. You can then use the Post-Mortem Debugger to analyze the crash.

**Price:** \$179 (includes Windows 3.0 and character-mode-interface run-time, post-mortem, and remote debuggers).

**Contact:** MultiScope, Inc., a Logitech company, 1235 Pear Ave., Mountain View, CA 94043, (415) 968-4892; fax (415) 968-4622.

**Circle 1273 on Inquiry Card.**

### Jasik's Mighty Mac Debugger

Jasik Designs' new version of its debugger is the closest thing you'll find to an in-circuit emulator for the Mac. The Debugger 2.0 provides source-level debugging for MPW 3.x (Pascal or C), MacApp, and Think C programs. Jasik's debugger, however, provides this capability as a true low-level debugger: It's not an application running under MultiFinder in lockstep with the program, like the Standard Apple Debugging Environment or Think's source debugger.

For those Macs with memory management units (68030-based Macs or 68020-based Macs equipped with 68851 paged MMUs), the Debugger now provides the ultimate in debugging protection: It uses the MMU to write-protect your code resources and the rest of the system from the program you're debugging.

When a program makes an invalid address reference or attempts to write into a section of memory that it doesn't own, the Debugger halts program execution. Instantly, the Debugger has nailed down a hard-to-detect program error.

An Incremental Build System for MPW lets you compile and link only the modified portions of a program, thus eliminating MPW's lengthy edit-compile-link cycles.

**Price:** Universal version (runs on all Macs, including the Mac IIsi and LC), \$350.

**Contact:** Jasik Designs, 343 Trenton Way, Menlo Park, CA 94025, (415) 322-1386.

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**Advanced Micro Devices, Inc.** 

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Austin, TX 78759-9797

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### Three Spreadsheet Forecasters

**T**he new version of Crystal Ball, a Monte Carlo-based forecasting and risk analysis add-in for Mac spreadsheets, offers new forecasting tools, support for larger models than the previous version had, and compatibility with WingZ and Full Impact. The program also works with Excel. Crystal Ball 2.0 lets you pose what-if questions that contain several variables and view the results and the probability of each result.

A new Correlated Variables feature takes into consideration the relationship of two variables (e.g., the rate of inflation and discretionary income in a sales projection model) being analyzed. The CV feature generates a series of random numbers for your assumptions and tracks the results, determining when a model that appears risk-free is suspect, and vice versa.

Other improvements include support for iterative calculations, multiple linked spreadsheets, and up to 8192 forecasts generated from a single model.

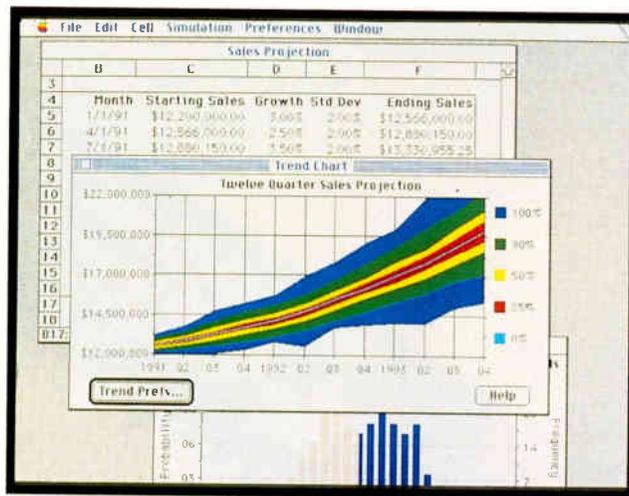
**Price:** \$395.

**Contact:** Market Engineering Corp., 1738 Wynkoop St., Suite 200, Denver, CO 80202, (303) 298-0020.

**Circle 1275 on Inquiry Card.**

**T**he new version of @Risk, a risk analysis and modeling spreadsheet add-in first introduced for Lotus 1-2-3, is compatible with Excel 3.0 for the Mac and Windows.

In addition to letting you launch a simulation from within Excel, it lets you launch a simulation in Excel and have any release 2.x of 1-2-3 perform the actual analysis when speed is crit-



*Crystal Ball's trend charting tool compiles multiple forecasts from a single model, showing the probability of various results. The program generates up to 32,768 assumptions per model.*

ical. You can also run multiple simulations in the background in 1-2-3 while you continue to work in Excel. Likewise, you can choose to model in 1-2-3 but present the results using Excel.

**Price:** \$395.

**Contact:** Palisade Corp., 31 Decker Rd., Newfield, NY 14867, (800) 432-7475 or (607) 277-8000; fax (607) 277-8001.

**Circle 1276 on Inquiry Card.**

**A**xcelis says the new version of its nonlinear optimization add-on for Informix's WingZ spreadsheet

program for the Mac offers new reporting, analysis, and graphing features. Evolver takes over the task of trying different what-if scenarios to optimize a value in a given cell. Evolver also works with Microsoft Excel on the Mac and Windows and WingZ for Windows.

A new three-dimensional landscape feature lets you view how close the current generation of solutions is to the overall best solutions, the company says. Evolver can work in the background and requires about 50K bytes of RAM. It can optimize

spreadsheets with linear, nonlinear, table-based, or random functions.

**Price:** \$345.

**Contact:** Axcelis, Inc., 1406 Western Ave., Seattle, WA 98101, (800) 292-3547 or (206) 624-2446; fax (206) 622-5790.

**Circle 1277 on Inquiry Card.**

### Timeslips Links to Mac Accounting

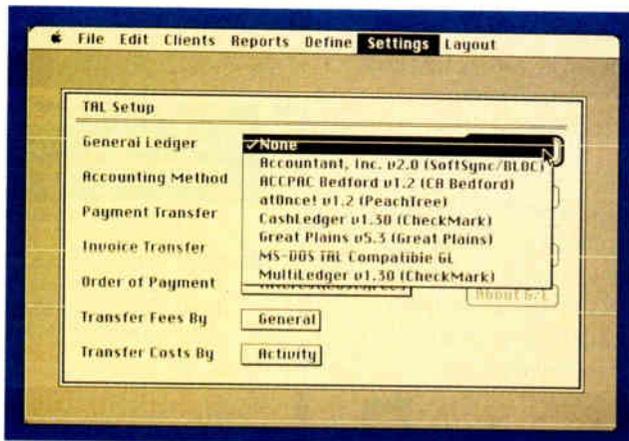
**W**ith the Timeslips III Accounting Link (TAL) for the Mac, you can link the Timeslips time and expense tracking and billing system to six general-ledger programs.

As with TAL and Timeslips III for DOS-based systems, once you install the TAL module, certain functions created in Timeslips III will be automatically posted to the linked accounting module. Timeslips III provides receivables, invoice, and payment acceptance capabilities. General-ledger programs supported include Computer Associates' ACCPAC Bedford; SoftSync/BLOC's Accountant, Inc.; Peachtree's atOnce!; Great Plains' Accounting Series; and CheckMark's MultiLedger and CashLedger. TAL for the Mac also extends the reporting capability of Timeslips III by adding open item invoicing and customized income reports such as client statements and invoice analysis reports. TAL will require Timeslips III 2.00a or higher (\$299.95).

**Price:** \$79.95.

**Contact:** Timeslips Corp., 239 Western Ave., Essex, MA 01929, (800) 338-5314 or (508) 768-6100; fax (508) 768-7660.

**Circle 1278 on Inquiry Card.**



*The Timeslips III Accounting Link interfaces expense tracking and billing to six general accounting programs on the Mac.*



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Other Carry-I products include the 8000 series XT & AT book-size personal computers and the 6000 series XT and AT book-size LANstations. All Carry-I product lines are bundled with DR DOS 5.0



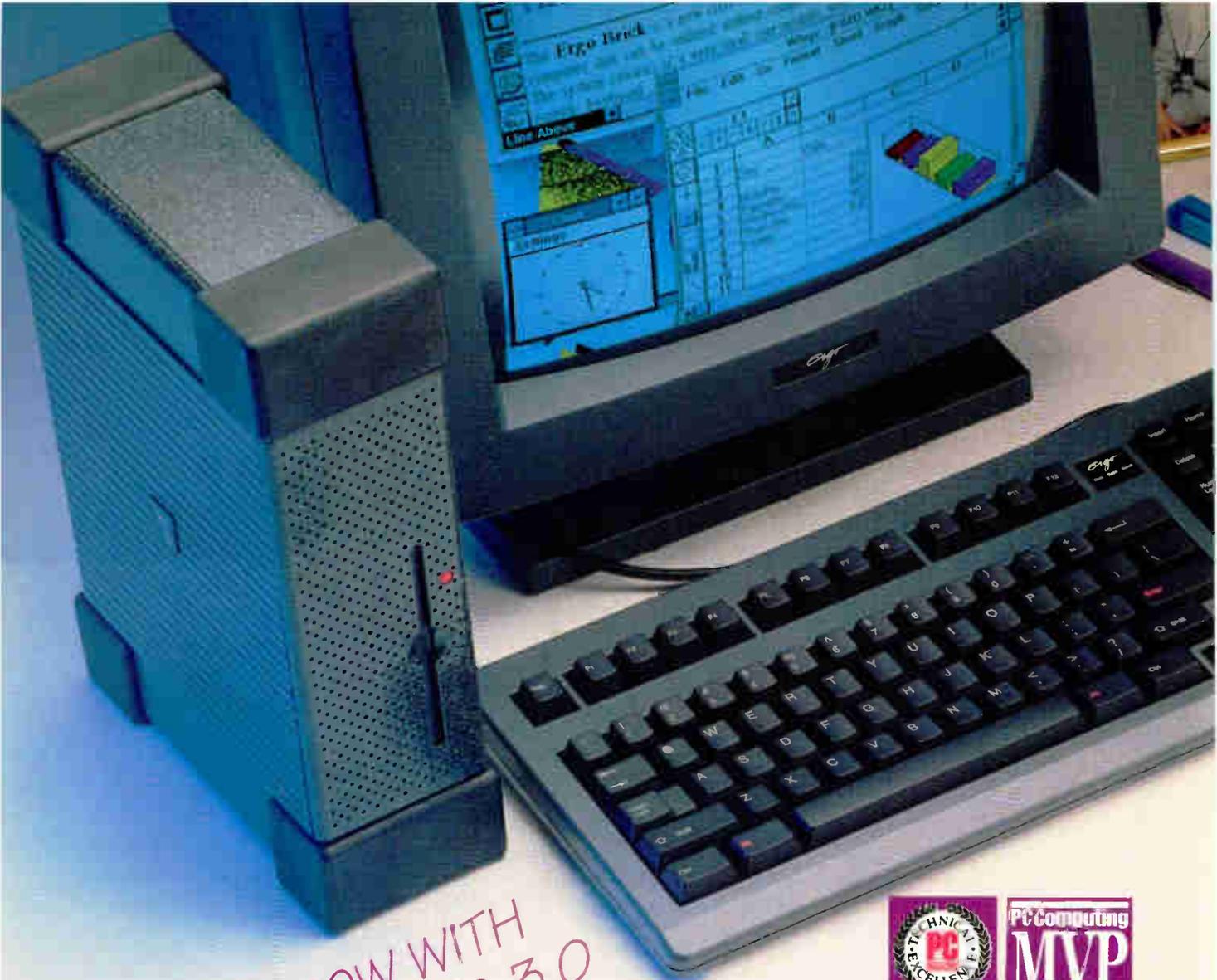
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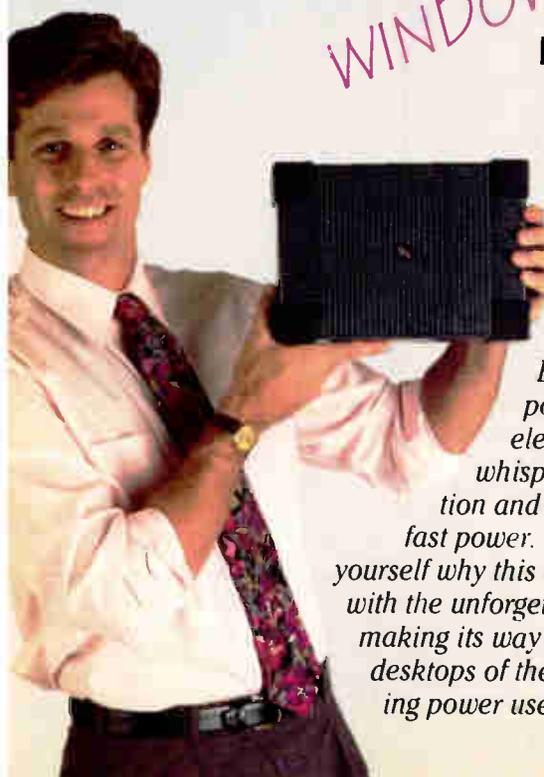


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Time to complete PC Magazine's full benchmark test set.

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**"The Brick is... a great personal computer in every respect. It takes up minimal desk space, it's both rugged and stylish, and it's extremely fast."**

Bill Machrone, *PC Magazine*, 1/91



**Fits in half a briefcase, leaving room for full-sized folders, notebooks, etc.**

system, video and hard disk benchmarks.

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Bricks are available with 16 or 20 MHz 386SX, 1-8 MB of RAM, a fast 44, 104 or 212 MB Conner or Teac IDE hard disk, and a 387 coprocessor socket. A 2,400 bps Hayes compatible modem is standard.

**"A whole new slant on portable computing... exceptionally ingenious."**

Portable Office  
12/90, Eric Grevstad

**"Recommended."**  
Jerry Pourmelle *Byte*, 1/91,

The fast VGA graphics feature up to 1024 x 768 non interlaced resolution with a full 1 MB of video memory. In fact, the Brick's video performance is twice as

fast as the average of 42 386SX systems tested to date by *PC Magazine!*

## Surprisingly Expandable

The Brick is only about the size of a ream of copier paper, yet you can still add

up to two ISA half cards internally. (one card with a floppy drive). A docking



port allows easy, drop-in connection to our Docking Terminal, \$349, which instantly hooks up all cables and provides another 16-bit 3/4 length slot. The "Stretch" version of the Brick accommodates full length cards.

**"A Tote-able That Outperforms the Desktops."**  
*PC Magazine*  
9/90, Matt Ross

## Brick & Windows Hot Special

It takes more than just software and a mouse to make a satisfying Windows machine. Our Brick & Windows Special comes with 4 MB of RAM (not 2 as others provide), Windows 3.0, DOS, and a

Logitech mouse with our hot 16 MHz 386SX Brick. You also get two award winning programs that are essential to fulfilling the promise of Windows. Adobe's wonderful Type Manager (ATM) with 13 fonts for true WYSIWYG display and high quality printed documents and Quarterdeck's QEMM 5.1 memory manager for running Windows on a network.

No other 386SX matches the Brick's graphics processing power, storage capacity, quietness and versatility. And while others give you Windows, we give you what it takes to make Windows 3.0 really perform.

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C O M P U T I N G

Circle 104 on Inquiry Card.

World Radio History

## PV-Wave Streamlines Data Importing

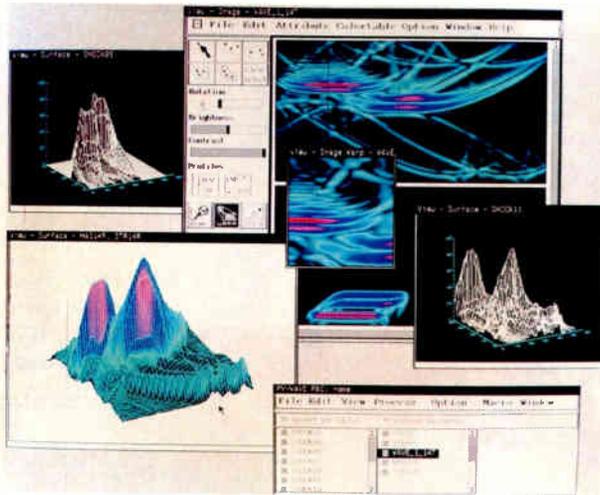
The Point & Click version of PV-Wave, an interactive visualization and data-analysis program for Unix workstations, includes an easy-to-use data import/export system, a data table editor, and graphics and imaging capabilities.

More than half of the R&D effort for the new program went into streamlining the data import/export process, Precision Visuals says. A menuing system can handle most of the data file formats used in the scientific community without requiring end-user programming. A set of tools for addressing other formats is also included.

A data previewer lets you read in and navigate through ASCII data files to identify file records and all or part of the data files with unknown formats. PV-Wave Point & Click lets you select from several missing data-handling and data value substitution alternatives, a helpful feature if you're working with time-series or test instrument data. The program supports standard CSV, TIF, PICT, and Structured Query Language data file formats and 8- and 24-bit image file formats.

You can use the program for data analysis and reduction, slicing and dicing, and what-if analysis. A data table window lets you scan and edit large data vectors and arrays and select data subsets. A macro language automates complex and repetitive tasks.

PV-Wave Point & Click is available for SunView and, soon, Motif-based platforms running on all Sun workstations, the Hewlett-Packard 9000/300 series, DECstations, and Silicon



Precision Visuals' Point & Click version of PV-Wave lets you import, analyze, and visualize data in several windows under Motif and SunView.

Graphics' Personal Iris line. **Price:** \$4500 for a single floating license.

**Contact:** Precision Visuals, Inc., 6260 Lookout Rd., Boulder, CO 80301, (800) 447-7147 or (303) 530-9000; fax (303) 530-9329. **Circle 1279 on Inquiry Card.**

## Visualize and Manipulate Data on the Mac II

Transform 2.0, a program for scientific data visualization and analysis, adds new data manipulation functions to its interactive color raster-imaging techniques. Version 2.0 lets you overlay contour and vector plots onto other images for comparison while adding data smoothing, array resampling, missing data interpolation, and support for fast Fourier transforms.

For visualizing the meaning behind data sets, the program supports color contour, color surface, and vector plotting. Spyglass says version 2.0 lets you visualize two-dimensional data

arrays as contour plots, where lines connect equal data values. The company also beefed up Transform's import capabilities to support data in generic files of byte, integer, or floating-point numbers, ASCII, and ASCII lists of (X, Y, data) triplets. Support for PICT, TIF, and FITS formats is also included.

**Price:** \$395. **Contact:** Spyglass, Inc., 701 Devonshire Dr., C-17, Champaign, IL 61820, (217) 355-1665; fax (217) 398-0413. **Circle 1280 on Inquiry Card.**

## DOS Utility Plots Data

For use with programs that can store data in the ASCII format, RPlot lets you quickly view and compare data sets from the DOS command line. It can overlay data sets on-screen or plot them on Epson-compatible dot-matrix or Hewlett-Packard LaserJet or DeskJet printers. In addition to letting you view the data, the program lets you create figures with error

bars, logarithmic axes, labels, scientific symbols, and other options.

**Price:** \$79. **Contact:** RSoft, Inc., 345 Riverside Dr., Suite 2G, New York, NY 10025, (212) 666-0959. **Circle 1281 on Inquiry Card.**

## TK Solver Plus for the RISC System/6000

TK Solver Plus, a math equation solver and graphing program, is now available in a Motif version running on the IBM RISC System/6000. TK Solver Plus features include a virtually unlimited number of linear and nonlinear equations; tables and high-resolution plots for presenting results; over 70 built-in functions; a back solver; and provisions for creating customized functions.

A library of models with hundreds of functions for statistical analysis, advanced numeric methods, utilities, and sample applications is included with the program. The program also includes applications such as Roark & Young on TK (to accompany *Roark's Formulas for Stress & Strain*) and Heat Transfer on TK (to accompany *Fundamentals of Heat and Mass Transfer*). The program is also available for the IBM PC and Mac (\$395 each) and Unix workstations.

**Price:** Unix versions, \$995 per user (volume discounts are available); owners of Eureka: The Solver (which Borland no longer supports) can upgrade to TK Solver Plus for \$195 until May 31. **Contact:** Universal Technical Systems, Inc., 1220 Rock St., Rockford, IL 61101, (800) 435-7887 or (815) 963-2220; fax (815) 963-8884. **Circle 1282 on Inquiry Card.**

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## Work with Color on Monochrome Screens

**M**acDraw Pro takes full advantage of 32-bit color QuickDraw and features a Pantone Matching System, file exchange through the XTND architecture, and named colors, for selecting colors on a monochrome monitor. If you use the program with a monochrome screen and select part of a drawing, the named color palette identifies the selected portion by color name or Pantone identifier, Claris says.

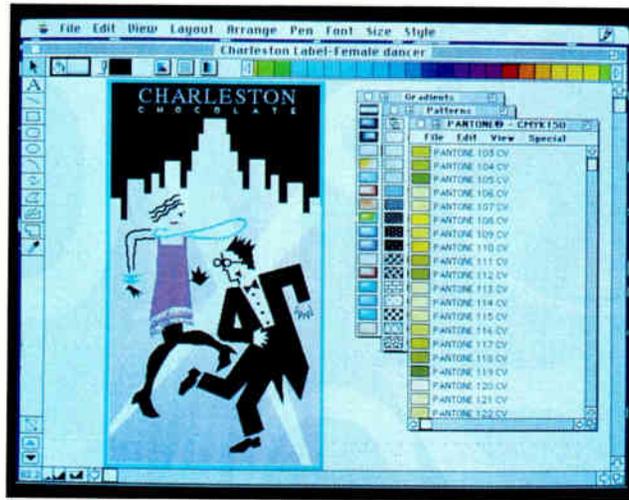
As you create the drawing, you can use either the polygon or bezigon tool. With polygonal modeling, you create the image by linking lines to points that you've established as you sketch the image. The bezigon tool gives you access to full Bézier curvature. An eyedropper tool lets you match colors in documents and extract colors from imported images. Other features include automatic color approximation (dithering) for displaying up to 2000 colors on a 256-color (8-bit) card, enhanced drawing tools, and rulers for precise placing and positioning of text.

The program supports Claris's XTND architecture for opening and working with images in formats such as PICT, Color PICT2, MacDraw II, Encapsulated PostScript, and others. The program runs on any Mac but requires 32-Bit QuickDraw for color.

**Price:** \$399.

**Contact:** Claris Corp., 5201 Patrick Henry Dr., Box 58168, Santa Clara, CA 95052, (800) 544-8554 or (408) 987-7000.

**Circle 1283 on Inquiry Card.**



MacDraw Pro now supports the industry-standard Pantone Matching System.

## A Smoother, More Powerful Streamline

**W**ith Streamline's lower price and the ability to realistically convert and portray artwork on the computer, Adobe is going after artists and CAD users who need to convert scanned and other images into PostScript line art. The program converts bit-mapped images such as scanned drawings, illustrations, forms, or schematics into Adobe Illustrator or Encapsulated PostScript (EPS) language files.

In addition to the \$200 price reduction, Streamline 2.0 adds new import and export formats for supporting other software programs. The program can now import files in Sun raster, TIF, PICT, PICT1, and MacPaint formats. As a benefit

to AutoCAD and MacDraw users, the program now exports in PICT and DXF formats. The program exports to applications that support Adobe Illustrator 1.1 format, EPS files for the Mac and IBM PC compatibles, and Adobe Illustrator 3.0 for Microsoft Windows users.

A new select tool lets you convert just a portion of an image. You can use this tool in freehand mode; the program automatically invokes the select tool if a file is too large for available memory.

Streamline now converts scanned continuous-tone photographs and gray-scale illustrations into PostScript line art at 2 to 16 levels of gray. As you scan in an image, the new Separate Shapes feature can identify individual shapes (e.g., counties within a map of a state) so that you can separate them from the whole image for later editing. It

### SPREAD THE WORD

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

does this by duplicating coincident borders and transparently attaching a border to each shape.

This duplication, which you can't see on the image, lets you treat each state individually, separating it from the rest of the image for further editing or color manipulation. The program also can be set to assign colors to the output based on types of line or area from the input file.

When the program imports scanned forms, it can strip out text from the document during line recognition and compensate for imperfectly squared images, converting lines skewed up to 5 degrees into perfect lines.

The program provides effects such as pen and ink, pastel, or charcoal and brush. Streamline 2.0 runs on any Mac. Adobe is also developing a Windows 3.0 version.

**Price:** \$195.

**Contact:** Adobe Systems, Inc., 1585 Charleston Rd., P.O. Box 7900, Mountain View, CA 94039, (415) 961-4400; fax (415) 961-3769.

**Circle 1284 on Inquiry Card.**

## Clip Art for Artists

**S**lide Link, a 35mm-slide service bureau, has released Backgrounds1, a selection of corporate and high-tech designs in more than 250 styles and color variations. You can use the images with programs that support CGM files with more than 16 colors and IMA files for Mirage and Pixie users. A PICT version for the Mac is also available.

**Price:** \$250.

**Contact:** Slide Link, Inc., 17951 Sky Park Cir., Suite E, Irvine, CA 92714, (714) 250-3131; fax (714) 250-0518.

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For additional information, ask for Dan Kalata

### From Modeling to Animation on the Mac

**W**here some programs offer modeling and others animation and rendering from imported objects, two programs provide all three for the Mac. Visual Information Development's Presenter Professional renders objects through a seamless interface with Pixar's MacRenderMan technology for creating pictures that have real-life shading, reflections, and blurs. Specular's Infini-D offers proprietary animation and rendering technology.

Presenter Professional provides parametric-based modeling instead of the polygonal method used in other programs. With polygonal modeling, an image is created by linking lines to points that you've established as you sketch the image. To get a more realistic appearance in polygonal modeling, you click the mouse more often, giving the program more reference points to link the lines. But with Presenter Professional, you can get a smoother appearance through the use of Bézier-like curves.

Parametric modeling results in slower screen refresh rates. To compensate, Presenter Professional 2.0 lets you work with a lower number of spline segments, which the company says gives a polygonal look as you model, but allows for quicker screen refreshing. When you're close to what you want in the model, you can add more points for a better look. This technique lets you create realistic models without having to use lots of shaders in MacRenderMan, as you would with polygonal modeling, Visual Information Development says.

The program's Digital



*Infini-D's libraries of surface types, such as glass, silver, and plastic, provide a base for adding realistic appearance to models.*

Clay push-and-pull surface sculpting capability lets you work with three-dimensional models as you would with a hunk of clay. The program provides for scene, light source, and animation path control with 3-D positioning and automatic inbetweening. With automatic inbetweening, once you have modeled your design and set up your key frames and views, Presenter Professional provides the animation at up to 60 frames per second. Hierarchical object animation lets you move parts of an object while moving the whole object.

**Price:** \$2199.

**Contact:** Visual Information Development, Inc., 16309 Doublegrove St., La Puente, CA 91744, (818) 918-8834; fax (818) 918-9935.

**Circle 1001 on Inquiry Card.**

**A** new company called Specular International has developed a challenger to Paracomp's Swivel 3-D. Infini-D offers 3-D modeling, rendering, and animation, and an alternative way of creating animations to the key-frame technique, in which you identify a starting

and finishing position and the number of frames in between. The Infini-D Sequencer lets you animate on the basis of time. If you want an action to take 30 seconds, you tell that to the program in a time line. There you can also add inertia, easing an action in and out.

Infini-D bundles 3-D texture mapping, predefined surface libraries, and shading capabilities in its program. The program allows for any number of light sources with varying degrees of intensity, hue, and color, plus control over ambient light. It also has support for multiple shadows, fractal terrains, reflections, refractions, PICS exporting, and 32-bit Color QuickDraw.

**Price:** \$895.

**Contact:** Specular International, 233 North Pleasant St., Amherst, MA 01002, (413) 549-7600; fax (413) 549-1531.

**Circle 1002 on Inquiry Card.**

### 3-D Design and Sketching

**M**odelShop II, Paracomp's 3-D design and sketching tool for the Mac, is designed for architects, urban planners, and other design professionals.

The new version adds animation capabilities, such as walk-through and fly-by views of models, plus shadow studies with an unlimited number of light sources. The program supports 1-, 8-, 24-, and 32-bit color, plus rendering, and it can export to DXF, PICS, PICT2, and 24-bit PICT.

**Price:** Between \$600 and \$800.

**Contact:** Paracomp, Inc., 1725 Montgomery St., Second Floor, San Francisco, CA 94111, (415) 956-4091; fax (415) 956-9525.

**Circle 1003 on Inquiry Card.**

### Smooth Shaded 3-D Objects with Strata

**S**trataVision 3d 2.0 offers 3-D modeling, scene layout, and rendering on the Mac. New extensions include a fractal-based terrain modeler, a free-form surface modeler, smooth shading, and support for multiple light sources and cameras. Using MacRenderMan, you can shade 3-D objects imported from other programs, as well as those created in StrataVision. Version 2.0 supports multiple animated objects, light sources, and cameras.

**Price:** \$695.

**Contact:** Strata, Inc., 2 West St. George Blvd., Ancestor Sq., Suite 2100, St. George, UT 84770, (800) 869-6855, ext. 300, or (801) 628-5218; fax (801) 628-9756.

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Hard Drives:	IDE	IDE	IDE	IDE	ESDI
MB/Ms	42/25	80/18	105/18	205/15	340/16
Mono VGA	\$799	\$999	\$1,049	\$1,349	\$2,199
Hires	\$999	\$1,199	\$1,249	\$1,549	\$2,399

### Microcom 386SX/16 Systems (1 MB RAM)

#### Standard System · Hard Drive · Monitor & Video Card

Hard Drives:	IDE	IDE	IDE	IDE	ESDI
MB/Ms	42/25	80/18	105/18	205/15	340/16
Mono VGA	\$1,149	\$1,349	\$1,399	\$1,699	\$2,549
Hires	\$1,349	\$1,549	\$1,599	\$1,899	\$2,749

### Microcom 386/25 Systems (1 MB RAM)

for 64K Cache (in Tower Case), add \$200

#### Standard System · Hard Drive · Monitor & Video Card

Hard Drives:	IDE	IDE	IDE	IDE	ESDI
MB/Ms	42/25	80/18	105/18	205/15	340/16
Mono VGA	\$1,349	\$1,549	\$1,599	\$1,899	\$2,749
Hires	\$1,549	\$1,749	\$1,799	\$2,099	\$2,949

### Microcom 386/33C Tower Systems (1 MB RAM/64K Cache)

#### Standard System · Tower Case · Hard Drive · Monitor & Video Card

Hard Drives:	IDE	IDE	IDE	IDE	ESDI
MB/Ms	42/25	80/18	105/18	205/15	340/16
Mono VGA	\$1,649	\$1,849	\$1,899	\$2,199	\$3,049
Hires	\$1,849	\$2,049	\$2,099	\$2,399	\$3,249

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### Microcom 486/33C Tower Systems (4 MB RAM/128K Cache)

#### Standard System · Tower Case · Hard Drive · Monitor & Video Card

Hard Drives:	IDE	ESDI	IDE	ESDI	ESDI
MB/Ms	105/18	150/18	205/15	340/16	650/16
486/25C Hires	\$2,999	\$3,399	\$3,299	\$4,149	\$5,099
486/33C Hires	\$3,699	\$4,099	\$3,999	\$4,849	\$5,799

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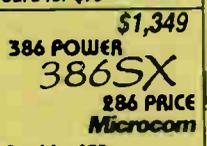
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World Radio History



THE NEXT GENERATION

### Utility for Embedded SCSI Controllers

**F**WB's Hard Disk ToolKit is for Mac hard disk drives with built-in SCSI controllers.

The toolkit replaces the installer software and consists of five modules: Formatter, SCSI Control Panel, FWB Benchmark, HD-ToolKit INIT, and HDToolKit Prober.

These utilities provide SCSI partitioning with password protection for individual partitions or the entire disk; diagnostics based on 14 different low-level SCSI tests and a historical profile of any defects found; benchmark tests (including tests for removable drives, CD-ROM drives, erasable optical drives, network volumes, and RAM disks); optimization of such SCSI parameters as cache control and error-recovery control; and a variety of other features.

**Price:** \$199.95.

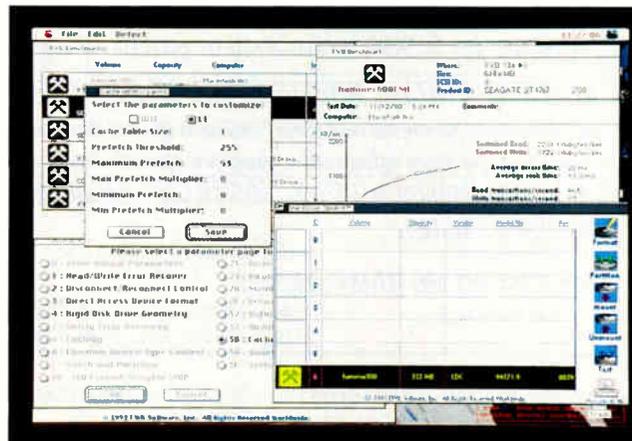
**Contact:** FWB Software, Inc., 2040 Polk St., Suite 215, San Francisco, CA 94109, (415) 474-8055; fax (415) 775-2125.

**Circle 1011 on Inquiry Card.**

### Run and Manage DOS Files on the Mac

**I**nsignia Solutions now has a version of its IBM PC emulation utility that runs MS-DOS programs without modification on the Mac Classic, LC, or Portable.

With SoftPC, your Mac emulates a 286-based machine running in real mode and CGA graphics with up to 640K bytes of RAM, depending on your Mac's available memory. If your Mac is on a network, such as NetWare/Mac, SoftPC can



*Hard Disk ToolKit replaces your hard disk's original installer with a SCSI utility that adds partitioning for different operating systems, diagnostics, and benchmarking.*

access PC file servers and print from the PC application directly to your Mac printer. The SoftPC window mimics the PC monitor.

Another utility, AccessPC, displays a DOS disk on the Desktop as if it were a regular Mac disk. With AccessPC 1.1 installed, you can insert a DOS disk into the Apple SuperDrive or other drives from PLI, Kennect, DPI, and Outbound that can read DOS disks.

Version 1.1 lets you mount multiple DOS partitions from a single disk, except Bernoulli cartridges, in which only the primary partition is mountable. The new version supports DOS 4.0 Large Partitions and DOS 3.3 Extended Partitions for mounting partitions larger than 32 MB.

Both utilities require 2 MB of RAM.

**Price:** SoftPC, \$199.95; AccessPC, \$129.95.

**Contact:** Insignia Solutions, Inc., 254 San Geronimo Way, Sunnyvale, CA 94086, (408) 522-7600; fax (408) 733-9541.

**Circle 1010 on Inquiry Card.**

### Add Voice Messages to Applications

**A** new utility that takes advantage of the new Mac IIsi and LC microphones lets you add voice messages to word processors, spreadsheets, and other applications. You can play the messages in selected applications running on any Mac running System 6.0.7 or higher and record messages with a microphone that works with Apple's Enhanced Sound Manager driver.

VoiceFont lets you embed verbal messages in your application by selecting voice from the Mac's font menu. Once you've recorded the message, a recognizable symbol appears in the document that signals the location of a voice message. You can place multiple messages in the document for later playback.

Applications that support VoiceFont include 4th Dimension, FoxBase Mac, MacDraw, Excel, PowerPoint, FullWrite Professional, MacWrite II, Word, Works, WriteNow!, and others.

**Price:** \$129.95.

**Contact:** Information Pre-

sentation Technologies, Inc., 555 Chorro St., San Luis Obispo, CA 93401, (805) 541-3000; fax (805) 541-3037.

**Circle 1008 on Inquiry Card.**

### Remote-Control Network Security

**M**agna's latest member of its family of security systems for the Mac lets a network administrator implement and enforce company security measures from a workstation.

Without having to leave your workstation, you can use Empower III to inspect and change security preferences for all the other Macs on the network.

The company has also released version 4.0 of Empower I, a Mac system-access control program, and Empower II, which combines system-access as well as resource-access security features. Version 4.0 of both programs adds password management controls for specifying options, such as forced change of passwords, passwords with mixed and special characters, and minimum password lengths.

Magna is also adding Empower ScreenLock, which offers basic password and screen-blanking capabilities. All programs run on a Mac Plus or higher.

**Price:** Empower ScreenLock, I, II, and III: \$69, \$169, \$296, and \$396, respectively.

**Contact:** Magna, 2540 North First St., Suite 302, San Jose, CA 95131, (408) 433-5467; fax (408) 943-0651.

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# We Build It RIGHT.

Next time you call around to price out PC's, make sure you ask this question: "How many service calls and returns did you have last month?"

Sure, some folks with the big fancy ads in this magazine probably sell more systems than we do. But then, you've got to remember this. A lot of those systems they sell have to be shipped more than once!

"Returns," "DOA's," "warranty work" . . . those systems that get reshipped can have many different names. But whatever they go by, it all means just one thing. If you buy your PC from someone else, chances are good you'll have to share it with their repair department. (And company size doesn't necessarily mean buyer security. Some well known companies have to allocate up to 15% of what you pay for repairing and re-shipping their systems during the first year you own them!)

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**386-25**  
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### Say Oops! Without Losing Files

**A** greatly expanded file-viewer list, an Oops! command, and partial logging are some of the new features added to XTreeGold 2.0, the newest version of XTree's hard disk management program. The Oops! command lets you retrieve deleted files, and you can now view files from Excel, Paradox, Quattro, Quattro Pro, Lotus 1-2-3, dBASE, WordPerfect, Microsoft Word, WordStar, Multi-Mate, Professional Write, PFS, XyWrite, Wang PC, Volkswriter, Total Word, Q&A Write, and others in their native format.

A Compare feature lets you select two directories, even if they are on two separate drives, and XTreeGold will tag files in one directory that aren't contained in another.

For network or CD-ROM users, the Partial Logging feature lets you log onto directories and subdirectories and access XTreeGold without logging onto the entire drive. The company says this feature saves time by skipping unnecessary log-ons. A ZIP manager lets you create, view, and unzip archive files. You can also view ZIPped files in ASCII format. XTreeGold adds pull-down menus to the command-line interface.

The program works on systems with DOS 3.1 or higher.

**Price:** \$149; owners of competing products can upgrade for \$50.

**Contact:** XTree Co., 4330 Santa Fe Rd., San Luis Obispo, CA 93401, (800) 282-5003 or (805) 541-0604; fax (805) 541-8053.

**Circle 1012 on Inquiry Card.**



*XTreeGold can search your hard disk, recognize over 700 applications, and build an application menu for you.*

### Unattended Backup in Windows

**S**itBack, the utility that backs up your files in the background while you work or during computer idle time, is now available for Windows 3.0. SitBack works on the presumption that even the best backup utility in the world is useless if backing up your files is a chore. It tries to make the process as painless as possible.

SitBack backs up your files to your hard disk drive, floppy disk drive, optical drive, or network drive. You can tell SitBack to back up specific files or directories or data files only. SitBack's SBWatch utility lets you perform backup operations as you use other Windows or DOS programs.

**Price:** \$99; 10-user network license, \$295; 100-user



*After a designated period, SitBack backs up your files.*

network license, \$695.

**Contact:** SitBack Technologies, Inc., 9290 Bond, Suite 210, Overland Park, KS 66214, (913) 894-0808; fax (913) 894-0250.

**Circle 1014 on Inquiry Card.**

### Audit Your PC

**P**C-Audit, for corporate MIS managers who need to determine who is running what on their PCs, monitors software use and implements revision control.

With PC-Audit, you insert the disk into a drive and it tells you what applications and files are inside. Managers can create a run-time disk for distribution to each PC. The program can provide a list of all install files or check software inventories against a user-defined listing of files and file locations, programs, and versions. The program can generate a variety of reports.

**Price:** \$195; run-time fees range from \$5 to \$25 per audited PC.

**Contact:** Greg Lewis Productions, Inc., 120 East Ave., Rochester, NY 14604, (716) 423-0319.

**Circle 1015 on Inquiry Card.**

### Add Speech to PC Applications

**D**o you find yourself comparing original paper work to on-screen numbers in a spreadsheet or a database or wish you could listen to E-mail as you read a memo on paper? Monologue 2.0 is a TSR program that lets you add speech to your application, which plays through the IBM PC's built-in speaker. Although it doesn't require any additional hardware, Monologue supports a variety of speech accessories, such as Covox's The Speech Thing and Creative Labs' Sound Blaster.

Monologue works with text-based applications only, although a version for Windows 3.0 will ship when Microsoft releases its multimedia extensions. The text-to-speech technologies developed by First Byte for Monologue differ from the memory-intensive technology of digitized speech, which records a human voice and stores it on your hard disk.

Monologue uses a two-phase process. First, the talking utility analyzes and translates text into an intermediate phonetic language, complete with pitch, duration, and amplitude codes for producing stress patterns in phrases and sentences. The second phase converts the intermediate phonetic language into speech signals.

Monologue 2.0 requires 256K bytes of RAM plus the memory needed to run the application on your DOS-based system.

**Price:** \$149.

**Contact:** First Byte, 3100 South Harbor Blvd., Suite 150, Santa Ana, CA 92704, (714) 432-1740; fax (714) 432-7057.

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### 4th Dimension and Peachtree Accounting

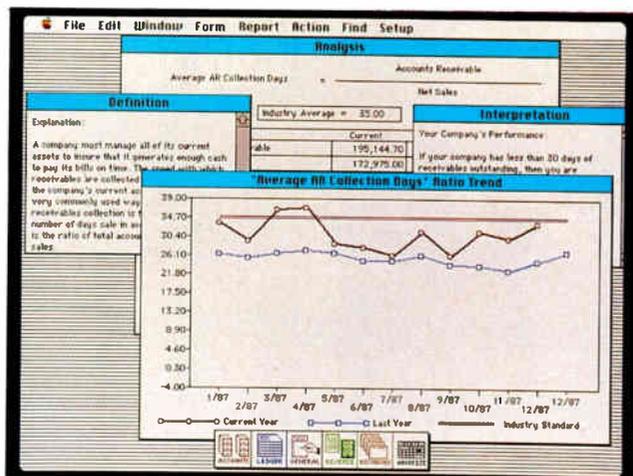
**P**eachtree says Insight Links lets you seamlessly add traditional accounting to front-end applications created in Acius's 4th Dimension relational database for the Mac. Insight Links lets you join 4th Dimension programs with Peachtree's general ledger, accounts receivable, accounts payable, and payroll modules of the company's high-end Insight Expert Accounting Series.

The high-end accounting modules provide reporting tools and guidance in interpreting and acting on these reports. Peachtree also markets the atOnce! accounting package for small businesses. It integrates general ledger, accounts receivable, accounts payable, and payroll functions on the Mac. **Price:** Insight Links, \$300; Insight Expert, \$695 per module; atOnce!, \$395. **Contact:** Peachtree Software, 1505 Pavillion Place, Norcross, GA 30093, (800) 554-8900, ext. 5823, or (404) 564-5700. **Circle 1018 on Inquiry Card.**

### WYSIWYG Reporting in Accountant, Inc.

**S**oftsync/Bloc has added over 25 new features, including font support with full WYSIWYG preview, to its Accountant, Inc., small-business accounting program. You can use any font and size in reports in version 2.0, the company says. The program also includes check-book reconciliation.

Accountant, Inc., 2.0 lets you organize account groups by total accounts and sub-total accounts, the company



*Peachtree's accounting modules provide in-depth reporting tools, such as average accounts receivable collection days.*

says. You can sort receivables and payables agings by name, account, or dollar amount and sort agings by invoice date or due date. Budgets can be set for individual months or fiscal periods.

The program runs on any Mac with a hard disk drive and 1 MB of RAM.

**Price:** \$595. **Contact:** Softsync/Bloc, 800 Southwest 37th Ave., Suite 765, Coral Gables, FL 33134, (305) 445-0903; fax (305) 444-5010. **Circle 1017 on Inquiry Card.**

### Choose Between System or Module Posting

**G**reat Plains says version 5.35 of its Accounting Series for DOS and the Mac lets you choose between module-posting and system-posting methods for posting accounting transactions on a network.

With module posting, as you post a specific module, other people on the network can enter data in unaffected

modules. Great Plains provides locking tables to show the affected files in the Accounting Series. System posting affects all batches across the series and requires all users to be out of the accounting system while posting occurs.

The company has also added more than 100 features to all 13 modules and its Printers Inc. and Property Management vertical applications. The enhancements improve each module by providing more detail on reports and simplifying repetitive tasks.

**Price:** Between \$495 and \$995 per module.

**Contact:** Great Plains Software, 1701 Southwest 38th St., Fargo, ND 58103, (800) 456-0025 or (701) 281-0550.

**Circle 1019 on Inquiry Card.**

### Entry-Level Accounting for Under \$200

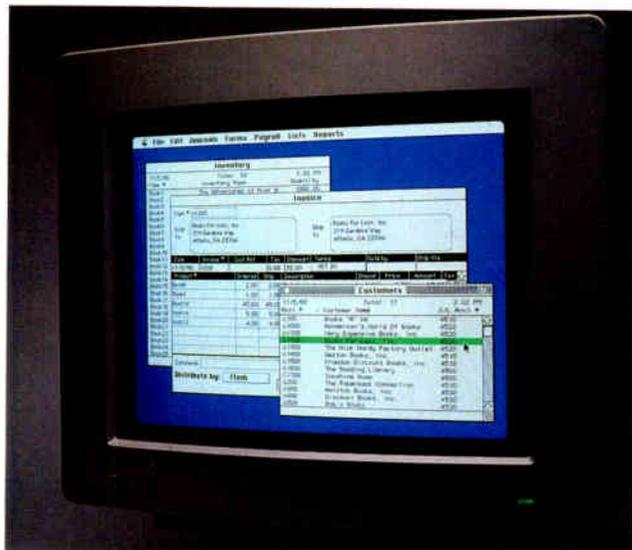
**A**CCPAC Bedford, Computer Associates' entry-level accounting system for MS-DOS and the Mac, now supports new government standards required for income and deduction reporting on the 1990 W-2 forms. ACCPAC Bedford version 3.4 for DOS-based systems and version 1.2 for the Mac also incorporate the new federal and state government payroll changes for 1991.

Both programs integrate general ledger, accounts payable, accounts receivable, payroll, job costing, and inventory control.

**Price:** \$199 each.

**Contact:** Computer Associates International, Inc., 11 Stewart Ave., Garden City, NY 11530, (800) 531-1236 or (408) 432-1727; fax (408) 432-0614.

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*Accountant, Inc., integrates general ledger, accounts payable, accounts receivable, inventory, payroll, and other modules.*

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### Profitwise's Fault-Tolerant Accounting

**P**rofitwise integrates the modules you need to run a small business on the IBM PC while offering several levels of fault tolerance to protect your data integrity. Profitwise 2.0 verifies that a transaction is complete before it updates the database. You can resume interrupted processes from the point of interruption without compromising accounting accuracy and control, Solomon says.

Previously available as an accrual-based program, the program now supports cash-based accounting. Other new features include the ability to print 1099 forms and updated W-2 forms to meet 1990 IRS requirements. The General Ledger can also post reversing entries for annual-based businesses that need to handle end-of-period adjustments. The Accounts Payable and Payroll modules now include the ability to reconcile bank statements to your accounting records.

Profitwise integrates general ledger, accounts payable, accounts receivable, payroll, invoicing, inventory, job costing, fixed assets, address management, and system manager applications in one program on a DOS-based system.

In addition to Profitwise, Solomon offers the Equity Pack, 12 integrated high-end accounting modules for DOS-based systems for under \$2000.

**Price:** Profitwise 2.0, \$229; Equity Pack, \$1995. **Contact:** Solomon Software, 1218 Commerce Pkwy., P.O. Box 414, Findlay, OH 45839, (800) 879-2767, ext. 782, or (419) 424-0422; fax (419) 424-3400.

**Circle 1022 on Inquiry Card.**



*By providing fault tolerance, Profitwise 2.0 protects the integrity of your accounting data.*

### Integrated Accounting for Unix

**I**BES has added several modules to its integrated financial, distribution, and manufacturing environment for real-time, transaction-oriented processing. IBES 4.0 supports more than 6000 data fields and comes with more than 400 pre-designed reports. It also supports user-defined fields and custom reports.

New modules added to the system include cash flow and human resources management in the financial/accounting area; shop routing processing, master production scheduling, production capacity planning, shop order tracking, and material requirements planning for manufacturing; and point-of-sale, warranty tracking, and requisitions for distribution. The system incorporates transaction processing with recover utilities for all

modules.

The minimum recommended system is a 386 with 4 MB of RAM and a 150-MB hard disk drive. The modules run on a variety of Unix workstations.

**Price:** Starts at \$2000 per module.

**Contact:** IBES Corp., 1201 Richardson Dr., Suite 200, Richardson, TX 75080, (214) 907-8475; fax (214) 907-9806.

**Circle 1021 on Inquiry Card.**

### Real-World Accounting for DOS, Unix

**R**ealWorld's entry-level accounting program integrates accounts receivable, sales invoicing, accounts payable, inventory management, payroll, check reconciliation, and general ledger in one package. The Payroll module supports new W-2 and 1099 forms for 1990.

Called the Practical Accounting System, the program is available in single-user and network versions that allow for up to three sales-invoicing terminals or PCs, plus a PC that supports all the program's functionality.

The company has also released DOS, Unix, and Xenix 6.0 versions of its high-end program, RealWorld Accounting and Business System.

**Price:** Practical Accounting System: \$495; network version, \$995; RealWorld Accounting and Business System: DOS and network versions, \$695 and up per module; Unix, \$895 and up per module.

**Contact:** RealWorld Corp., 282 Loudon Rd., P.O. Box 2051, Concord, NH 03302, (800) 678-6336 or (603) 224-2200; fax (603) 224-1955.

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### Customizable Unix Accounting

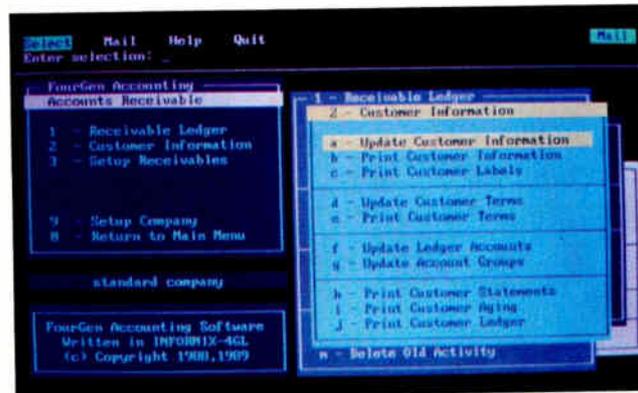
**T**he FourGen customizable Unix accounting program is now compatible with version 4.0 of Informix-4GL. The new program offers automatic code location and definable function keys, along with context-sensitive help and personal to-do lists.

FourGen 3.5 consists of eight modules: general ledger, accounts payable, accounts receivable, order entry, payroll, inventory control, fixed assets, and purchasing.

**Price:** Cost depends on platform; for a 386-based system with source code, \$3900 per module.

**Contact:** FourGen Software, Inc., FourGen Building, 7620 242nd St. SW, Edmonds, WA 98020, (206) 776-5088; fax (206) 672-4950.

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*FourGen 3.5 combines eight accounting modules with customizable fields and free-form notes.*

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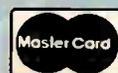
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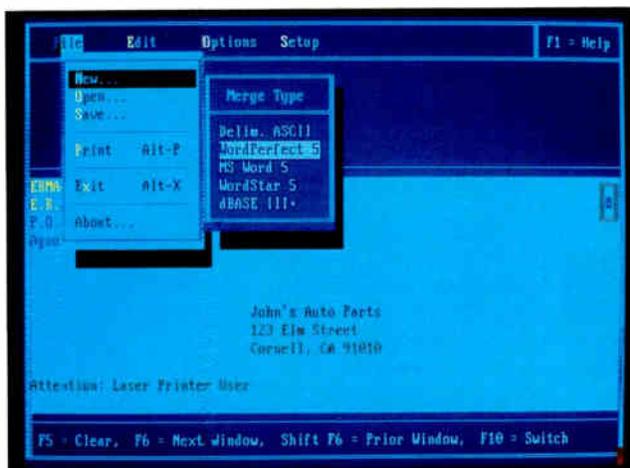
To further customize your mailings, you can add a special message to your envelopes. Laser Envelopes lets you choose any font that your printer supports, and you can use up to eight different fonts per envelope. It will print on any size envelope that your printer can handle.

Laser Envelopes runs on the IBM PC or PS/2s with 128K bytes of RAM, DOS 2.0 or higher, and a Hewlett-Packard LaserJet, DeskJet, or compatible printer.

**Price:** \$59.95.  
**Contact:** E. R. M. Associates, 29015 Garden Oaks Court, Agoura Hills, CA 91301, (800) 288-3762 or (818) 707-3818; fax (818) 707-1510.  
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## Spreadsheets Speak for Themselves

**V**oice-It's debut products bring a new feature to two popular software programs: Lotus 1-2-3 release 2.x and WordPerfect 5.1 can now incorporate human speech as a presentation function. You can use the program to attach an audio message to a particular



*Laser Envelopes release 3 makes your envelopes get noticed by adding messages and fine-tuning element positions.*

worksheet cell or document paragraph. The messages can be used as explanations, outlines, informal notes, personalized directions, or any other way you choose.

Voice-It uses Artisoft's LANtastic plug-in Voice Adapter to record and play back dictation. To record a message associated with a particular piece of information, you move the cursor to the appropriate worksheet cell or paragraph, press a function key to invoke Voice-It, and begin recording the message into a microphone. You press another key to stop recording, and Voice-It stores the recording as a disk file. To play back messages, you must first be running 1-2-3 and press a function key. As each recording plays, the associated cell or paragraph appears on the screen. Voice-It records and plays messages using a telephone handset, or you can use an amplified speaker for addressing more than one person.

You can relay Voice-It documents via LAN or disk. The programs work on DOS systems and require 240K bytes per minute of compressed recording or 480K

bytes per minute of non-compressed recording.  
**Price:** \$199 with Voice Adapter; \$99 without.  
**Contact:** Voice-It, Inc., 1001 Snowden Farm Rd., Collierville, TN 38017, (901) 853-4456.  
**Circle 1028 on Inquiry Card.**

## DocuComp II Compares Files

**T**he often-tedious task of comparing revised versions of a document is made easier by Advanced Software's DocuComp II. Once you've revised the material, DocuComp II merges the two versions and uses specially designated type styles to show additions, deletions, text moves, and other editorial changes. The resulting composite document retains the formatting of the original text. You can customize the program by choosing how you want to illustrate changes; for example, you could show deleted text by displaying it in bold-face, italic, or shaded type.

DocuComp II currently supports WordPerfect and ASCII files. A Microsoft Word version should be available this spring. Docu-

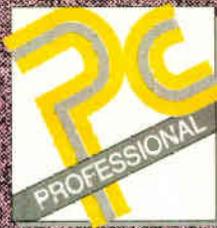
Comp II runs on DOS and Macintosh systems.

**Price:** \$199.95 for single-user DOS version; \$695 for five-user network version; \$159.95 for Mac version.  
**Contact:** Advanced Software, Inc., 1095 East Duane Ave., Suite 103, Sunnyvale, CA 94086, (408) 733-0745; fax (408) 733-2335.  
**Circle 1029 on Inquiry Card.**

## PS/2 Multiple Operating Systems

**P**S/2 users no longer have to commit to a single operating system, thanks to Aox's OS/Master configuration and control software that works with Aox MicroMaster upgrade boards to give you access to different operating environments on the same computer. OS/Master comprises configuration and control programs that let you select which boards will run which systems. You can support the operating systems you choose, including DOS, OS/2, and Novell NetWare 386, and combine them to develop a customized environment.

OS/Master lets you create nondedicated file servers from your existing machine, and, according to Aox, the MicroMaster upgrade boards raise the performance of a 286- or 386-based PS/2 to that of a 386- or 386-level machine, increasing the processing speed by up to 10 times, and providing a platform for 386-based software.  
**Price:** Not available.  
**Contact:** Aox, Inc., 486 Totten Pond Rd., Waltham, MA 02154, (800) 232-1269 or (617) 890-4402; fax (617) 890-8445.  
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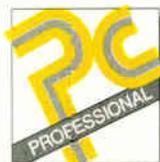
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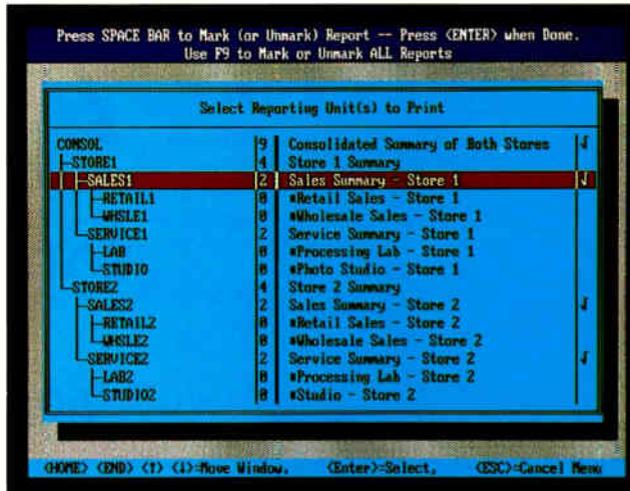
# NEWS

WHAT'S NEW • ACCOUNTING/REPORT GENERATION

## Financial Reports on a Platinum Platter

Generating financial reports across departmental lines can be a difficult task. Lengthy character strings that represent several structural levels of a company are prone to typos and error, and reorganizing a fixed chart of accounts to represent organizational changes in a company isn't a task many accountants relish.

FRx: the Financial Reporting Extender offers advanced reporting capabilities that don't require direct links to the chart of accounts. FRx, which works with IBM's Platinum General Ledger, eliminates the need for lengthy account codes and scripting by offer-



Instead of requiring you to change codes for each account number, FRx lets you change the menu tree.

ing a way to generate reports using pull-down menus. To reflect changes in the reporting structure of a company, FRx lets you

change the reporting tree instead of changing the codes for each account number. The system includes extensive on-line help and a

spreadsheet-like interface, making it easy to use.

The program comes in two versions: The standard edition lets you generate reports that go two levels deep into departmental summarization, while the advanced edition can go 10 levels deep and can integrate spreadsheet reports from applications such as Excel. Both versions require Platinum's system manager (\$95, three-user network license, \$1095) and the Platinum General Ledger (\$795). The Platinum Series comprises 20 modules in all. **Price:** Standard edition, \$495; advanced edition, \$1995. **Contact:** IBM Corp., 1133 Westchester Ave., White Plains, NY 10604, (800) 426-7699, (800) 327-5711, or (714) 727-1250. **Circle 1026 on Inquiry Card.**

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# THE UNIX MULTIUSER PLATFORM

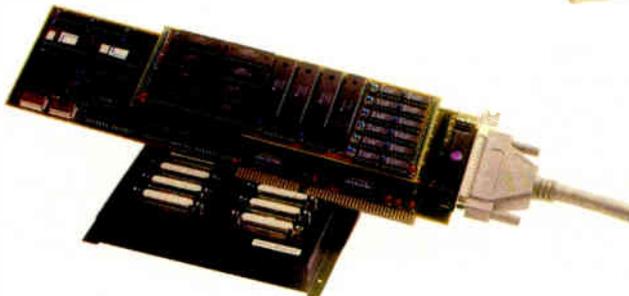
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# NEWS

WHAT'S NEW • ANIMATION

## Two Professional Animators

**T**he Animation Stand, a paint and 2-D animation system for film and video output, allows production of theater-quality 35mm and 70mm animated films and posteffects on the Mac.

Version 1.3 supports Rebo's high-definition television Macintosh frame buffer, which acts as a normal Mac monitor and has sufficient on-board memory to allow The Animation Stand to accommodate and compute 9-MB HDTV images under System 6.0 without system extensions, the company says. You can work in formats of up to 2048 by 1536 pixels at 35mm resolution and 4096 by 3072 pixels at 70mm or 35mm, low-grain



*When you import an object into EIAS, you can make it come alive with professional animation.*

resolution.

**Price:** \$2000.

**Contact:** Linker Systems, Inc., 13612 Onkayha Cir., Irvine, CA 92720, (714) 552-1904; fax (714) 552-6985.

**Circle 1005 on Inquiry Card.**

**I**n addition to its ability to import PostScript Type 1 fonts and convert them into 3-D models, the Electric Image Animation System (EIAS) can render objects extremely quickly on power-

ful Macs. The program can render a 24-bit image of a 7000-plus-polygon object with texture mapping on both the object and the background, sophisticated anti-aliasing, and Phong shading in about 2 minutes.

EIAS is not a modeler. It imports objects that are created with many different modelers, including Swivel 3D, AutoCAD, Mac3D, and CAD-3D.

EIAS requires a Mac IIx with a floating-point coprocessor and 4 MB of RAM; an 80-MB hard disk drive; a 24-bit, 640- by 480-pixel frame buffer; and a 13-inch high-resolution monitor.

**Price:** \$7495.

**Contact:** Electric Image, Inc., 9690 Telstar Ave., Suite 225, El Monte, CA 91731, (818) 444-1819; fax (818) 444-1135.

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- **Home Legal Advisor 6.1 (3 disks) (3290)** — Over 150 legal forms for almost everything including wills and living trusts.
- **Names & Dates 4.01 (2 disks) (3140)** — Great personal information manager! Keeps track of anything and everything.
- **Takin' Care of Business (6 disks) (1230)** — Easy to use and loaded with features. General Ledger, Accounts Receivable/Payable, invoicing, check printing and much more. Professional accounting for non-accountants. (HD)
- **PC-Write 3.03 (3 disks) (3820)** — Easy to use word processor that is loaded with features including spell checker.

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- **Business (2 disks) (2630)**
- **Butterflies (2695)**
- **Church (2615)**
- **Education (2 disks) (2640)**
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- **Strategy Games (2461)** — Risk, Othello, Chess, Nyet (Tetris clone), and others. (CGA)

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- **Automenu 4.7 (3515)** — Latest version of the most popular menuing program of all time!
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- **Mealmaster 6.14 (2 disks) (3160)** — A complete recipe filer. Comes with over 450 recipes to start you off.
- **Mr. Label 5.0 (3235)** — Powerful & versatile label maker.
- **Online Bible 5.0 (14 disks) (3170)** — Complete KJV Bible. Includes Greek/Hebrew Lexicon & Cross Reference. (HD)
- **PC-Key-Draw 3.75 (4 disks) (2780)** — An exceptionally powerful graphics program. Comes with a large collection of ready-made graphics. (CGA) (HD)
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## WINDOWS 3.0

Note: These disks require Windows 3.0.

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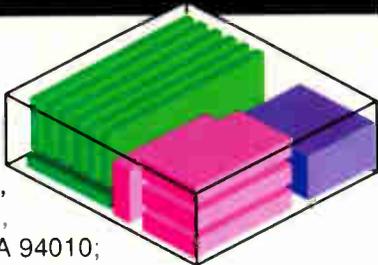


FACT FILE

EDITORS' CHOICE

**Tangent  
386SX/20**

Tangent  
Computer, Inc.,  
303 Beach Rd.,  
Burlingame, CA 94010;  
(800)223-6677,  
(415) 342-9388.



**List Price:** With 1MB RAM, 1.2MB 5.25-inch or 1.44MB 3.5-inch floppy disk drive, one parallel and two serial ports, VGA monitor, \$1,644; with 2MB RAM, 60MB hard disk, DOS 4.01, \$2,278; with 105MB hard disk, \$2,384.

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PC Magazine

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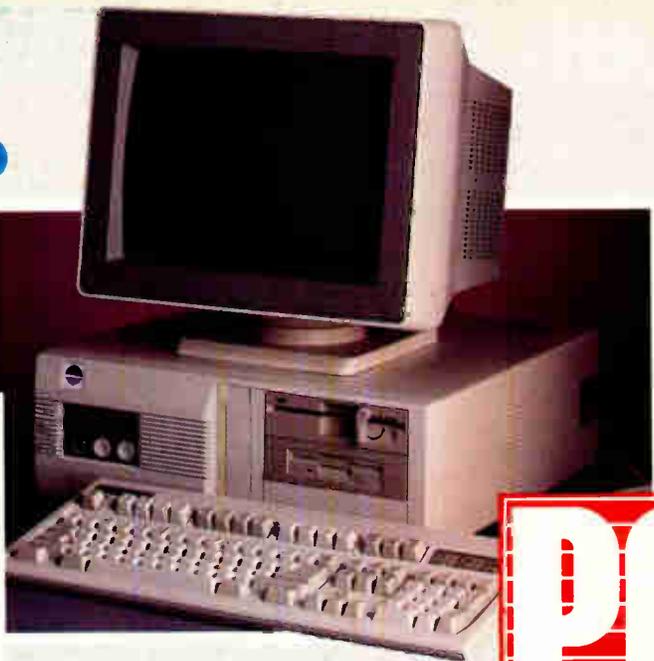
Here's how PC Magazine summed up the Tangent 386<sup>TM</sup>SX/20 (Tangent's Model 320s):

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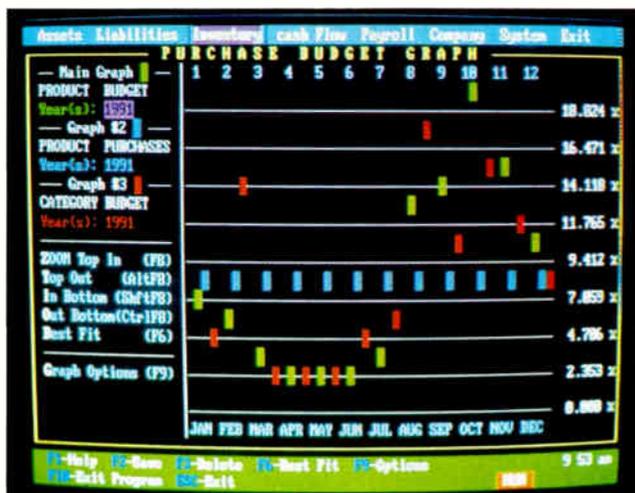
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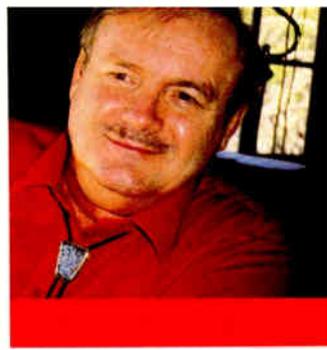
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## USER'S CHOICE AWARDS

**I**t's the end of the year, meaning that it's time for the annual User's Column Orchid and Onion Parade, Awards, and Trend Analysis. I know: everyone else did their end-of-year stuff months ago. It happens that I believe a year ends on December 31, not back in October in time for the January issue. So it goes.

A lot of things happened in 1990. The i486 chip became more commonly available, and there was some movement in pricing on the 386. The 386 instruction set is the wave of the future, and this is a healthy trend.

Windows 3.0 showed what Windows will be like once they get it done properly. Apple dropped Mac prices and put it into the mainstream. MS-DOS 5.0 went out to beta testers, and DR DOS 5.0 is shipping. These are all important events because they bring some healthy competition in the part of the industry that most needs better technology: the development environment. We don't really care what our operating system costs (within reason), since we buy it only once; the more it supports software developers, however, the less we'll pay for applications software; money spent on a good operating system is an investment in keeping total computer costs down. Of course, it won't hurt if the operating system is easy to use. . . .

Lotus won an important lawsuit, and Ashton-Tate lost one. Memory prices quietly fell to where they'd been before the U.S. government decided to "help" us with a trade agreement. Alas, there was no break in the unrelenting war the FCC wages on lower prices and start-up companies. So it goes.

Programming languages got better, and Borland's object-oriented Turbo Pascal showed there can be objects for the rest of us—yes, even those who refuse to learn any variant of C. The trend toward powerful languages learnable by users continues.

### Two Cheers

With all that and more happening, it's no easy task deciding where to begin, but I'll open with a new feature: the Two Cheers list. I leave it to you to imagine what kind of cheers I have in mind.

Two Cheers to John Sculley for keeping Apple prices high all these years, and thus ensuring the instant success of Windows 3.0. Without Apple's untiring efforts to keep up prices, Microsoft wouldn't have had to come up with a graphical user interface for the rest of us, and they wouldn't have been able to sell the one they did develop.

Two Cheers to Ashton-Tate for getting a sensible judgment in a look-and-feel case. It may not have been quite the judgment they were looking for, but the effect on the industry will be good. Congratulations.

Two Cheers to Symantec for fixing Norton Utilities 4.5 when it wasn't broke. Norton Utilities 5.0 has some new and valuable features, but it leaves out some of the most used utilities of the old version. Also, Two Cheers

for Norton Safe Format: we all use it, we all need it, but why couldn't it let us tell it to blast away instead of endlessly analyzing the disk information we don't want anymore?

Two Cheers to TurboTax, who make a product that people swear by, but managed to ship copies missing a critical file just before tax time last year. . . .

Two Cheers to whoever at Microsoft reads bug reports. If you send a bug report fax, they'll read it, but it can take as long as two months.

Another Two Cheers to Microsoft: they're busily adding features to MS-DOS and Windows, when they're at the ragged edge of being able to support what they already make. What will they do, hire more support people? They already account for some incredible percentage of the phone calls to Washington state.

And finally, Two Cheers to Prodigy, whose ads have got a lot of people using on-line services, but whose policies then sent great numbers of subscribers to all the *other* electronic information utilities. What the heck, the more people on-line, the better. . . .

### Three Cheers with Orchid

Three Cheers and an orchid to Mouse Systems for adding high-order IRQ interrupts to their bus mouse card. It won't matter to 8-bit system users, but a lot of us 286

**Jerry hands out his awards for the best products of 1990 in a variety of categories**



and 386 users are running out of interrupts; Mouse Systems mice can be set to IRQ 15 or even a higher number, and thus won't interfere with scanners and serial ports.

Three cheers to LANtastic: Artisoft sells a network, not a religion. And it installs easily and works.

A big orchid to Bill Gates, who pioneered the fight to get CD-ROM technology out into the industry and stuck it out when Philips and others tried to rain on his picnic. This is the year CD-ROM came of age, and it wouldn't have happened without Bill's investment of time and energy. I hope Microsoft's Bookshelf makes a bundle; it deserves to.

A small orchid to Commodore, who continue work on the new operating system for the Amiga. If the Amiga got half the support the hardware deserves, it would be a formidable competitor in the business world.

A large orchid to Hewlett-Packard for the LaserJet IIP, the laser printer for the rest of us. If it's as rugged as my ancient LaserJet I Plus (the Printer That Will Not Die), the IIP will be around in the next millennium.

**An Onion Parade**

A large generic onion to all the companies that don't pay any attention to their Install software. I get very weary of having to fight installation programs. As an example, we recently set up a Gateway 2000 386 (a good solid machine) and decided to equip it with a Logitech TrackMan Trackball.

The trackball works fine, and the control software is excellent, but the software comes on a 3½-inch floppy disk and will install only from the A drive. Since the Gateway 386 has a 5¼-inch drive A and a 3½-inch drive B, trying to install from B produces a disk selection error. Sure, there are ways around that—for that matter, the program isn't copy-protected, so you can simply make a 5¼-inch installation disk—but why should we have to?

Logitech gets only a small onion because TrackMan is a pretty nifty device. I find, to my surprise, that I prefer mice to trackballs; but for those who don't, TrackMan is a good choice, unless you are left-handed: unlike RollerMouse (which is also a good trackball, but much larger than TrackMan), TrackMan is

relentlessly right-handed.

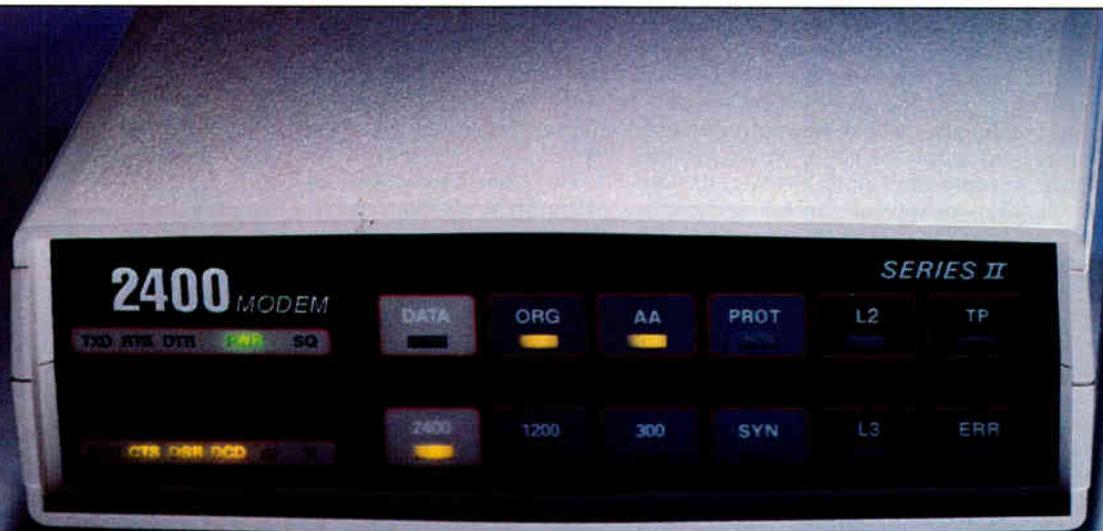
One large onion goes to Acer for their "smelly" scratch-and-sniff ad; and a clove of garlic to the BYTE ad salesperson who accepted that dumb thing.

A fair-size onion to Jensen & Partners International, who thought it might be interesting to turn Modula-2 into C. The old JPI compiler was pretty good; the new one borders on the absurd.

There were the traditional nominations of a small onion for BYTE's subscription department, but the good news is that they're getting it under control. Maybe next year I can leave this one off. I haven't had a complaint about BYTE subscription services being really *awful* in six months. . . .

**The Big Onion**

And the Onion of the Year, with Garlic Clusters, goes to Special Agent Tim Foley of the Chicago office of the U.S. Secret Service. While I have good reason to know that many Secret Service people are conscientious and highly competent, Mr. Foley's actions in Austin, Texas, regarding Steve Jackson Games not only exceeded his authority, but weren't even



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half competently done.

All told, a sorry chapter in the history of the Secret Service, and no service at all to those genuinely concerned with electronic fraud and computer crimes.

**The Big Orchid**

The Orchid of the Year goes to Mitch Kapor, for funding the Electronic Freedom Foundation and providing legal help and support to Steve Jackson, whose business was nearly ruined by the Secret Service in Austin. I hold no brief for electronic thieves and snoops, but many of last year's government actions were worse than the disease.

Thanks, Mitch, from all of us.

**The Long List**

A number of great products showed up at Chaos Manor last year. My goal has always been to think of a way to organize the annual User's Choice Awards, but I haven't been able to do that. I suppose it's appropriate that I do this chaotically.

**Backup and Data Storage**

First, in the category of data storage: Colorado Memory Systems tape units are

low in cost, high in performance, and very reasonable in price. Installation is so simple I won't bother to describe it: just follow the directions. I used the DJ-10 120-megabyte tape unit to back up 48 MB from the Gateway 386: it took under 10 minutes. The Colorado Memory Systems tape units can be installed internally—they take up about the space of a half-height 3½-inch floppy disk drive—or externally.

In my case, the drive is mounted externally, with a controller in the Gateway 386 and another in a machine out back; this allows easy data transfer as well as backup. Alex has installed a lot of these for clients and never has any problems with them. The Colorado Memory Systems tape units win a User's Choice Award. Highly recommended.

**Machine of the Year**

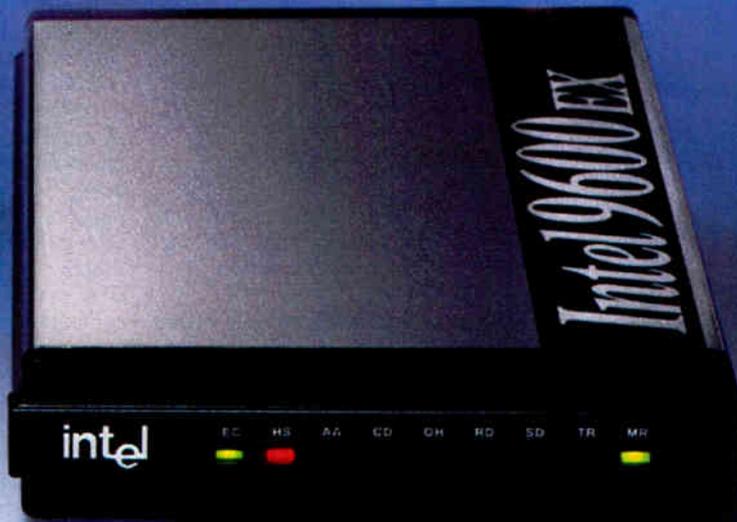
There's always stiff competition for the "most useful" system at Chaos Manor. Certainly the most spectacular system, and winner of a User's Choice Award, is the Cheetah Gold 486. This machine is so fast it scares you. Larry Niven has been using it as his workstation as we

pound out *Fallen Angels* and *The Moat Around Murcheson's Eye*, and sometimes when he saves a chapter, the Cheetah 486, working through a Perceptive Solutions, Inc. (PSI) HyperStore caching hard disk drive controller (more on that in a moment), saves the file so fast that Larry doesn't think it saved at all, and he does it again.

I named my Cheetah 386 Big Kat; with that name taken, I suppose I have to call the 486 Real Big Kat? In any event, we've beefed it up. The hard disk drive controller is by PSI, with 4 MB of cache on the controller; this gives such lightning performance that most benchmarks are meaningless. Let's just say that no matter what the task, including enormous AutoDesk Animator jobs, this system is spectacularly fast.

The only real rivals to PSI controllers come from Distributed Processing Technology; I've had a DPT SmartCache controller working in Big Kat for over two years without a glitch. This controller is solid and reliable and works with all the software we know of.

Both DPT and PSI get User's Choice Awards; but PSI gets the Best Controller



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## USER'S COLUMN

of the Year for their HyperStore. The deciding factor is that the PSI controllers use single in-line memory modules (SIMMs) for the caching memory; thus, you can buy the controller itself and shop around for more memory to fill it up. DPT controllers require their own proprietary add-on memory cards, which runs the cost up. Also, PSI controllers can be configured with their Mediadapter board, a piggyback board that lets the controller function as ESDI, SCSI, or other. This makes it much easier to use the PSI controller with your older hardware.

As for machines, the workhorse I do nearly all my writing on—I'm using it now—remains Big Kat, my older Cheetah 386/25 with the DPT SmartCache, Priam hard disk drive, Video Seven VGA board, Northgate OmniKey Plus keyboard, Maximum Storage WORM (write once, read many times) drive, Zenith Flat Technology Monitor, and USRobotics Courier HST 9600-bps modem. It's powered through a Clary uninterruptible power supply. I'm running Quarterdeck QEMM-386 and Desqview under MS-DOS 3.3; I expect at some point I'll change over to MS-DOS 5.0 and Windows 3.1, but I feel no pressure to do that. This machine is clearly the "most useful" one at Chaos Manor, in that I make my living with it, and it certainly gets hard usage. On the other hand, it's hardly new.

The other candidates for machine of the year are the Cheetah 486, the Arche Legacy 386/33 (which is certainly the fastest 386 in the house), the Gateway 2000 386, the Ergo Brick, and a small GoldStar GS-310 386SX.

You can say something special about every one of those. Begin with the Gold-Star GS-310. This small-footprint machine sells for less than many 286s. It's easy to add memory—it takes standard SIMMs—and it runs both Desqview and QEMM-386 just fine. My son Phillip has been using it as a kind of portable, carrying it to various colleges in support of his debate team, so it gets hard usage; and it has yet to develop any problems. I have no trouble giving this the Most Bang for the Buck User's Choice Award for 1990.

I've already described the Cheetah 486. It's certainly the fastest and most powerful machine in the house. If you need 486 power for AutoCAD or Unix, or if you just like big, powerful machinery, it's hard to beat the Cheetah 486, which collects yet another User's Choice Award.

The Arche Legacy 386/33 is another

powerful machine. It has been used as a test-bed for a lot of stuff, including Sound Blaster, the Kraft Thunderstick game controller, and Wing Commander, as well as LANtastic network cards, Rolermouse, the Pioneer CD-ROM six-pack drive, and Colorado Memory Systems tape drives and controller. Everything works just fine. The video card for the Arche Legacy is quite fast; we're able to keep up with Wing Commander's spectacular graphics. The Arche Legacy has the neat feature of slowing down to 8 MHz if you want it to do so; with some games, that can come in handy. It runs Desqview, QEMM-386, and our beta-test copy of MS-DOS 5.0 with no problems. It's faster than Big Kat. I have absolutely no hesitation in giving the Arche Legacy 386/33 a User's Choice Award.

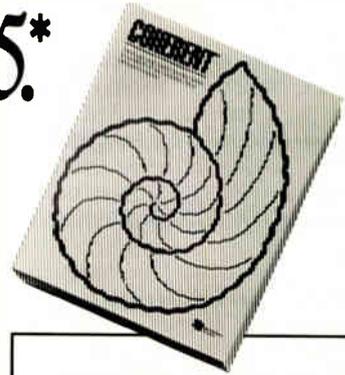
The Gateway 2000 386 is a lower-priced machine, but it's very well made. The standard hard disk drive controller is an Ultrastor Ultra 12 ESDI controller, which is faster and more reliable than the usual Western Digital controller. The Gateway comes with surprisingly complete and well-written documentation. We have it running with MS-DOS 5.0 with no problems. There's a built-in game port; I plugged the Kraft Thunderstick into that and turned on Wing Commander, and it all ran fine without any tuning or tweaking. The Gateway is a bit slower than the Arche Legacy, but it's plenty fast enough, and the VGA board doesn't seem to have much trouble keeping up with Wing Commander's spectacular graphics. There is no hardware switch to slow the Gateway 2000 down.

A number of companies are selling computers by mail. None of them are perfect: I have letters of complaint about most of them. But I don't have any about Gateway, and all the Gateway users I've heard from are happy. We used this machine as a test-bed for the US Video and Willow boards, California Memory Systems tape drives, TrackMan, ScanMan, and Maximum Storage WORM drive. There have been no problems. I have no hesitation in recommending the Gateway 2000 386, which gets a User's Choice Award.

Finally, there's the Ergo Brick, which I have written about several times. It's small, it fits into a briefcase, it holds a lot, and it's fast. It is now my regular companion when we go down to the beach house.

The only problem with the Brick is that you can put only short boards in it, and that's no real problem since the only board I think of to go in it is a fax board,

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Min. Memory Required	640K	1-2 meg
Performance*	38.7 sec	100.3 sec
Price	\$99.95	\$1495.00

Byte Exec benchmark, 1000 iterations on 20 MHz 386. hardware requirements: 1.2 meg 5¼" or 1.4 meg 3½" floppy, and ard disk. Does not run on Microchannel machines.

and the Fax 96 fits in there just fine.

The Brick isn't cheap, but you get a lot for the money. I'm really fond of the little sucker, and I don't have any problems at all giving it a User's Choice Award.

Cheetah recently raised their prices, and by quite a lot. The performance is magnificent, and the cost, while high, is competitive for that much performance. I do wish they cost less, but the Cheetah Gold 486 gets the Machine of the Year award in the PC category.

I have added a new award category because now that Apple has lowered prices, Macs have become competitive throughout the cost/performance spectrum; and what Macs do, they do very well indeed. The Machine of the Year Award for 1990 goes to the Mac IIcx; it has easily become the most useful Mac system here, being used with Excel and WingZ to control a number of business operations and analyses.

The neat part about the Mac systems is that as long as you stay with the standard operations (e.g., Excel, WingZ, and Microsoft Word), you really can sit a newcomer down at it, show what you need done, and go away. The User's

Choice Award and Machine of the Year, Macintosh Category, go to the Mac IIcx.

**Video and Monitors**

Video boards and monitors are improving weekly. They're getting faster and more spectacular. You can expect even more rapid developments in video graphics this year.

Meanwhile, the most spectacular addition to the Chaos Manor visuals is a Number Nine Graphics Xccelerator. It's *not* a stand-alone board; you need a VGA board to run with it. The Number Nine board takes a separate slot and attaches to the VGA board—nearly any VGA board will do—with an edge-connector cable. (Some video boards feed out through a pin connector, in which case you'd need the appropriate cable to connect the video card to the Number Nine board.)

Once the board is installed and connected to your VGA card, you can set up the Number Nine board to run at 1280 by 1024 pixels noninterlaced, with a palette of some 16 million colors. Many other resolutions are possible. Whatever you are running with it tends to look spectacular.

We put the Number Nine board into the Cheetah 486, where it happily runs AutoDesk Animator and a whole bunch of fractal software. The Number Nine board feeds into the Hitachi Accuvue 20-APF monitor (this is why Niven is using the Cheetah 486 as his workstation: he likes really big monitors because he doesn't have to wear his glasses to work with them). The combination is something to see. If this is where graphics are headed, I can't wait to get there.

If you're looking for high-end graphics capability, the Number Nine Graphics Xccelerator is a great way to go, and it looks great on a Hitachi 20-inch high-resolution monitor. Both Hitachi and Number Nine Computer get User's Choice Awards, and the Number Nine board is the choice for Graphics Product of the Year.

One last point: clearly not everyone will need to have a 20-inch high-resolution monitor costing more than they paid for their computer. My personal monitor remains the Zenith Flat Technology Monitor: the newest model isn't as heavy as the older ones and doesn't need a fan. The Zenith is a 31-kHz monitor, not a

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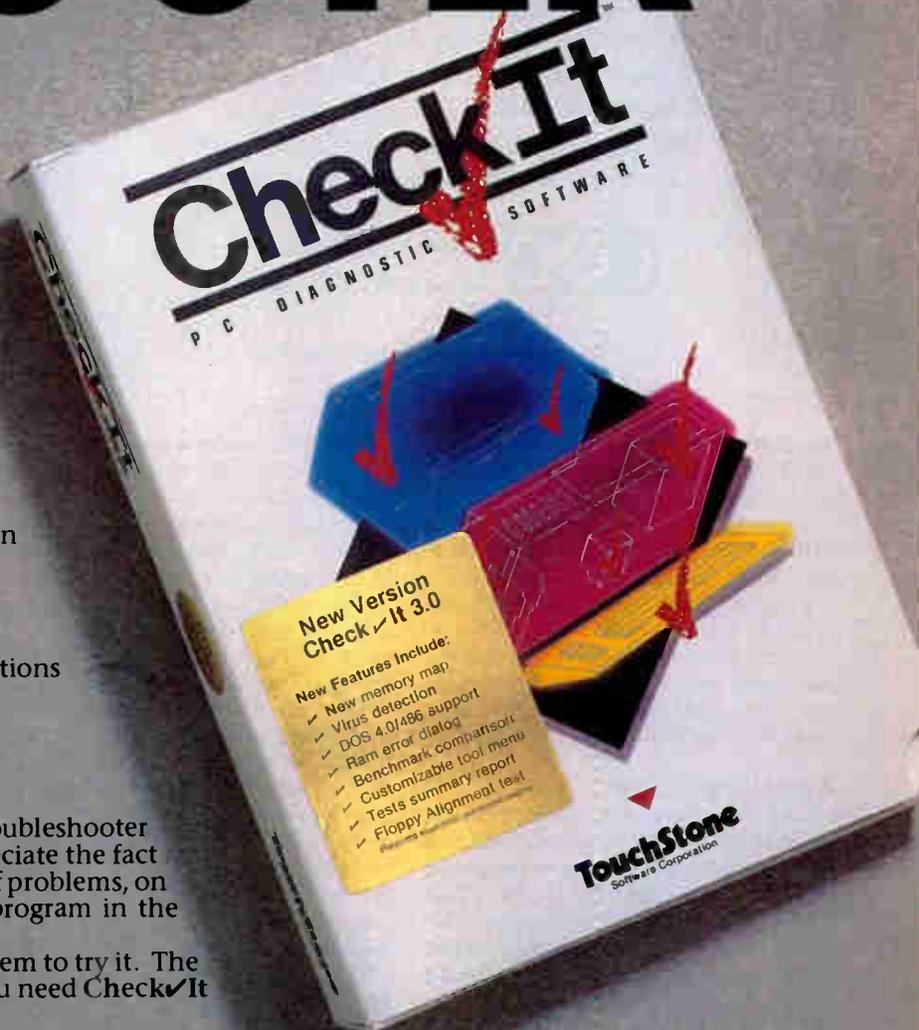
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## USER'S COLUMN

ple using CD-ROM because it's easier to use; no more long waits for your data. As the installed base of CD-ROM drives grows, so will the effort put into making CD-ROM software. The result should be a satisfying positive feedback. When you couple fast drives with better retrieval software and new advances in the art of making CD-ROMs, you have the ingredients of a new phase in the computer revolution.

Hitachi makes (at least) two models of CD-ROM drives: one is shaped like a small shoe box, but, while faster than the older drive, it is no breakthrough. The other is shaped like a pizza box and is extremely fast. The pizza box model, alas, requires you to use one of those horrible jewel-box carriers for your CD-ROM. I really hate those carriers because not only are they expensive—several dollars at least—but about half the time they're extremely hard to open.

To get more information on the CD-ROM revolution, get yourself a copy of the catalog of the Bureau of Electronic Publishing (141 New Rd., Parsippany, NJ 07054, (201) 808-2700). The catalog is an education in itself: you won't believe just how many CD-ROM products there are already.

Because I think the rapidly expanding installed base of CD-ROM drives is extremely significant, and that speeding up the CD-ROM reading process will do much for the industry, the Product of the Year Award goes to Hitachi for their fast CDR-1700S CD-ROM drive.

### CD-ROMs

There were a number of outstanding CD-ROM products last year. Quanta Press (2550 University Ave. W, Suite 245N, St. Paul, MN 55114, (612) 641-0714) continues to pump out an amazing variety of CD-ROM databases, including the CIA World Database, specialized stuff on agriculture, and so on. Their latest is Middle East Diary, a CD-ROM on the Middle East containing a great number of relevant documents on the history and culture of the area. The Bureau of Electronic Publishing put out a collection of documents, some rare, all interesting, on U.S. history. Grolier has improved their Academic American Encyclopedia.

There's also World Library's Library of the Future Series, First Edition. This one has a great collection of 450 books—all classic and most in the public domain, but an interesting set—and better-than-adequate retrieval software. When I started playing around with it, I found myself reading Samuel Butler's *The Way of All Flesh* until quite late into the night.

multisync, and while it works with most video boards, there are a few that it can't work with.

We use a lot of monitors around Chaos Manor; machines often arrive without one. When that happens, the "standard" I generally hook up is the Princeton Graphic Systems Ultra-14 multisync monitor. Princeton monitors work with just about everything. They're rugged, they have good color, and they're very good value for the money.

### A Significant Trend

I think one outstanding development for the year was one that no one else seems to have noticed at all: Hitachi is shipping a really fast CD-ROM drive, the CDR-1700S. That's important because CD-ROMs are becoming increasingly important. A couple of months ago I said that I wished every library in the country had a CD-ROM drive. A reader wrote to tell me that's very nearly true already: libraries are taking to CD-ROMs, which I suppose shouldn't surprise me.

Meanwhile, Dak and other quality high-tech mail-order houses are selling CD-ROM discs and drives direct to consumers; this in itself will raise the installed base.

CD-ROM technology won't be completely mature until the drives are both cheaper and faster, and some kind of eas-

ily portable reader screen is available. When it's as convenient to carry a CD-ROM reader as it is to carry a book—even a large hardbound—the book industry will really feel the impact of CD-ROM competition.

The screen hasn't been developed, although I understand that they now sell the Sony Bookman in Japan, which is getting closer to a real hand-held CD-ROM reader. No matter: long before we have portable CD-ROM readers, CD-ROM itself will have had a really significant impact on scholarship. Imagine, for example, exact and computer-enhanced images of the Dead Sea Scrolls taken in different light and contrast conditions and published on CD-ROM. This would give any scholar access to the primary documents: the entire cost of a high-resolution imaging system plus CD-ROM drive wouldn't come to more than the cost of a short trip to Jerusalem to view the documents themselves.

The same could be done for other rare documents and images. In addition, every word ever published on the subject could be indexed and included with the images—and the total production cost of the package would be a few dollars per disc. There's enormous potential for CD-ROMs in scholarship and business.

Hitachi's faster and cheaper drive will significantly increase the number of peo-

## USER'S COLUMN

Not only that, but I went back to it rather than going to the bookstore and getting a copy, which tells me that they've made this easier to use than I thought it was. Library of the Future Series wins the User's Choice Award as CD-ROM of the Year.

### The Software Scene

As I said above, I have mixed emotions about Norton Utilities. Version 4.5 was extremely valuable. Norton Utilities 5.0 did have a few improvements, but it left out some of what made version 4.5 so useful. I gather Symantec is fixing that now. Let's hope so.

On the other hand, if you have a Mac, you need Norton Utilities Mac. It's what Mac users have been needing for years, even if they didn't know it. Back on the PC scene, the latest version of Norton Commander has an imperfect, but very usable, MCI Mail management front end and several improvements.

I use Norton Commander and Norton Utilities a lot; indeed, I routinely install these, along with LapLink from Traveling Software, before I begin testing any new machine. If you don't have them, get them. Highly recommended.

A candidate for best software is Outside In. This is an extremely useful TSR program that lets you look into disk files of most popular word processors, spreadsheets, and databases (alas, Paradox and Q&A are not supported, although Q&A Write is, as are dBASE, FoxBase, Microsoft Works, and several others). It runs on a PC and works with both PC and Mac files. You can import stuff from your files into your word processor. This is one of those programs that once you have it, you'll wonder how you did without it. Definitely a User's Choice Award. Recommended.

One of the neatest programs of the year is Grammatik IV, the style and grammar checker. It's configurable, you can turn different rules on and off, and it works. I don't put everything that I write through it, but when I'm in a hurry, I find it valuable; it often finds errors I've missed. Grammatik IV won't teach an illiterate to be a professional writer, but it's amazing how much you can learn by using it. User's Choice. Recommended.

The two most valuable products I got this year were GrandView 2.0 and Info Select. That latter is the "improved" version of the Tornado free-form database; once again, some of the improvements weren't.

On the other hand, Info Select can save you a great deal of time, and it's a program you will actually use because

using it is pretty simple. You do have to spend some time puttering around, but go ahead and do that: it's fun, and the best way to learn Info Select features.

GrandView, for those few who don't know, is Symantec's outline program. It works. I have GrandView outlines on my portables, and when we're at the beach house, I often retrieve an outline for character collection. GrandView can import and export to most word processors, although the results are likely to be a bit messy; the outline formatting gets in the way of conversion of the text. But that doesn't even matter. I'm pleased to give GrandView and Info Select the User's Choice Awards for Most Useful PC Software of the Year.

### Accounting

I currently recommend Quicken for accounting. This is one of the few cases where I recommend something that I do not use: I still use the accounting package that I wrote back in CP/M days, largely for sentimental reasons, but of course I understand how it works. I don't recommend that anyone else try it.

Get Quicken. It's easy to set up, it does the job, and you can arrange to have it pay your bills through a modem. I know a number of people who do it that way, and I intend to set up that capability Real Soon Now. If I'd had Quicken, I wouldn't

have bothered to write my own program. Quicken gets a User's Choice Award. Recommended.

### Laptops

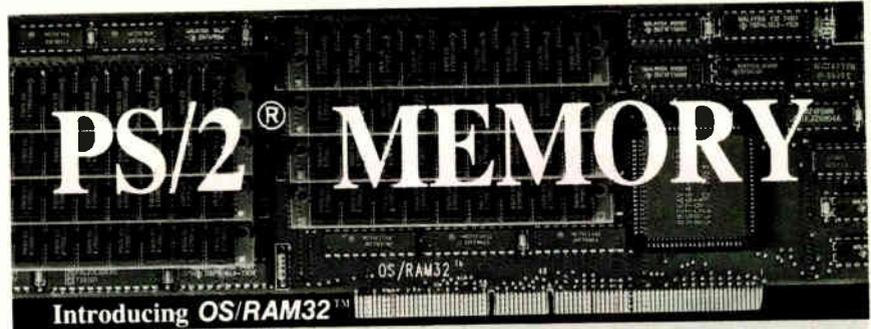
There were many new laptops in 1990, and I expect more this year. I used about 20 laptops in 1990 and find myself in agreement with the BYTE editors: the User's Choice Award for Laptop of the Year is the Texas Instruments Travel-Mate 2000 LT286. Fair warning: it is *not* the laptop to take outside on the beach at noon; under those circumstances, you won't be able to see the screen. Otherwise, though, the screen is quite visible, the power requirements are reasonable, and it's *light*. I like it.

### Gadget of the Year

There wasn't any contest on this one.

Several years ago, Stefan Possony, Francis X. Kane, and I wrote a book called *The Strategy of Technology*. Colonel Kane was at that time Director of Plans for USAF Systems Division. One of the strategic concepts he developed and got started was GPS, the Global Positioning System: a series of navigation satellites that enabled those with suitable equipment to locate themselves within a few feet anywhere in the world.

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the Magellan GPS NAV 1000 Pro to let all of us use the system. The Magellan is a hand-held, battery-powered gizmo considerably smaller than a shoe box. You use it by taking it outside, where it can see some satellites, and turning it on. It's nearly that simple: there are good instructions in the Training Guide, and more instructions are on the unit itself.

Once it has been set up, it will tell you where you are to within some 30 feet. It's a bit faster if you already know your altitude; if you don't, Magellan will find that for you, too. The unit comes with an auxiliary power source and software and cabling to let you use it with your laptop.

Magellan is the User's Choice Award Gadget of the Year.

**Keep Them Flying**

I don't know what category to put this in: All Computers' All ChargeCards will

put new 386SX life into your old 286 machines. They work with nearly anything, including the Zenith Z-248; one of my old friends from ARPANET has used these to update about 50 of the government-model Z-248s and is very happy with them.

You probably don't have that many machines, but if you've got an AT and want to run Windows or Desqview, get the appropriate All ChargeCard for your machine; you won't be sorry. The All ChargeCard gets a User's Choice Award. Recommended.

**Games**

It was a good year for computer games. Two notable ones were Lucas Films' Secret of Monkey Island, which is both fun and hilarious, and Interplay Productions' Lord of the Rings, which has flaws but is well designed and can be fun. Cen-

turion, Defender of Rome, from Electronic Arts is great fun, if a bit disappointing overall.

Koei improved their largely script adventure games and took the odious copy protection off. Koei games require a bit of patience: you won't win quickly, but there's considerable satisfaction in doing it. Harpoon from Microprose Software was easily the best modern war game of the year.

It was a good year for game equipment, too. We put a Sound Blaster sound board into the Arche Legacy 386/33, and the Ad Lib sound board into the Cheetah 486, and hung a pair of Radio Shack stereo speakers on each board. There's a lot of software that can take advantage of good speech and sound boards, and they enhance the fun of computer gaming.

With all that said, despite the general excellence of the games this year, there

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wasn't much dispute over which ones are the games of the year. There are two: one, Microprose's Railroad Tycoon, is the next best thing to having a wonderful set of electric trains.

The other outstanding game is Wing Commander from Origin Software. This is the kind of game I generally don't like: it's a shoot-'em-up in space. However, they've got the story line down pat, and the game sucks you right into the action; once you start playing, you find—or at least I found—the darn thing irresistible.

Both these games can be played on EGA systems with standard IBM sounds, but that's not the way to enjoy them. For Wing Commander, get a Sound Blaster: it comes with a game control port, and I guarantee you will get a joystick if you get hooked. For Railroad Tycoon, either Sound Blaster or Ad Lib will do fine. You will also want to have VGA, and Wing

Commander can take advantage of EMS memory.

Wing Commander and Railroad Tycoon tie for Game of the Year. I still play them both.

**Winding Down**

The book of the month is a new translation of *The Iliad* by Robert Fagles. I don't read Greek, but it's clear to me this is what Homer had in mind. It reads like—well, like a highly entertaining epic.

The computer book of the month is Bob Brant's *Build Your Own Macintosh and Save a Bundle* (Windcrest Tab Books). I once swore I'd never review another Tab book because of the horrible editing, but clearly the company has changed since being bought by McGraw-Hill. Brant's book is definitely worth having whether you contemplate building

your own Mac or not, since it will also help you understand and maintain the machine. It goes into everything from the Mac Plus to the IIfx; accelerators; add-ons, including video; and more. Well written and easy to read.

Now back to work: Niven and I will finish *Fallen Angels* this week. ■

*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 "jerrypp."*

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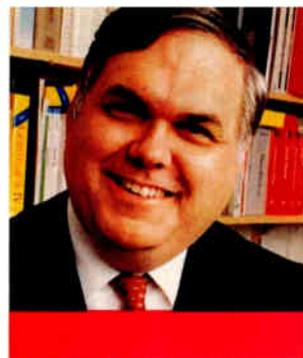
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## WINDOWS AND THE BUSINESS WORKSTATION

**T**here was once a time when picking out a computer for your business was relatively easy. You went down to the computer store and looked at all the machines on display. If you were lucky, the computer salesperson would show up to keep you company and tell tall tales. Eventually, your decision came down to how big you wanted the hard disk drive to be and whether you wanted a color monitor. For a while, at least, IBM-compatible computers were true commodity items.

Now, things have changed. While many machines can still be looked on as generic clones, the commodity nature of the computer business has been changed forever with the advent of graphical user interfaces. GUI packages require significant system resources, and the level and selection of resources depends heavily on the applications for which you plan to use the computer. It makes a great difference whether you use a machine for word processing or for massive spreadsheets and multitasking.

So what do GUIs demand of today's business workstation? Assuming that you're planning to use Microsoft Windows 3.0, and that you plan to use several applications concurrently, you'll need a large hard disk drive and a lot of memory. But that's not all.

### Workstation for Windows

Here's how I have a Gateway 2000 386/25 configured for use as a platform for both networking and for Windows 3.0: 4 megabytes of RAM, a 150-MB ESDI hard disk drive, a Super VGA video controller, an 80387 math coprocessor, and a 3Com 3C503 Ethernet card.

A high-end machine? You bet, but I do a lot of multitasking, and the workstation must also communicate with Novell NetWare 386. Some users could do just fine with a 386SX-based machine if their multitasking needs were more limited. Still others could use a less-expensive 286-based machine, but they'd lose the ability to multitask DOS applications.

In general, the requirements for a useful workstation have changed greatly over the last few years. Where once a 640K-byte, 8088-based machine was fine, the advent of Windows 3.0 makes a 386- or 386SX-based machine more useful. Keep in mind, though, that the useful economic life of a personal computer is only three years, and the useful hardware life is about five years. For that reason, there's no point in worrying about requirements that might crop up more than a couple of years hence. The reason for this is that most com-

panies amortize their computer purchases over three years, which is reasonable given the rate of change in the industry. For some companies, it takes five years to depreciate hardware, and by then most computers are only marginally useful if they are running at all.

A couple of the items on my standard Windows workstation aren't strictly necessary for all Windows users. One is the math coprocessor, but I'm using that in support of some graphics packages that I'll be telling you about in a few months. Meanwhile, a few other packages, such as Microsoft's Excel 3.0, also take advantage of the math coprocessor. Likewise, a hard disk drive as large as 150 MB may be overkill for some users, but many of today's applications, especially those intended for Windows, use many megabytes of hard disk space. Extra space costs relatively little, and you'd be surprised at how fast it can disappear.

One of the other facts that I've found in the months since Windows 3.0 was shipped is that the number of applications supporting Windows has increased dramatically. This was highlighted by the fact that I managed to fill up the entire 150-MB hard disk on the Gateway 2000 almost as soon as I began installing Windows-related software. The disk space on the file server offered some relief, but that's starting to fill up, too.

In some cases, the surge in applications designed for Windows has meant that the learning curve for users is less steep than it once was. Many applications use similar actions to create similar results, although the environment is not nearly as standardized as you would find on the Macintosh, for example. On the other hand, many applications work fine in a Windows environment but do not use the Windows interface. In many of these applications, the use of the

**GUIs such as Windows  
3.0 complicate  
PC purchase decisions**



software under Windows may cost you some utility. I have found, for example, that WordPerfect 5.1 cannot find the mouse when used under Windows.

**Problems with Windows**

When I wrote about some of the problems with Windows in the *BYTE IBM Special Edition* last fall, some readers took issue with my statements. This caused me to check more carefully, but in the process I found that problems were more wide-

spread than I had previously suspected. In short, Windows can be fairly fussy about its hardware environment, and it won't run on everything or work with software or hardware you might already be using. Also, some things about the Windows environment seem to stretch the limits of knowledge for many users.

Some machines, for example, simply won't run Windows 3.0 at all. There are a couple of IBM PC clones in the BYTE offices in Peterborough that won't run

Windows, despite the combined efforts of the BYTE staff. To this day, senior editor Ken Sheldon has to take our word for the existence of Windows, since he is one of the unfortunates who has been assigned a non-Windows-capable computer. There was a time when I didn't think that Windows would run on the Gateway 2000, either. In that case, it turned out that the Windows driver for the ATI video card installed in the machine was defective. When I told Windows that the card was a generic VGA card, the problems disappeared, but not before I became convinced that Windows multitasking bordered on the mythical.

**A Taxing Problem**

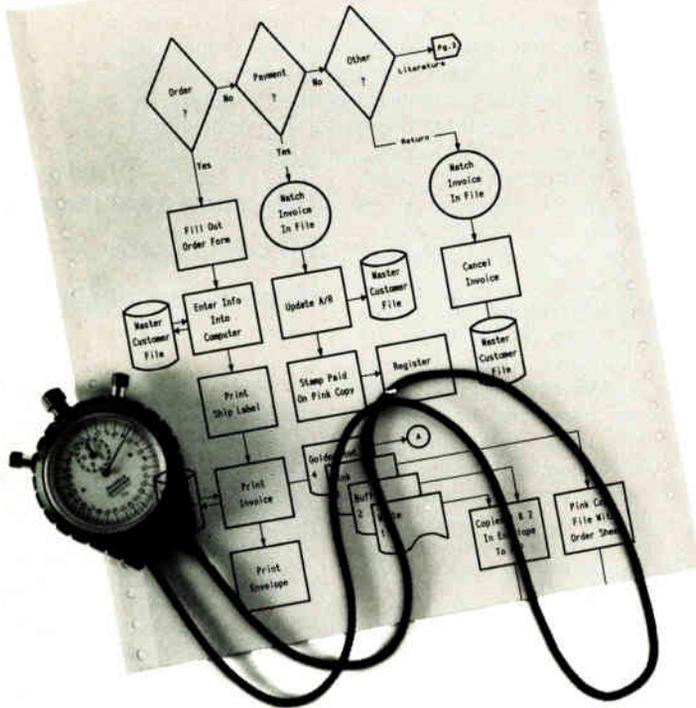
Some things still escape precise description with Windows 3.0. On New Year's Day, for example, I spent a few minutes installing MacInTax for Windows from SoftView. This is an excellent package that I began using last year after a few years of using PC Tax Cut. One of the things you do with MacInTax for Windows is install a slew of those fonts the IRS loves. The fonts are required for MacInTax to work with the HP LaserJet III and compatibles. Once I saw that the fonts weren't all that hard to install, I went ahead and installed more soft fonts for the LaserJet that I had on hand. Finally, in a fit of font fiddling, I installed ZSoft's SoftType, which has yet more fonts for use with Windows.

Once I did this, MacInTax for Windows would no longer print properly. A once-perfect tax form would now show odd blank spaces in some places and superimposed text in others. I still don't know why it's doing this, although I suspect that I'll have to reinstall MacInTax for Windows to cure it. While normal users don't go through font orgies, the fact that installation of unrelated software can have an effect on a Windows package is something that users need to be aware of and to look for if results are not as anticipated.

**Networking with Windows**

Just when you think you have a handle on the Windows challenge, there's always the challenge of networking. Once I got the Gateway 2000 up and running reliably with Windows, Unisys sent me its latest i486-based computer. Included with the machine was yet another copy of Windows 3.0. Since I was eager to use this machine, and since I have a certain upper limit on the amount of machinery that I have space for, I decided almost immediately that I'd need to add both machines to the LAN if I expected to be

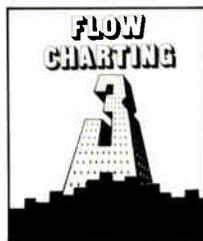
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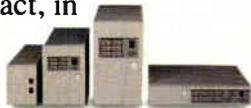
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able to print on the LaserJet with them. This meant that I'd have to find a way to make Windows 3.0 work on a networked computer, and that I'd have to do it in the 386 enhanced mode. As it turns out, networking with Windows is not always easy, and it's not even always possible. While I was able to add both the Unisys 486 and the Gateway 2000 to the LAN, I had to change to new network interface cards to do it. In some cases, even that's not enough. The first thing I did was try using a Micom/InterLan 5010 Ethernet card that was already installed in the Gateway 2000. I never found the proper combination of I/O addresses and interrupts to let the machine work with Windows 3.0 and the other peripherals that were attached. Since 3Com had sent me some of its 3C503 Ethernet cards at about that time, I tried those instead. The default settings didn't produce any better luck than I had had with the card that it replaced. One important difference, though, is that the only setting on the card that I had to set with jumpers was the I/O address. Everything else was set with software, which made finding a usable combination much easier.

As it turned out, the default I/O address of 300 hexadecimal conflicts with many VGA cards, including those in both the Gateway 2000 and the Unisys. This doesn't seem to matter unless you're running Windows 3.0, which meant that I could use either Windows or the network, but not both. I solved the problem after asking for advice on BIX and doing a bit of sleuthing with Manifest from Quarterdeck Office Systems. I changed the jumper to a new I/O address, 2E0h, and told the NetWare shell to use IRQ5. After that, everything worked fine. Unfortunately, all such solutions are not so easy. Many users of Token Ring cards, for example, have found that they have to tell Windows 3.0's memory manager to exclude large segments of memory. Even worse, users of some Northgate Slimline computers have found that there is no way to use ARCnet and Windows at the same time. Because these machines have their video card on the motherboard, and because of the way they handle memory, the Windows 3.0 memory manager is unable to resolve the conflicts between the requirements of ARCnet cards and the requirements of the video hardware. At this point, a solu-

tion short of buying a third-party video controller apparently doesn't exist. Most Northgate computers don't have this problem, nor do all the company's Slimline machines, but some of them do. Once you have Windows 3.0 and the network running at the same time, you can switch between network resources and those on your workstation easily, for the most part, although there still can be surprises. For example, Windows displays each virtual disk drive on your network as if it were a real drive, and when you use the File Manager to switch to that drive, it reads the entire file server so that it can get you a picture of the directory. This is fine on some file servers, but as hard disk drive sizes grow, the time required for this increases, and while it's going on, there is a fair amount of disk activity on the server. In extreme cases, the File Manager can use up a significant amount of time, such as when you're using a good-size VAX as a file server. If the VAX is heavily loaded and traffic is slow because of that, you can wait for several minutes while the File Manager tracks down the VAX's directory structure. The added disk activity, meanwhile, can also slow down access for other users, especially if the computer that you're using for your server isn't quite big enough for the job. Despite the difficulties, the results can be rewarding for those who want to use Windows 3.0 in a networked environment. Keep in mind that you need to buy hardware that will support the needs of Windows, and you need to buy from a vendor that will offer adequate support. Part of this comes from making sure that all your requirements are met, rather than from simply buying whatever is cheapest or best known. Likewise, the solution to selecting the best workstation may take work and time, so be prepared for that as well. Finally, it all depends on clearly defining your requirements. That way, both you and the vendor will know what your goals are and will have a better chance of meeting them. ■

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

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

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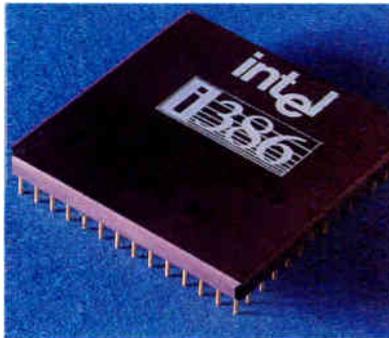
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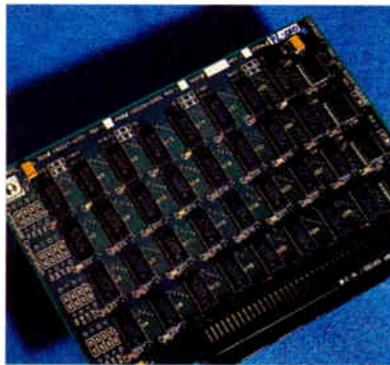
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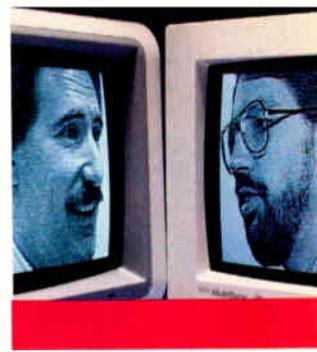
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# ROUNDTABLE



**BYTE** columnists, staff, and contributors debate the issues

## WHITHER INNOVATION?

**R**oundtable 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.

**KEN SHELDON:** Looking back at the history of the personal computer, innovation sometimes came from large companies, which funded research through facilities such as the Xerox Palo Alto Research Center, but just as often it came from garage shop inventors (à la Jobs and Wozniak) who left large companies or who started their own companies (à la Gates). So where do people look for innovation today? Is it still possible for the mythical “little guy” to make a better mousetrap? Or do you have to be a highly funded company to make your mark now? What are the things stifling innovation? What can people do to encourage it?

**JERRY POURNELLE:** With better languages come better software. Today it is important to think of things for the computer to do and for the computer to do them well. With good enough languages, accountants can write accounting programs that are readable by other accountants, engineers can do engineering, and so forth. That trend is beginning to slowly emerge, but it has been much slower than I would have thought.

**BEN SMITH:** COBOL is still the best language for accountants. It was designed with the criteria that you mentioned, and it is definitely the standard. Look where it came from, though: the Navy! This brings up a point about innovation: This discussion should be about what comes from the big team and the little team. Unix, after all, originally came from the efforts of two folks at Bell Labs. COBOL, I think, came from one person in the Navy. Pascal came from a computer-science professor in, I believe, Switzerland.

**WAYNE RASH JR.:** The primary author of COBOL is Grace Hopper. I once had an interesting discussion with her about COBOL and the future of computing. She believes that COBOL ought to be scrapped as soon as possible. She’s convinced that it’s holding up innovation because of its limitations.

Innovation is a creative process that can exist in nearly any environment, but it will flourish in only a few. While there are many important factors to creativity, and therefore innovation, the size of the organization is not one of them. Hewlett-Packard’s work on the calculator and DEC’s work on the minicomputer show a great deal of innovation in the corporate arena. Today, you can see significant innovation at IBM labs in Zurich and elsewhere, where major strides are taking place in nanotechnology.

The innovators need time and financial support to devote to the innovation. For example, Visix’s Looking Glass got its initial start-up capital from a company that funds a large number of research efforts. Other innovators start with personal funds and then find their own investors. Still others are purely corporate in origin.

In many cases, a lot depends on the scale of the project. While development of a software package is often within the grasp of an individual, a larger project might depend on corporate resources, simply because most people cannot afford to pay for it. There are two parts to innovation: creating the item and convincing people that it’s useful.

**TREVOR MARSHALL:** Innovation invariably comes from a small organization or group—often from the mind of an individual. Big companies develop; they don’t innovate. The aerospace industry is a good example. I don’t know any engineering manager who goes to a meeting at, say, McDonnell Douglas and says, “Today I want you guys to make a major breakthrough in airfoil technology.” Instead, he or she might say, “Let’s work on the design of the airfoil and try to make it more efficient.” That’s what big

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## ROUNDTABLE

organizations do well. The problem is that virtually no funds are available for entrepreneurial support these days. I formed YARC with my own savings. It is a \$3-million-a-year company with some impressive contracts and further growth potential, yet not one venture capitalist has seriously thought about backing it. They want it to grow to \$20 million a year and then organize a leveraged buy-out for a sure-fire financial investment with no significant risk.

**LARRY LOEB:** Innovation is an individual's provenance, not something that a committee can do well. The individual may, of course, draw on previous works to effect the innovation (why reinvent the wheel?), but those previous works alone won't make the innovative solution obvious. It takes a clarity of vision to see the whole of a problem beyond its individual parts that points the way to innovation. Large groups dilute this clarity by the introduction of extraneous structural factors; for example, writing reports instead of spending time doing what you are writing about. Yet, the financial and logistic resources of an organization are needed to popularize and produce any innovation that emerges.

One way to resolve this seeming impasse is the formation of "fellow" positions within an organization, much as Apple has done. This reduces the structural constraints so that the individual can spend more time productively.

**STAN MIASTKOWSKI:** It all comes down to dollars and cents. Small companies usually operate on a shoestring. They just don't have the budget to compete with the huge advertising and promotional campaigns of large companies, despite the fact that many of the heavily promoted products are boring knock-offs or even inferior.

The industry's venture capitalists, who once kick-started this industry by backing true innovation, are no longer interested in really innovative products. As the economy stagnates, the situation is likely to get worse.

Fortunately, the current state of the economy is forcing both individuals and volume buyers to get the most value for their dollars. This opens a door for the companies that are selling truly innovative solutions. The most conservative buyers will stick with products that are "tried and true," but some will search for innovative value.

**FRED LANGA:** Don't we punish innovators? There is so much emphasis on

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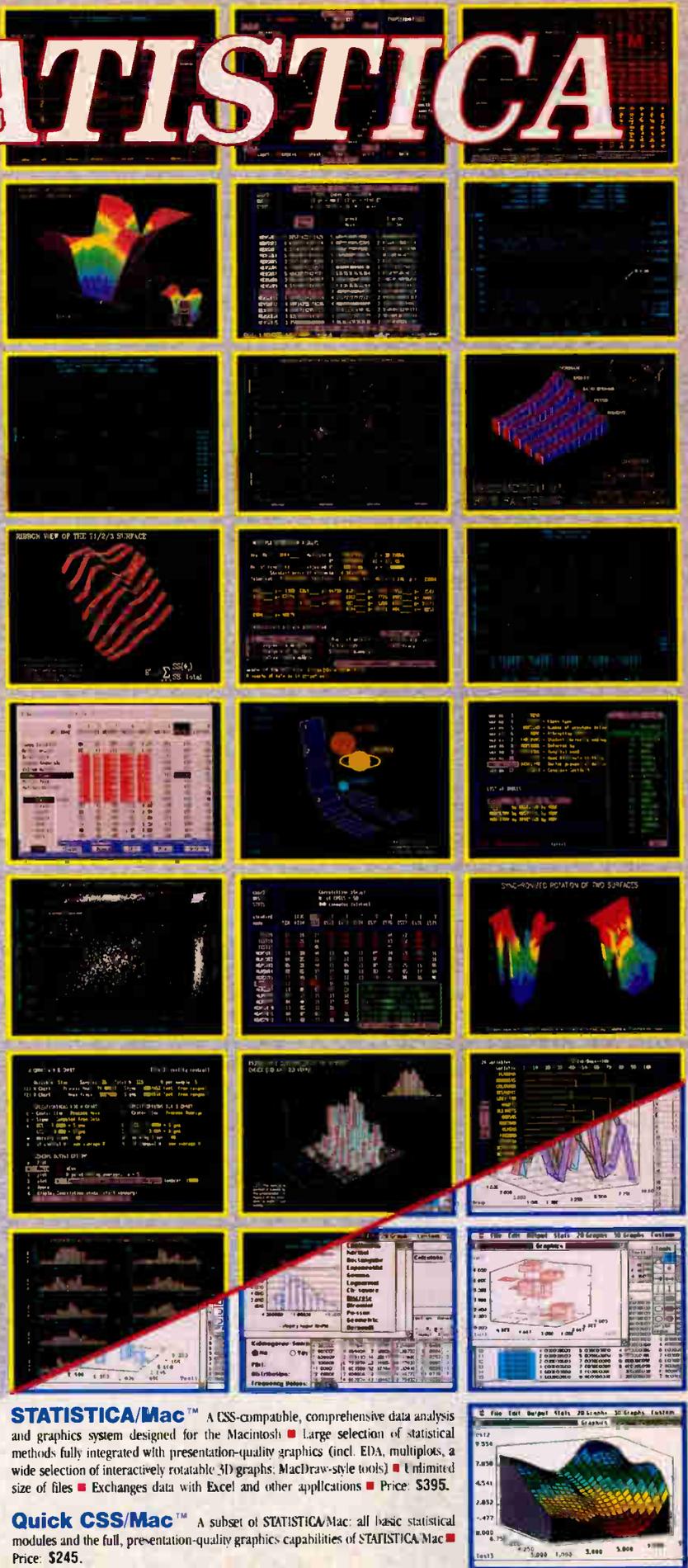


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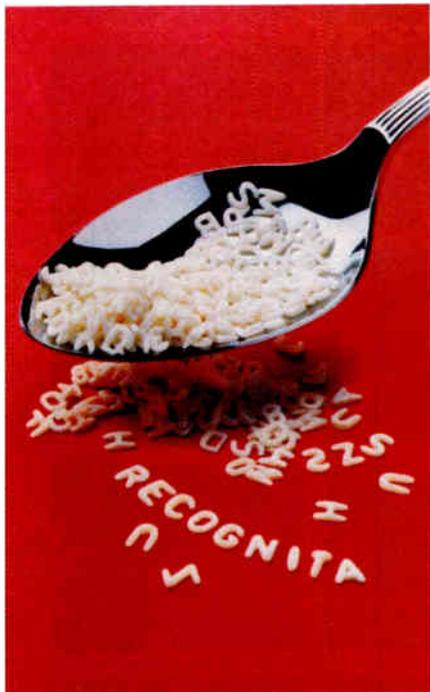
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## ROUNDTABLE

"compatibility" that innovation often gets lost in the shuffle. The Atari 800 had demonstrably superior graphics to the Apple II's, but it didn't support Apple's huge software base, so it didn't go anywhere. The Amiga offers lots of advances, but in nonstandard ways that doomed it to a niche. Look at the Next. It's not compatible—but it's innovative. Does the world really want innovation?

**RASH:** The world does want innovation, but on a realistic basis. The world has to protect its investment. We don't punish innovation, but we do make innovators find ways to fit their innovations into the way we live.

The Next is a good example. It's a nice machine that is innovative in some ways, but mostly it's innovative in ways that make life hard in the real world. For example, why ship a machine without a floppy disk drive? Innovation like that is like selling a car without wheels.

The problem with the Next system and many other machines is that the innovation is incomplete. The machine is black and cube-shaped, but the black-cube look is no more functional than some other color or shape. It also has a nifty version of Unix and a laser printer. But is its version of Unix better than what Sun or Apollo is using? Finally, it has Display PostScript, which is innovative, and for some functions (publishing, mostly) it's even useful. But other ways work well to achieve the same end for less money.

The other cases you mentioned prove that innovation isn't everything, but it is important. If the Amiga wasn't as innovative as it is, it would have died long ago. The fact that it still sells in large numbers shows that innovation can make up for poor marketing.

**LANGA:** Is the problem, then, that of telling real innovation from useless change? The Next comes with NextStep, a nice collection of object-oriented programming tools and class libraries; it's about the slickest environment going. But what gets attention is the matte-black finish and the shape. If NextStep were offered by itself, would it have fared better if everyone's attention hadn't been diverted by silly black paint jobs? Would we have paid more attention, or less, if no one had ever heard of Steve Jobs?

**LOEB:** Steve is a good hook to get Next noticed, because you know what Steve's already done. But that track record also colors the expectations you bring to the machine. You expect some innovation, so you are less surprised by it when it is

**I**nnovation for its own sake, while interesting, simply isn't enough.

there. Getting rid of floppy disk input may be one person's innovation, but the market didn't see it as that.

**RASH:** But that's the point: Innovation for its own sake, while interesting, simply isn't enough. The innovative product must still exist in the real world, solve real problems, and work for real people if it's going to have any direct effect on the world. Otherwise, it may serve only as a prototype or an inspiration.

Without Steve Jobs, I doubt that we would have noticed the Next at all. All the comments I hear about the Next in the business world rarely mention NextStep. It's looked upon as a flashy, but overpriced and rather slow, workstation.

**DAVID FIEDLER:** Take something even lower-tech than computers: TV. There is a big push on for HDTV, but a number of real-market factors are in the way of that. First, HDTV broadcasts are likely to be incompatible with today's TVs. Second, the American public has shown in the past that it is not unduly influenced by quality; what it wants is convenience (i.e., VHS versus Beta videotape format or 35mm versus Instamatic cameras).

**LANGA:** Jerry, you have stated many times how the FCC rules alone make it virtually certain no more garage start-ups will succeed. About the closest thing to a small start-up making good lately is Cheetah, and that's not a unalloyed success. Cheetah has produced some nice hardware, but it was often late and over the announced price. The company was bought by Northgate. Could a neo-Jobs and a neo-Wozniak succeed today?

**POURNELLE:** I don't see how in PCs; not with innovation. Northgate was a marketing success, but then it had to buy Cheetah to get innovative technology. The government, as always, operates to stifle initiative. The major enemy of capitalism is capitalists, who want to restrict entry into whatever they have developed, which means to stifle innovation. ■

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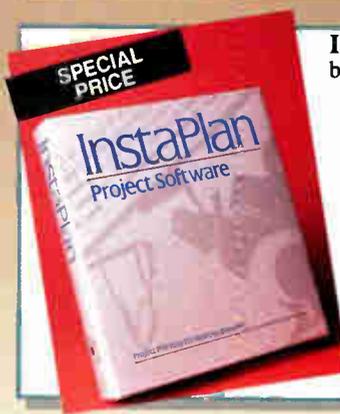
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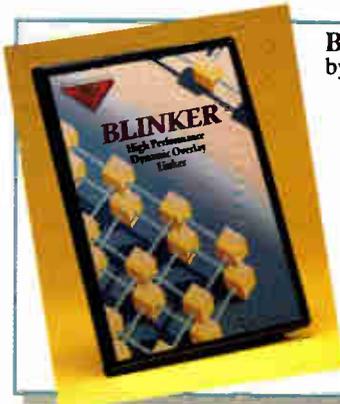
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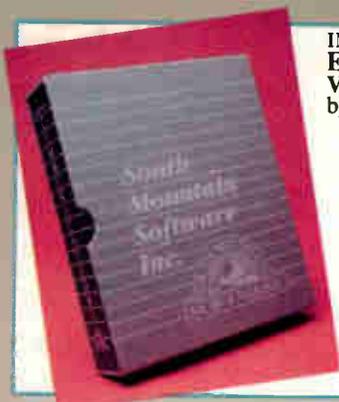
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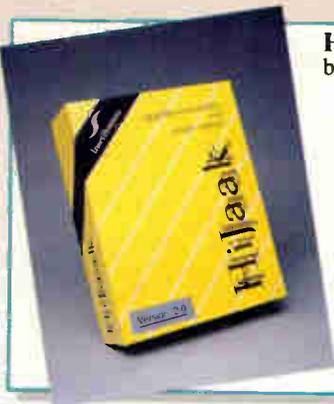
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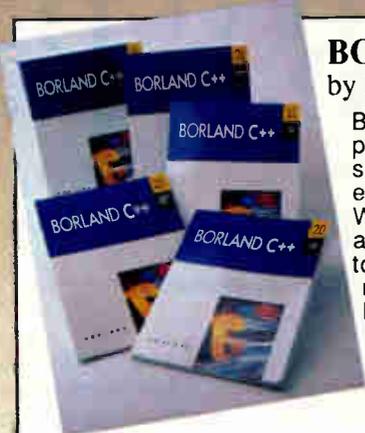
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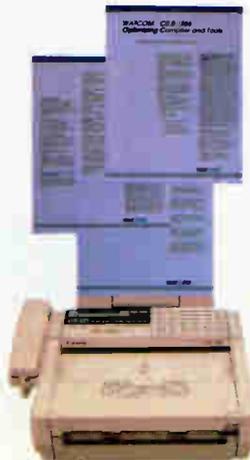
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# Computing in the U.S.S.R.

Soviet "informatics," suffering from years of official policy that has hindered hardware and software development, looks toward the future

IGOR AGAMIRZIAN

**O**n December 7, 1988, the academician Andrei Petrovich Ershov died in a Moscow hospital at the age of 57. His death went unnoticed in a country concerned with the tragic consequences of the Armenian earthquake. However, for specialists routinely dealing with computer science in their work, the event signified the end of an era.

This article is not an obituary of Ershov. It may, however, be the obituary of Soviet computer science, a demise that threatens to become the straw that breaks the back of our collapsing economy.

## In the Beginning . . .

The first computers appeared in the late 1940s and early 1950s in the U.S., Great Britain, and the U.S.S.R. The cold war between the East and West caused an avalanche in the development of military equipment, and the creation of new arms required ever-increasing calculations. Thus, the first generation of computers was intended to solve the problems of ballistics and nuclear physics.

In the 1950s, however, the U.S. began using computers to solve business problems. Work began to automate programming and create high-level languages; programming in machine codes had become too time- and money-consuming. The first valve-operated monsters were replaced with solid-state devices. Backing, main, and internal storage volumes grew significantly. Performance became thousands of times faster.

Progress in the development of high-level programming languages and their compilers predetermined the look of programming. In the 1960s, ALGOL occupied the leading role in the U.S.S.R. Classical Soviet developments of compilers were associated then with ALGOL.

A series of computers called BASM (the Russian abbreviation for large electronic computing machines) was created under the guidance of S. A. Lebedev. In the mid-1960s, this led to the construction of the first line of Soviet program-compatible computers, called the M-20. The family included the M-20, BASM-3M, BASM-4, M-220, and M-222. The first compilers engineered for these computers were called Alpha, TA-1, and TA-2. Ershov, S. S. Lavrov, and M. R. Shoura-Boura headed teams of programmers that created the first Soviet ALGOL compilers for the family of M-20 computers.

In the late 1950s and early 1960s, the U.S.S.R. established centers for the





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## COMPUTING IN THE U.S.S.R.

development of informatics and computer science. (Informatics deals with information processing, including mass media, publishing, and intelligence activities. Here, however, I use the term to mean a sphere of problems associated with data processing involving the use of technical aids.)

In the U.S., the motivation for developments in computer science shifted from military applications to the search for methods of increasing labor productivity. Advances in microelectronics led to the creation of ICs, which permitted the development of a third generation of computers. Software became more complicated, and operating systems replaced the second-generation master-control programs.

At the same time, informatics and computer science in the U.S.S.R. again came under the influence of politics. (The golden age of Soviet informatics fell within the years of Khrushchev's thaw—you cannot imagine cosmonautics without computer science, and the attention Khrushchev paid to cosmonautics is well known.) Conservative forces that came to power were interested only in preserving the status quo and unavoidably contributed conservatism to policies regarding technology. Developments were curtailed all over the country. The American IBM Model 360 (1965) was suddenly adopted as the Unified Computer System by the Council for Mutual Economic Assistance (CMEA), or Eastern European countries.

The era of developments ended in 1968 with the appearance of the last computer in the BASM family, the BASM-6. After that, there was nothing. Millions of rubles were invested in the development of computer science to no end. The country once again took the fruitless road of copying Western models and assumed that by copying another technical innovation it would save so much that the products would surpass those of competitors. (Edsger Dijkstra, a classic software engineer who visited the U.S.S.R. in the late 1970s, said in a public speech delivered in the Grand Hall of the Academy of Sciences in Leningrad that he regarded the fact that the U.S.S.R. produced IBM computers as the biggest U.S. victory in the cold war.)

You might think that the history of informatics in the U.S.S.R. after 1965 is that of a thoroughly planned strategy against the Soviet people. But this strategy was planned not by bad Americans but by good and experienced Soviet leaders trying to improve the public welfare. The cause was indifference, selfishness, apathy toward tomorrow's problems, an absence of responsibility to the people—everything associated with what we now call the administrative system.

That system failed not only in informatics and computer science but in agriculture, industry, transportation, and communications. One example: Why did the shuttle *Buran* take off so late? Undoubtedly, one reason was the absence of the computers required to simulate its aerodynamics. Americans made calculations for their shuttle on computers of the 1970s, which surpassed Soviet computers of the 1980s.

### The Soviet Seventies

In the early 1970s, the most popular computers in the U.S.S.R. were the M-222 and the Minsk-32. Scientists at the Nuclear Physics Institute in Dubna created one of the first Soviet FORTRAN compilers, and FORTRAN for the M-20 appeared. A new line of Soviet computers was announced—the Elbrus—whose design was suspiciously similar to that of systems from the American company Burroughs. Everyone looked forward to the appearance of ES (“Unified System”) computers, which were to be compatible with the IBM Model 360.

I first saw an ES computer when I was studying informatics and computer science at the faculty of mathematics and mechanics at Leningrad University. My fellow students and I were

# An American Programmer in Moscow

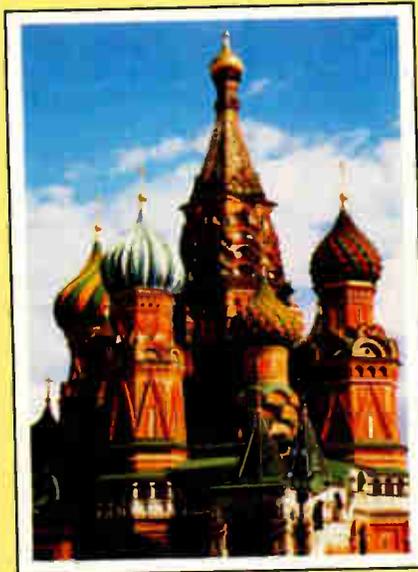
Alex Lane

Nearly 15 years had passed since I had been in the U.S.S.R., and the border guards were just as steely-eyed as ever. But I passed through the line with hardly a glance from the customs officer, met my driver, and headed for downtown Moscow. For the next few days, as part of the Borland team at the First International Computer Forum, I'd be showing off Borland products, talking with Soviet programmers, and seeing Soviet computing up close.

It should come as no surprise that Soviet programmers look and act very much like their American counterparts. They ask much the same questions, too. While waiting for a customs official to unlock a vault, several young programmers who had volunteered to help carry boxes of literature plied me with questions. What languages did I program in? What did I think of FORTRAN? What about upcoming Borland products? Windows? OS/2?

Not all questions were about computing. One fellow asked me how Americans went about finding jobs after graduation. My answer fascinated them, since the idea of going out on your own to look for work is quite foreign to the Soviet mind. Another naively asked if Americans really were taught to hate Russians.

When it comes to producing code, I found that Soviet programmers know their stuff. Their major stumbling block isn't the quality of hardware or software; it is the quantity. I saw mostly 286 and 386 hardware, obtained from Pacific Rim countries. Software is routinely pirated, and masses of accompanying



documentation are no barrier to piracy, despite the nonavailability of photocopy machines. Soviet programmers simply combine computer technology with the *samizdat* (self-publishing) technique of political dissidents to create complete versions of documentation for electronic distribution.

Ironically, copy-protection schemes are high on the list of software that Soviet programmers like to develop. I sat through several demonstrations of such schemes, complete with vague explanations of the modus operandi, and none of the programmers could be convinced that the schemes could be broken.

Closely associated with copy-protection software is work on antivirus programs. I was told viruses were a serious

problem in the Soviet Union, especially since they were often aimed at "the system" by disgruntled individuals. One programmer was hard at work developing a virus-description language that would allow a programmer to easily create software to detect and neutralize newly identified viruses.

While most Soviet programmers understand English and work with English source code, a third major area of programmer involvement is the Russification of foreign programs. Efforts here range from some neat hacks by one-person shops to complete systems, such as the one developed by the ParaGraph joint venture for Paradox.

Of course, programmers everywhere dream of developing the next killer application—the one that will sell millions of copies and bring them fame and fortune. Soviet programmers are no different, and for the duration of the forum, there was a steady stream of hopefuls at the Borland booth wanting to show their pet applications. Technically, most of the programs were pretty sharp. However, virtually all of them had been developed with no market in mind and so were of limited interest.

Soviet computing is on the verge of an expansion akin to the growth in the U.S. in the 1980s. Soviet developers are becoming aware of the domestic and international markets. Don't be surprised to find the U.S.S.R. emerging in this decade as a major player in the computer revolution.

*Alex Lane is a senior technical writer for Borland International. He can be reached on BIX as "a.lane."*

proud of Soviet software engineering, convinced that there were positive aspects in our dated computer hardware: It was a training factor that enabled us to engineer applications that were better than American programs. Americans, we thought, did not care about efficiency, but we had to, so we were better programmers. (It was true, to a certain degree. At least, the West always treated Soviet programming schools with respect, and a

Soviet programmer emigrating to the West could find a job with ease.)

At that time, programming was becoming a mass specialty in our country, and the need for automatic-control equipment for thousands of plants required new software. As the ES computers were put into use, more users preferred FORTRAN and PL/I, and the ALGOL traditions in the U.S.S.R. faded away.

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## COMPUTING IN THE U.S.S.R.

System programming became devalued, as Soviet clones of foreign computers and "borrowed" copyright software became available.

Few people realized that further progress in informatics was impossible without system developments. We naively hoped that small groups of highly qualified software engineers scattered all over the country would be able to withstand the powerful stream of copyrighted software. We did not understand that the creation of successful software is another science, for which understanding optimum translation algorithms is insufficient.

The late 1970s saw the development of CM computers, a family of small computers, bringing a CMEA program for the creation of computers modeled after the most successful American minicomputer, the PDP-11 from DEC. As the system's mass production was organized, the country soon filled with new Western software. There followed a period of conversion (i.e., the adjustment of Western software to Soviet computers, involving the translation of program messages into Russian.)

Soon, we forgot our own system development traditions. It was much more convenient and profitable to steal than to create something of your own. A whole generation of programmers was unable to create its own programs but could readily understand and improve other programs.

How could borrowing (or more honestly, stealing) foreign intellectual efforts become almost a state policy for informatics and computer science? The reason lies in the deepest contempt for intellectual creative work. In developed countries, copyright laws protect the humanitarian as well as scientific and technological spheres. In the U.S.S.R., the product of intellectual work does not belong to its author; it does not even belong to the organization within which it is developed.

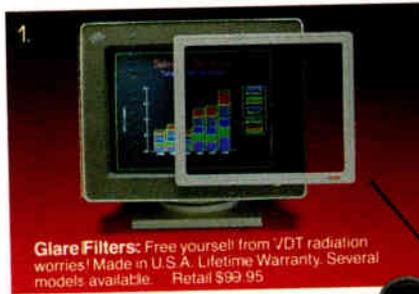
Unfortunately, this is one of the main reasons for our decline in these disciplines. Why should we invest in products if we can obtain everything free? At first glance, it might seem more profitable to use stolen programs. Most Soviet software is only produced in a few copies, and some programs are used only by their authors or programming organizations. A special fund of algorithms and programs, state and regional, has existed for many years in the U.S.S.R. Programmers are well aware of the complications they must overcome to incorporate software into this fund.

Some readers may object to my thesis that the cause of all mishaps in Soviet informatics and computer science lies in copying. What about the international tendency toward unification of computer architectures and software? Clones of the Intel 8086 chip are produced not only in the Soviet Union (the KM1810BM86) but also in Japan, Hong Kong, and Taiwan. IBM PC-compatible computers are produced not only in the Soviet Union (where they are called Iskra-1030 and ES-1840) but by hundreds of companies in dozens of other countries.

But there are differences: Unlike companies in the U.S.S.R., other countries' companies buy licenses and technologies. Buying technologies gives them a lead in time (Southeast Asia begins to copy new American products within several months, while the U.S.S.R. waits several years) and quality (the reliability of Taiwan-made microcircuits surpasses that of masterpieces produced by the Soviet Ministry of Electronic Industry).

Long ago the U.S.S.R. brought itself into information dependence on the U.S. In the 1970s and 1980s, there was little support for the rare attempts at independent hardware and software development. The absence of competition led to the loss of objective quality criteria and the attempt to improve the product.

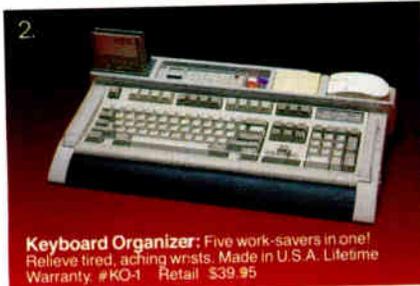
There is a saying among Soviet programmers: Programs may be bad, good, or working. We like good programs very much. Americans prefer working programs. Because the working



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programs and hardware are useful, the Soviet dependence on American information technologies grew, and that dependence became marked when personal computers appeared on the scene.

### Bypassed by the Personal Computer Revolution

With the advent of personal computers, a revolution broke out in the world, but it bypassed the U.S.S.R. Its leaders noticed nothing. Soviet industries, infamous for their immobility and habit of copying foreign models, failed to produce decent computers. Even substandard computers were manufactured in such small lots that you could not speak seriously about the computerization of the country.

Alarm was raised. Many famous specialists expressed apprehension and offered constructive steps. Legislative acts were issued, new departments were formed, production plans were set up and failed. Ershov, who was well aware of the danger of further decline in informatics and computer science, put forward a slogan: "Programming is the second literacy."



**T**he personal computer revolution bypassed the U.S.S.R.

That slogan did the trick: It drew attention to the problems of computerization and education in informatics. A vast educational program was started, and informatics became an obligatory school subject. However, the pioneers of this process assumed that industry would provide schools with the necessary equipment within two to three years. Industry failed, and in most schools, the subject is taught on paper only. Students are lucky if they are able just to *look* at a computer two or three times a year. Thus, the students become indifferent, or they do not like the subject. In many cases, the teachers set the tone: Informatics and computer science are usually presented by teachers of physics or mathematics who often have only vague knowledge of the subject.

In a paper published in an American magazine several years ago, comparative figures were given on computerization in the U.S., Japan, Great Britain, and other countries. The author was disturbed that the U.S. did not occupy the leading position in the computerization of education. "We are lagging behind, which may lead to a tragic end," the author concluded—a funny and sad conclusion for the Soviet reader. The U.S.S.R. is not just lagging behind; it is facing the risk that a generation of Soviet citizens will be unable to understand citizens of all but the least developed countries. We Soviets risk separating ourselves with a new curtain—not an iron curtain this time, but a steel curtain of ignorance. We risk finding ourselves alone, because even our CMEA partners are ahead of us by more than two or three years (computerization in Poland, Hungary, and Bulgar-

ia—although they do have certain problems—is decent enough and is improving much faster than the U.S.S.R.'s).

### A Few Hopeful Signs

In recent years, some positive tendencies appeared. Unfortunately, all processes are too slow, and we lack time. Solutions to certain problems are not efficient and often hinder, rather than accelerate, resolution of the problem. However, fine efforts exist, such as the temporary science and technology team, Start, set up in 1985 to design a new generation of hardware and software. The result of this effort is a working model of an original and very promising multiprocessor computer and accompanying original software. Unfortunately, the project ended in spring 1988, and our industries seem to be uninterested in the results of this development.

Nor has there been much interest in the Soviet Academy of Sciences' project Shkola (School), headed by E. P. Velikhov. Shkola was a serious attempt to solve the problems of computerization. Regrettably, no progress has been made. That cannot happen until the national economy is restructured.

But most Soviet enterprises, even in modern spheres like microelectronics, are not interested in developing and improving their production capability. Unfortunately, developments in informatics and computer science require powerful material, information, and technological bases; and it is useless to hope that new Soviet computers may—even if the developers enjoy the most favorable conditions—be created in university laboratories or institutes of the Academy of Sciences.

When a successful model is made, there arises a need for large-scale ICs, whose design requires equipment the U.S.S.R. doesn't have. We cannot obtain CAD systems as our foreign counterparts do because we do not have adequate technical resources—that is, computers and peripherals (e.g., high-resolution displays). These systems belong to enterprises that are uninterested in the introduction of new products. The vicious circle is closed. It may be opened again only as a result of deep restructuring of the economy.

The beginnings of economic self-regulation (a socialist market) is the only chance to catch up in informatics. However, the market mechanism cannot correct the decline. Given the existing (or more accurately, nonexistent) copyright laws, it is more profitable for enterprises to copy products or to buy licenses for production from abroad, primarily from the U.S.

Therefore, together with economic changes (here, let me be a little naive and expect that the ruble will be convertible in two to three years), we urgently need state stimulation of promising areas of science and technology. The state should create economic conditions under which the use of domestic products would be more profitable than the use of foreign products. This may be achieved by a combination of actions, including judicial, financial, and tax measures. It should be done as quickly as possible; in fact, it should have been done yesterday.

While the creation of hardware requires considerable resources, personal computers greatly reduce such requirements for software. Unfortunately, the U.S.S.R. suffers from a deficit of equipment, and its prices are 150 times higher than those of the U.S. (neglecting the symbolic exchange rate and considering real wages, the state price for a professional personal computer is about 40,000 to 50,000 rubles, while a qualified programmer earns about 300 rubles a month).

This was why programming and mediator cooperatives and Centers of Scientific and Technological Creative Work of the Youth were created for the development of software products. It is curious that mediator organizations, although charging up to 50 percent of the contract cost for establishing relations

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Circle 146 on Inquiry Card.

World Radio History

# An Editor's View

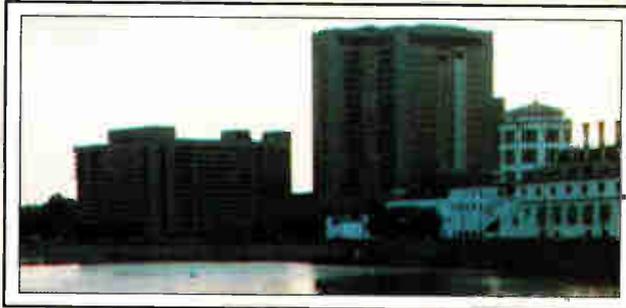
*Last year, BYTE's editor in chief, Fred Langa, was a guest at the First International Computer Forum in Moscow. He later attended the first East-West High-Tech Forum in Budapest, Hungary. Here are some of his impressions of Moscow and Soviet computing.*

**M**oscow is a monochrome city, built primarily of beige bricks, with some concrete and red brick here and there. The city is amazing for what is there, and equally amazing for what is not there.

Looking out the window of my hotel, I could see four TV antennas, and that was all. There were no satellite dishes anywhere to be seen, and I saw only one pair of microwave dishes the whole time I was there.

In the shops, there were few cash registers. Some of them had a cash drawer and did all their accounting manually on a piece of paper. The high-volume shops—such as food vendors and theaters—used an abacus. It was ironic that one of the forum's themes was the need to lift the Coordination Committee on Export Controls restrictions so more advanced machines (including RISC machines) could be imported into the Soviet Union—this is akin to having a donkey and wanting it to go faster, so you feed it unleaded high-test gasoline.

It is simply not going to work. What



is needed are basic calculators and simple computers in large numbers. That seems to be far more important in terms of fundamentally changing Soviet society than getting a very limited number of workstations into the hands of an elite. However, anything that brings more computers in and enhances a computer culture—with all the intercommunication and worldwide standards that implies—would help.

At the forum, Jack Byers, vice director of JV Dialogue, spoke of the many difficulties that joint ventures face. Each joint venture in the U.S.S.R. has to have a wide base of support: hotels, so you have a place to put international guests; food, so your workers won't

have to stand in line at restaurants or food stores; groceries, so your workers will not have to worry about getting essential items for their homes; cars, to move workers around; gasoline and mechanics for the cars—the list goes on and on. A successful joint venture doesn't just provide a job or an opportunity; it has to build an entire minisociety for its workers. You can't take anything for granted.

## Adventures in Soviet Software

The East-West High-Tech Forum was a kind of "Dating Game" for would-be partners in joint East-West high-tech ventures. Among the many attendees of the forum was Rusty Schweickart, president of NRS Communications. (You may remember him from his astronaut days.) Schweickart noted that computers in the U.S.S.R. are status symbols and are held tightly by those few who have them. A Soviet citizen added that it was like paper clips: Only 5 percent are used to clip papers; the other 95 percent are used in unexpected ways. In

between a customer and a developer, found themselves in very favorable conditions.

Currently in the economy, such mediators are necessary. However, in the future, programming should be recognized as a free, creative trade, and the organizations should be able to conclude direct contracts with the programmers. (This is possible today, but the job is paid from the organization's wage fund, and this is highly unprofitable for the organization.)

## A Soviet ACM

In the U.S., public organizations like the Association of Computer Machinery have had a great effect on computer science. The absence of such an organization in the U.S.S.R. has hurt the development of informatics and computer science. The functions of such an organization were often borne by state working groups and committees of the Academy of Sciences, especially the Commission for System and Mathematical Software for Computers (the so-called Ershov's commission, headed by Andrei Ershov). Such organizations could deal with sci-

entific and technical problems, but not with the social and judicial aspects of informatics development. Until recently, the creation of a public organization that could deal with all the existing problems was impossible, because such an organization could threaten the departments' monopolies.

On February 17, 1989, the All Union Society of Informatics and Computer Science was convened. About 200 voting delegates and 700 guests gathered for the inaugural congress and were handed the new society's draft charter (anonymous, as usual). Unfortunately, its authors thought traditionally; the charter did not address problems like the protection of authors' rights, public examinations, the organization of an information exchange, and so on. The only new idea was the creation of self-supporting Centers of Scientific and Technical Services run by the society; that is, another group of mediator organizations. The society was to be a consultative body of the State Committee for Informatics and Computer Science of the U.S.S.R., the same body that had initiated the formation of the society. The state committee had decided to create a society in its pocket,

the same way, computers get used in very different ways. They are so flexible and valuable that they're snapped up and jealously guarded.

Irina Savelyava, a Soviet lawyer, told me that Hungary was the first Eastern-bloc nation to offer software copyright protection. The Soviet Union is one of the last remaining countries *without* such protection. A long discussion on intellectual property ensued, during which the Soviets' consensus was, "There is no piracy in the Soviet Union, because it is not illegal to copy software." This is not a trivial point; the U.S.S.R. has no history, mind-set, or legal basis for the private ownership of software. (They're even struggling with ownership of concrete items, such as land and factories. Ownership of intangibles like software is hard for them to understand.)

Stepan Pachikov, general director of ParaGraph, perhaps the most successful Soviet software company, says he runs into this issue every day: People buy one copy of a ParaGraph package and then call to ask for instructions on how to make copies for the other 100 or 1000 people in their firm. The idea of one-copy-one-user or a site license is unheard of.

Nevertheless, Pachikov maintains that "free copying" (not piracy) is good because it seeds the market and helps develop users and programmers who otherwise would have no access to Western software. Case in point: A software package that costs \$400 in the West

costs about *two years' wages* in the Soviet Union. Can you imagine spending two years' salary on, say, Microsoft Word? As Pachikov said, "Gorbachev makes 24,000 rubles per year, or about \$1200. Gorbachev himself could only afford to buy three copies of Microsoft Word in a year."

In the West, product support is often used to discourage piracy: no registration number, no support. But in the East, says Pachikov, vendors really can't offer good support (although some are trying) because "it's harder to get a phone line than to get a nuclear submarine."

#### Hardware Hassles

Leonid Tomberd, a researcher at Estonia's Institute of Cybernetics, related some problems with the development of Soviet hardware. For instance, most U.S. chip leads are spaced  $\frac{1}{10}$  inch apart. The Soviet ministry in charge of cloning Western chips mandated metric spacing, but  $\frac{1}{10}$  inch works out to be about 0.254 millimeters, an odd metric size.

The Soviet solution? A *metric inch*—0.25-mm spacing. This means that Soviet clone chips can be exact electrical and functional equivalents of their Western counterparts, and look exactly the same—until you try to plug them into a Western socket. They won't fit.

That's more than an inconvenience. It means all Soviet chip assembly hardware won't work with anything but Soviet chips, and a fair chunk of the actual

Soviet chip-fabrication equipment and its products are worthless on world markets.

To make their quotas, Soviet chip manufacturers pump out chips with little or no quality control. Tomberd says a typical DRAM shipment has 25 percent to 50 percent bad chips. For CPUs, he said, it's not uncommon to get a defect list with each chip—a list of instructions that chip will not run. Can you imagine trying to assemble a system from chips like that? Can you imagine programming for chips like that?

To force support for the Soviet computer industry, the government has mandated the use of Soviet equipment. For example, Tomberd says that ministries were forced to use Soviet IBM mainframe clones that cost 1 million rubles, took up precious office space, and required 30 people to operate and maintain—yet had a throughput roughly equal to about two Western personal computers.

Even now, the ministries can't get rid of these dud mainframes. No one wants them; no one will pay anything even close to the paper value of the machines. If they give them away or sell them at their real value, it will look as though the sellers are doing something illegal—dumping a machine supposedly worth a million rubles for virtually nothing. Until the laws of depreciation change, they're stuck with the old gear. Once again, there's no correlation between real worth and actual prices, and they have no easy way out.

and the draft charter left departmental interests associated with informatics and computer science intact.

The absence of openness and democracy at the congress resulted in an organization that was composed of delegates who had no idea how or when they were elected to their positions. I. N. Bukreev, a deputy chairman of the state committee, who is now the chairman of the presidium of the society, told one of the congress delegates, "You were elected by voting secret from you!" What resulted was a congress made up of delegates representing the leadership of large enterprises, institutions, or ministerial departments, while the areas of science and technology were poorly represented. Some of the leading scientists in informatics and computer science were not invited, while, as the report of the credentials committee stated, there were 14 delegates without higher education.

Time will show the vitality and usefulness of the All-Union Society for Informatics and Computer Science. I will be glad if it improves informatics and computer science in the U.S.S.R. For now, it seems that users groups—which in the 1970s played

a significant role in spreading information, forming public opinion, and evaluating new software products—might be more useful. Perhaps they should take on another form, but public initiative is necessary to ensure consolidation of forces at the upper level. Some timid, positive attempts have been made, such as the creation of clubs of professional programmers in Leningrad and other cities, which may be the basis for uniting efforts by the leading qualified developers.

This article contains words of sorrow. The current state of Soviet informatics is not happy, and there are no promising perspectives for tomorrow. Those involved in informatics and computer science can only look to the future for some hope. ■

*Igor Agamirzian received his undergraduate and doctoral degrees at Leningrad University. He is currently a senior research fellow at the Leningrad Institute of Informatics of the Soviet Academy of Sciences, as well as an assistant professor for the computer science department at the Electrical Engineering Institute, Leningrad. You can reach him on BIX c/o "editors."*

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# A Talk with Intel

Designers of Intel's 386, i486, and future microprocessors talk about what lies ahead in CPU design, and the implications for personal computers

**W**e recently spoke with three of Intel's top engineers about what lies ahead for the 80x86 family of microprocessors. John Crawford (right) was the chief architect for the 386, i486, and upcoming i586 microprocessors. Dave Vineer (center) led the design team for Intel's 386SL microprocessor. Bill Rash (left) is Intel's director of the Platform Architecture Center.

**BYTE:** Can you give us trends or movements that we can expect to see in the i586, i686, or i786 microprocessors?

**JOHN CRAWFORD:** I think there's a fair number of trends that we charted in the Micro 2000 project [Editor's note: See the text box "Micro 2000" on page 132], starting with the basic semiconductor technology: devices doubling every two years, frequency continually going up, number of pins going up, all these kinds of trends. All of that factors into, from a customer's point of view, overall performance doubling every 18 months. So we look back on that kind of a trend, historically, and project all the growth rates into the future, and say, "Ah, this is something like what we'll see at the end of the decade."

**BYTE:** One of the key things about the 486 was its integration of functions that were previously in separate ICs. Can we expect to see more of that kind of integration in future processors? And what kinds of functions can we expect to see?

**DAVE VINEER:** I think the 386SL is another example of integration. [Editor's note: See "Portable Chips," December 1990 BYTE.] If you look back a long time ago, back in the days of the 186 and 286, if you had suffered through any of Intel's product pitches, you would have

seen two vectors, an integration direction and a performance direction. The 186 went in the integration direction, and the 286 went in the performance direction. The 486 was unique in that it actually went along both vectors—one of those happy situations where a higher-integration part performed better.

**BILL RASH:** In the Micro 2000 project, we talked about microprocessors with 50–100 million transistors on them, executing over a thousand MIPS, running at 250 MHz, having six different execution units all on the same die, sharing one memory that they're running out of. That's just sort of the ultimate point, as you carry the extrapolations to their



# Micro 2000

Kenneth M. Sheldon

Intel engineers predict the shape of a twenty-first-century microprocessor

**W**hat will the microprocessor of tomorrow look like? According to Intel, it will be 10 times faster, have almost 100 times as many transistors, and incorporate more functions than the most powerful processors now available.

Last year, Intel engineers laid down the broad outlines for what they expect their leading microprocessor to look like in the year 2000. They drew on previous design experience, trends in chip fabrication, and expected advances in electronics technology to make their predictions. They called the anticipated chip the Micro 2000.

## More Transistors

In 1975, Gordon Moore, chairman of Intel, predicted that the number of transistors that could be put on a chip would double every two years—a prediction that has proved quite accurate. According to Moore's Law (as it has come to be called), the Micro 2000 could have

more than 50 million transistors on-board—20,000 times as many as Intel's original 4004 chip had, and 40 times as many as the i486.

Memory chips, which tend to be more densely packed with transistors than logic chips are, have increased in capacity at roughly the same rate. If the trend toward integrating more memory functions onto microprocessors continues (as a way of eliminating data bottlenecks), the number of transistors on the Micro 2000 could reach 100 million.

## More Megahertz

Cramming all those transistors onto one chip will mean making them a lot smaller. The transistors in the Micro 2000 will be  $\frac{1}{2}$  the size of current transistors, with a corresponding increase in the rate at which electrical current can be driven through them. The bottom line is that Intel expects the Micro 2000 to operate at a clock rate of 250 MHz.

Achieving that kind of speed will re-

quire developing new materials (e.g., tungsten) to interconnect transistors and new ways of arranging them (e.g., putting them in stacked multiple layers rather than a single large layer) to reduce the distance a signal has to travel.

## More Power

What do you do with 100 million transistors? Intel engineers have detailed two possible scenarios for using them. The first is a high-performance multi-processing chip (see the figure) that would incorporate four CPUs, each with 4 million transistors, each able to perform at 700 million instructions per second. That's a total of over 2000 MIPS, or 2 BIPS (*billion* instructions per second) for the entire chip.

This version of the Micro 2000 would include two *vector units* to perform vector processing, a technique borrowed from Intel's i860 RISC chip (which borrowed it from supercomputers) to perform floating-point calculations at high

extreme, of where we will find ourselves. And in the integration vector, we talk about having a single-chip PC in 1993. Then, further out in the decade, adding capabilities like speech recognition and full-motion video, all these kinds of things built into just a single die. All you would do is just hook up your memory to it.

**JOHN CRAWFORD:** And whatever else you need to be able to get input and output.

**BYTE:** Can you define what you mean by "PC on a chip"?

**DAVE VINEER:** Our definition of "PC on a chip" for 1993 is the [equivalent of the] IBM AT Model 339. So, what was an IBM 339, that will be our PC on a chip. It will be a 386 CPU, but functions that are included on that level of board will be on the piece of silicon.

**BYTE:** Memory will be extra?

**DAVE VINEER:** Memory will be extra. In my opinion, it's going to be a long time before we see memory integrated. The never-ending need for it continues to grow faster than the transistors. The people who are making DRAMs are having trouble keeping up with the sizes that we'd like to see, so that's not an

area where Intel can greatly benefit the market in the short term, so I don't see that as something that we'd integrate. Cache RAM is something where we can give you better performance, and on the SL we integrated it 'because we also found that we could get better power.

## Hitting the Wall

**BYTE:** As you get tighter and tighter integration, are you running up against physical barriers in terms of how small a trace can be?

**BILL RASH:** The process technology road map looks pretty clear-cut for us, for the decade. We don't see any real problems getting down to 0.3- or 0.2-micron features. In fact, there's been a whole flurry of articles out on how basically the semiconductor industry's convinced itself it doesn't need x-ray lithography for quite a while—we can continue with deep ultraviolet lithography and get down to those types of dimensions.

**BYTE:** Where do you hit the wall in terms of physical limitations? And then what kinds of other technologies come in to take you beyond that?

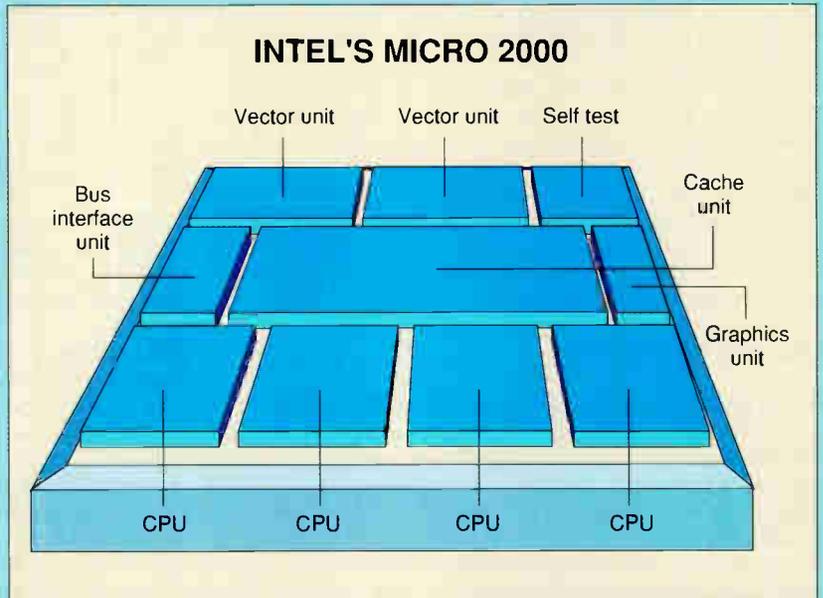
**BILL RASH:** To be quite honest with you, I think the biggest challenge we have is just finding the right kinds of features that

speed. It would also have a 2-megabyte cache memory (compare that to the i486's 8K-byte cache) so that it won't often have to go off-board for data, as well as a graphics unit (made up of 4 million transistors) designed to provide high-resolution, HDTV-quality, full-motion graphics.

**More Integration**

The other possible design for the Micro 2000 would trade off some performance for even higher levels of integration; it would have only two CPUs, one vector unit, and a smaller cache. The remaining transistors would be used to incorporate on a single chip all the functions necessary for a personal computer.

Currently, the 386 microprocessor requires about as many transistors for support logic chips (250,000) as are on the chip itself (275,000). Extrapolating from that, Intel has allocated 8 million transistors for "miscellaneous PC" functions, such as controlling disk drives and memory and communicating with other systems. Engineers have also allotted 8 million transistors for the Human Interface Unit, which they admit is a black box: a yet-to-be-designed device that will make computers easier to use than ever before, perhaps by incorporating such technologies as speech recognition.



*A high-performance multiprocessing version of the Micro 2000.*

**Compatibility**

Ah, but all this new technology means we'll have to throw out all our old software. right? Not so, says Intel.

Intel claims that the Micro 2000 will continue to be upwardly compatible with the 386 and will run all software that currently runs on that processor. Of

course, the availability of so much additional raw computing power could pave the way for new applications that make current programs look antiquated.

*Kenneth M. Sheldon is BYTE's senior editor for features. He can be reached on BIX as "ksheldon."*

really take advantage of all the transistors that we have and being able to partition a system in a way such that you take the things that have to be very, very fast—that have to communicate with each other—and put them together so that they can communicate all on a single die. Because the moment you have to go off-die, you sacrifice a tremendous amount of bandwidth capability, and you put this little bottleneck in the system where you try cramming data through.

Another challenge in general is just having the software develop in time to really take advantage of that level of performance as well. Obviously, you don't need 1000 MIPS to run the software that any of us have today. There has to be an awful lot of software developed between now and the end of the decade that's going to consume that much power [for] somebody to want to do it.

**BYTE:** How about multiprocessing? The 486 has some capabilities in that area. Are you looking to expand that capability in future processors?

**JOHN CRAWFORD:** From our perspective, that's probably more of a systems issue than a chip issue. I think we have enough basic hooks in the product line today to support that, and we see a number of companies—Sequent being one; NCR is another one—that have multiprocessor systems based around

our product line. So, it's a question of taking advantage of that. There's a significant amount of work at the system level to get multiple processors working together.

**BYTE:** What do those hooks consist of?

**JOHN CRAWFORD:** Well, things like having the memory hierarchy stay consistent; that's certainly a very important one. Another key one is some kind of method for signaling between the processors. Some kind of memory-locking scheme is a typical one—that's the one that we use. Those kinds of things.

**BYTE:** There's going to have to be a fairly significant shift in software platforms for a multiprocessor chip to be useful. Do you foresee that being something that's going to have to go hand-in-hand with hardware development, or do you see either one driving that?

**BILL RASH:** I think we see a number of trends today that indicate the direction it's going in. Look at the way OS/2 is set up—by supporting multiple threads and multitasking, it gives you the ability to use those multiple processors. Obviously, if you're going to run two processors at once, [you use] one processor per program. But even in the case of the single application, in a single-user environment, multithreading means that,

in your spreadsheet, while one processor is drawing the screen for you, the other processor can be recalculating the spreadsheet.

So we see a direction in products like OS/2 that says the software is going to be able to take advantage of multiple execution units in parallel. And even Microsoft talks about Windows long-term incorporating the capabilities of multiple threads, like OS/2 has. So this is an important feature that all the major operating systems in the world are moving toward.

Take a look at the kinds of applications that consume that performance. At Comdex, we had a demo of a speech-to-text conversion running on a portable 486 computer. It would transcribe continuous speech—you didn't have to pause between the words. [It had] a 1000-word vocabulary, and a 486 was doing the speech-to-text conversion.

**BYTE:** What was it running?

**BILL RASH:** It was running Dragon software. It wasn't doing it in real time; you'd talk for a while, and it would pause a bit, and out would pop the text. So a 25-MHz 486 isn't quite there yet for real-time performance. But the software's running now, and I'll admit the human interface isn't perfect, but give them time, and with some faster CPUs coming along, you'll be able to do the speech-to-text conversion in real time. But the issue of continuous recognition has been solved; you don't have to pause between the words, and multiple speakers could talk to it. It's not perfect—it won't take any accent and convert it—but it shows that the software really made a jump forward into what I view as a very critical human interface technology, the computer getting to the point where first it can transcribe the text. Then, of course, you let all the linguists go to work on figuring out the meaning of the words in the text; but first off, at least you get it into text so that the computer can start figuring out the meaning of it.

And certainly there are applications where just simple commands are useful. I'd love to have an answering machine I could at least give a few simple instructions to: "Is this person here?" The thing could say yes or no. "How can I get hold of them?" Those kinds of things. You can envision your computer on your desk becoming an answering machine that can actually talk to the people on-line and give some reasonable set of answers on a limited set of topics.

#### A Designer's Frustrations

**BYTE:** What's been the most frustrating thing about the software that runs on the hardware you've designed?

**DAVE VINEER:** I think the most frustrating thing for me has been the length of time that it's taken to finally take advantage of the 32-bit power. Still having 16-bit operating systems and programming interfaces is really hampering a lot of people.

**BILL RASH:** Both Dave and John are engineering users, so they run these monster programs that consume, what, 400, 500 MB of program space?

**DAVE VINEER:** Even running things like PowerPoint under Windows—it's slow at times, and it

could be significantly faster if it was 32-bit.

We introduced the 386 in October 1985, and by November, we were all very frustrated that significant 32-bit applications hadn't yet surfaced and that Microsoft hadn't done a 32-bit DOS, etc. But clearly, there needs to be a critical mass of installed hardware, and there has to be a clear trend... well, there has to be a market for the 32-bit software in order for it to be produced. Particularly, the events of the last couple of years have really set in place that installed base, and it's just a question of time now until that takes over.

**BYTE:** Do you think that when OS/2 2.0 comes out, it will be significant enough that people will really start jumping on it? Will the performance difference of a full 32-bit implementation be significant enough to jump-start OS/2?

**BILL RASH:** In general, I don't know if the conversion will necessarily happen on OS/2. Windows will also go to 32-bit, but that transition will be really pushed hard by the fact that users are going to discover that, on a piece of hardware that used to work at a certain speed, when they get the 32-bit version of this application, all of a sudden the responsiveness goes up. That will motivate a lot of people to spend whatever the upgrade fee is to get the new release of the 32-bit application. There's a great business opportunity for all the application vendors out there to sell yet another upgrade to their favorite application.

**BYTE:** Are there features of your chips that have been overlooked or misinterpreted? Things that you would like to point out?

There's a significant amount of work at the system level to get multiple processors working together.

John Crawford



**BILL RASH:** Power management inside the 386SL. One of the things we've seen is that there has been a lot of interest in building desktop PCs [PC compatibles] that don't have fans, that are totally silent. So the idea of having power management in your desktop system is that the system shuts down when you walk away from your PC, and it cools off internally. When you sit down and start using it again, the fan may not ever turn on, even between keystrokes. And the way you do that is that you power down the PC as much as possible in the desktop.

**DAVE VINEER:** Anytime you take advantage of something like this, there's some big design effort that has to go into it. We've added a specific form of power management on this chip, a specific set of tools that you can use, and those tools are mostly implemented in the hardware. Now, you could totally ignore those and do it the old-fashioned way, but there are many

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things that the old-fashioned way could not do. And without taking advantage of some of the tools that we gave specifically to solve some of these problems, they could make the same sort of machines that they have today—"they" being any particular company—and reach approximately the same level of power as they have today. It would be slightly lower because it's a static part . . . but to take full advantage of it, they would have to redesign and rethink how they're going to do their power management. The hardware—obviously, it can be smaller now.

**BYTE:** So, six months from now, we'll see a whole new crop of notebook portables coming out?

**DAVE VINEER:** I'm sure we will.

**JOHN CRAWFORD:** Higher performance, smaller package, lower power, longer battery life—which means lighter, because they'll have smaller batteries.

**DAVE VINEER:** That's really the trend that I think we're going to see for a while. We're not going to see longer battery life; we're going to see smaller, lighter machines, because they're going to make the batteries smaller to take advantage of the fact that we use less power.

**BYTE:** So we'll be sticking with the 2- to 3-hour battery life that we now have?

**DAVE VINEER:** I think so. There will be some that are going to go up. There are a few lunatics out there who say that as long as

it needs to be plugged in, it's a worthless machine. Someday that may happen: [computers] powered by the electricity in your finger.

**BYTE:** Or a solar-powered panel?

**BILL RASH:** Or the heat of your body; you put it in your shirt pocket, and the heat of your body recharges the battery.

Again, it's interesting. The features of those notebooks translate to the desktop. Power management is one thing. Another thing is this idea of auto-resume. I mean, why does everybody have to boot their computer every day? It's really kind of crazy. They walk away, the system shuts down, they come back the next morning, and [the system is] back to where they left it off, and it wasn't consuming power all night, heating the building up.

### The Hunt for Bugs

**BYTE:** When the 486 first came out, a couple of bugs were reported; there was some obscure arithmetic instruction that wasn't working right. Was that just a normal process of the chip being built?

**JOHN CRAWFORD:** Well, any of these products is extremely complicated, and although one of the keys to our success is making sure that we can build these things and eliminate these kinds of errors to produce a product that is reliable, we can build millions of them and sell millions of them—that's an extremely complicated thing.

**BILL RASH:** I think that what's interesting is that as the parts get more complex, the number of errors keeps going down with each generation. So we continue to refine our ability to essentially do zero-defect design so that the designs work from the beginning. That is our goal—zero defects; I'm not going to claim that we will get there next year, but we cut the number of errors by a factor of three in going from the 386 to the 486.

**DAVE VINEER:** There's a certain number of bugs that you can find before you "tape out," and a certain number that you find after [going to] silicon. On the SL, we tried for the first time to boot DOS on [a simulation of the 386SL running on] the mainframe. We have an IBM 3090. And it took approximately two weeks of continuous running to get to the C: > prompt. This is running a full logic simulation of the chip.

Now, all of us know that just because the DOS prompt comes up doesn't mean your PC's perfect; there are many machines that give you the DOS prompt that have lots of incompatibility problems. So you can see that, if we were to try to run Windows—which you know how long you wait for—we wouldn't be there yet.

So there's always a magic point where the design engineer says, "I've found as many bugs as is practical without seeing real silicon," and runs the real silicon. Now, whether the customer sees the bug or we see the bug is dependent on how soon our customers want to see the silicon. Everybody's chomping at the bit; they want to see it the same day we do, and we want to hold off and

■ *Maybe a laptop will be nothing more than a Docking Station for a credit card.*

*Dave Vineer*

■ *I think there's a lot to be done in the world of software.*

*Bill Rash*



## A TALK WITH INTEL

debug it and make sure it's as clean as possible before they get it, but nobody's willing to wait. That endless cycle of balancing the teeter-totter is what causes some customers to see bugs, and some not. And the ones who see bugs are the ones who know that they're getting silicon that we haven't gotten all the way through yet.

**BILL RASH:** This whole area of finding bugs in our silicon early has been a big area of focus for Intel in the last few years. We've really invested a lot of effort into developing some totally different approaches to try and find the bugs in our designs before they get to silicon, before they get to one of our OEM customers, and certainly before they show up on the shelf in a computer store.

**DAVE VINEER:** One of the interesting anecdotes is that we had 386-based workstations to develop the 486, and a lot of those are still in service. We also used the 386-based workstations for the SL—a nice incestuous relationship.

**BILL RASH:** Actually, I think there was an interesting story where we discovered that one of the idiosyncrasies of the 386 masked a bug early in the 486 design, because the workstation executing a certain instruction did it exactly the way the 486 would have.

**BYTE:** A kind of genetic flaw?

**BILL RASH:** We discovered it before the design went out, but I remember there was a story about the fact that we were using a microprocessor that was identical to the one that we were simulating.

### New Technology

**BYTE:** What kinds of new technology do you see coming out of laboratories that will have an impact on the way you design chips?

**DAVE VINEER:** Well, our group has been kind of inward-focused, because we haven't figured out what to do with 100 million transistors. Offer me a billion, and I still don't know what to do with them.

**BILL RASH:** There are other things that are not related to transistors but that affect a lot—for example, different ways of packaging. Look at this board; see how thick it is? [Editor's note: See the prototype laptop board shown in "Portable Chips," mentioned above.] If you think about the silicon die on there, it's considerably thinner than those packages. By the time you want to start slipping something into your pocket, this kind of packaging is unacceptable. You've got to come up with much simpler ways of mounting the silicon dies themselves onto substrates that are thinner than this to interconnect things. So there is a lot of technology on packaging that's going to be critical in making computers into something that you can slip into your shirt pocket.

**BYTE:** More integration?

**BILL RASH:** Could be. The key is to eliminate all this plastic we put around the silicon die. More low-tech stuff.

**DAVE VINEER:** There's the "chip on board" that we've been doing a lot with in the last few years. Memory cards are another example. Possibly you are going to see CPU cards. Maybe a

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laptop will be nothing more than a Docking Station for a credit card.

**BILL RASH:** What's fascinating is that display technology is moving into the realm of semiconductors. If you think about what are the best displays that you can get today, they're all active displays, with literally a transistor per pixel, and it's almost semiconductor technology. Or four transistors per pixel in order to do color, with one redundant transistor in the group. Again, that's the kind of technology that will give me my hand-held computer with a nice hi-res display. The trick now is to get the equivalent of a 50-MHz 486 all integrated in there, with enough memory to do speech recognition for me so that I don't need my "chicklet" keyboard; I can just talk to the silly thing to take notes and things like that.

**JOHN CRAWFORD:** I think that's where a lot of the more exciting stuff that we see is coming out of, not from the silicon technology per se, but in a lot of the peripheral equipment, if you will: displays, speech recognition, multimedia, all this good stuff.

**BYTE:** Do you think it makes sense to have a special chip for speech recognition?

**BILL RASH:** Speech recognition is an extremely software-intensive application. It takes megabytes and megabytes of data patterns and code, things like that. It's hard to imagine that as a dedicated chip, because the thing has to be trained for the vo-

cabulary. I find it hard to believe that you could have a dedicated chip that you could magically feed an analog signal into and out pops a string of ASCII text, all in one chip. Maybe 10 years from now, but in between, there is going to be a need for an awful lot of software that a more general-purpose microprocessor grinds through in order to do the pattern recognition that is an essential part of speech recognition.

**BYTE:** It's intriguing that you don't know what to do with all those transistors.

**JOHN CRAWFORD** (*laughs*): I didn't say that; I've always got plenty of ideas.

**BILL RASH:** It is a challenge to make sure that we can really use those transistors, because if you don't use them effectively, what you end up with is, somebody else builds something with half the number of transistors that does the job just as well, and you're at a cost disadvantage.

**DAVE VINEER:** Or, more embarrassingly, does the job better.

**JOHN CRAWFORD:** I think it's also a fact that if you look out 10 years from now, it's very hard to predict exactly what we're going to build. If you look back 10 years, were we predicting that we'd have 486s and i860s and SLs in the marketplace? I don't think so. So predicting what we are going to be building 10 years from now is very risky. But I think that in terms of some of the raw technology numbers, the relentless march of

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semiconductor technology is going to continue, and we can project from that. For next year's—1991 and 1992—product plans, we have a very good idea of what's going to be in the marketplace, at least from Intel. If you look out to the 1993, 1994, 1995 time frame, we have a *fairly* good idea of what we're going to build, what we'll have available. Of course, things will change as time goes on.

**DAVE VINEER:** That's part of my comment, too, of not knowing what to do with a hundred million transistors. If you really sit down today and say, "OK, I'm going to build this wild machine, and I'm going to put everything in it," I'll guarantee you can't spend a hundred million transistors. It's like spending a million dollars in a day or a month and walking away with nothing.

**BILL RASH:** Want me to tell you how, Dave?

**DAVE VINEER** (*holding up a notepad*): This is my laptop, today. I'm looking for something that replaces this. This is it. This is what I want. When I can do everything that I can do with this pad of paper and this pen, I might be happy. That means being able to tear things out and hand them to my secretary. It means being able to draw pictures, it means being able to put in text, it means being able to keep my calendar, and everything else. This is my calendar. So, this is how I live, and this is what I'm looking to replace. If you can imagine this as a laptop, this in electronics, that's how I can account for 15 million transistors. Now what do I do past that? I guess I can start talking to it.

**JOHN CRAWFORD:** Well, if you want to double the performance, I can tell you how to use 60 million.

**DAVE VINEER:** OK, 60 million. But I guess I'm against having it implanted in my head.

**BILL RASH:** [That brings up] this whole idea of the human interface that we have to the computer, and what happens when you really think about integrating audio into your computer, such that your computer can literally answer your telephone for you [and] file away your telephone messages. The laptop you carry with you: You set it next to your main computer, maybe on an infrared link, or an RF link, and the two update each other. You don't even have to hook it up—just sort of bring it close to your home computer, and they update each other as to what happened lately.

[It could] even give you your telephone messages and transcribe them from speech to text so you can see your E-mail messages on your little hand-held that you carry around, because they've been transcribed for you. Or you call up your computer and listen to your E-mail messages, which are transcribed from text to speech; you can hear what E-mail messages you've received while you're traveling.

People are going to really think through some of these scenarios of what people do, and what kinds of technologies have to be integrated into a PC to really make everybody more productive and [do] less drudgery work on their computers. And I think there's a lot to be done in the world of software. I think we're developing an awful lot of hardware here, to crank out the horsepower to do it. ■

*BYTE staff members participating in this interview were Owen Linderholm, Rich Malloy, Andrew Reinhardt, and Kenneth M. Sheldon. You can reach them on BIX as "owenl," "rmalloy," "areinhardt," and "ksheldon," respectively.*



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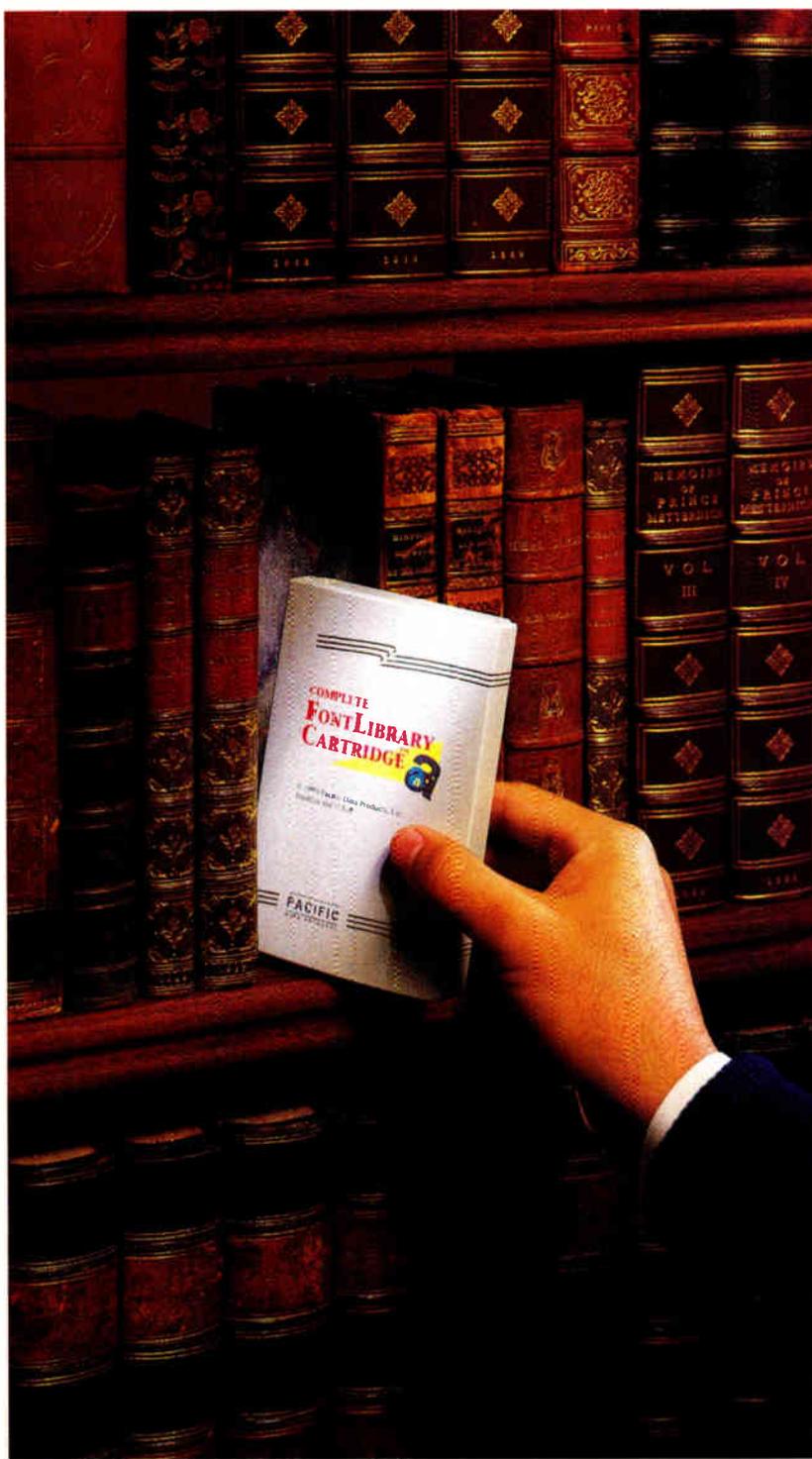
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**W**ith new communications capabilities, users are operating PC serial ports at higher data rates. Digital data communications services provide data communications at 56,000 and 64,000 bps, and ISDN basic rate interfaces providing 144,000 bps are now emerging. New data compression functions within modems and other data communications equipment (DCE) make 4-to-1 compression of text data possible. As a result, users are developing applications, such as CAD/CAM and LAN interconnect, that require serial communications at rates substantially above 9600 bps.

Unfortunately, at rates above 9600 bps, PC serial ports can operate unreliably, particularly when the operating system is multitasking (e.g., Windows, OS/2, or Unix). Even a TSR program can affect the reliability of serial communications. Windows 3.0 claims support for serial communications up to 19,200 bps. However, when users have problems with the integrity of data transmission, technical-support personnel as well as communications hardware and software vendors regularly suggest setting the maximum serial port rate at 9600 bps, assuming that the problems result from the inability of the communications channel to support the higher data transfer rates.

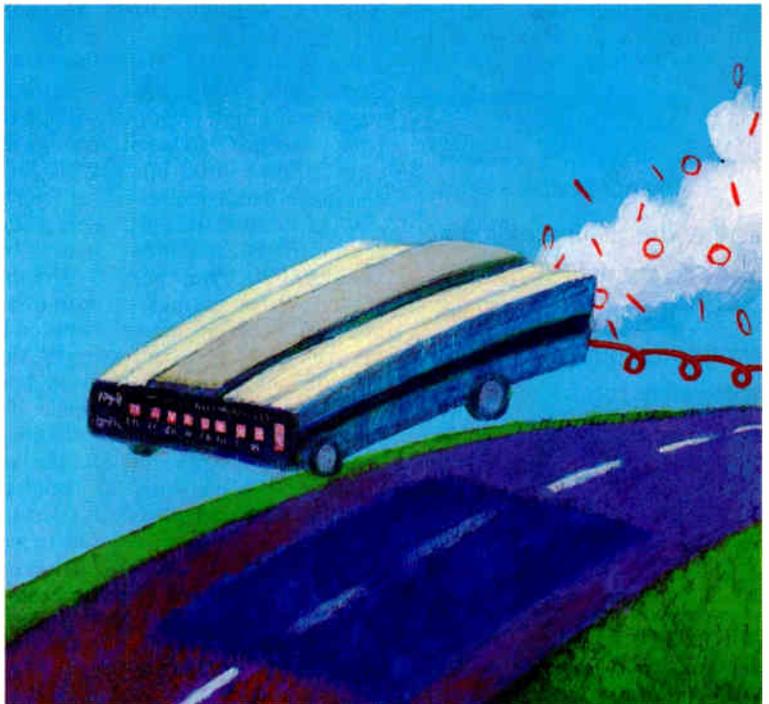
In fact, these particular data-integrity problems have nothing to do with the operation of external communications. The problems lie within the PC. Whether your computer communications system has such problems depends on its processor type (e.g., 286, 386, or i486), bus clock rate, and cache memory organization, as well as the actual serial data rate supported.

## Within the PC

The serial communications process begins when an application or operating-system service requests the processor to transfer data on the PC bus to the serial port. If the computer bus is be-

ing accessed by another application at the same time, the communications process will be delayed. However, the serial port operates at a fixed data rate. If a delay occurs that exceeds the number of bits transferred per byte divided by the channel transmission rate in bits per second, the serial port sends a NUL character to the remote DCE. When transmitting from the PC, the NUL character only reduces the effective data transfer rate of the communications channel; it does not cause data loss.

The situation can become serious when data is received. Data loss can occur if the serial-to-parallel converter in the modem attempts to place data on the computer bus when the computer bus is active doing other tasks. If a data byte cannot be passed on to the PC communications application by



**MAXIMUM DELAY ALLOWED FOR DATA RATES**

*The table assumes the most efficient communications software supporting 8-bit bytes. It is possible that the effective serial port rate (in bytes per second) on the personal computer bus may be different in either direction.*

Delay before data is lost/delayed	Serial port (bytes per second)	Communications channel (bps)
6.6667 ms	150	1200
3.3333 ms	300	2400
0.8333 ms	1200	9600
0.5556 ms	1800	14,400
0.4167 ms	2400	19,200
0.2083 ms	4800	38,400
0.1428 ms	7000	56,000
0.1250 ms	8000	64,000

millisecond (ms) = .001 second

the time the next data byte is assembled from the modem, then data is lost. The amount of data that gets lost depends on the type of serial-to-parallel converter connecting the modem and the computer bus (e.g., what size buffer is operational) and the length of time the computer bus is occupied with other tasks.

A data compression function can also make the symptoms of a data-integrity problem more confusing. When transferred data is not compressible, data loss problems may not appear. In some cases, only when compressible data is being transferred does the effective data transfer rate exceed the physical limits of a PC system—a more difficult situation to troubleshoot, and all the more reason to test the capabilities of a system before it is placed in service.

Data-integrity problems rarely occurred when communications took place at 2400 bps and PCs worked on one application at a time. At those rates, interruptions of 6 or 3 milliseconds, respectively, would not cause a problem in an IBM AT.

An 8-MHz AT requires about 0.25 ms to support a single serial port interrupt. Modems operating at 9600 bps and using data compression can cause data to transmit four times faster (4800 bytes per second). When the maximum delay before data-integrity problems occur is 0.2083 ms, a single interruption of 0.25 ms will cause data loss. Such interruptions are common in a computer system that supports multiple applications.

The table above shows the maximum delay allowed for various data rates. If the communications software application is designed to work

with asynchronous modems without data compression, it may transfer data to the serial port (transmit direction) at one-tenth the transmission rate. The software anticipates the transmission-rate reduction that occurs when the start and stop bits are added in the serial port.

When data is lost as it passes between a modem and a computer, it is not corrected by an error-controlled modem (using either MNP level 4 or V.42). Error-controlled modems can only detect and correct data errors that occur between the DCE devices (e.g., on the communications channel). The data-integrity problem is particularly distressing for users who have modems with error control, because even with that, you cannot be certain if you are losing data or not.

**True Throughput**

The text box "Determining Serial Throughput" on page 147, describes the issues that affect serial port throughput. Although determining the speed of the modem is reasonably straightforward, determining the actual compression performance and any data transfer problems between the serial port and the microprocessor is more difficult. Only when you consider the sum of these items can you determine the actual throughput of the communications system.

Communications Test Program from R. Scott Associates (Raleigh, NC) is a good tool for evaluating the true communications throughput (including the effect of compression) provided by modems and the communications channel. If you use CTP with the same PC configuration as the communications application, you can start identifying possible computer-related communications performance problems. To accurately project performance by the compression used, you need to send the same type of files as you do when running the application.

Unlike common communications programs, which poll the serial port for received data at a fixed rate, CTP responds to each interrupt (single byte) on the serial port. This provides a more accurate indication of the communications channel throughput without considering degradation from the limitations of the PC.

Even though CTP is designed to test the maximum throughput of the communications channel, using it on a single PC in a loopback test is valuable. To perform this test, set up one PC with the same configuration (but with two serial ports) that you will use for the application (see figure 1). Establish a local connection using two modems and two telephone lines and invoke CTP. Or, you can bypass the local phone system by patching between the modems with RJ11 cable and using the Hayes modem ATO (originate) and ATA (answer) commands on the originating and answering modems, respectively.

The throughput tests are best run over a long enough time span to provide a realistic metric of the data being transferred between the transmitting and receiving applications. Measuring the throughput over a long time span is a better metric of the throughput than you could anticipate through practice. For example, if the test file takes less than 5 minutes to transfer, make a file consisting of multiple copies of the original file and transfer the larger file.

Don't make the mistake of measuring throughput by the time it takes to transmit from the first to the last byte. The correct way to measure throughput is from the first byte transmitted to the last character received. This accurate measure of throughput requires the use of a common time reference in the receiving and transmitting applications, easily done when you use CTP and a single PC.

CTP allows you to perform the test in a single direction (half-duplex) or in both directions at the same time (full-duplex).

*continued*

**BYTE ACTION SUMMARY**

**Speed Traps**

Despite the claims of many vendors to the contrary, modems often do not deliver data throughput in actual applications at rates even close to the ones attested to. Here's how to test your applications environment to identify when data throughput is less than that desired and, if so, how to improve it.



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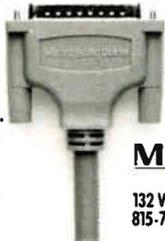
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## HIGH-SPEED SAFETY

ceiving the test file. Such processor-/bus-intensive activities should indicate if data loss can occur.

When you compare the original and transferred files, any discrepancies indicate data loss. If there is data loss, several possible approaches will prevent it. First, you can reduce the maximum allowed serial port data rate of the connection. While this is certainly not desirable, it is better than running the risk of undetected data loss. Alternatively, use a faster computer.

Next, you can prevent, by software design or user instruction, the operation of simultaneous applications that cannot be supported without the risk of data loss. Disk formatting is an example of a processor-/bus-intensive task that can be avoided during communications. However, avoiding other simultaneous applications can be difficult to enforce and more difficult to accept.

Finally, you can obtain hardware and software that corrects or prevents this type of problem without degrading system performance. This is the best approach.

### Application Software Error Control

If the communications application software offers a means to detect and correct errors through to the remote end system, then any bytes that are lost on the computer bus would be detected and corrected. Protocols such as Kermit, XMODEM, YMODEM, and other PC-based error-control protocols perform this function. There are several caveats, however:

1. The protocols (especially earlier versions) used by communications application software may not be communications-efficient.
2. Many software communications applications do not have access to an error-control protocol within them.
3. The software-based protocol has to be available at both ends of the communications, which may not be possible in PC-to-host communications.

Rather than correcting errors by retransmission, the communications system throughput would be higher with a solution that eliminates the errors.

### A Different UART

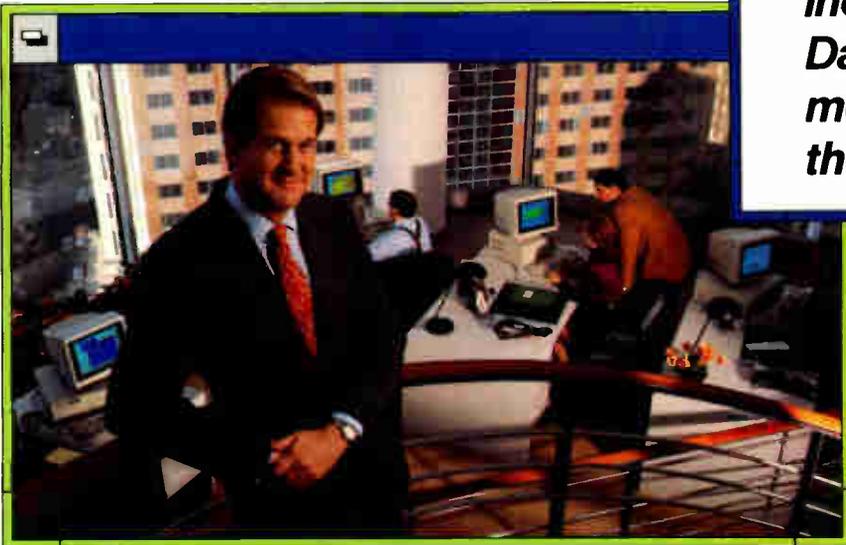
In IBM-compatible PCs, the original 8250 universal asynchronous receiver/transmitter (UART) provided the serial-to-parallel connection from the serial communications channel to the parallel computer bus. The latest 8250 version, the 16550A, includes a small (16 bytes in each direction) buffer. Newer computers and serial cards, including the larger IBM PS/2s, use the 16550A. The 16550A assists greatly in preventing data loss, but the communications software needs to turn on the buffering for it to perform any differently from the 8250.

Manufacturers of communications software applications are starting to deliver software products that check whether the UART is a 16550A, and, if it is, they turn on the buffer. Verifying that communications applications implement the 16550A buffer can be a way to solve the computer bus data loss problem. Be sure to verify that the communications application actually enables the buffer; then, test your communications system to be sure. However, if the 16550A isn't available, or if computer bus delays might be longer than 15 byte times, a different solution may be in order.

### Hayes ESP/ESD/ESI

Hayes is one of several high-speed modem vendors that is offering solutions to this kind of problem. Hayes recently announced

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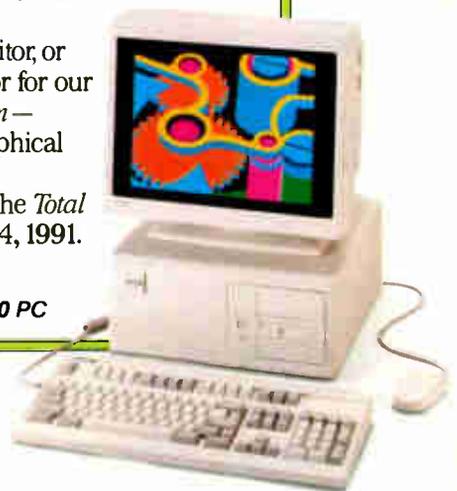


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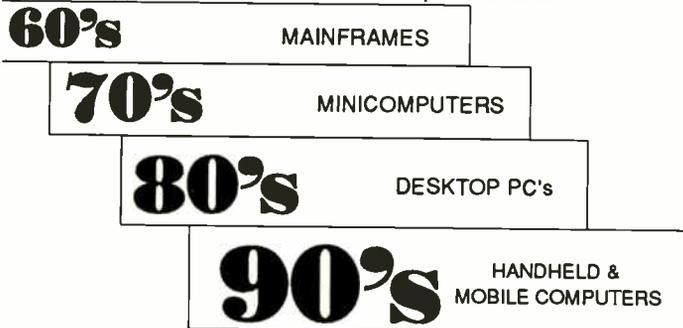
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its Enhanced Serial Port; the related serial communications software driver, Enhanced Serial Driver; and a public definition of the interface between them, the Enhanced Serial Interface. The ESP board is a plug-in card (both EISA and PS/2 versions) that has a 1000-byte buffer in each direction to prevent data loss. It interweaves with the software ESD to be sure all bytes transferred across the bus reach the intended local destination.

In fact, the Hayes ESP/ESD/ESI solution supports the following four ways of solving the serial port data-integrity problem:

- First, support for the 16550A, which requires that the communications application software utilize the additional buffer.

- Second, an enhanced 16550A mode that uses separate logic in the ESP around the 16550A to identify when the received data is overrunning the capacity of the PC. It will then exert flow control (RTS or DSR) to prevent data loss. This mode does not attempt to ensure more efficient line utilization in the transmit direction, nor does it require that communications software applications support the 16550A.

- Third, an enhanced buffered mode that supports buffered transfers between the PC and the ESP card, utilizing a Hayes-supplied software driver. In this mode, bidirectional flow control utilizing RTS/CTS, DTR/DSR, XON/XOFF, or transparent XON/XOFF is supported.

- Fourth, a true DMA mode. DMA is a specific high-speed transfer mode designed into the ISA, EISA, and Micro Channel architecture versions of the IBM computer bus. By utilizing DMA, efficient data transfers can be made with minimum use of the PC/bus resources. Hayes provides software drivers for use under Windows and OS/2 to support a DMA transfer mode.

Because it requires purchasing a new serial port card and a special software driver, the Hayes solution is quite an expensive one. But it minimizes the use of expensive PC resources, because the communications between the modem and the microprocessor memory use DMA. DMA is significantly faster and more efficient using the computer bus resource than using the polled character-by-character access that normally takes place. The most significant deterrent to the use of DMA is the few communications software applications that currently support it.

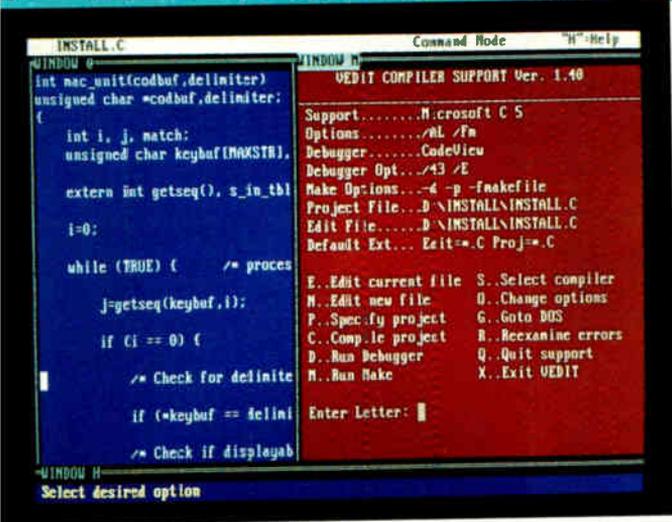
### The Multi-Tech Intelligent Serial Interface

Multi-Tech Systems (Mounds View, MN) also offers several alternative approaches to maintaining data integrity through the serial port. The most innovative approach, the Intelligent Serial Interface (ISI), borrows from the de facto standard for connecting asynchronous serial ports to LANs. The developer of this interface, Network Products, calls it Network Communications Services Interface, and the company that promulgates its use, Novell, calls it Network Asynchronous Services Interface. Since a wide range of communications software for LAN interweaving supports it, this standard offers an existing solution to maintain data integrity across the serial port. NCSI provides the connection between the LAN software and the higher-layer application or external communications.

The NCSI interface transfers blocks of data across the computer bus in response to an interrupt request and is only a slightly less efficient use of the computer/bus resources than is a DMA transfer. A drawback is that ISI requires communications applications designed for LAN communications, even if you are not planning on using it for a LAN, as is shown in figure 2.

An issue that may affect the NCSI performance is that many current software applications with NCSI support the interface

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Block-column copy (40x200)	2 sec	30 sec	2 sec	2 sec
Delete one column in file	9:58 min	1:50 hour	1:03 hour	Cannot
60,000 replacements	3:18 min	1:44 hour	1:32 hour	Cannot

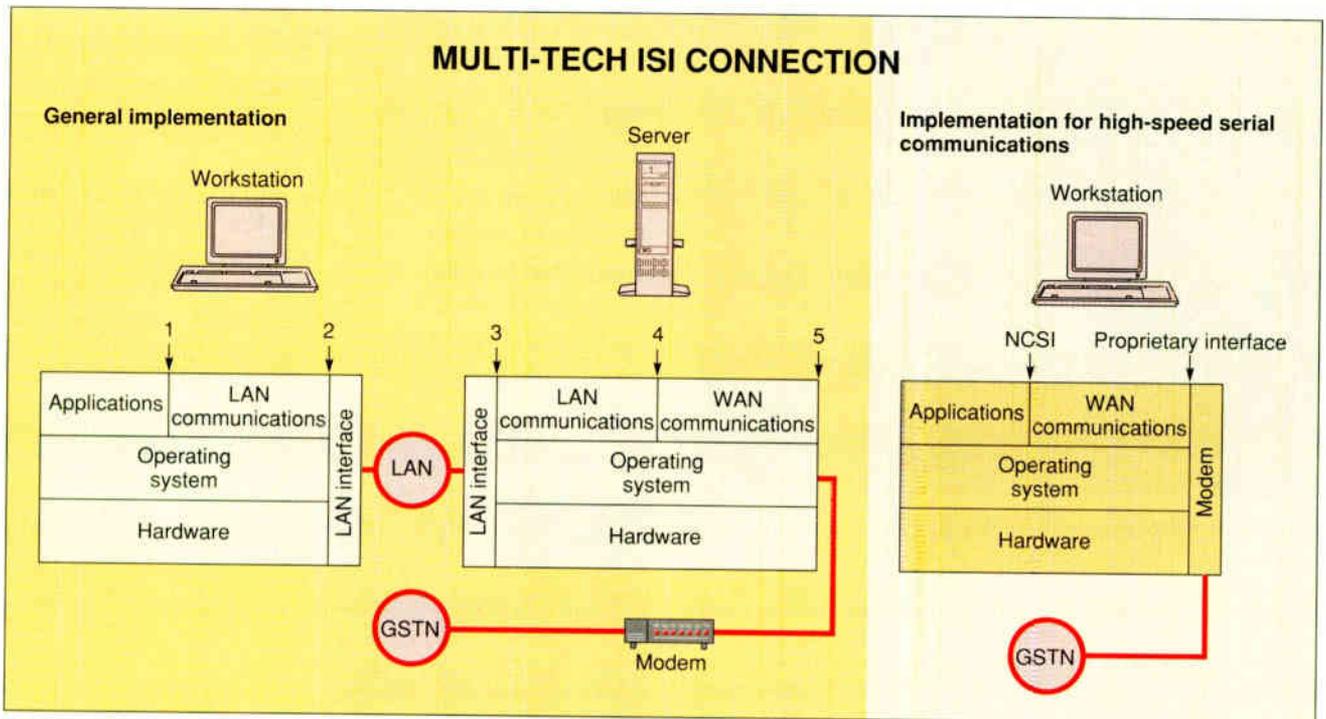
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**Figure 2:** The Network Communications Services Interface provides the connection between LAN software and the higher-layer application or external communications. Essentially, you are taking advantage of an established network standard to do high-speed serial communications. Interfaces 1 and 4 are possible NCSI interfaces. Interfaces 2 and 3 are proprietary interfaces currently. Interface 5 can be a serial port or a bus interface (with an internal modem).

only at 19,200 bps, but 38,400 bps is desirable for use with data compression and 14,400-bps modems. In the future, more NCSI will likely offer support for 38,400 bps.

The drawback to the NCSI approach is that it will operate only with a Multi-Tech internal card or a Multi-Tech serial card. It is, therefore, potentially as expensive as the Hayes ESI approach.

**Forval Turbo Interface**

Forval America (Salt Lake City, UT), a new high-speed modem manufacturer, has taken a different approach to handling the problem of data loss within the computer. The company calls its solution the Forval Turbo Interface (FTI).

An FTI looks exactly the same to the PC bus as an 8250 on the modem card plugged into the bus. In fact, it actually operates more like a large 16550A that does not need to be turned on by the communications application software. The FTI has a built-in buffer of 1000 bytes in each direction. However, each byte is delivered to the computer bus and an interrupt request generated. If the byte is accepted by the computer bus, the next byte is delivered. If the byte is not accepted by the computer before the next byte is assembled from the communications channel, the first byte remains, and the second byte is stored in the second location in the buffer. The third byte is stored in the third location in the buffer, and so forth. In this way, the FTI can hold data that cannot be accepted by the computer bus until the bus has time to accept it. Since the FTI is designed into the Forval modem, it can also provide flow control to the opposite end of the communications channel should the 1000-byte buffer begin to fill.

The advantage of the FTI is that it provides reliable and compatible operation at high data transfer rates with existing com-

munications software applications in existing IBM-compatible PCs. The disadvantage is that the FTI is only available in Forval modems and that the interface is interrupt-driven and not as efficient a use of the computer bus resource as is the Hayes ESP or Multi-Tech approaches.

**General Solutions to Data Integrity**

Since each manufacturer's solution to PC data integrity is manufacturer specific, each solution requires its own communications software (or driver). A general solution for all hardware communications devices, or DCE devices, requires an accepted standard. The Telecommunications Industry Association TIA TR-29.2 is the U.S. standards committee that develops digital interfaces to PC fax devices. Work has been under way for over a year to develop a standard transfer method for high-speed serial communications for fax applications. It is possible that a standard way to support high-speed PC fax applications could also be used for other high-speed serial applications.

But communications software companies have not been active in this work, and communications hardware vendors are often interested in popularizing their proprietary solutions to the data-integrity problem. Gaining consensus from competing companies to create a TIA standard thus remains an elusive solution to data integrity. ■

*Ken Krechmer is the principal of Action Consulting in Palo Alto, California, a firm involved in data communications standards and product development. He is also the technical editor of Communications Standards Review, a technical newsletter of the activities occurring in wide-area network standard groups worldwide. He can be reached on BIX c/o "editors."*

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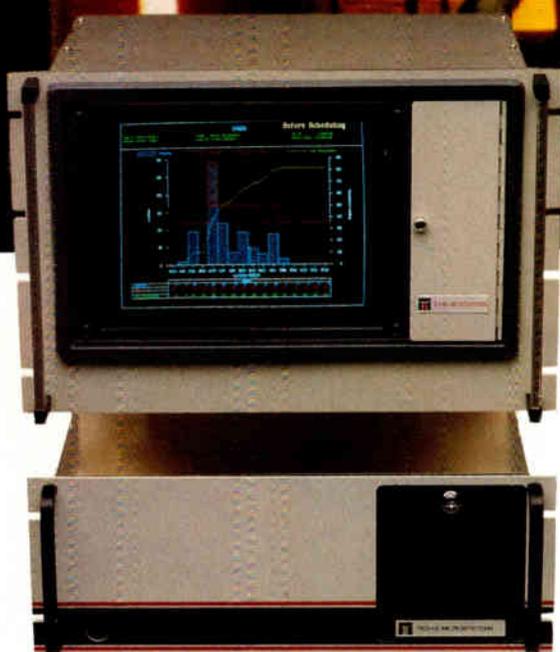
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# THE PAPERLESS OFFICE

One of the ironies of the personal computer revolution is the amount of paper it has produced. Back in the mid-1970s, many people thought that one of the effects of personalization of computer technology would be the obsolescence of paper. (Little did they comprehend the attraction of seeing our words in 37 fonts and type styles, all on the same page.)

The effect of computers, of course, has been to increase the amount of paper we put out. When it is so easy to create decent-looking output, there is little reason to exercise restraint. This has created its own problem: the care, feeding, storage, and retrieval of all those paper documents. It has also created a new technology called *document image processing* (a.k.a. the paperless office) to handle the mass of paper documents we've buried ourselves in.

In "The World of Documents," Gerald P. Michalski describes how the concept of a document has been radically changed by computer technology. He outlines how you can integrate imaging with many different technologies, such as text management, hypertext, and groupware, to garner the greatest utility from your information system. Two of the satellite technologies described by Michalski are described in detail in a couple of related text boxes. In "Moving Data Using EDI," Sharon Fisher describes electronic document interchange, an ANSI standard for the automatic transfer of business information. In "Warm for Forms," Mark Skapinker describes how electronic forms processing can go a long way toward making the paperless office a reality.

The central technology of the paperless office is document image processing. Paper documents are scanned into image files stored (usually) on optical disks. The documents are then available for retrieval, viewing, and printing. In "Catch the Wave of DIP," David A. Harvey takes a close look at the technologies that build an imaging system.

DIP is more than a technology. In "Practically Paperless," David A. Harvey and I examine some DIP success stories: companies that have implemented document imaging to solve very real problems. The cases examined range from simple network configurations to enterprisewide, mainframe-based imaging Goliaths. In a related text box titled "The Evolution of DIP," David Silver traces how DIP has changed from the days of microfilm.

It is easy to get carried away by technology, and DIP is no exception. In "The Dark Side of DIP," Christopher Locke brings into focus the problem of indexing as it relates to the storage and retrieval of stored images. Locke stresses that indexing documents is not a low-level task but rather one akin to knowledge engineering. He is also leery about assigning documents using rigid classification schemes; he views an archive as a vein of information to be mined, not as a static, lifeless entity. In a related text box, Locke describes some of the numerous products available that reveal the challenge of indexing.

In "Divide and Conquer," David P. Wright and Christopher L. Scofield describe an optical character recognition system based on neural network technology. They see a bright future for this technology in the paperless office, particularly in forms processing. In a related text box called "Recognizing Script," Jane Morrill Tazelaar describes an innovative handwriting-recognition system from the Soviet Union.

A completely paperless office is not yet a reality and may never become one. Regardless, the myriad ways that computer technology lets us view and link documents will enable us to see information in new and different ways. And that's worth a lot more than an office without paper clips.

—Bob Ryan  
Technical Editor  
State of the Art

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# THE WORLD OF DOCUMENTS

No system is likely to need all the technologies of Intelligent Document Management, but you may well need more than one

GERALD P. MICHALSKI

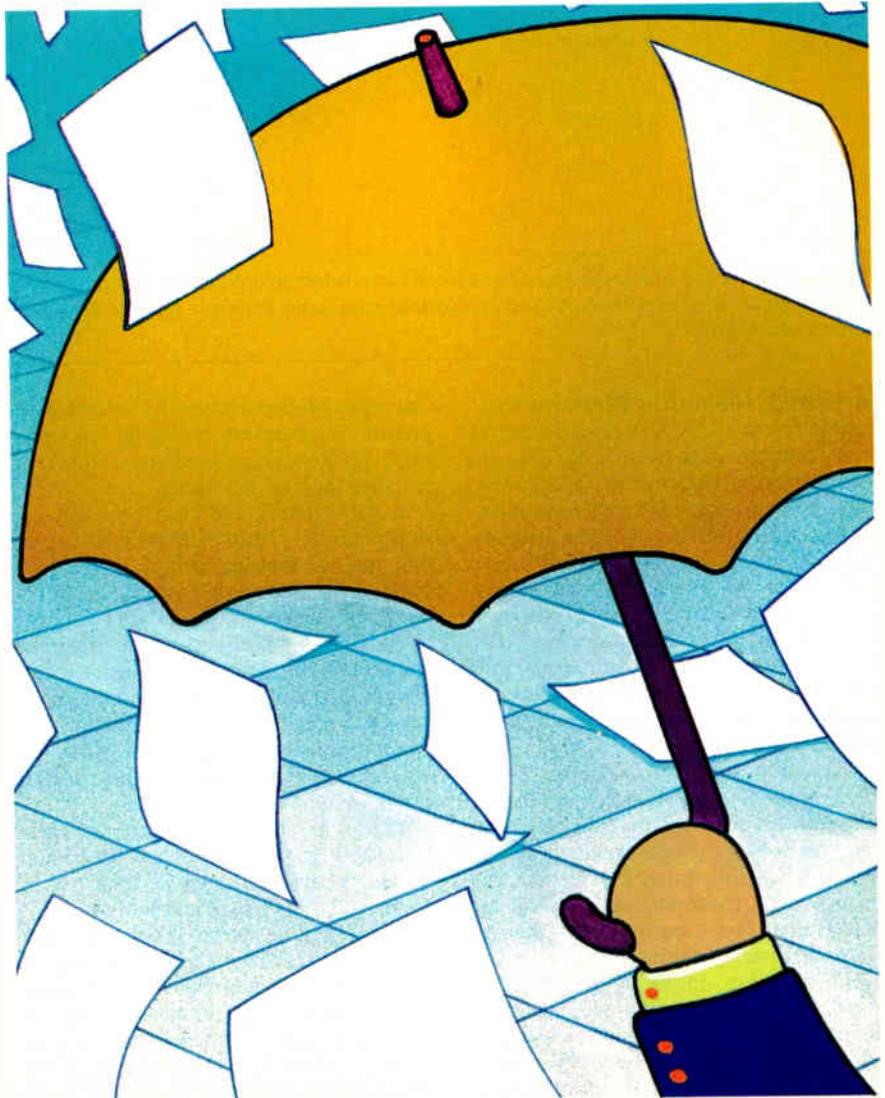
**T**he world of documents as we know them is disintegrating before our eyes. The mental map we typically use that equates a file object with a document is fast being replaced by a more complex mapping. Hypertext and “hot” or “active” links between objects are blurring the differences between one file object and the next. In a well-engineered system, these objects and their links can all look like a single document.

One working definition for a document would be the following: A document is a snapshot of some set of information that can

- incorporate many complex information types;
- exist in multiple places across a network;
- depend on other documents for information;
- change on the fly (as subordinate documents are updated);
- have an intricate structure, or complex data types such as full-motion video and voice annotations; and
- be accessed and modified by many people simultaneously (if they have permission to do so).

Each of the people accessing a document may have a different purpose for doing so. For example, a customer-service representative may need to view a complaint letter to tell its author its current status. A manager may need to view the same document alongside other letters about the same issue to diagnose the problem.

*continued*



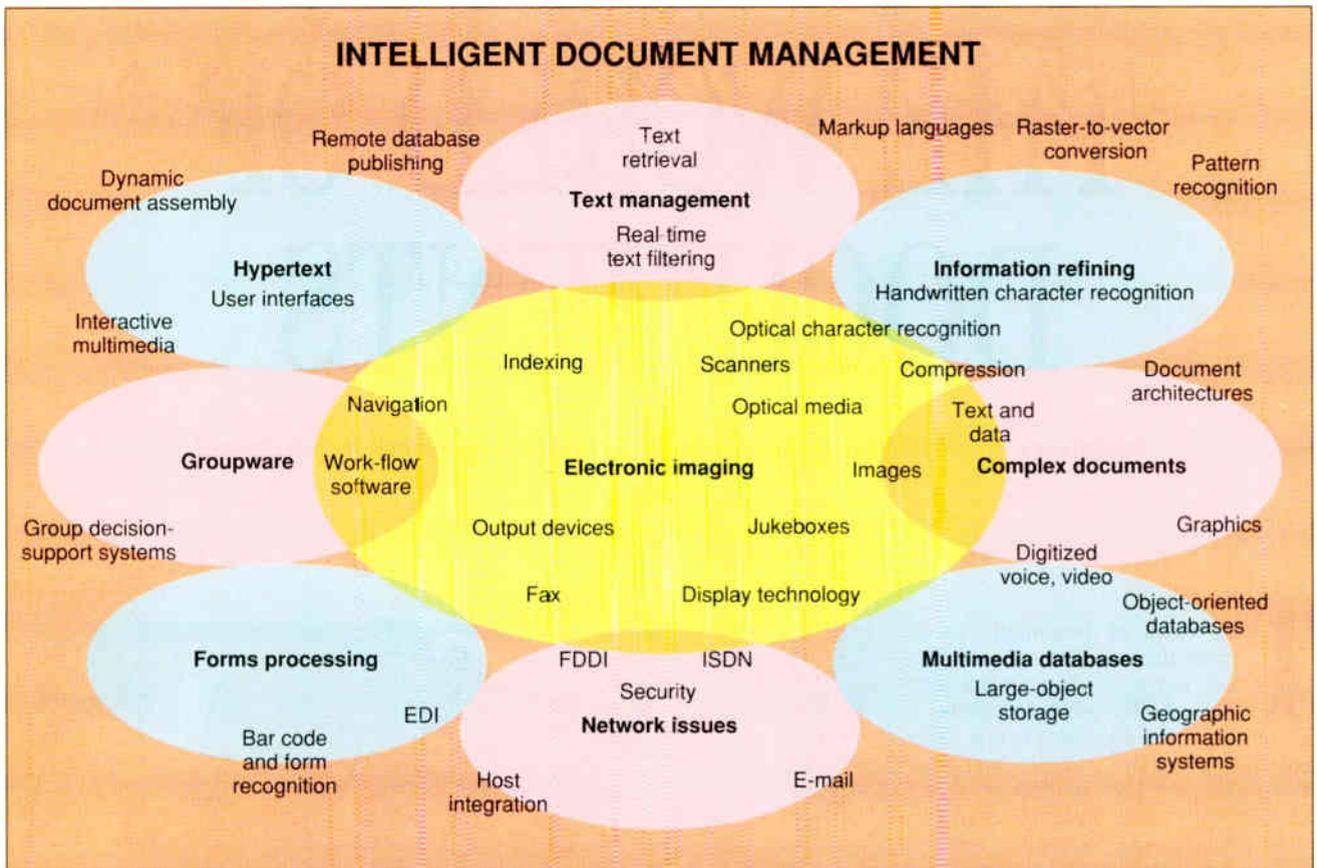


Figure 1: The scope of imaging systems extends into other related technologies under the concept of IDM. The location of the various technologies does not imply a formal structure; it simply reflects their relationships to one other. (Courtesy of New Science Associates)

**Intelligent Document Management**

Few tasks in today's business environment revolve around the task of filing and then retrieving a document. Thus, many of today's imaging offerings have incorporated functions like database lookups, integrated word processing, and predefined work flows. But few vendors present a complete and integrated solution to the problems of creating, storing, managing, manipulating, and disseminating information. Most vendors extend the architectures that they developed in response to another need.

The umbrella term *Intelligent Document Management (IDM)* extends the scope of imaging systems into other, related technology areas, as shown in figure 1. This diagram is conceptual, not formal. The technologies it shows are placed near one other in a way that reflects their relationships.

For example, much of the early research in hypertext was also research about what is now called *groupware*. Doug Engelbart's work on the Augment/On-line System and the work on Zog at

Carnegie Mellon University intended to provide a seamless browsing environment for academics and researchers to enhance their collaboration.

Assume that figure 1 is a three-dimensional model, richly interconnected, and that you are looking at it from the perspective of electronic imaging technology. Just because a topic like "text retrieval" is located across the diagram from database technology doesn't mean that the two are not related and interconnected. In fact, they are. No relationship is simple. Each topic has an effect on others; the effects just weaken as the topics become more distant.

The technologies shown are not categories, but sets of features and functions. Some systems require only one or two of them; others will need a rich mixture.

Imagine a research laboratory that wants to move from keeping records in spiral-bound notebooks to an integrated system that catalogs the activities of the researchers and aids them in creating innovative products. Laboratory work has changed a lot from the early days when

all notes and calculations could be kept in notebooks. Now, researchers have computer models on disk.

A successful laboratory system might rely on multimedia databases to store data, texts of various kinds, electronically scanned photographs, and data streams representing the results of experiments or test tabulations. The researchers might need full-text access to each other's research papers, and the ability to comment on each text and circulate those comments to others in their field or company.

A hypertext information environment would help to cross-reference all the relevant works and provide a browsing mechanism to help bring previously unseen relationships to the fore. Such a system would probably require high-resolution displays, much mass storage, and high-bandwidth communications. If information to be stored on the system adhered to a common set of storage standards at the file and data-stream level, it would vastly improve the ease of interchange among tools.

*continued*

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*Info World, Hercules' 34010 Graphics Board  
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World Radio History

# Moving Data Using EDI

Sharon Fisher

Some say that the paperless office is as much of a pipe dream as the paperless bathroom. But one technology making real contributions toward reducing the amount of paper in today's offices is the Electronic Data Interchange standard.

The EDI protocol, also known as ANSI standard X.12, lets business organizations exchange data in a standard format, reducing the need for many standard forms like purchase orders, invoices, and even tax returns.

In addition to reducing the volume of paper, EDI also greatly reduces the amount of rekeying or repunching a company must do; this lets you spend your time on other tasks, saves the rekeying time, and eliminates errors introduced through rekeying. Consequently, some major user organizations require the use of EDI not only in-house but also by all their suppliers—an action that's contributing to the spread of EDI.

## Roots of EDI

EDI was first developed by users in groups representing their various industries (e.g., purchasing, transportation, and financial applications); this is unlike many of today's standard's bodies, which are composed primarily of vendor representatives. At first, the groups focused on developing standards within their industries, but gradually they moved to transindustry standards.

EDI took its first steps toward becoming a bona fide standard in the late 1970s; in 1983, it was published by ANSI as a group of five distinct stan-

dards. New standards for forms are being added all the time; the 1989 release included 32 standards, while the 1990 committee has approved development for nearly 100 additional standards.

Some 18,100 organizations use EDI worldwide, according to estimates by EDI, Spread The Word!, a consulting firm specializing in EDI. The firm publishes a directory that includes 9400 U.S., 1000 Canadian, 1000 European, and 600 Asian companies; moreover, it estimates that an additional 2500 U.S., 100 Canadian, 2300 European, and 1200 Asian companies have not registered. According to EDI, Spread The Word!, the number of EDI users is also growing at a galloping 45 percent annually, from 1465 registered user organizations in July 1987 to the current 12,200 registered user organizations.

Continuing EDI's heritage, nearly 60 industry-specific groups help promote EDI's use among their members. In addition, almost 20 geographically based users groups help their members work with EDI.

## What Is EDI?

The EDI protocol itself specifies only the format in which the data is transmitted—for example, specifying that the purchase order number will always be in a particular location. The protocol's format is based on a group of *data elements*—the smallest named units of information in the standard. Data elements are identified by a reference number, and the data-element dictionary specifies the name, description, type,

and minimum and maximum lengths of each. In addition, data elements that are codes rather than textual fields include lists of the valid code values and definitions in the dictionary.

The X.12 standard is actually made up of four parts: the X12.3 data-element dictionary; the X12.5 interchange control structures, the EDI equivalent of an "envelope"; the X12.6 application control structures, or the formal description of the EDI architecture; and the X12.22 segment directory, which defines segments. Segments themselves are a list of related data elements, such as multiple lines of an address.

Other EDI components are the transaction set (the actual data that EDI is to transmit) and the functional group (a collection of similar transaction sets). Several purchase orders, for example, are collectively a functional group but are individually a transaction set. Headers and trailers lead and follow transaction sets and functional groups.

Other than the headers and trailers, the data format itself is fairly simple: the name of the field—which might be BT for "bill to" or ST for "ship to," for example—followed by the information, such as the lines of the address. Each address line is separated from another by a data-element-separator character. A segment terminator comes at the end of each related group of data, such as a four-line address.

## The Parts of EDI

Because the EDI protocol itself specifies only the format in which the data is

Few research labs can afford to move to such a system today. Most are working to provide some of the functionality where they sense their priorities lie. For example, many pharmaceutical companies have submitted their documentation to the U.S. Federal Drug Administration on optical disks, hoping that electronic storage of page images will speed the approval process. It will, but only insofar as the approval process involves looking up static documents. It ignores the need

of clinical experts to review tables of test results and run their own analyses; it ignores their need to search the full text of the document database. More broadly, it does not supply the interactive analytic capabilities that regulators need in order to give approval.

## Navigating Around the IDM Chart

Here's a tour of figure 1, starting with the word *navigation*. This term is placed near the confluence of four technology

areas (electronic imaging, text management, hypertext, and groupware) because it describes the commonalities between these feature sets. For example, the fields chosen as indexes in an imaging system provide the means to navigate to the documents you need, typically by entering a case number, social security number, or client's last name.

In work-flow applications (with predefined document-routing instructions prescribing that documents move from desk

transmitted and does not address the way in which two companies establish the communications link, you can implement EDI on a wide variety of computers—from Apple IIs to DOS PCs to Unix workstations to mainframes—and transmit the data using a number of existing data transmission protocols, including asynchronous communications and several IBM communications protocols, such as 3780.

On the PC level, some 30 vendors offer software that lets you implement EDI, according to a list distributed in the EDI Yellow Pages International directory. Prices of the PC software generally range from \$500 to \$6000; most are between \$1000 and \$2500, but one is as much as \$18,000.

EDI is similar to the X.25 communications protocol in that both computer software and a network are required to transmit data and you can either make use of a public data transmission network or set up your own. At present, about 18 vendors, including such familiar network names as Sprint Telenet, BT Tymnet, and CompuServe, offer EDI network services, according to the EDI Yellow Pages International directory. Costs for EDI networks vary. Factors determining the price include a monthly fee, hourly on-line charges, per-document or per-character charges, and volume discounts.

In general, the network services offer three types of transmission: Asynchronous, supported by nearly all the vendors, lets you call in over a standard dial-up line with a modem; bisynchro-

nous, provided by all the services, uses existing but older IBM communications protocols; and Systems Network Architecture, provided by most of the networks, uses more up-to-date IBM communications protocols. Transmission speed ranges from 1200 bps to 9600 bps, but most companies use 2400-bps bisynchronous transmission.

Setting up your own EDI network is far more complex and expensive—the software costs as much as \$128,000. It's generally done only by very large organizations that plan to embrace EDI in a big way.

#### Getting into EDI

You can move into EDI gradually, on a department-by-department basis, says Bob Payne, a partner in EDI, Spread The Word! "A lot of new users start by just licensing software for the PC, having it receive purchase orders, printing those out, and then keying those into any order-processing system they might have," he explains. This allows you to receive purchase orders faster than you might using the U.S. Mail, although it is more costly, and it is probably the cheapest way to fulfill an EDI requirement. (The EDI Yellow Pages International directory also includes a 12-step "paperholics anonymous" list of suggestions for implementing EDI.)

A way to take greater advantage of EDI is to integrate it with your company's order-processing software, says Payne. "Some PC software packages do a pretty complete job of preparing a file that a user could bring into an order-

processing system," he notes. Unfortunately, he says, few vendors have integrated EDI functionality, so you have to do it yourself. But that final step is what you should plan for, according to Payne. "You can integrate that final step, eliminate manual operation, and do EDI with other customers," and gradually leverage the investment by expanding to other customers, he says.

"If you're Levi Strauss, you have software to receive purchase orders in that format, and you can use that same software with any department or any apparel retailer," Payne explains. "That's the beauty of it, and that's where the standard really comes into play."

As a bonus, EDI can make even small companies look "big," Payne says, in the same way that letterhead and word processing adds a professional look. "They can look as good as somebody like Levi Strauss does," he says.

#### FOR MORE INFORMATION

Data Interchange Standards Association, Inc., 1800 Diagonal Rd., Suite 355, Alexandria, VA 22314, (703) 548-7005. (Ask for the X12/DISA Information Manual, ASC X12S.)

EDI, Spread The Word!, P.O. Box 811366, Dallas, TX 75381, (214) 243-3456. (Ask for the EDI Yellow Pages International.)

*Sharon Fisher is a San Francisco-based freelance writer specializing in computer communications. She can be reached on BIX as "sharonfisher."*

to desk as tasks are completed), documents actually navigate their way around an organization. A work-flow environment is much more distributed than a central-control model. It's like having a roomful of autonomous crews that work at their own pace, pulling work off the queues and sending it on as they finish.

Sometimes people are not sure where they want to navigate. They want to bump into things, learn, and get new ideas, often without needing one specific

document. What they require is a rich browsing environment, and that's what a well-authored hypertext system is.

Text management falls on both sides of the navigation issue. On one hand, text-retrieval systems (similar to indexes in imaging systems) help you navigate to specific documents. On the other hand, text-filtering systems can be loaded with individual user profiles that map their interests. Thus, the filtering system continuously watches a stream of information

(e.g., a newswire feed or E-mail messages) and pipes only the relevant ones into the appropriate "to read" folder.

These two sides of navigation highlight two facets of IDM: You can manage intelligent documents, like those that move themselves around an organization, or you can manage documents intelligently—for example, by not scanning documents that are not likely to be retrieved. Because these technologies are not yet inexpensive enough and powerful

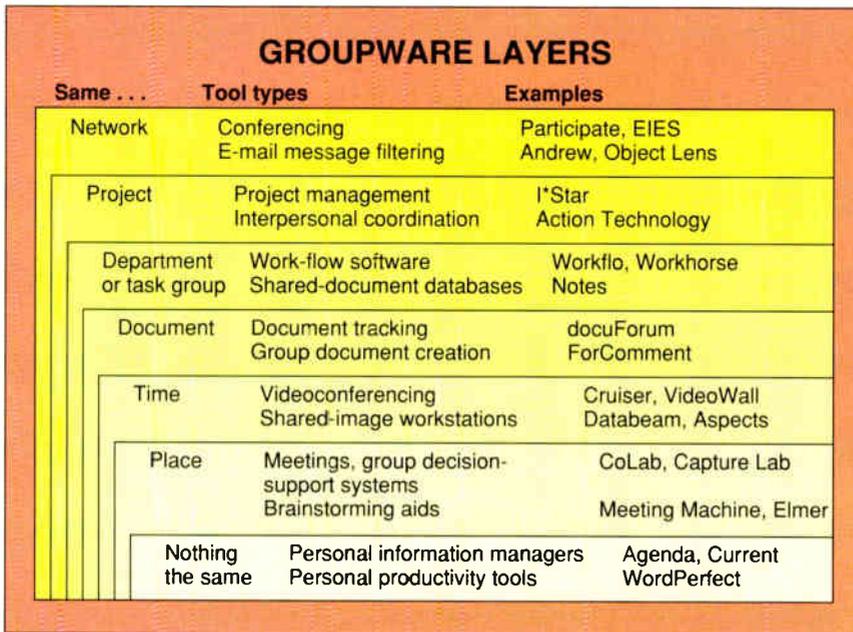


Figure 2: Various groupware features cluster together according to the workgroup that tends to use them. (Courtesy of New Science Associates)

complich work together, whether they are sitting next to each other, across the country from each other, or in the same seat (at different times). Figure 2 illustrates the different features of groupware that become handy when people have certain things in common; several features can come in handy at once.

For example, work-flow software features, like those that are found in File-Net's systems, are typically used at a departmental task-group level to move work around. Such a group may want to create a database of shared documents—as you can, for instance, with Notes from Lotus Development (Cambridge, MA). Notes also has other features, including text filtering, forms building, and multimedia E-mail.

If group members are working more closely (perhaps assembling a single document, such as a bid or a market study), they may need software that manages the component parts of the document, as well as software that allows one member to make comments on another's document. The author, on reviewing the comments, can either approve them (in which case the document is permanently altered) or refuse them (in which case the document is left intact).

If you bring workers together more, by working at the same time, they may want to view the same document in real time. Videoconferencing and shared-screen systems (e.g., the Aspects system for Macs from Group Technologies in Arlington, VA) provide such help. Meeting-room enhancements developed by Xerox Palo Alto Research Center provide similar tools to people in one location.

You should not ignore personal-productivity tools and personal information managers, even though these are usually designed for one person only. If you hook an application like Lotus Agenda to your E-mail network, it can help filter your mail—a groupware function.

WordPerfect (Orem, UT) has been advertising the groupware capabilities of WordPerfect Office recently. That's a word processing company broadening into office automation and advertising groupware. The walls are all tumbling down, and that's why it makes sense to view these features as just that: features.

Above work-flow systems are features that enhance the coordination of work across the enterprise and even between enterprises. As more people get on-line accounts and send messages, intelligent filtering features, like those in the Object Lens project at MIT, will enable you to cope with the volume and accomplish more work.

continued

**BYTE ACTION SUMMARY**

**Intelligent Document Management**

Intelligent Document Management extends the scope of electronic imaging into other, related technology areas: hypertext, groupware, information refining, multimedia databases, network issues, text management, complex documents, and forms processing. All these areas are related and interconnected, some of them more closely than others. Some document imaging systems may require only one or two of them; others will need a rich mixture.

enough to be widespread, you must make careful economic choices to get 80 percent of the desired effect for 20 percent of the cost and effort, where possible.

To complete the tour, I will move to forms-processing systems. In the IDM perspective, Electronic Data Interchange is a subset of the forms world: In essence, EDI standards are predefined forms exchanged electronically, full of information, instead of being mailed out the door on preprinted stock (see the text box "Moving Data Using EDI" on page 162).

If the forms are still in a paper state and EDI is not readily achievable, marking the forms with things like bar codes and buying scanners with built-in bar code recognition can dramatically speed the sorting of inbound mail.

Finally, electronic forms, whether front ends to a database, enhanced forms software, or forms built with Lotus Notes' built-in forms editor, can bind workers together more closely by facilitating their work across the corporate network as well as between organizations. This is why forms processing is so near to groupware (see the text box "Warm for Forms" on page 166).

**Workgroups**

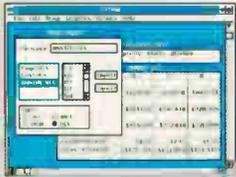
The term *groupware* has been much maligned of late, but it still has value. You can replace it with "computer-supported cooperative work" or "workgroup computing," if you wish. But the term covers features in software that help people ac-

**THINX SMART:** Thinx takes data and represents it as graphic images.



*Behind each image is an array of data that you input.*

By linking information to images, Thinx™ software, for the first time, allows you to manipulate streams of complex data simply by moving those images. Now “Intelligent Graphics” can be used to form connections, find relationships and make judgments. For instance, offices, equipment, furniture, and people all have an effect on a building’s cost, profitability and countless other aspects of its operation. Yet, with Thinx, all this can be represented and analyzed by manipulating a graphic image of the building.



*Link several databases and spreadsheets and use all the data at once.*

**THINX FAST:** Thinx works the way you like, with Windows\* and the leading spreadsheets and databases.

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# Warm for Forms

Mark Skapinker

In any study of the *paperless* office, you need to look carefully at what paperwork makes up the *paperful* office. Forms represent a significant part of office paperwork. In fact, much of the savings you can realize in creating a paperless office comes from the computerization of business forms.

The issues are enormous. According to Datek Information Services of Waltham, Massachusetts, forms make up over a third of all business documents; U.S. companies spend more than \$6 billion every year on preprinted forms; U.S. companies waste \$2 billion in preprinted forms; and U.S. businesses spend from \$94 to \$120 billion per year to distribute, store, and process forms. While most organizations measure the cost of business forms by the cost of buying a paper form, it has been found that for every \$1 spent to buy a paper form, \$60 is spent to process it!

## The Forms-Processing Domain

When examining the paperless office and forms, you need to consider two issues: the storage and recording of "paper filled" forms using techniques such as imaging, and the creation of "paperless" forms via electronic forms processing. Here, I am examining this second issue: the state of forms processing today and the impact of this emerging market. While much effort is going into imaging paper forms, it is obviously preferable to create a paperless form in the first place. The economic and ecological benefits are evident.

High-end forms-processing software products are made up of a number of necessary components. Designing and filling forms are two distinct functions: Designers design, and fillers fill.

The forms designer software must include all the power and control needed to define what a form looks like from a

desktop publishing graphics-standard perspective. The designer also needs to specify where the filled-in fields will appear and what their attributes (e.g., numeric data only or a mask) will be. Designers also define the relationship between fields via calculations, lookups to databases or lists, and other database information, such as indexes and relational links between forms.

## Entering Data

Forms fillers, on the other hand, tend to be relatively unsophisticated computer users. The filler program needs to be easy to use, but it has to include sophisticated print and data-entry capabilities. Often, fillers can be filling in forms on multiple platforms, so the fill software has to be available on different types of machines. There is also a need for batch-type filling for printing forms directly from other applications. Given its graphical nature, forms design software is best suited to a graphical environment like Windows 3.0. The filler software should run on both graphical and text-based machines.

With forms being created, distributed, and filled electronically, you may wonder why you need a print capability at all. The answer is simple: Changes in forms processing, like any changes in office procedures, do not happen all at once. The software must cater to the evolution from a manual system to a completely automated one. Another reason is the need for signatures. By signing a paper form, fillers take responsibility for the contents of the form.

Some products, such as PerForm Pro from Delrina Technology (Toronto, Ontario, Canada), include an electronic signature capability for forms fillers. This security system includes the ability to include a private key for signing and locking any data on the form, as well as

a public key system for verifying or unlocking the data. Electronic signatures are more secure than paper signatures because they can lock fields from tampering. Because of government users' high degree of interest in forms software, this electronic signature should be a government-approved type.

Many other more obvious features are needed in a forms processor, including the ability to share data. This is done by storing the data separately from the form, allowing different sources to access the data in both forms and tabular format. Once the filled form is saved, it is important for it to be available to other users, via printing, fax, networks, or E-mail.

## The Form of the Future

A number of forces are speeding up the acceptance of forms processing. One important development is the standardization of corporate computing in the form of standard graphical interfaces like Windows 3.0, standard communications, and database standards such as Structured Query Language. Other technologies, such as pen-based systems, should add a significant boost by making electronic forms filling a portable exercise.

Over 50 percent of large corporations have started using forms-processing software, and the technology is now cost-effective for many businesses. Forms processing represents an evolutionary software technology that ultimately leads to huge savings in costs and paper.

*Mark Skapinker is cofounder and president of Delrina Technology, Inc., of Toronto, Ontario, Canada, publisher of PerForm and PerForm Pro forms-processing software. He can be reached on BIX c/o "editors."*

## Black Gold

Images are dumb. If you want to do anything with them, you either have to tag them with additional, searchable information, such as an index, or continue to

process the documents to turn the images into useful electronic information.

Figure 3 shows a stair-step model illustrating a concept called *information refining* that was coined by John Clip-

pinger (Coopers & Lybrand, Boston). As with petroleum refining, information refining assumes the existence of "deposits" of raw materials (i.e., information) that someone makes economic decisions

about investing in to derive a higher-value product (i.e., searchable documents).

The stair-step model shows the steps people go through—and they vary widely—to get more value out of documents. The *x* axis (or run of the steps) indicates how much money is spent to process a given batch of documents; the *y* axis (the rise) represents how much understanding of the document the computer system contains (versus the need for someone to read the document and try to understand its content).

The information refining scenario, then, goes like this: A piece of paper is scanned and ends up as a bit map in the computer. If there is text on the page, chances are that an optical character recognition (OCR) system can make sense of it, but not 100 percent accurately.

If accuracy is needed (and there exist text-search tools that search inaccurate text, so 100 percent accuracy does not have to be a design goal), then someone or some application has to proof the results. The proofing can involve lookups against a dictionary or client list, or potentially some AI as an aid to discern context and create full sentences. This may well be enough. The computer does not need to fully “understand” every document.

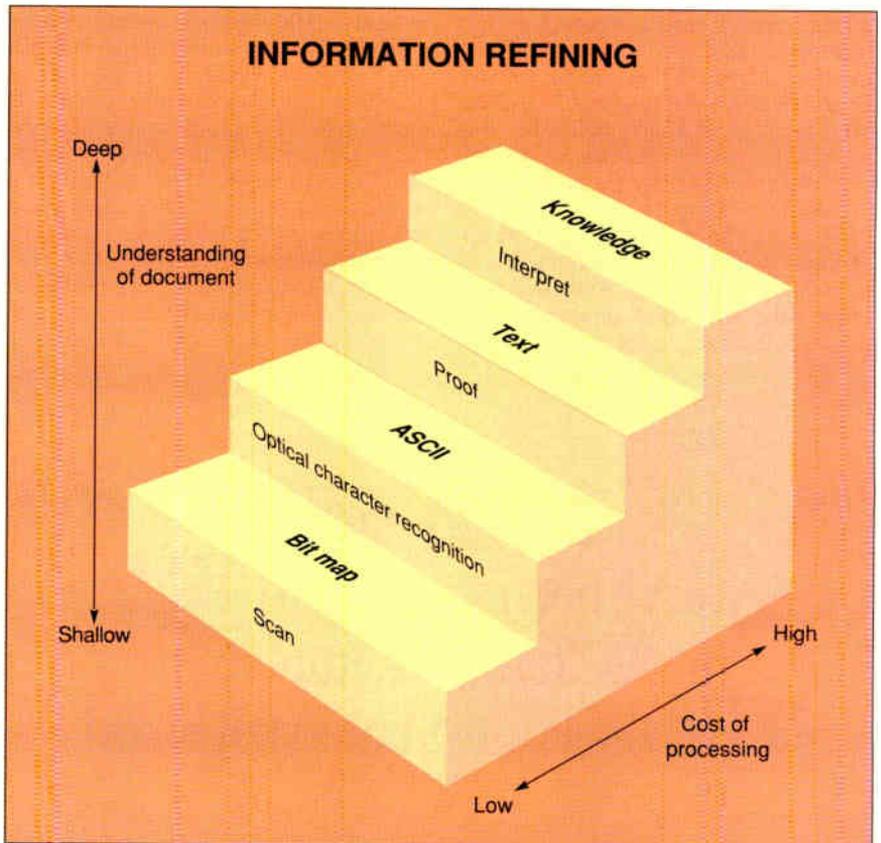
Finally, some interpretation of the words often needs to be made. Within limited domains, such as resumés or wire transfers of funds, AI can be helpful today. EDI messages are a special case. They enter this model at an extremely high level of understanding, because two parties have agreed on the exact nature of the contents of each of the fields.

With slight changes to the steps, this model also works for graphics. For instance, instead of using OCR, you might invoke a raster-to-vector converter to isolate known objects and derive their attributes.

### Planning Issues

As you decide whether to process the documents hiding in your organization, you should also consider what format you want them in. If multiple people or applications need to access these documents, it's considerably easier if they all conform to a single format. Several compound-document formats exist today, in various stages of completion and sophistication.

Another issue that is sure to come up as you evaluate imaging systems is the effect that storing and moving such large objects has on your database and network



**Figure 3:** This stair-step model illustrates information refining—the steps that people go through to get more value out of documents. The *x* axis indicates the cost, and the *y* axis represents how much the computer “understands” the document. (Courtesy of New Science Associates)

capabilities. For example, a normal alphanumeric database record requires about 2000 bytes, while the compressed image of an attached business letter might need 50,000 bytes. (Imagine your family sedan with a 10-car freight train attached.)

While network protocols do their best to packetize the information and route it efficiently, the image still has to be reconstructed at the other end. In any event, objects of this size will have a significant effect on the network.

Consequently, most imaging systems use not only large stores of magnetic disk, but also optical-disk storage—often jukeboxes. And, network administrators who might contemplate putting 30 users on a single LAN pull back to 10 or so when constant image traffic is involved. These size factors complicate performance tuning, backup, and disaster-recovery techniques.

Many technology features and functions remain undiscussed. Special-purpose databases, such as those with an object or geographic orientation, are slowly

claiming their place next to text and more traditional DBMSes. The object-oriented variety may make it a great deal easier to store documents with very complex structures, as well as documents that contain unusual data types (e.g., video and sound).

Scanners, displays, and printing devices are all key elements to the success of document imaging. As their prices go down, your deployment strategy may change substantially. For example, low-cost laser printers on LANs may well be a good alternative to centrally located, much more expensive page printers. If the distributed printers are also fax servers (there are some fax devices that can now double as laser printers, and vice versa), the added benefit may sway your decision.

### Where to Start?

In choosing a document imaging system, consider these points:

1. Understand all the technical features and functions required by a document

management system, and accept the fact that there is as yet no "silver bullet" system that does all things for all people. Every vendor's offering involves trade-offs. Some offer functionality but trap you in a proprietary platform; others provide markup functions but no engineering-document support.

2. Examine the business around the application that you want to automate with an imaging system. Ask some questions beyond the immediate application. For

instance, is this business about to change radically? Is a restructuring in the offing? Are standards either present or emerging in this environment that will make complex imaging systems unnecessary? Is there a way to redesign the system to obtain input information in electronic form? Who is the real client of the system you are contemplating, and what is its real purpose?

3. Do an in-depth document profile of the department in question. Do not stop

at counting the piles of paper on people's desks and in the file drawers. Examine how the information is actually used. Is full-text search needed? Model the document life cycles. How often are documents accessed within five days? Within 15 days? Within 90 days? How secure should the documents be? Who will have access privileges? How many versions will have to be kept?

4. Pick your technical features carefully. Decide on the minimum drop-dead feature set (i.e., if they don't have x, you won't buy the system) and then broaden it to include the features that changes in the application environment are likely to require in the near future.

5. Match that feature set to current vendor offerings and their stated platform, product, and market strategies.

The likelihood that any system you build will require all the technologies represented in the scope of IDM is slim; conversely, the likelihood that you will need more than one is high. Which ones you need depends, as usual, on your environment and your applications. But it is impossible to make an educated decision about which system to select without an understanding of the base technology features and functions and the way they affect one another.

**The Next Plateau: Mainstreaming**

The computing community is now nearing the end of an epoch that can be called the Federal Highway Projects (FHP) phase of the Information Society. Just as the U.S. government sponsored and funded the construction of a nationwide infrastructure of roads, tollways, interchanges, and bridges, most organizations are focused tightly on designing and building their own infrastructures.

These new infrastructures consist of networks (local area, metropolitan area, or wide area), platforms (with the ensuing messy operating-system and user-interface issues), and connections (gateways, bridges, routers, and various hybrids).

The major problem is that there has been no decree from "on high," wherever that is, about how wide to make the roads, how long to make the ramps, or what color to paint the signs. Indeed, each organization is fending for itself amid the jungle of offerings, all of which at least try to say that they can interoperate.

Once the FHP phase has passed, imaging systems will be regarded as mainstream technologies, not as the specialized systems that they are today. In the

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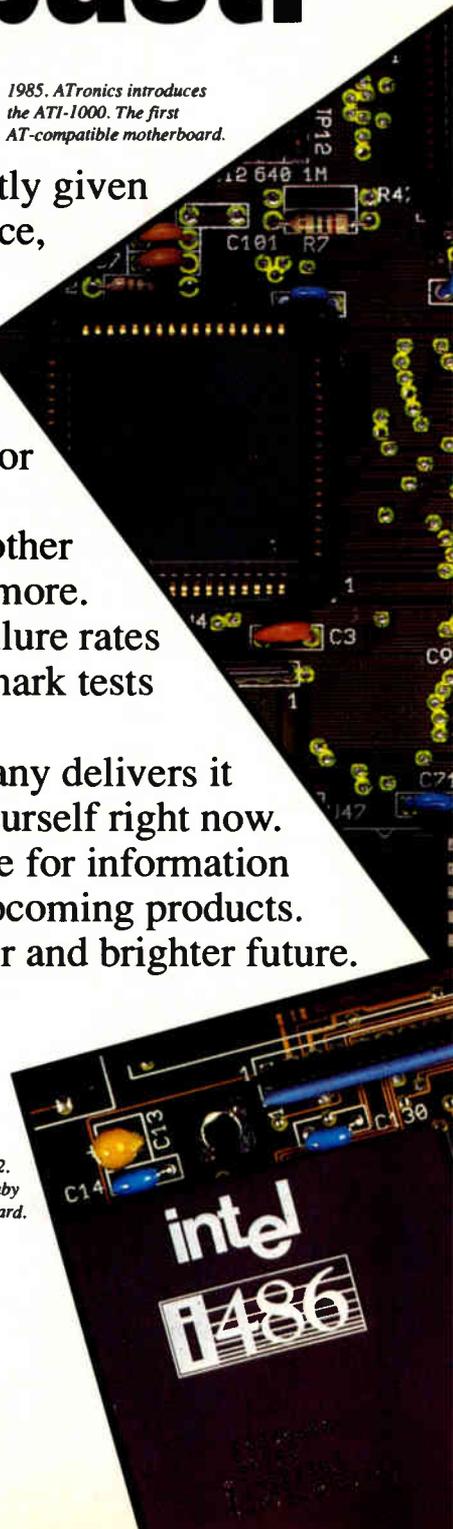
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## THE WORLD OF DOCUMENTS

early days of imaging technology, there were two major market segments, located at opposite ends of the spectrum of complexity and cost. I'll call them the high end and the low end.

The high end of the spectrum involved high-speed item processing—generally, checks, credit-card slips, and passenger flight coupons—and avoided long-term storage of the images, preferring instead to lift the images, read them, and discard them. High-end systems from companies like BancTec (Dallas, TX) and Teknekron Financial Systems (now TRW Financial Systems in Berkeley, CA) could cost \$10 million or more.

The low end involved stand-alone storage and retrieval systems that used early optical disks. Although these systems were much less expensive than those at the high end, they still could not break the \$100,000 barrier, and costs per document retrieved were too high to justify widespread use.

With the advent of FileNet's Workflo system in 1985, a new market emerged between the two ends. Today, this market is rich with offerings that not only include specialized image-processing vendors like FileNet and Plexus Software, but also most of the major hardware vendors (e.g., Bull, DEC, Hewlett-Packard, IBM, NCR, Unisys, and Wang) and some smaller, innovative vendors like ViewStar and Micro Dynamics.

Over the next five years, the offerings in this middle imaging market will integrate more fully with standard office environments and E-mail packages. Until then, however, buying and installing imaging systems will require careful study, experienced people, and special tuning to obtain performance up to expectations. Companies that can do this have begun to change the nature of competition in their industries, turning time and information into allies.

Once past the FHP, companies will be free to harness the benefits of the next epoch of computing by adopting new data types (e.g., image, voice, and video), by finding new ways of looking at existing information, and by moving into new computing paradigms. Most notably, this means moving from a world of personal and central computing to a world of social computing. ■

*Gerald P. Michalski is a vice president of New Science Associates, a retainer market research firm based in Southport, Connecticut. He holds an MBA from the Wharton School of the University of Pennsylvania. You can reach him on BIX c/o "editors."*



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# CATCH THE WAVE OF DIP

Document image processing is a working and usable technology helping more and more offices attain a near-paperless state

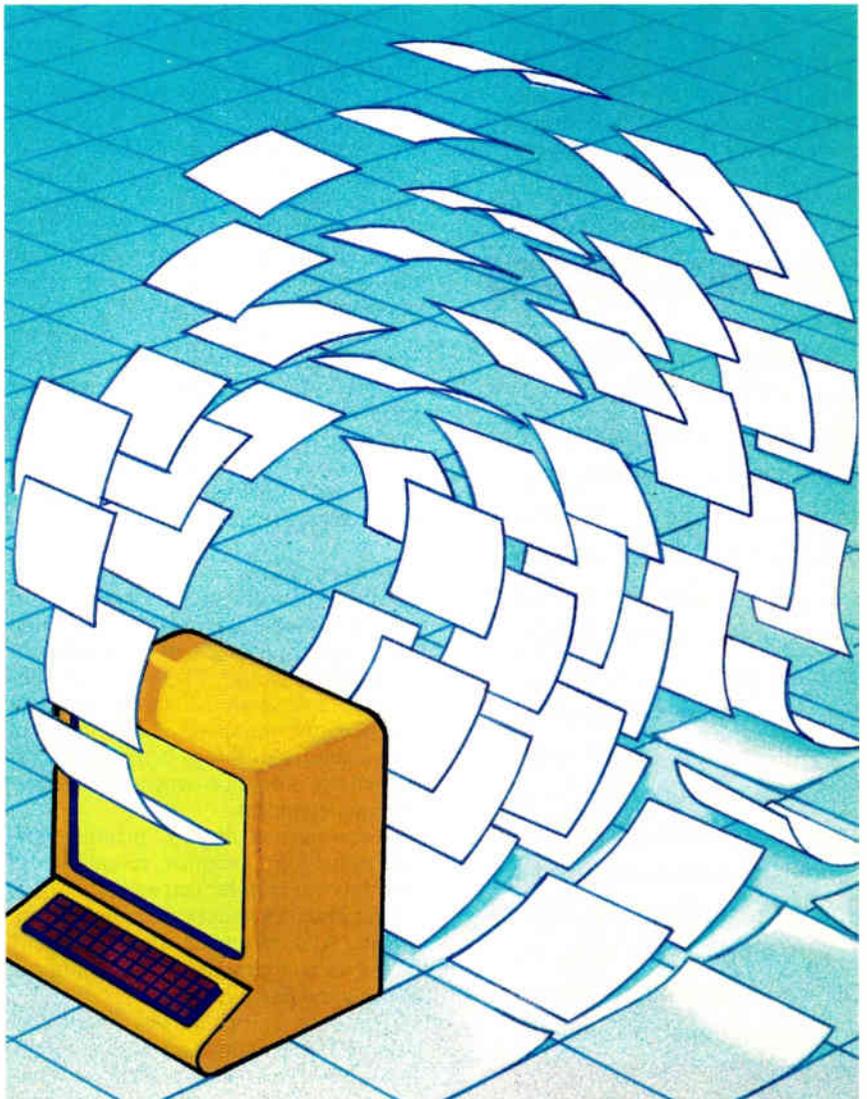
DAVID A. HARVEY

**A**t last year's fall Comdex, Bill Gates unveiled his vision for the future of personal computing. *Information at Your Fingertips*, playfully presented as a *Twin Peaks* take-off, featured a truly integrated PC environment that incorporated fax, remote pen-based input, E-mail, and multimedia.

One of the challenges along the road to the integrated desktop is dealing with the piles of information that exist in paper form. American business alone produces close to 1 trillion pages of paper a year. Charitably assuming that it's letter-size paper, that's enough to blanket the surface of the earth, with some to spare. In an age when concerns about deforestation, the erosion of the rain forest, and the mounting solid-waste-disposal crisis have become reality, finding ways to conserve paper has become imperative.

Not only does American business waste paper, but according to various sources, it costs about \$25,000 to fill a four-drawer file cabinet and \$2160 to maintain that cabinet for a year. In addition, about 3 percent of all documents are incorrectly filed or lost, and the average cost to recover a document is around \$120. Finally, the average executive spends a grand total of about four weeks per year waiting for documents to be located. You know how it goes—you spend 20 minutes pawing through the file cabinet and a half hour looking through the various unsorted piles in the storeroom.

Not so long ago, the term *paperless office* was likely to engender very little except ridicule; that's not true anymore. The lengthy strides made within the last few years by the underlying technology



make document image processing (DIP) systems a reality—today.

In the end, the goal of a thoroughly paperless office may remain unattainable. People will forever continue to scribble random notes on paper, generate ideas on index cards, and so on. But given the state of the art of DIP, people can now move closer and closer to that goal.

If *Information at Your Fingertips* is the vision, the reality is the often problematic integration of disparate technologies, operating systems, CPU platforms, and software.

Multiuser, multithreaded, and multitasking operating systems, such as Unix and OS/2, offer the promise of a “document-centric” approach. So, too, do integrated graphical operating environments, such as Presentation Manager, Microsoft Windows 3.0, and the various Unix graphical user interfaces.

The promise shows in the way these systems use Dynamic Data Exchange (DDE), Multiple-Document Interface (MDI), Electronic Data Interchange (EDI), Installable File System (IFS), and voice technology, and in improved integration of device drivers. However, the ground has barely been broken.

With no “killer” application looming on the horizon, defining a paperless-

office environment becomes more a function of technology than of any set standards. For example, at the lowest level, a paperless office could simply be one that employs scanning technology to store and index invoice and billing information.

At higher levels, you find integrated networked systems that manage fax, E-mail, scanner input, optical character recognition (OCR), full-text and keyword indexing, EDI, and data collection from the field. You can then make this information available to anyone on the network from within a variety of applications. While both of these examples remain true to the overall vision, they are far from presenting as seamless and transparent an implementation as Gates's *Twin Peaks* takeoff.

To arrive at a reasonably consistent definition of the technology behind a paperless office, I'm going to put aside the differences between operating systems and platforms and deal with the essential components.

The figure illustrates the basic components of a paperless office. The model I've used here shows the highest level of integration of all technologies and software possible with today's technology. The various groupings in the figure illustrate modular components that you can remove or add to achieve varying levels of complexity and integration.

The basic hardware of a paperless office is essentially the same across different levels. From the simplest single-user installation to the multimillion-dollar mainframe-based system, DIP hardware boils down to inputting via scanner, storing on optical media, and outputting via video display terminal, printer, or fax.

### The Eyes of DIP

Scanning a document into electronic format as a simple image is a fairly mundane task, supported by a well-established technology. The only real difference among the different levels of complexity is the speed and resolution of the scanner. All things being equal, the real choice is volume-dependent, not resolution-dependent.

Given current display, printing, and fax technology, scanner resolutions of 200 dots per inch for text and 300 to 400 dpi for graphics images are more than adequate. And remember, the final quality of a scan is dependent on the quality of the original document.

The only times that you might consider using 600-dpi and higher-resolution scanners are in cases where extremely high-quality (Linotronic) output is

necessary, or where users at a site wish to store ultrahigh-resolution images in anticipation of improvements in fax and monitor technology. Given that the current state of the art in fax technology only allows the transmission of 200-dpi images and that even the highest-end monitor delivers essentially the same resolution, I don't see high-resolution scanning as a major concern for the average DIP installation.

Resolution aside, the speed improvements that a high-end scanner provides come from the scanner engine and from the use of hardware-based compression schemes. Midrange and high-end scanners use dedicated controllers with their own processors to manage the chores of scanning and compressing the data.

A typical midrange installation might include a 286-based microcomputer scanning station along with a central RISC-based server. The images would be scanned and compressed on the workstation and transmitted to the server, where they might or might not be decompressed and then passed on to the archives. At the simplest level, documents will, in all likelihood, be scanned, rasterized, and stored with little or no compression, other than that offered by TIFF, Publisher's Paintbrush (from ZSoft in Marietta, GA), and bit-map file formats.

As the complexity of the system increases, so do its compression needs. The trend, in general, is toward storing images using CCITT Group 3 or Group 4 compression. These algorithms provide a size reduction of approximately 10 to 15 times that of the original.

For easy installations, software compression is doable but relatively slow. According to Pawan Gupta, product marketing manager for Kofax Image Products, software compression approaches hardware speeds when you start using 33-MHz 386-based or faster microcomputers. The advantage to using CCITT compression is that by adding the appropriate header and decompressing when necessary, you can fax the image without any conversion or rasterize it into a TIFF file as needed.

The input needs of DIP systems are not limited to paper, however. A growing number of installations have found it necessary to import microfilm archives using specialized scanners.

Another way to get paper information into a DIP system is with transparencies. By using high-speed photography to shoot the documents on-site, you can send the developed slide film to a scanning house, where images are grabbed directly off the film.

*continued*

## BYTE ACTION SUMMARY

### Document Image Processing

The current state of the paperless office is basically the same as that of DIP. The components include input via scanner, storage on optical media, and output via a video display terminal, printer, or fax. In a large implementation, the system can exist as part of a network. Wherever your system lies, from the simplest single-user installation to a multimillion-dollar mainframe-based system, DIP can significantly reduce your dependence on paper.

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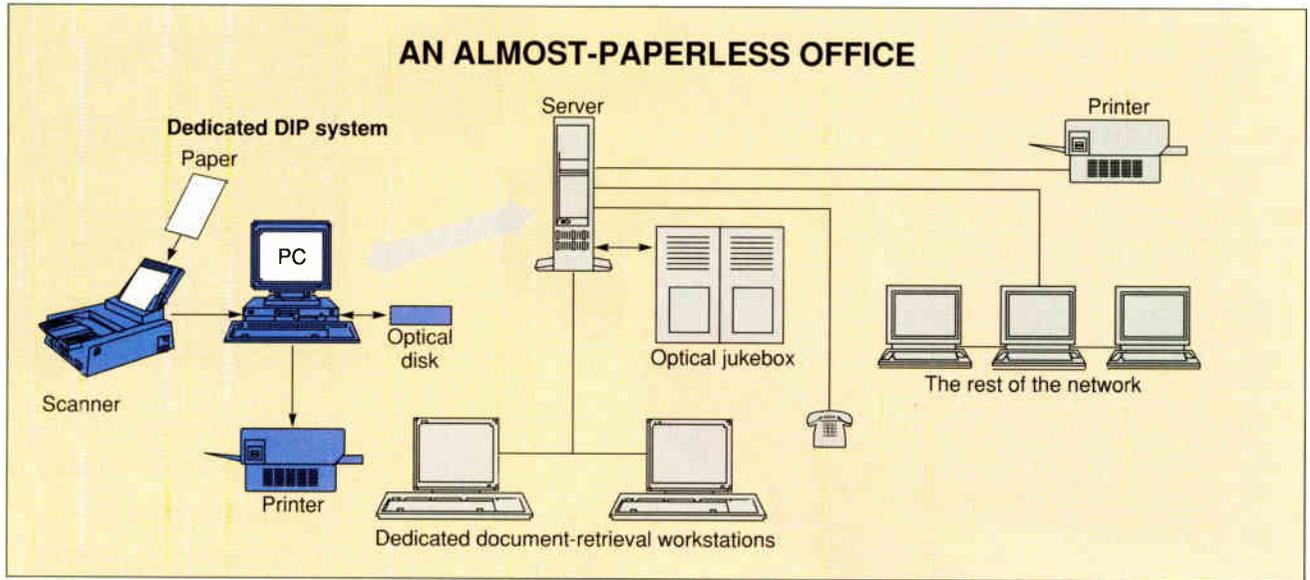
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*A high-level, integrated, networked DIP system. The highlighted grouping at left represents the lowest level of DIP implementation. In the high-level system, this grouping becomes one of several dedicated scanning stations that send compressed files to the server.*

In the future, DIP systems (especially those used in the medical arena) will need to combine with imaging systems and allow the indexing, storage, and retrieval of medical images like those created by nuclear magnetic resonance, CAT scans, x-rays, EKGs, and EEGs.

**Optical Drawers**

The storage requirements for even the lowest-level DIP system are tremendous. Even with CCITT Group 3 or Group 4 compression, a typical business document takes up about 40K bytes to 50K bytes per page. Sheer volume aside, DIP requires an archival storage medium that is relatively stable and insensitive to physical disruption, something that conventional hard disk drives are not.

The long-term storage technology of choice for DIP systems is optical. You can use local hard disk drives, in conjunction with optical technologies, for indexes and temporary storage of documents that are being processed. CD-ROM, WORM (write once, read many times), and rewritable technologies each offer a different set of advantages for DIP installations.

The advantages of CD-ROM technology are not realized until you have to distribute the information to several remote sites over a dispersed geographical area. CD-ROM offers several distinct advantages as a distribution medium.

According to Rick Holt of OnLine Computer Systems (Germantown, MD), "CD-ROM is useful for distributing in-

formation that needs to be under revision control." Because you can't modify a compact disc, it is easy to resolve any issues that arise from claims of outdated specifications; for example, OnLine Computer Systems has developed a Computer-Aided Product Selection system that includes the parts' specifications, parametric searching, and searches by part type. Publishing and distributing documentation is a task to which CD-ROM is particularly suited.

Hewlett-Packard now publishes much of the documentation for its operating systems on CD-ROMs. With the advent of CD-WORM technology (see the text box "A Marriage of Convenience: CD-WORM" on page 178), you can make use of published CD-ROMs and have most of the functionality of a WORM—all in one box.

WORM drives are well suited to archival storage. A copy of a document on a WORM drive is considered a legal copy, which means that you can eliminate the corresponding paper document or microfilm.

In addition, most WORM file systems have built-in audit trails. As a result, they can track a document throughout its life cycle, from creation to final approval. DIP software can take advantage of this feature to enable you to instantly examine changes made in various versions of a document, as well as keep track of revision and approval dates.

In DIP systems that allow document annotations, the entire history of the

document can be made immediately available, including proposed—but not implemented—changes, who reviewed and created the documents, and suggestions for future revisions.

WORM media both automate and centralize this information, which offers substantial cost and labor savings over traditional paper-bound filing systems. In traditional systems, cross-indexed folders with notes scribbled in the margins must be located, sorted, and then recombined into a report.

What CD-WORM promises is a standardized WORM file system. The immediate benefits will be tremendous. This technology will allow not only multiple sourcing of drives, but also data transfer via "sneaker net" to remote sites and the generation of multiple copies of archival disks that anyone can read.

Rewritable drives are much more standardized and much faster than WORMs, and you can alter or delete files on them. This makes rewritable media useful where archival permanence is not vital. By using IFS technology like Write-Once File System software from N/Hance Systems (Dedham, MA), it is possible to create a virtual WORM on a rewritable drive and bypass the permanence issue. However, the legality of a copy created under such a file system is uncertain.

Whichever optical technology is used, it is clear that single drives are probably useful and appropriate only for the lowest-level implementations. Optical jukeboxes, which consist of a multiple-drive



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# A Marriage of Convenience: CD-WORM

**A**n exciting new development promises to package the functionality of a CD-ROM and a WORM (write once, read many times) drive in a single box. Called CD-WORM, the technology will allow the multifunction drive to read current ISO-9660- and High Sierra-format CD-ROMs, as well as write CD-ROM- and CD-WORM-format disks.

According to Wink Saville, vice president of research for Meridian Data (Scotts Valley, CA), a major developer of the technology, the CD-WORM drives should be available in about 18 months. You can expect CD-WORM prices to be comparable to the price of current CD-ROM drives.

Current systems, such as Meridian Data's CD-Professional, are capable of writing to a compact disc using either Yamaha or Sony CD-writable drives, and they are compatible with either the Yellow or Red Book standards. The downside is that the system costs upwards of \$30,000, and it can only write to the entire disk at once. When data is written "disk-at-once," the system writes to the entire disk, leaving no free space, and you cannot write to that disk again.

Understanding how a CD-WORM functions necessitates a little back-track-

ing. On a standard hard disk, data is organized into a series of concentric rings known as *tracks*. Tracks are divided by a series of angular lines running from the center to the outside of the disk. These lines subdivide the tracks into sectors. Data can be written to a conventional hard disk a sector at a time.

A WORM disk uses a similar pattern of organization, but because the data is stored in a series of pits burned into the media by a laser beam, a bit written to a WORM disk is unalterable. One of the biggest drawbacks to WORM media is the lack of a standard file structure. The result: Data that is written by one manufacturer's drive can usually only be read by that company's equipment, and no one else's.

On the other hand, CD-ROM is highly standardized. Initially, a group of companies got together and established the High Sierra format. An international committee then reviewed and modified this format and finalized what is known as the Yellow Book specification. Consequently, any CD-ROM conforming to this standard can be read by any CD-ROM drive.

Data on a CD-ROM is organized in a continuous spiral, which is further subdivided into sectors. Although it's not ultimately important, location on a CD-

ROM is measured in minutes and seconds. CD-ROM drives seek to a given location on a disk; they use information contained in a key channel to determine the rough location and then step quickly over the transitions in the spiral to that area. Once there, they use the information contained in a 4-byte header to determine the precise location.

Information contained within the spiral on a CD-ROM is written in a 4-to-1 interleave. This means that to obtain a piece of data located in one sector, five sectors must be read. Meridian Data calls a unit consisting of four sectors a *packet*. Due to the nature of the interleave, the CD-WORM won't be able to write data in a sector-at-a-time format; instead, it will write its data a packet at a time.

The packet size can vary from one sector to all the sectors present on the disk. According to Saville, "If a packet is one sector in size, you're going to waste four others. In other words, data written with a packet size of one sector would end up wasting 80 percent of the disk."

While a conventional WORM can update each sector once, a CD-WORM will only be capable of appending sectors when writing in the packet-at-a-time mode. With disk-at-a-time writes,

array fed by a robotic arm, are quickly becoming commonplace. Most major optical-drive manufacturers offer jukebox systems that you can use in conjunction with everything from a PC to a minicomputer or a mainframe.

Optical jukeboxes allow constant on-line access to many gigabytes of data, eliminate the need to manually switch cartridges, and, more important, deal with the intricacies of addressing multiple drives.

While the digitization and storage of data is relatively consistent among the various levels of DIP systems, the software is not. Software ranges in complexity from simple DOS or DOS/Win-

dows-based single-user applications to multitasking, multiuser packages that are designed to run on RISC and mainframe-based platforms.

## The Brains of DIP

As with hardware, the various software modules necessary to implement a DIP system are relatively consistent across the various levels. The essential components of a DIP software package consist of document input, manipulation, retrieval, and indexing.

Input software varies widely among the various levels. While the base process of document input and indexing remains relatively constant, adding OCR

and using object-oriented file systems greatly increase the complexity of the process.

At its simplest, a package like Paper Tamer from Flagstaff Engineering lets an operator control the scanner, designate scanning batches, preview the image on-screen, and manually index the document by keywords. In these systems, documents are generally stored as compressed CCITT files or as simple raster images. Batch control lets you group documents contextually, and keyword indexes enable a rudimentary level of retrieval and indexing.

As complexity increases, so do the various strategies for manipulating docu-

only one write is physically possible per disk.

What needs to happen in the near future, according to Saville, is the development of a media standard that will be a superset of the Red and Yellow Books, and a plan for a file-system standard that supports packet-oriented writing and reading.

At the time of this writing, Saville said that "a group of companies has gotten together and looked at the problem and will be submitting a document within the first quarter of this year to an international body, which will then standardize it." Also, he hopes that this will ultimately turn out like the High Sierra format, where people implemented the standard before the ISO had fully worked it out.

Ultimately, Saville sees CD-WORM technology as having the potential to replace current WORM drives. He cites higher storage capacity (640 megabytes versus about 200 MB for WORM) and lower costs for blank disks. Although disks are currently priced between \$50 and \$100, Saville sees prices coming down to about \$10 per disk due to the availability of the same type of technology for recording audio CDs.

Perhaps the loudest cries coming from those who use optical technologies have consistently been for the implementation of multifunction drive technology and, of course, for lower prices. These cries are being answered, however, with CD-WORM's ability to read existing CD-ROMs and write both disk-at-a-time and packet-at-a-time WORM disks, and with the projected price of \$2000 per CD-WORM drive.

ment input. One thing that remains constant is the need for a human presence to feed the machine, generate the simplest level of keyword indexing, and verify the quality of the scan. One trick that On-Line Computer Systems uses for automating the indexing process is to create a mask that uses OCR to recognize the page number of the document that is being scanned.

Retrieval in a simple system is enhanced by searching the keyword index for matches and selecting the document or group of documents to be displayed. You can then view or print the documents as necessary.

What is constant about these kinds of

storage and indexing schemes is that they ultimately lead to the creation and storage of a document image. Things become really tricky when you start to add elements like full-text copies of a document and object-oriented filing systems.

### When Is a Document Not a Document?

For the simplest systems, where the need is primarily one of maintaining an electronic filing cabinet of document images, you really don't need to convert the text in the document into ASCII or other machine-readable formats. As complexity increases, however, this conversion becomes a significant factor in designing and implementing a DIP system. Machine-readable text is a necessity where you must share the information contained in the document, when you perform text searches, or where you need to make changes to a document or forms.

Information sharing is especially important when dealing with various generations of a specification, for example. In these cases, you want the ability to take portions of previous specifications and import them into a new proposal. For lawyers, the ability to cut and paste text from one brief to another could eliminate a great deal of redundant clerical effort. In business, the ability to drop sections from, for instance, regional sales reports generated several years ago into a current report not only would save time but also might facilitate new and innovative analysis.

While information sharing is more or less possible without a complex DIP system, the ability to perform text searches is not. Once a document has been converted and stored as a text file and then indexed, the advantages of ASCII become distinct. In a situation where an engineer needs to find every instance of the use of a particular piece of hardware, the primary advantages become those of speed and convenience.

Other applications, however, provide advantages that actually improve performance and lead to solutions that may have been previously unrecognized. An epidemiologist utilizing a text search on a medical-records database could quickly find all the cases manifesting the symptoms of the disease under question. In addition, information in arrays suggesting patterns that a simple paper or microfilm-based search would have missed might be retrievable.

### Stand Up and Be Recognized

The thorn in the side of DIP is OCR. While OCR algorithms have radically

improved in terms of recognition and speed, especially in hardware implementations such as True Scan from Calera Recognition Systems (Santa Clara, CA) and fast software-based OCR packages such as OmniPage Professional from Caere (Los Gatos, CA), they still suffer from enough inaccuracy that they cannot be fully automated.

True, a good OCR package is trainable; an even better OCR package recognizes simple handwriting, letting you input annotations on documents and notes. However, OCR is still not at the point where you can rely on it to fully recognize a complete document without error. This is not a major problem if the text is relatively consistent and uses fonts that the package can handle without trouble.

OCR is well suited to handle documents that have multiple graphical images along with running text. Since it's necessary to scan the graphics, it's probably worthwhile to use masking and implement OCR at the same time. The crisis emerges when the OCR system needs to recognize multiple documents with dissimilar vocabularies and typefaces—not to mention the problems inherent in recognizing printed text in which characters touch each other.

Even when processing relatively simple documents, an OCR system requires an operator. Furthermore, that person must have some degree of specialized knowledge about the subject of the documents to make informed decisions about misrecognized text. When errors occur, even with only one or two per page, it may well be more cost-effective to use standard data entry (which doesn't require specially trained operators and the process of double-keying to ensure accuracy) than it is to use OCR.

According to Holt, "Our experience with OCR is that it's really very, very slow and prone to error, even with 10-point-type text. The time and cost it takes an editor to bring up the OCR output and then correct one or two errors per page is about the same time that it takes to have it keyed by a high-volume contractor."

Regardless of how it arrives, once the text is in the system, you must store and link it to the appropriate images. The traditional approach used on a document search lets you bring up the text, the image, or both. This approach is more than adequate for installations that aren't dealing with graphical images and don't need to use and manipulate text or have a legal copy of the document archived in electronic format.

When you must store and manipulate

multiple graphical images, as well as text and archival copies of the document, this method begins to suffer from performance problems. But while the next step toward resolving these problems may be a small one for the hardware, it's a giant leap for DIP.

### OLE: Taking On the Bull

One of the shiny new buzzwords around Microsoft these days is *OLE* (for object linking and embedding). Basically, OLE takes an object-oriented approach toward documents and information.

According to Russ Werner, general manager of systems marketing at Microsoft, "The compound document is a metaphor for this type of work. People want to be able to incorporate data from multiple sources, data types, and physical locations into different kinds of objects, whether it be a word processing object or some other object. Sometimes you want the information to be a part of the document; sometimes you want it to be in other places (i.e., embedded or linked)."

The power of this approach allows a framework to be set up in an application or document that is data-type independent. Windows will be one of the first places where OLE turns up; demonstrations of OLE have already been shown in conjunction with Lotus Notes and Microsoft Excel.

Werner says that along with OLE, Microsoft is "taking a look at the file systems and what's necessary to make them more object-oriented." This may include maintaining object links, change notification, and more attributes. Within the next few years, says Werner, you'll be seeing a major change in the file system architecture, either in the file system itself or in the elements that manage the file system.

If Windows is not your platform of choice, take heart. With the introduction of WLO (pronounced "willow," for Windows Library for OS/2), Microsoft's strategy will be geared toward taking the Windows application set and hosting it on DOS, Windows, and OS/2.

The important aspect of treating different elements of a document as objects allows you to manipulate, edit, and view documents in a variety of ways. In addition, you can use each object (while still retaining its identity) with a variety of different objects, and you can edit each object in the context of those objects. Add OLE to the DDE and MDI facilities of Windows, and the possibilities for designing DIP applications become practically endless.

Kofax's Ko-App, included as a compo-

nent of the Kofax Image-Processing Platform, is a full-featured Windows imaging application that allows scanning, faxing, and image manipulation. It supports DDE and will incorporate OLE in the future.

### More Than One Way to Say OLE

While OLE may be new to Microsoft, it's old hat in the DIP field to Interleaf (Cambridge, MA). OnLine Computer Systems uses Interleaf's active-docu-

## **T**he dawn of object-oriented documents gives a new vision of the paperless office.

ment technology to implement an object-oriented approach to the components of the documents.

Using Interleaf's display technology, which embeds the formatting logic, you have the ability to reassemble and display a document at viewing stations on the fly. Bit-mapped images are scanned in and stored as CCITT Group 4 elements; vector images are stored as computer graphics metafiles; and text is saved as ASCII. When reassembling the document, a TIFF header is attached to the decompressed CCITT; the appropriate vectors, text, and tables are retrieved; and the document appears the same as when it was scanned in.

Not only does this process facilitate updating single elements of a document, but it also lets the system create hyperlinks between text and graphical objects. Markers are embedded in the text stream and are used to provide an anchor for the software that displays this information, letting it call up the linked images.

Regardless of the specific approach, the dawn of object-oriented documents promises an entirely new vision of the paperless office that is daily moving closer to the dream of *Information at Your Fingertips*. The final task of DIP software is to allow the retrieval, output, and manipulation of the stored images.

### The View from the Top

The layer of the application that provides an interface to the management, creation, viewing, and editing of stored documents is perhaps the most critical, as it is the main layer you will work with.

At the lowest level, you must be able to retrieve documents by date, scan batch, and keywords. This is where the indexing software shows its mark. More sophisticated applications need to allow you to index documents and objects both by context and content, as well as allow document retrieval by revision level, creator, and status.

At the next level, you must integrate documents from a variety of sources. Incoming faxes, documents that have been created electronically, and scanned documents must all coexist under a common index. This task requires sophisticated tools that work on a network. You have to be able to create and save documents locally, while at the same time saving them as part of the archive. In addition, you must file incoming faxes and make them available for immediate viewing.

Finally, the DIP system must be able to output the documents in several formats. On a simple level, this means that a dedicated document workstation lets you locate and then print or fax a document. Things become more complicated when you have to provide the information to one of several dedicated terminals or globally to every workstation on the network.

In high-end systems, a central server (or multiple servers) combines with the network to form a distributed DIP system. Professional Image from Computer Signal (San Ramon, CA) is a good example of this sort of system. What all high-end systems have in common is the ability to seamlessly incorporate high-speed printing (often through the use of SCSI printers), fax, and retrieval into a networked environment.

### A Working and Usable Technology

At the lowest level, setting up a DIP system involves using a simple document-imaging software package in conjunction with a high-capacity storage device and a scanner to create an electronic filing cabinet. From this level up, the basic methods and hardware employed to manage information on paper remain relatively constant. What changes are the levels of sophistication in the software and the speed and capacity of the hardware.

A kind of modularity exists in DIP that lets installations migrate up through the various levels without needing to start over. Perhaps the most important thing

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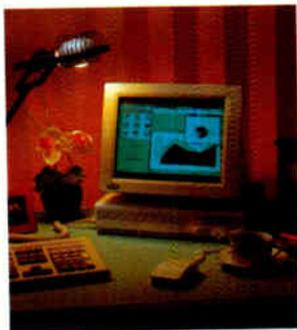


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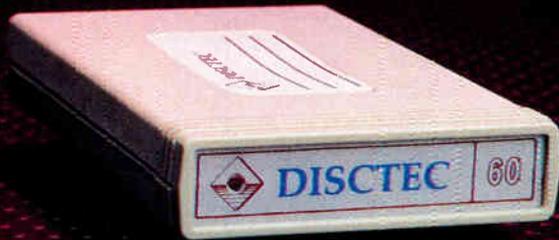
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## CATCH THE WAVE OF DIP

to do if you are installing a DIP system, with an eye toward expansion, is to make sure that the software you use stores images in a format that other packages can deal with. For the present time, this would seem to be the compression and file structure offered by CCITT Group 3 and Group 4 standards.

Equally important is identifying the documents that are most suited to digitization. At the outset, the most likely targets are those documents that are relatively static and occupy the greatest physical and temporal space in a particular organization. Examples might include processed orders, personnel files, medical records, and the like.

Once these categories are determined, you can then develop a plan to digitize the paper and train staff to use the new technology. As familiarity and comfort with the DIP system increase, the system can grow to incorporate incoming documents (e.g., faxes, correspondence, and orders) and to manage documents from the time of their inception through some sort of "active-document" technology.

Regardless of what approach you take, it is clear that DIP is a working and usable technology. In the coming year, expect to see more and more paper converted to machine-readable formats. The DIP revolution, when it finally arrives, will not be an overnight coup. Rather, it will emerge gradually as test installations turn into full-fledged systems and as more paper-bound sites begin to use the technology.

The emergence of DIP systems, combined with the push by Microsoft and others toward a "document-centric" approach in which data is treated as objects and the document at hand becomes the context in which people work, will greatly change the way in which computers are used. *Information at Your Fingertips* may be a vision now, but it certainly provides a direction toward which the industry can work.

The office of the future may not be entirely paperless, but the advantages of having instant and integrated access to information, combined with the enormous cost savings associated with digitizing paper, make the move to eliminating those trillion sheets per year extremely practical. All in all, the elements are present to really make DIP stick. ■

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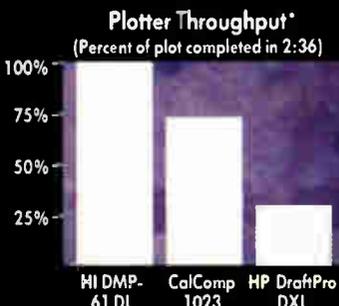
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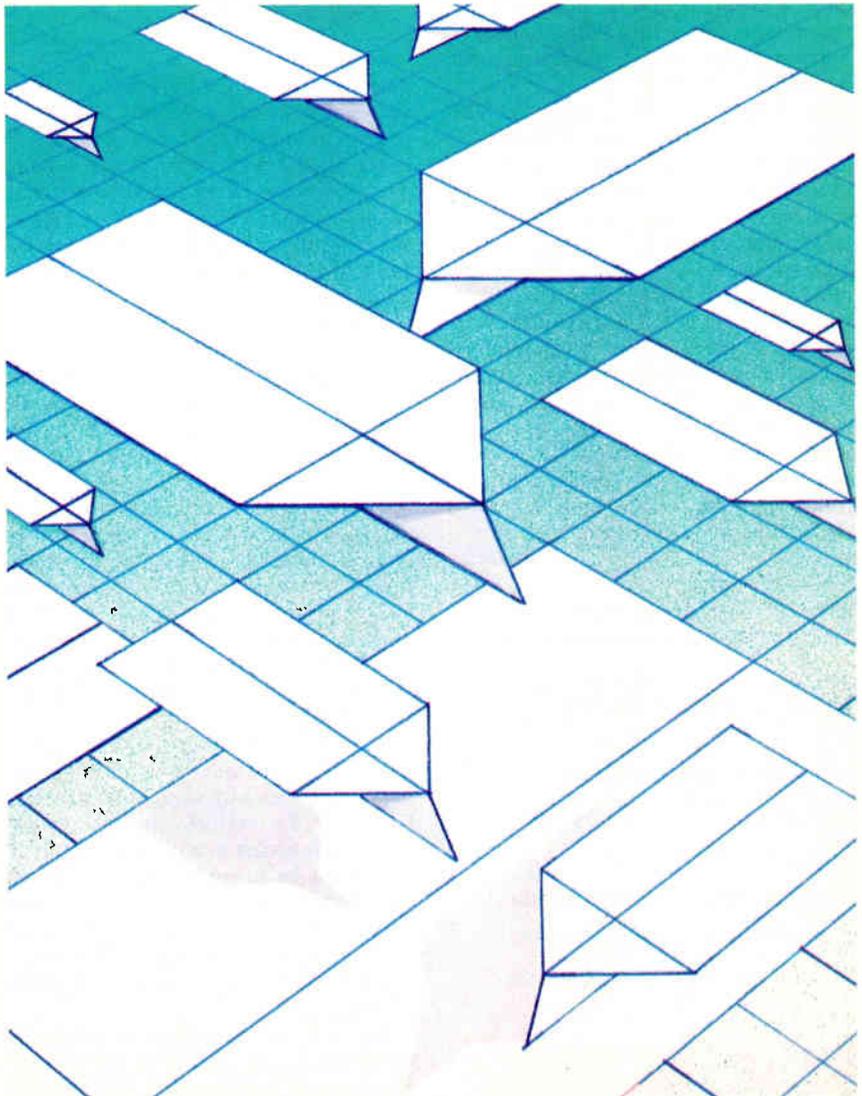
DAVID A. HARVEY AND BOB RYAN

One of the biggest attractions at the 1939 New York World's Fair was "The House of the Future," which attempted to show the future direction of automation in the home. Today, the newsreels that trumpeted the House of the Future seem like quaint reminders of a much simpler time. Similarly, the phrase "paperless office" is viewed by many as an embarrassing reminder of a time not long ago when faith in computers and their capabilities was unbounded. As quaint—or even disreputable—as the phrase has become, however, document image processing (DIP) is making the paperless office a reality for many businesses with well-defined document-handling needs.

DIP systems run the gamut from relatively inexpensive stand-alone software systems to sophisticated, network-based minicomputer and mainframe systems. The degree to which you invest in the technology depends on the volume of documents you deal with and your need to access them quickly. Here we'll look at how DIP has met the needs of a number of different organizations.

## Paper Airplanes

Alitalia was an airline faced with a paper crisis. Each of its 30,000 yearly purchase and repair orders required 10 supporting documents. As required by Italian law, all these documents had to be stored for two years before being transferred to microfilm in the company's general archives. The 750,000 documents were stored in three 16-shelf automated filing cabinets and nine other paper-storage devices. On an average day, 65 documents had to be located and retrieved, resulting



in the loss of many hours of employee time—not to mention the time that was required to update and maintain the filing system.

Management was growing frustrated with its inability to integrate electronically stored information with the paperwork and with the fact that the paper documents were accessible by only one person at a time. What management wanted was a system to store, access, and archive all those documents, provide multiuser access, and integrate the paper-based information with the information in the company's on-line databases.

**DIP on Trial**

As they began looking for options, members of Alitalia management came upon the LaserView Document Image Management System from LaserData. According to Tonino Luciani of Alitalia's technical materials planning and purchasing department, they decided to test the system for a three-month period. Software, says Luciani, was the most important consideration.

Working closely with Society Per Software (a LaserData vendor) of Rome, Alitalia installed a DIP system consisting of two scanning and retrieval workstations connected to a local laser printer, a DIP server connected to a 20-disk optical jukebox and a laser printer, and two remote-retrieval workstations equipped with laser printers. The first phase—installing an electronic archival system—has satisfied the company's initial desire to get a handle on its paper-based documents and get rid of paper files. The second phase will involve linking the imaging system with the company's mainframe to allow information to be exchanged between the two systems.

**Nuts and Bolts**

Each document in the Alitalia system is scanned in by an operator who then en-

ters the appropriate index information for document type, purchase order number, item number, and box number (used if a paper copy of the document needs to be stored). Additionally, the software automatically date-stamps the documents and assigns a supplier code.

To improve performance, the system uses two databases. The first, a daily

**The legal profession brings a new set of needs to a DIP system.**

database, holds the information from each day's scanning activity. The other, a general database, holds information about all the documents in the system. This was done, says Luciani, to separate scanning and retrieval activity. After scanning, the images are compressed using CCITT Group 2 and Group 4 standards and sent to the jukebox.

The retrieval front end enables you to perform keyword searches, display up to nine different documents on-screen, scale or rotate the image (useful if the document was scanned in upside-down), zoom in on particular sections, and output the document.

The Alitalia implementation is an example of a DIP system that is primarily archival in nature. The future for Alitalia holds both a linkup to its mainframe and expansion of the system to cover other departments. Due to the modularity of the LaserView system, expansion should be much less painful than the initial installation.

Connecting the system with the mainframe will eliminate the duplicate imaging of electronically created documents. Currently, for example, when the company sends a telex to a supplier, the telex must then be scanned into the system. This type of situation results in about a 45 percent duplication between imaged and electronically stored documents, a redundancy that the company would like to eliminate.

Overall, Luciani has been extremely pleased with the results of the system. Not only has the system eliminated the

time, expense, and wasted space associated with traditional files, but it has allowed Alitalia to search more thoroughly for needed information. To Luciani, the system provides the best compromise between a document file and a database.

**Keeping Them Flying**

Alitalia isn't the only airline making use of DIP. At the Minneapolis/St. Paul International Airport, Northwest Airlines has replaced a microfiche-based document-retrieval system with one based on Metaview, a DIP system from Metafile. Moving from microfilm or microfiche to DIP is not an unusual development (see the text box "The Evolution of DIP" on page 188).

Northwest's problem was with maintenance manuals. For example, the manuals and parts catalog for a Boeing 727 total about 50,000 pages. Having highly skilled—and highly paid—maintenance workers searching for the proper document on a microfiche system was neither fast nor cost-effective.

In cooperation with Metafile, Northwest created a LAN-based DIP system that stores the maintenance documents on optical disks. Metafile's Metaview is an object-oriented language built from the ground up to support imaging applications as well as cooperative processing between workstations on a LAN and between LANs and larger systems. In addition to significantly cutting the time required to retrieve a maintenance document, the Metaview system provides better indexing and output quality than the microfiche system it replaced and makes it easier to keep the information on the system up to date.

**DIP and the Law**

While the above examples deal with the need to store and manipulate information and images to fulfill archival and record-keeping tasks, the requirements of the legal profession bring a new set of needs to a DIP system.

The day-to-day work in the business of law is intellectual in nature. Thus, a lawyer needs the ability to locate information based on content and context. For example, a lawyer preparing to defend against a look-and-feel lawsuit not only needs to verify that the necessary briefs and pleadings have been filed, but also needs access to information that will help to prepare and substantiate the case. This means full text-searching abilities and the ability to group information by the content rather than the context of a document.

The legal department at Executive

**BYTE ACTION SUMMARY**

**DIP Case Studies**

A number of companies have adopted document image processing. They serve as models of situations where this technology can address a real need.

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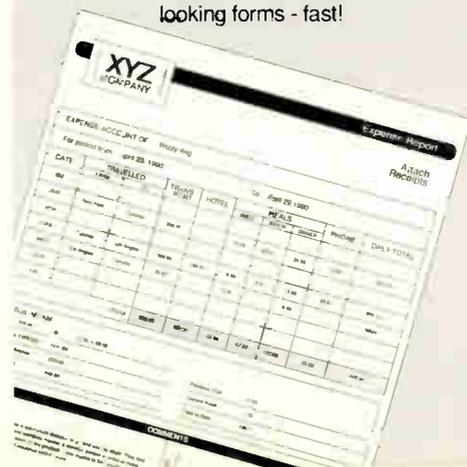
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World Radio History

# The Evolution of DIP

David Silver

Companies are always trying to reduce the amount of space and time required for filing and retrieving original documents. Paper documents have traditionally been stored and managed with file cabinets and a variety of indexing schemes. Retrieving these documents often mirrored the type of procedure associated with retrieving books from libraries.

New technologies have risen, however, to meet the need for compact storage and easy retrieval of documents. Document image management (DIM), which began with microfilm technology in the 1970s, is now a rapidly growing application for the PC environment.

The number of paper documents that need to be managed is astounding. According to the Association for Information & Image Management, American businesses generate more than 1 trillion pages of paper documents a year, and 2.7 billion new sheets of paper are put into file folders every day.

## Paper and Microfilm

Microfilm was the first DIM technology developed to address the needs of paper-intensive businesses. During the 1970s and the early 1980s, advances in computer technology substantially increased the output of paper associated with most applications, greatly increasing the demands on manual paper-storage methods.

Microfilm offered companies numerous benefits over paper-filing systems: lower space requirements, easier and faster access to documents, improved file integrity, increased security, longer document life, and lower costs through productivity gains and space savings.

But while microfilm offered significant improvements, it fell far short of what was necessary to efficiently pro-

cess and retrieve documents. Storing the documents required that they be sent off-site to be filmed, a process that typically took up to two weeks and consequently left companies without access to these documents during that time. Retrieving documents was a mechanical process that was often as time-consuming as retrieving paper documents from a file cabinet.

## The Computerized Alternative

In the early 1980s, advances in computer and computer-peripheral technologies combined to bring about the first computerized document storage and retrieval systems. These first document image processing (DIP) systems featured proprietary minicomputers combined with new optical disk drives, paper scanners, and laser printers.

DIP systems revolutionized document management. For the first time, you had immediate on-line access to document images from your computer. Laser printers provided clear, near-perfect output of document images while database programs provided document-tracking functions for fast retrieval. In addition, these systems improved company work flow and productivity by taking advantage of LAN technology to electronically route document images throughout an organization. And DIP systems surpassed microfilm by further improving space savings, document security, file integrity, and document longevity.

The use of new technologies is always expensive, and minicomputer-based DIP systems were no exception. The cost of an average installation often exceeded \$300,000. While financial institutions and government agencies embraced this new technology and its many benefits, the cost of these sys-

tems, coupled with their proprietary architectures, kept DIP technology from becoming widely used.

## Let's Get Small

By the late 1980s, it was clear that if DIP was to become a force in document management, significant changes had to be made. Fortunately, improvements in DBMS software, scanners, laser printers, and display technology were under way simultaneously, and the price for optical storage was decreasing rapidly. At the same time, advances in personal computer technology (particularly the 386 processor) and the development of affordable, off-the-shelf PC add-in boards to control specialized DIP functions combined to bring about a new generation of PC-based DIP systems.

These PC-based systems have made DIP available to nearly everyone. By offering compatibility with standard hardware platforms, operating systems, LANs, DBMS packages, and graphical user interfaces, PC-based DIP can be easily integrated into existing equipment and applications. Through this level of integration, PC-based DIP systems have become open, cost-effective alternatives to expensive, proprietary minicomputer-based systems.

Today, PC-based DIP is a mainstream application; insurance companies, financial institutions, legal firms, government agencies, and hospitals are among the many types of businesses using it. Starting at as little as \$15,000, PC-based DIP offers not only significant cost advantages but also performance benefits. DIP can now be easily integrated with other applications such as faxes, forms, and desktop publishing to help manage information distribution and output.

PC-based DIP also takes advantage of

Life (Los Angeles, CA) has such a system. Using LaserFiche LAN (developed on the Kofax platform) from CompuLink, the department has installed a system consisting of a NetWare LAN and LaserFiche LAN document-imaging software with image folders.

The basic hardware consists of eight Everex Step 386/20s, an Everex Step 386/25 server, and two Hewlett-Packard LaserJet II printers. The DIP hardware

consists of three high-resolution Monitor monitors, four Genius monitors, six Panasonic optical drives, a Fujitsu 3909 scanner, and a Calera TrueScan optical character recognition board. The OCR and optical drives are located on the server, while the scanner is attached to a dedicated workstation.

According to Jim Veach, vice president and assistant general counsel at Executive Life, the primary attraction of

the DIP system comes from its ability to retrieve documents by folder and perform word searches. What Veach likes about the system is that CompuLink worked very hard to design and implement it to fit how a lawyer thinks and works. The LaserFiche LAN system allows the creation of virtual folders, both at the time of the initial scan and anytime thereafter. This lets lawyers superimpose an organizational system that is con-

network technology. Configured in a network environment, it fosters information-sharing throughout an organization. Document images can be routed throughout a company in the order in which they need to be processed, enabling you to have immediate, on-line access to thousands of documents without leaving your PC. In fact, networks allow multiple users to simultaneously view a single document image. With networking also comes the ability to automatically transmit fax images over phone lines, thereby permitting image-sharing among remote company offices.

**Today and Tomorrow**

Imaging has already become an integral application for a variety of industries. Further developments in DIP applications software, both vertical and horizontal, combined with the diminishing prices of PCs and peripherals, will encourage the number and types of industries using DIP to grow.

The 1990s will bring further improvements that will make PC-based DIP systems an essential and affordable technology for document management. Speed improvements in image compression and expansion; scanning, printing, and image retrieval; and a new generation of high-performance, advanced DIP applications will combine to bring about better DIP systems.

These improvements will make DIP attractive to more companies and industries. In the future, DIP will evolve beyond the task of document management to work in concert with other technologies to further foster information sharing and ultimately improve overall corporate productivity.

*David Silver is president of Kofax Image Products (Irvine, CA). You can reach him on BIX c/o "editors."*

textually familiar, with attendant increases in productivity.

"If you can get your day working so that you can complete a task, instead of having to stop halfway through because you're unable to get a document, your efficiency increases tremendously," says Veach. He adds, "In a paper world, you get a concept in your mind—you start thinking about it—and then you have to stop thinking, get the document, and try

to start up again."

Currently, the DIP system at Executive Life is fairly small, with less than half the department (three attorneys, two paralegals, and three secretaries) on-line. Two of the attorneys are steadfastly putting every incoming document into the system. After this trial run, Veach sees the system expanding. He thinks that the Windows version will be a significant factor in this. Another boost to the system, he says, will be when the attorneys begin to draft their documents electronically. At the moment, Veach scans in every incoming document and puts file-bound documents into the system as they are used. He plans to gradually move all the paper in their 17 horizontal file cabinets onto disk.

**Going Paperless**

What started in 1969 as Brigadier General Robert F. McDermott's "impossible dream" of a truly paperless company has become a reality for USAA, the San Antonio, Texas, based insurance company he heads. Possessing the largest DIP system in the world, USAA has a virtually paperless environment in the areas that the imaging system serves. The system, which was the prototype for IBM's ImagePlus MVS/EVA system, drives some 1400 high-resolution imaging terminals that serve over 2000 users, both local and remote.

According to Charles A. Plesums, USAA's senior director of image technology, "We made a 90-degree change in the company by taking the paper that was lying flat and making it vertical. Other than that, the work flow remained the same."

To get a clearer picture of how this works, take a look at a day in the life of a typical document in the property and casualty policy service and underwriting system at USAA. When it first arrives in the mailroom, a letter is opened by a machine, and its pages are removed and arranged by a clerk. The pages are then transferred to a mail analyst.

The analyst reads the mail to determine the applicable customer and the routing of the document and enters that information into the computer. Indexing is largely automated. All the analyst needs to do is enter an IMS index transaction (a descriptive code, often the form number) and the customer name. The computer then supplies the routing and indexing data, although the analyst can add additional categories if necessary. Once the index is stored, a temporary key number is generated and written on the document. Total time elapsed? Only 11

seconds per document.

USAA's system is unique in that the indexing information is entered prior to scanning. According to Plesums, this speeds up processing by allowing the analyst to deal with exceptional situations, such as payments that should be refused and returned, original documents that need to be returned, and forms that need to be filled out. Because the analyst makes critical decisions before scanning, the operation is more efficient than if every document were scanned first before exceptions were dealt with.

The last phase of the input process involves checking the quality of the scan and entering the temporary document ID number to link it with the already-generated index. The paper trail stops there. As soon as the document number is entered, the document becomes available to all users of the system—including those at remote sites.

USAA's user interface is essentially a "virtual paper" interface, both in terms of how a document is manipulated and the time it takes to manipulate it. A document is stored in the form of a folder with virtual tabs and subtabs that provide access to specific pieces of customer information.

To retrieve a document, you issue an IMS transaction called Sendwork. The system then checks your qualifications, supervisor assignments, and priorities of work in the queue and selects the best document for you to process. The document is then displayed on an imaging terminal that consists of a high-resolution display and a dedicated cursor keypad that enables you to turn pages, zoom, rearrange pages, enter a specific page number, and perform other paper-handling functions. Interestingly, when windowing and mice were given a trial on the system, users did not respond favorably to them, opting instead for the cursor keypad.

Actual document processing involves the use of the graphics terminal, which is shared between two users, and a separate terminal for standard data entry. The document display shows the document, and the data terminal displays the history log and notes on the file. When finished with a particular document, you can then forward it (along with comments) to someone else for additional processing, save it to the archive, or suspend it until further information is available.

**Peak Performance**

Retrieval time depends on the age of the document. Those processed within the past year are retrieved within 15 or 20

seconds. Requests for older documents, which require the operator to manually mount an archived disk, take a couple of minutes.

To store and retrieve documents that are created on-site, USAA uses an approach called "presentation text," which links textual data to pregenerated forms in a forms library and then archives the text. The result is that each customer's image file contains not only incoming paper, but WYSIWYG copies of all out-

going correspondence, policies, and any other electronically gathered data.

In order not to compromise performance on its host mainframes, USAA opted to have separate CPUs within its IBM image system. The need for separate CPUs for the image-processing system becomes apparent when you consider that about 150,000 index items linked to about 1 million images are processed every day. The image system is served by two IBM 4381s, which use

transaction processing to link to the information in USAA's IBM 3090s.

Smart indexing strategies are also important to maintain system efficiency. The upper limit is 300 pages on a document, and the optimized document size is 20 to 30 pages.

The storage subsystem is made up of five optical jukeboxes and 30 stand-alone optical drives that use 12-inch WORM (write once, read many times) media. By 1995, when the company can legally begin to discard images that are stored in the system, it will contain 250 million documents with over 1.5 billion pages and consume over 2 terabytes of disk space.

For the future, USAA is working on an image system that will support property and casualty claims processing, in addition to underwriting and policy servicing. This expansion effort will result in the addition of 2500 to 4000 terminals. The challenges the company faces in claims processing involve being able to store and retrieve the 1 million color photographs and approximately 400,000 tape recordings it receives each year.

According to USAA, its DIP system has saved 39,000 square feet of office space and freed up 120 employees from file maintenance. The net savings is approximately \$5 million per year.

Because much of the customer service work in the insurance business is done over the phone, the ability to nearly instantly recall documents has also resulted in an estimated 2 percent to 10 percent time savings. Each percentage point of improved productivity provides an additional \$1 million per year in savings.

### Range of Opportunities

The above examples, ranging from small workgroup-size installations to mammoth enterprisewide systems, illustrate the range of problems you can address using a DIP system. In considering such a system, however, you should be thorough in assessing your needs before responding to a problem by throwing technology at it.

While not the solution to all document management problems, DIP is a viable solution to many of them. In such instances, DIP can actually provide the closest thing to a paperless office that you are likely to see in this century. ■

*David A. Harvey is a Houston-based computer journalist specializing in the technology and implementation of optical devices. Bob Ryan is a BYTE technical editor. They can be reached on BIX as "daharvey" and "b.ryan," respectively.*



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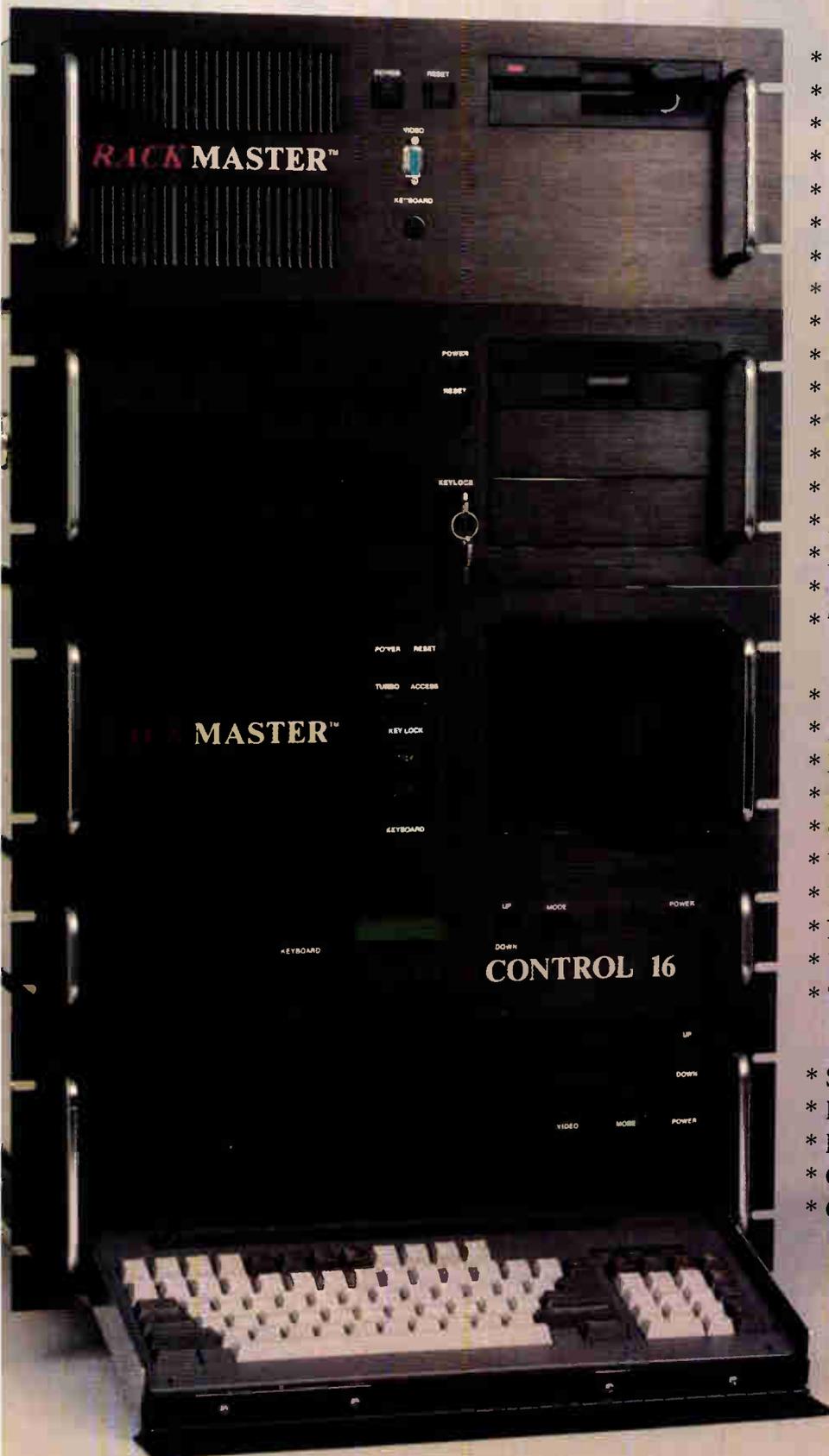


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# THE DARK SIDE OF DIP

Do you know where your documents are?  
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**CHRISTOPHER LOCKE**

"Mirror, mirror on the wall,  
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—The Wicked Queen  
from *Snow White*

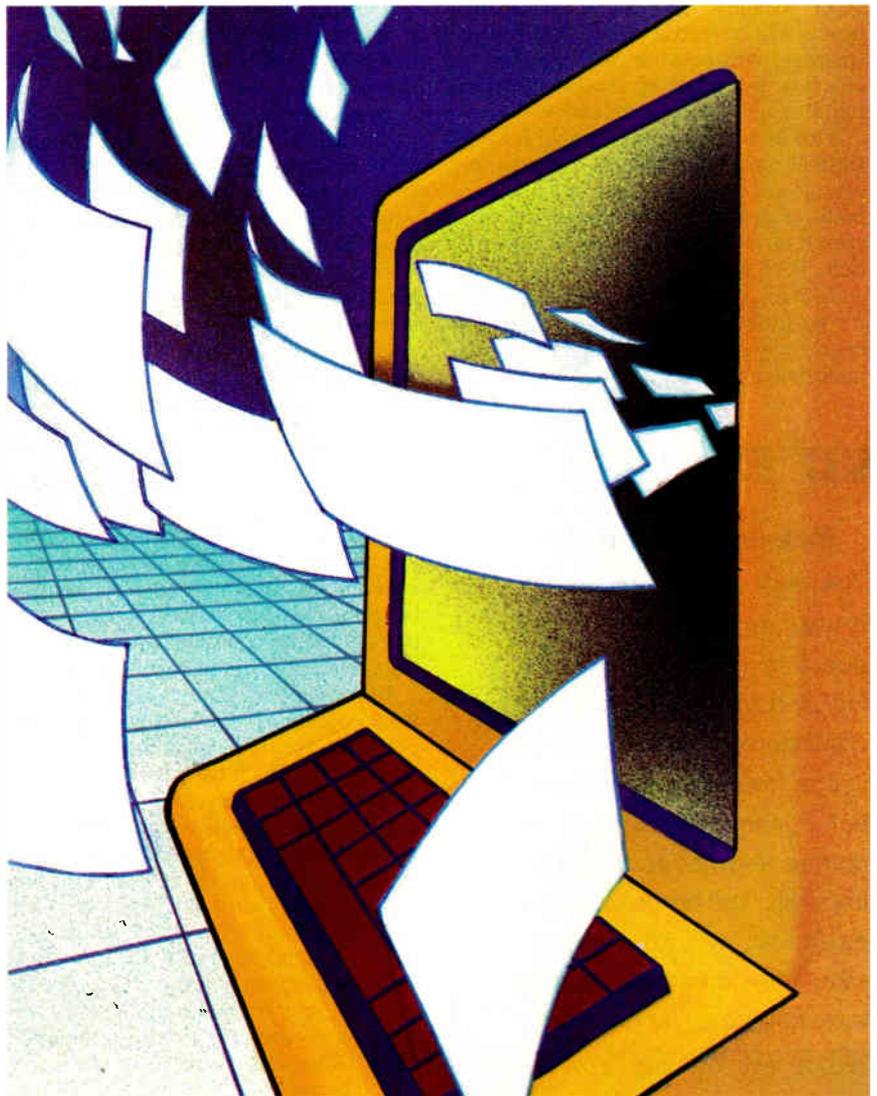
**T**he moral of many folk tales is that the image—the seemingly accurate representation of reality—often deceives, usually with dire consequences for those who put their trust in such alluring reflections. In the case of document-imaging systems, this ancient warning is still well worth heeding.

Since imaging produces picture-perfect digital facsimiles of document pages, how can these images lie? When only a few dozen pages are involved, they don't; each screen image is a faithful replica of the paper document from which it was taken.

However, when an imaging system contains thousands or millions of pages, it rarely reveals the whole truth. The issue here is not accuracy but the retrieval of only those pages that are relevant to your immediate needs. If the system holds back crucial information, then, in effect, it lies.

Information systems don't lie intentionally, but all information-retrieval systems tend to lie by omission: They simply have little way of knowing what they contain relative to your queries. In document-imaging systems, this deceit by omission is an inherent attribute of the technology that can cost organizations millions of dollars after all the glamour wears off.

This fatal flaw involves the definition of the contents of document images so that relevant information can be recalled



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**Indexing Vocabularies**

If you substitute an imaged document for a book, the real problem will begin to emerge: How will this document be retrieved? While few, if any, documents will be 600 pages long, there will be many thousands of shorter ones to search through. Even this simplified example should suggest that indexing is not a low-level task, and it becomes more complex as larger volumes of text are involved.

Choosing the right primary indexing term is not especially difficult at the level of a single book. The choice can be somewhat arbitrary as long as it is consistently applied. But the choice is tougher when many books are involved—for example, at the Library of Congress. This national document repository faces a challenge different from that of back-of-book indexing. However, the problems are related, and both are intimately connected to document imaging.

The Library of Congress does not (yet) attempt to provide as detailed a description of its holdings as a book's index does of its contents, but it does try to roughly characterize the subject of each book. Library of Congress subject indexers attach several topic descriptors to every nonfiction work published in America. You can find an example on the copyright page of any modern nonfiction book under the somewhat odd rubric Library of Congress Cataloging-in-Publication Data (see the figure).

The terms *artificial intelligence*, *computers*, and *expert systems* (computer science) in the figure are Library of Congress topic descriptors. The complete Library of Congress Subject Headings are available in three large volumes at most libraries. Or you can consult the CDMARC Subjects CD-ROM—MARC being an acronym for machine-readable cataloging (see the text box "Investigating Indexing" on page 198). This CD-ROM is a terrific bargain, especially for anyone considering document imaging. You might as well get an early taste of the indexing demands you're really going to be up against.

Two fundamental ideas underlie the Library of Congress Subject Headings. The first is to guarantee (or at least encourage) consistency in the selection of indexing terms. The problem here is often called *vocabulary control*, and, logically, the solution is called *controlled vocabularies*. Such agreed-upon lists of valid terms guide subject indexers in classifying a book's subject matter consistently, so multiple indexers will not apply multiple synonyms at random (see the table).

*continued*

on demand. The technical term for this challenge is *indexing*, and it applies to any form of computerized information retrieval. This seemingly straightforward concept is also employed in the back pages of any respectable reference book.

While it may seem tangential to note that works of fiction don't have indexes, this fact is very much to the point. Rightly or wrongly, publishers assume that novels will be read linearly; that is, users (readers) will become familiar with the contents of a novel by processing (reading) its pages from front to back.

This assumption doesn't hold for nonfiction; potential readers may simply want to check a single fact in a 600-page book or scan several relevant pages in search of some highly specific information. Few people have the time or the dedication to wade through an entire text for so little return. A table of contents helps, but usually not enough. Thus, the index was conceived.

**Why Index?**

Although such an index represents a simple concept, creating one is no laughing matter. Take, for example, a 600-page tome that deals in part with AI. Give it to 10 different indexers to see what they come up with, and the first thing you'll notice is that no two indexes will be substantially alike. Because the process requires selectivity, and because of differing background knowledge, different indexers notice and emphasize different key words, phrases, concepts, and relationships.

In addition, it is unlikely that all indexers will decide to standardize on the same indexing terms. For example, *artificial intelligence*, *expert systems*, *intelligent machines*, *knowledge-based programming*, and *automated reasoning* may or may not refer to the very same thing. Without a careful consideration of context and a good deal of specific knowledge of the field, it would be hard to say. Although there are only five terms in this example, there could easily be a dozen that were fundamentally synonymous. The 10 indexers aren't likely to settle on a single term. Some would use one term, some another.

An individual might not decide to use just one term—grouping all related references under, say, *artificial intelligence*—but rather list each term in separate locations in the book's index, with differing page references for each.

Understanding that such an approach would needlessly confuse readers, an experienced indexer would choose a single term under which to supply page references to all related concepts—say, again, *artificial intelligence*—but would then list the other synonyms in their alphabetical index locations along with a pointer to this primary term—for instance, "Expert Systems. See Artificial Intelligence." Indexers must accommodate large, heterogeneous readerships whose members may be inclined to look for any one of many possible phrases when using an index to locate material about a specific concept.

**BYTE ACTION SUMMARY**

**Indexing Documents**

The dark side of document-image processing is the question of retrieval. Indexing documents properly and consistently for later retrieval isn't a low-order clerical task but a complex exercise requiring knowledge engineering skills. DIP tends to underestimate, or underemphasize, the complexity of this task. Let the buyer beware.



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CDMARC SUBJECTS FOR AI

A file dump from CDMARC Subjects for AI. This CD-ROM was developed from the eleventh edition of the Library of Congress Subject Headings. UF (use for) is the reciprocal of a USE pointer (equivalent to a SEE pointer in the previous edition). BT= broader terms; RT = related terms; NT = narrower terms.

- Artificial intelligence
  - UF AI (Artificial intelligence)
    - Artificial thinking
    - Electronic brains
    - Intellectronics
    - Intelligence, artificial
    - Intelligent machines
    - Machine intelligence
    - Thinking, artificial
- BT Bionics
  - Digital computer simulation
  - Electronic data processing
  - Logic machines
  - Machine theory
  - Self-organizing systems
  - Simulation methods
- RT Fifth-generation computers
  - Neural computers
- NT Adaptive control systems
  - Automatic hypothesis formation
  - Automatic theorem proving
  - Computer vision
  - Error-correcting codes (Information theory)
  - Expert systems (Computer science)
  - GPS (Computer program)
  - Heuristic programming
  - Machine learning
  - Machine translating
  - Perceptrons
  - PURR-PUSS (Computer program)
  - Question-answering systems
  - VL1 system
  - VL21 system

Since such synonyms do exist, controlled vocabularies must also provide "See" pointers from terms that are discouraged for indexing use to those that are approved (e.g., "Computer Control. See Automation" or "Computer insurance. See Insurance, computer"). In addition, "See also" pointers are provided to suggest related keywords (e.g., "Computer input/output equipment. See also Automatic speech recognition").

The second fundamental idea behind the Subject Headings is to establish not just terms but categories of terms, and relationships among these categories. "See also" references point to what are technically called *related terms* (RT). In addition, the Subject Headings classification includes pointers to *broader terms* (BT),

which indicate more inclusive subject categories, as well as to *narrower terms* (NT), which name more specific subcategories (see the table).

What begins to emerge here is a quasi-hierarchical representation of a field of knowledge. Although it differs radically from a synonym list, this sort of extended conceptual taxonomy is often called a *thesaurus*.

While "See" pointers and the approved terms they indicate may be the product of arbitrary decisions, "See also" pointers entail some knowledge of the domain under consideration. In fact, the subject analysis that librarians perform to create these categories and relationships is strongly akin to what the AI literature calls *knowledge engineering*.

What You See and What You Get

These and related library techniques have evolved over untold thousands of worker-years of deep experience in document-collection management. Chances are good, however, that you would really rather not wade into all this. Here is where document-imaging systems come in, right on cue. High technology promises to solve all your problems while at the same time enabling you to bypass such complexity.

But think for a minute. Did librarians come up with such schemes because they enjoy complication? More likely, these techniques exist because they—or something very much like them—are crucial to doing the job. The job, in this case, is to serve the information needs of communities very much like your own.

If you're seriously considering document imaging, your organization has probably already encountered just such indexing and retrieval hurdles—they apply as much to paper-based filing systems as to computerized databases—possibly without much clue as to how deep such problems can quickly become. Don't expect imaging vendors to point them out, either, because their technology offers no substantial relief.

Most product literature, and even trade-press reporting, makes little mention of indexing as it relates to document imaging, except to acknowledge that the process requires "manual" effort. But it's not referring to the kind of manual effort required to type 80 words per minute. Rather than a task that can be handed off to low-cost temporary help, indexing of this sort requires knowledge-engineering skills.

Part of the problem—but only part—is that after a document has been captured in an imaging system you don't actually have the real document anymore; what you have is pictures of pages. (If you have ever wanted to cut a long but particularly relevant passage from a document image and paste it into a report, you know that a picture really is worth a thousand words—of typing.) Apart from optical character recognition (OCR), manual indexing is the only way to tie these pictures to meaningful concepts by which they might be retrieved.

In fact, document-imaging technology suggests many surprising parallels with the old on-line database systems once used almost exclusively to search bibliographic records of periodical literature. In those days, storage was too expensive to allow keeping the full text of documents on-line. As with imaging systems today, the documents themselves weren't



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World Radio History



# Investigating Indexing

**T**here is no better way to understand the real challenges and opportunities involved in text management than to get your hands dirty in the problem. The following is an eclectic mix of software tools, R&D efforts, and professional associations that should provide plenty of insight into the wide range of options that full text affords.

## TEXT MANAGEMENT SYSTEMS

### Concordance

**Professional Edition** .....\$995

A hybrid text/database that allows a combination of fixed fields and fully indexed free text. Includes a full programming language for building applications.

Dataflight Software  
10573 West Pico Blvd., Suite 68  
Los Angeles, CA 90064  
(213) 785-0623

**Folio Views** .....\$495

An information storage and retrieval system that enables full-text indexing and search as well as hypertext navigation. Topical/structural segmentation of text bases is a strong feature.

Folio Corp.  
2155 North Freedom Blvd., Suite 1500  
Provo, UT 84604  
(801) 375-3700

**Hyperties** .....\$349

An information system whose primary method of retrieval is the navigation of hypertext networks. Significantly, this is an *authoring* tool in addition to its presentation capabilities.

Cognetics Corp.  
55 Princeton-Hightstown Rd.  
Princeton Junction, NJ 08550  
(609) 799-5005

## DOCUMENT STRUCTURE: TAGGING AND RECOGNITION

### Author/Editor

**for Mac** .....\$495

**for DOS** .....\$695

**for Unix** .....\$1100-\$2500

An editor for Standard Generalized Markup Language. If you keep hearing about SGML but don't know what it's all about, here's a good place to begin learning about a powerful and growing document management/interchange methodology.

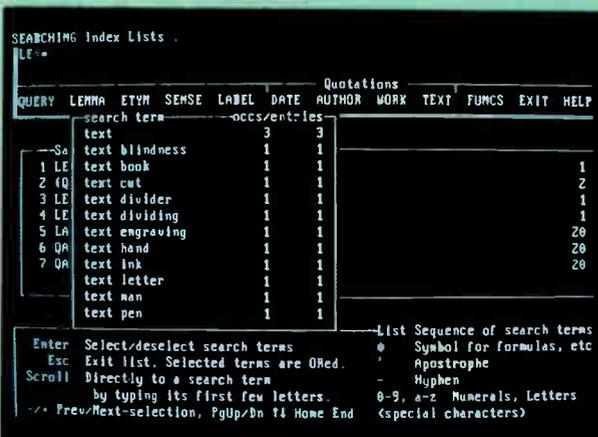
Softquad  
720 Spadina Ave.  
Toronto, Ontario,  
Canada M5S 2T9  
(416) 963-8337

### FastTag

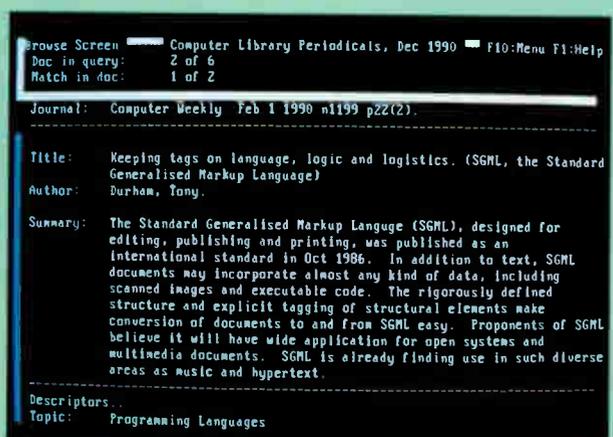
**for DOS** .....\$2400

**for Unix** .....\$3100

While OCR recognizes characters, FastTag's pattern-matching capabilities



**Screen A:** A screen capture from the Oxford English Dictionary on CD-ROM. The OED text data has been specially tagged for each of the categories shown: LEMMA (headword), ETYM (etymology), SENSE (definition), and so on. This enables the creation and display of an inverted file for each of these categories. Here, the inverted file of main dictionary entries or headwords pops up to facilitate selection. You can make multiple selections from this list, as well as from the inverted files for other categories (e.g., ETYM and SENSE) to produce a complex Boolean query. (Screen shot provided by Christopher Locke)



**Screen B:** A screen capture of a record from the December 1990 edition of the Computer Library CD-ROM. Note especially that the descriptors listed under Topic are subject headings. In the new incarnation of this product, Computer Select, you can now browse these descriptors in an inverted file that enables point-and-shoot selection of multiple subject headings to retrieve associated documents (i.e., similar to screen A). (Screen shot provided by Christopher Locke)

recognize document *structure* and convert it into various machine-readable markup formats, SGML among them. Avalanche Development  
947 Walnut St.  
Boulder, CO 80302  
(303) 449-5032

**CD-ROM:  
TOOLS AND APPLICATIONS**

**CDMARC Subjects** .... \$315 per year (updated quarterly)  
This CD-ROM contains all the subject descriptors used by the Library of Congress (and many information vendors) to describe document content. Function keys enable a sort of hypertext navigation through the thesaurus structure (see the table in the main article).  
Library of Congress  
Customer Services Section  
Cataloging Distribution Service  
Washington, DC 20541  
(202) 707-1312

**The Original Oxford English Dictionary on CD-ROM** .....\$950  
The OED is the operating-system manual set for the English language. The tagged structure and full-text indexing used here enable searches never possible with the massive 13-volume hard copy original (see screen A).  
Oxford University Press  
Electronic Publishing Division  
200 Madison Ave.  
New York, NY 10016  
(212) 679-7300 ext. 7370

**Computer Select** ..... \$995 per year (updated monthly)  
A highly practical collection of full-text and abstracted articles from hundreds of computer-oriented publications. This new incarnation of the older Computer Library CD-ROM makes far better use of the subject indexing descriptors attached to each document record (see screen B).  
Computer Library  
One Park Ave.  
New York, NY 10016  
(212) 503-3523

**TOOLS AND LANGUAGES**  
Word processors are inadequate for much of the preprocessing required for serious text management applications.

The products listed here are programming tools that may require some effort to master but will repay that effort in greatly increased control of textual information.

**MKS Toolkit** ..... \$249 for DOS  
The regular-expression-based pattern-matching capabilities of Unix tools like *ed*, *sed*, *grep*, and *awk* constitute a sort of Swiss Army knife for text processing. The MKS Toolkit provides these and many other extremely useful text manipulation capabilities in a DOS environment.  
Mortice Kern Systems  
35 King St. North  
Waterloo, Ontario,  
Canada N2J 2W9  
(519) 884-2251

**PolyAwk** ..... \$195 for DOS  
**Sage Professional Editor** ..... \$295 for DOS  
Sage offers *awk* either by itself or as a built-in language for modifying and extending the Sage Professional Editor text-editing environment: tools within tools within tools.  
Sage Software  
1700 Northwest 167th Place  
Beaverton, OR 97006  
(503) 645-1150

**Snobol** ..... \$95  
**Spitbol** ..... from \$195  
**Icon** ..... \$295  
These three programming languages employ powerful pattern-matching techniques designed specifically for processing text. They are available in various PC, Macintosh, and Unix implementations.  
Catspaw, Inc.  
P.O. Box 1123  
Salida, CO 81201  
(719) 539-3884

**THE HIGH END**

**Topic** ..... \$15,000-\$150,000  
This document-retrieval system uses "concept retrieval," a shared-knowledge-base approach that captures information about subject matter of interest to users and stores it as reusable objects called topics.  
Verity, Inc.  
1550 Plymouth St.  
Mountain View, CA 94043  
(415) 960-7630

**Text Categorization Shell** ..... \$124,000 (includes installation and training)  
TCS automatically categorizes text by semantic content rather than simple lexical string occurrences. It has been used by Reuters for subject indexing its on-line text databases.  
Carnegie Group, Inc.  
5 PPG Place  
Pittsburgh, PA 15222  
(412) 642-6900

**IntelliText** ... (inquire about licensing)  
Although a commercial product has not been released, this thesaurus-based text management technology incorporates many of the concepts referred to in this article and is currently licensable.  
Intelligent Technology Group  
115 Evergreen Heights Dr.  
Pittsburgh, PA 15229  
(412) 931-7600

**The CLARIT Project** (inquire about sponsorship arrangements)  
CLARIT stands for Computational Linguistic Approaches to Retrieval and Indexing of Text. This research project has obtained encouraging results and is open to corporate sponsors seriously exploring text management solutions.  
Laboratory for Computational Linguistics  
Carnegie Mellon University  
Pittsburgh, PA 15213  
(412) 268-8574

**DOCUMENT MANAGEMENT EXPERTISE**

The following are excellent sources for publications on library science as well as of people who know how to apply the principles discussed here.

American Library Association  
50 East Huron St.  
Chicago, IL 60611  
(312) 944-6780

Special Library Association  
1700 18th St., NW  
Washington, DC 20009  
(202) 234-4700

really there. Instead, the physical page-pictures were kept on library shelves, and the database was an automated assistant for paper-based filing and retrieval.

To index records in these on-line bibliographic systems, some types of consistent information were placed into structured database fields: author, title, journal, publication date, and so on. For books, such information might include Dewey decimal classification, Library of Congress call number and card number, and ISBN (several of these more arcane data items are shown in the sample Cataloging-in-Publication Data record in the figure).

However, providing only this type of standard information puts a tremendous burden on searchers: It assumes that you know exactly what you're looking for, which is seldom the case. More often, you want to know about something and are not even sure what that something should be called. It might have 50 possible expressions or perhaps only one that is so new or technical you've never heard the term used before. Only rarely will you know the titles of articles or books in which the concept appears or the name of an author who has written on the subject.

### Needles and Haystacks

Two remedies were developed to deal with these inherent shortcomings of fixed-field database retrieval. The first was simply to add a new field: Subject. Subject indexing implies both the existence and skilled use of a structured thesaurus of related concept categories into which the elements of a controlled vocabulary have been appropriately placed.

From such a thesaurus, an indexer selects keywords that accurately describe a particular document and attaches them to that document's database record to assist retrieval. It is crucial that the indexer selecting these subject headings have sufficient understanding of the document itself, the field of knowledge that forms its context, and the methodology for applying subject headings. This level of indexing is a fundamental requirement for retrieving the pictures of pages from a document-image base. Unless you have already developed a comprehensive controlled vocabulary, a domain-specific thesaurus, and a pool of competent indexers, you are either leaving a big hole in your imaging budget or designing an information system that will stonewall everyone who uses it.

The second remedy for inadequate fixed-field database descriptors is to develop document abstracts. In an abstract, each document is summarized in a suc-

cinct and cogent paragraph, and the full text of these abstracts is then automatically indexed so that almost every word serves as a retrieval hook. Applied to good abstracts, this software-driven inverted-file indexing technique greatly increases the likelihood of a user finding relevant material.

However, succinctness and cogency are not inexpensive. Their cost is a function of knowledge—abstracters are relatively high-level knowledge workers in the true sense. Some people believe that

**E**ffective  
retrieval is the only  
rational reason  
to build text/image  
systems.

AI will eventually master the natural-language understanding problem, thus enabling the automatic generation of abstracts. While such wishful thinking is not supported by the current state of the art, interesting document classification and indexing results have been obtained using certain AI techniques (see the descriptions of the Text Categorization Shell and the CLARIT Project in the text box).

### Semantically Speaking

As the cost of storage continues to drop dramatically, on-line information services—and especially CD-ROM applications developers—are moving away from providing rudimentary fixed-field bibliographic citations (with or without subject keywords and searchable abstracts) and toward delivering full text. That is, search-it, dump-it, cut-it, paste-it ASCII. At first, such systems may seem to be technological marvels: Every word is a keyword.

While the value of full-text databases is hardly to be denigrated, the initial enthusiasm they inspire can give way to massive frustration for all the reasons given so far: no controlled vocabulary, no thesaurus, no clues. The problems that give rise to this frustration are technically termed *recall* and *precision*.

These can be roughly translated as: "How am I supposed to read 300 documents before 5:00 p.m.?" and "That's not what I meant!"

What documents are about simply can't be captured by casually jotting a few words in a database header or even by dumping all the discrete words the documents contain into an inverted-file index. Even for full-text document databases, higher-level tools are required to perform the type of sophisticated semantic analysis prerequisite to the construction and maintenance of an adequate thesaurus. More important, such tools must be put into the hands of intelligent and knowledgeable people who are not adverse to long hours of difficult intellectual work. The American Library Association and Special Library Association are good sources for locating such people.

But serious consideration of full-text databases is not the focus here; picture bases are. To overcome this rigid dichotomy, there are hybrid possibilities worth exploring. If you can afford even more storage than images require—and that's a lot—it may be feasible to create full-text indexes for certain types (or portions) of imaged documents. This involves using OCR to convert page images into ASCII (where such conversion is possible).

The ASCII will be "dirty" unless you correct the inevitable OCR errors, but while clean text is certainly preferable, it isn't necessary for certain indexing applications. You can use automatic file-inversion techniques to create an index in which every word that the OCR process captures correctly is linked by a pointer to its corresponding page image. The rest you just throw away.

While this approach is more involved and costly than straight imaging, it remarkably improves retrieval. The cost comes into perspective if you consider that effective retrieval is the only rational reason to build information systems of this type in the first place. However, after putting such a hybrid text/image system together, you will still have the same challenge that accompanies any full-text retrieval effort: the knowledge engineering that goes into constructing a first-class thesaurus of relevant concepts.

In this regard, a product called Topic is an education in itself, and it will work just as well with dirty OCR-image results as it will with plain text. However, whatever the tools used, information managers would be ill-advised to view this essential knowledge-engineering process as an optional step in creating usable document-retrieval systems. The

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real problem for unalloyed imaging systems is that it's not optional, it's impossible.

**Knowing About Knowing**

So far, I have not admitted that there are situations in which there is no alternative to document-image management. OK, I admit it. If you have zillions of forms filled out in handwriting, imaging is better than paper, yes. If you have lots of critical graphical material, ditto. There are probably many other cases, but just because there may seem to be no practical alternative, the indexing problems described here don't go away.

For this reason, handwritten forms will sooner or later be converted into machine-readable ASCII. If the information they contain is valuable enough to justify imaging in the first place, the indexing currently applied to these images will so degrade retrieval that the costs directly resulting from lost business opportunities will make even manual conversion seem cheap by comparison. The more critical such information is to an organization's health and longevity, the sooner the crunch will be felt.

The core issues here are epistemological: How do we know something? What constitutes knowledge? Although raising such questions has always been seen as unbusinesslike, if not downright flaky, look for this to change. Despite the glut of verbiage about the information age—information society, information economy, information anxiety, and so forth—something has definitely changed from the time when the focus of business was

almost exclusively on product.

Now we speak less of production and more of productivity, less of quantity and more about quality. These are significant reflections of a new concern for how new things can be done, how old things can be done better, and the human understanding required to do either. Rather than a set of objective facts that can be known in advance, knowledge is the result of such understanding.

In contrast, document-image processing presupposes that what is important in a document is already known. You type "This document is about x" into the index field. But that's today. What about tomorrow? You may want to turn to your information resources to mine a completely different type of ore.

It's interesting how many times you hear the phrase "for as long as records have been kept" and then notice that the data doesn't go back very far. This does not necessarily mean that record keeping began on the date given or that records before that date contain no relevant data. Often, it means that the records contain information that has only recently been perceived as worth knowing about and, therefore, was not previously indexed. As a result, this information is not currently retrievable. In fact, it's extremely misleading to refer to such data as information if no one can get at it. By any meaningful definition, information must *inform* someone.

For example, not long ago, there was no name for the disease now known as acquired immune deficiency syndrome. Although it was as deadly then as it is to-

day, medical diagnosticians didn't know what to call it, or even what it was. Today we know a lot about AIDS, but it took longer than it might have to arrive at this knowledge. Meanwhile, an unnamed contagion spread through unsuspected vectors.

Granted, the history of AIDS so far has had deep social, political, and legal ramifications. Might it also have had a significant technological component? Could the medical records maintained in databases—as images or otherwise—have been better used to correlate the emergence of an as-yet undiagnosed constellation of symptoms with the histories of patients in which these symptoms were being observed?

Such records may very well have contained vital information that was not readily accessible because of inherent shortcomings—not in the ability of medical researchers, but in their information systems. If there is no name, there will be no explicit field or index term. If there is no retrieval hook, responses to queries will not return any documents. If searchers asking intelligent questions are not informed, events will follow their own course with no one the wiser.

**Shuffling the Deck**

Although somewhat hypothetical, this example is relevant if it makes you ask, "What am I missing in my own work?" In fact, epidemiology forms a good analogy to what many organizations would like to do better today: track potential yet unidentified problems and opportunities, and either head them off before they

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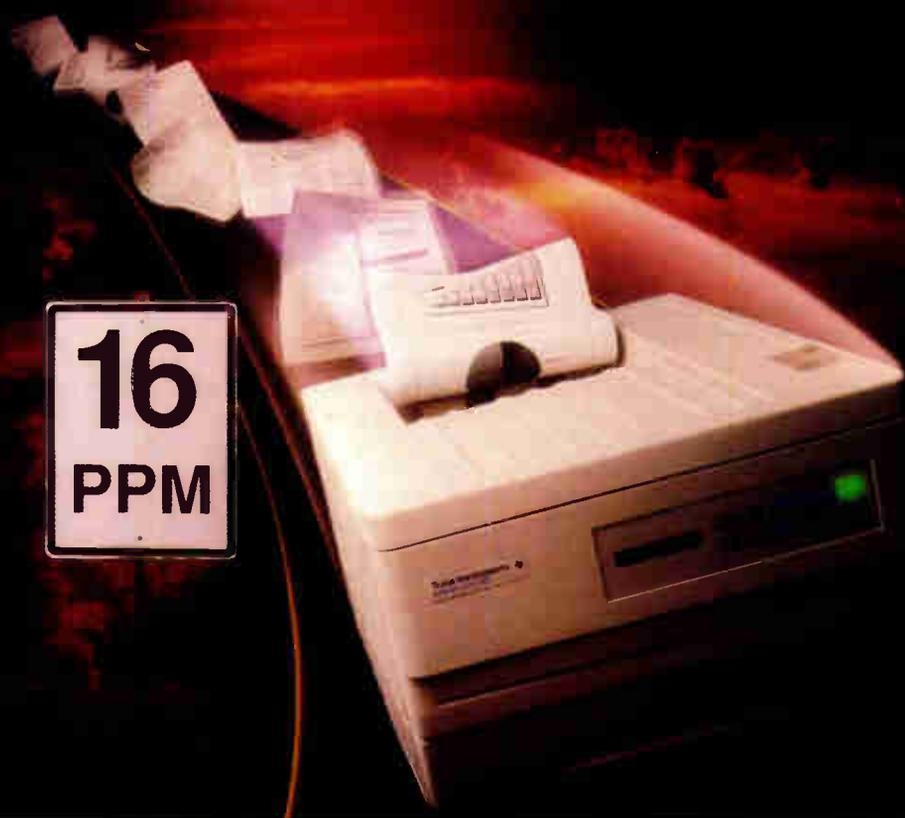
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**TEXAS  
INSTRUMENTS**

become critical or take advantage of them before the competition catches on.

Accomplishing this task involves pattern recognition of such a high caliber that it is often referred to as intuition and considered a near mystical skill. Yet people do this sort of thing all the time, and more could do it more often if they were given software tools that enabled and encouraged deeper exploration of documentary evidence.

For example, say you have 10 fields in a customer-service database in which to type notes on the last bug-report call or 10 keywords to attach to the image of a letter from an irate consumer—or make it 20, 50, or 500. This sort of structured data about characteristics you have already identified as significant will never be adequate. You will always be caught short if you can't quickly restructure or reindex information in light of more recent intelligence. (Think of the CIA here; this type of intelligence may often involve no new data, but rather a new way of perceiving and interpreting existing information.)

Information resources, and especially document collections, are not just moun-

tains of facts you already know but research bases to explore for clues about what you don't yet understand. More than that, they are the foundation on which new knowledge will be built by accretion. Detailed annotations and even off-the-cuff comments by knowledgeable people can add enormous value to documents if, and only if, they are also retrievable.

Hypertext linkages created between related texts can likewise be high-value-added contributions to greater comprehension, the nonnegotiable prerequisite to effective action. But all this requires text, not pictures of words. In fact, it requires more than text. It calls for sophisticated conceptual maps that you can continually debug and incrementally extend to make sense of the words, which are themselves simply tokens of some presumably real territory beyond the document.

#### Eye of the Beholder

Since I opened this article with a quote from the Wicked Queen, I'll close with one from Raymond Chandler and Robert B. Parker's *Poodle Springs*, something a

little less fabulous and more contemporary. Listen to legendary private eye Philip Marlowe in the process of searching a dead woman's apartment. You can almost hear Bogart's sibilant inflection:

"The cops would have seen all this. They'd have looked at everything like they do, and anything that mattered would be down in a box in property storage with a case tag on it. Still, they didn't know all the things I knew, and I was hoping I might see something that wouldn't have meant anything to them."

If you look at document-image databases as the modern equivalent of property storage, the analog of the case tag would have to be an index-field entry. Instead of putting potential proof into plastic baggies with little labels, the police can now just snap a picture and scribble a few notes on the back. Me, I'm more like Marlowe, I guess. I'd rather get closer to the hard evidence and decide for myself who's the fairest of them all. ■

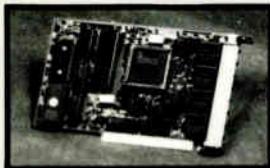
*Christopher Locke is director of industrial relations at the Robotics Institute, Carnegie Mellon University. You can reach him on BIX c/o "editors."*

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- A host computer under the UNIX, VAX/VMS or IBM AS/400 system with a PC connection.

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The EEF software package, including the document manager, the retrieval engine, the hypermedia interface, and 20 hours of customization services.

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World Radio History

# DIVIDE AND CONQUER

Neural networks take a novel approach  
to the problem of automatic handwriting recognition

DAVID P. WRIGHT AND CHRISTOPHER L. SCOFIELD

**F**or over 30 years, people have been touting the paperless office. Clearly it's not here yet. One obstacle has been the inability to find a way to mechanically read human handwriting and convert it into a computer-digestible form such as ASCII text. A second difficulty has involved the task of entering scanned information from forms into a computer database.

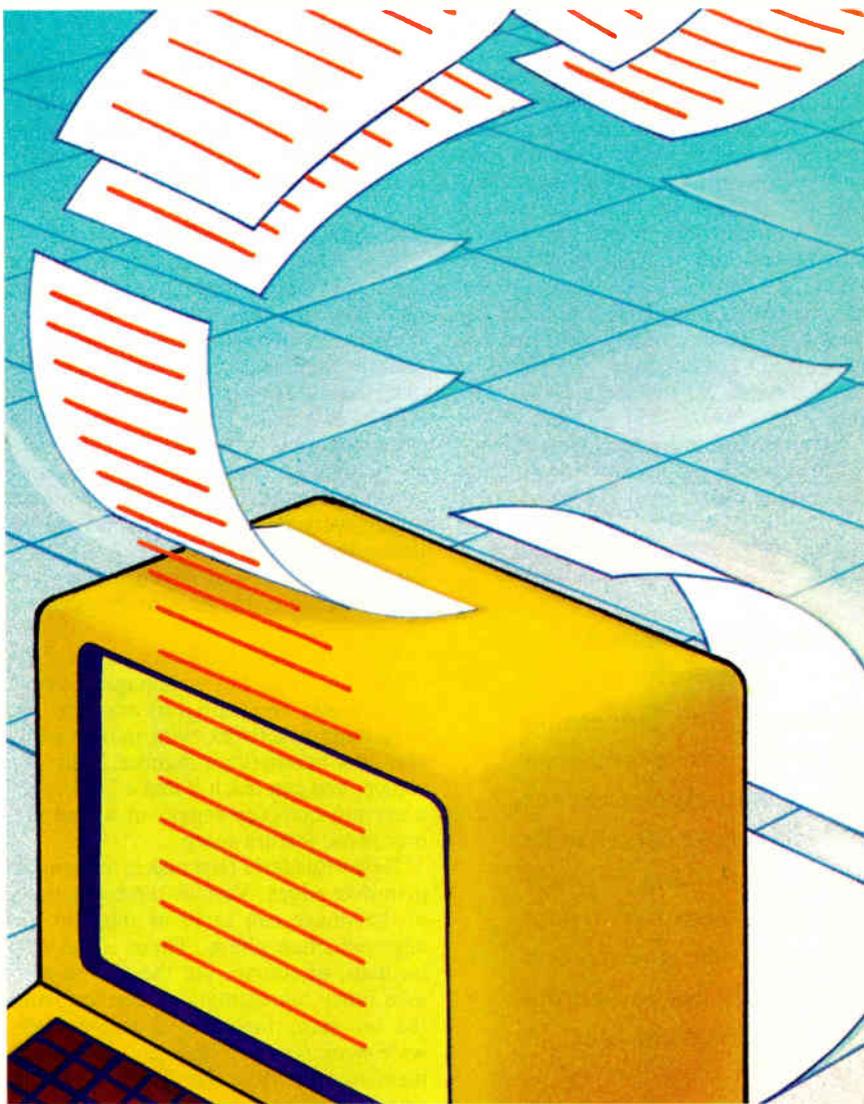
Nestor (Providence, RI) has developed products that can overcome these difficulties using its proprietary neural network technology. It has developed software that can be trained, in real time, to read unconstrained handprinted characters in English, as well as the thousands of Japanese kanji characters. (For information on a company with a product that reads script today, see the text box "Recognizing Script" on page 210.)

## An Ocean of Forms

Our society is dependent on forms. Try to apply for almost anything—insurance, credit cards, motor vehicle registration, employment—and you'll have to fill out a form. Filing taxes, medical claims, sales orders, census information, and subscriptions also requires filling out forms.

What happens to those forms? Usually, someone reads them and then keys the information into a database. Manual data entry remains widespread. For example, over 50 billion checks are cleared yearly in the U.S.; most of these transactions are entered manually. The IRS estimates that there are over 194 million tax receipts per year, and most of these transactions are handled manually as well. But keyboard entry is slow, inaccurate, and expensive.

*continued*



There are several ways to automate forms entry. For \$60,000 and up, page scanners are available that will perform quite well on forms with machine print and neatly hand-printed block characters. Most of these systems read forms specifically designed for optical character recognition (OCR), with special inks that are invisible to the scanner and with separated character boxes for hand-printed characters. The IRS 1040EZ is the most common example of this type of form. However, high cost and limited flexibility restrict the use of these expensive machines to specialized markets.

At the other end of the spectrum, for about \$500 you can buy an OCR software package and get excellent results with machine-printed text in almost all modern font styles. However, these packages are not well suited for forms recognition because output data must be formatted, machine print must be of high quality, and hand-printed characters cannot be recognized at all.

Character recognition from forms presents many problems that are not encountered with machine-printed text. The form itself and the location of the data must be correctly identified. Each character's position, as well as its value, must be determined. Background information must be removed so that characters are separated from the form. Hand-printed information, or machine print that is degraded, must be accurately separated and recognized. These issues have yet to be resolved with off-the-shelf OCR software.

Nestor's newest product, NestorReader, attacks the problem of recognizing handwritten characters. The company is

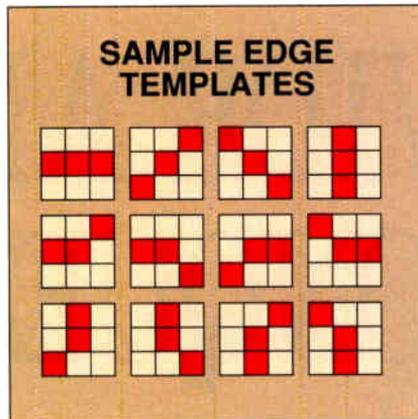


Figure 1: Edge templates, or kernels, are like cells in the visual cortex that react to horizontal, vertical, or angled lines.

working to add the ability to identify which form an image represents (e.g., Is it a 1040EZ?) and which regions of the image correspond to data fields (e.g., Where is the Total Deductions field?). Nestor believes that the technique used to recognize characters will extend readily to the recognition of fields and forms.

### Recognizing Handwriting

Traditional OCR systems seek to match a character image with a template stored in memory. Since every person writes differently, that technique won't work for hand-printed characters. Nestor's transputer-based system solves the problem with a two-phase approach. First, the system extracts a data set, or *feature vector*, from each character. A feature vector describes the distribution of primitive edges—vertical, horizontal, and angled lines—throughout the image of the character. Then a neural network discovers which character the feature vector most closely matches.

What defines characters in the first place? That's the key advantage of a neural network: You train it by example. By presenting a network with many examples of a handwritten number 2, for instance, you can teach it that a 2 occupies a certain complex region in a multidimensional feature space.

NestorReader's first task is to identify primitive edges. Various representations of the image can serve as input to the edge-detection phase. There is the raw bit map, of course, but the system also uses other representations derived from the bit map, including a single-pixel-wide *medial axis*, or skeleton, and a complementary outline that traces the character's outer boundary.

The system processes these input representations using a collection of 3- by 3-pixel edge templates, or *kernels*, like those shown in figure 1. You can think of the kernels as cells tuned to detect different kinds of edges, like the cells in the visual cortex of a cat that react to horizontal or vertical shapes. The system centers a 3-by-3 window on each pixel of the image, compares the bits found there to each of the edge templates, and assigns the image pixel a value corresponding to the best-matching template. If the character's bit map is a 50- by 60-pixel rectangle, the result is a list of 3000 edge orientations.

### Organizing the Edges

The next step is to lay a grid over the pixel array. The 50-by-60 bit map might yield a 5-by-6 grid of 10-pixel-wide subwindows. But it's the number of subwindows—not their size in pixels—that matters. A smaller character occupying a 25-by-30 cell would also yield a 5-by-6 grid, although the subwindows in that case would be only 5 pixels square.

For each subwindow, the system counts up the number of edges of each type associated with each pixel in the subwindow. A grid of 5-by-6 windows yields 30 histograms, or tables, describing the frequency of edge occurrences in each window. In this way, the system spatially organizes the edge frequencies with respect to the image. These 30 tables, when concatenated, form the feature vector that supplies input to the neural network. Suppose there are 12 edge templates, as shown in figure 1 (in practice, there can be more). The feature vector comprises 360 values—30 tables by 12 templates. Each value represents the frequency of edge occurrence at some location in the image.

### Building Models of Clouds

The neural network's job is to match each of these feature vectors to a character. It performs this task by modeling feature vectors in a many-dimensional feature space—for instance, a 360-dimensional space in the case of feature vectors with 360 values. The feature vector for an instance of 2 appears as a point in this space. Additional instances of 2 appear as neighboring points, and the class of all 2s composes a "cloud" of points. Now you can see why it's crucial to normalize the number of dimensions: All comparison must take place in the same feature space.

The class of all 3s makes up another cloud in the feature space. Objects like the 2 and 3 clouds have complex bound-

## BYTE ACTION SUMMARY

### Real-Life Neural Networks

Automating the processing of business forms remains a major challenge. Current OCR technology can't handle human handwriting. But new techniques based on neural networks show great promise. We may live to see the paperless office after all.

aries. To model these boundaries, the network uses basic building blocks called *radius-limited perceptrons*. These are *n*-dimensional hyperspheres, where *n* is the number of dimensions in the feature space—in our example, 360. During its training phase, the network builds up models of clouds corresponding to 2s and 3s by a process of accretion. Let a data point (e.g., a 360-element feature vector) representing 2 enter the network. If an existing sphere encloses it, and that sphere belongs to the 2 cloud, then there is no action required. The network correctly recognizes that pattern.

What if no sphere encloses the point? The network adds a new sphere to the collection of spheres that model the 2 cloud. The new sphere's center is the given point; its radius is the distance to the nearest sphere belonging to a non-2 cloud. The network thus refines its model of the 2 cloud.

Now a new point enters the network. It represents an instance of 2, and there is an existing sphere that encloses it, but that sphere belongs to the 3 cloud. That's an error. The network then responds by shrinking the enclosing sphere's size, thus adjusting the 3 cloud's boundary.

Over time, by means of both positive and negative reinforcement, the network's model of cloud boundaries grows more accurate. It learns when to identify a pattern as an instance of 2 and, just as important, when not to. Although the modeling occurs in a multidimensional feature space, it's conceptually similar to what happens in 3-D CAD. Instead of modeling the surface of an object by means of polygons, here we're modeling the volume of an abstract cloud using abstract spheres.

### Running the Neural Network

Figure 2 illustrates the flow of information through the network. The first layer buffers the input. It accepts feature vectors one at a time; in our example, the input layer will require 360 cells.

The second layer of cells corresponds to the hyperspheres used to model the clouds. The relationship between the first and second layers is many-to-many. Weights that are assigned to the second-layer cells correspond to points in feature space at the origin of spheres. Thresholds of cell response correspond to the radii of the spheres. The number of cells in this layer may be quite large. Activation of a cell in this layer corresponds to finding an enclosing sphere for a point; adjustment of cell-response thresholds corresponds to adjusting the influence of a sphere in response to negative feedback.

The third, or output, layer contains one cell for each recognizable class of character. If our system recognized just the digits 0 through 9, there would be 10 cells in the third layer. The relationship of the second layer to the output layer is many-to-one. Each second-layer cell belongs to a class: 2, for example. Each cell in the output layer performs what is in effect a logical OR for a set of second-layer

map, another with the medial axis, and a third with the contour. If the networks arrive at different opinions, they vote, and the system abides by the majority decision. If, during training, the opinion derived from a particular representation seems consistently more valid than others, the system can increase the weight given to that opinion.

### Tools of the Trade

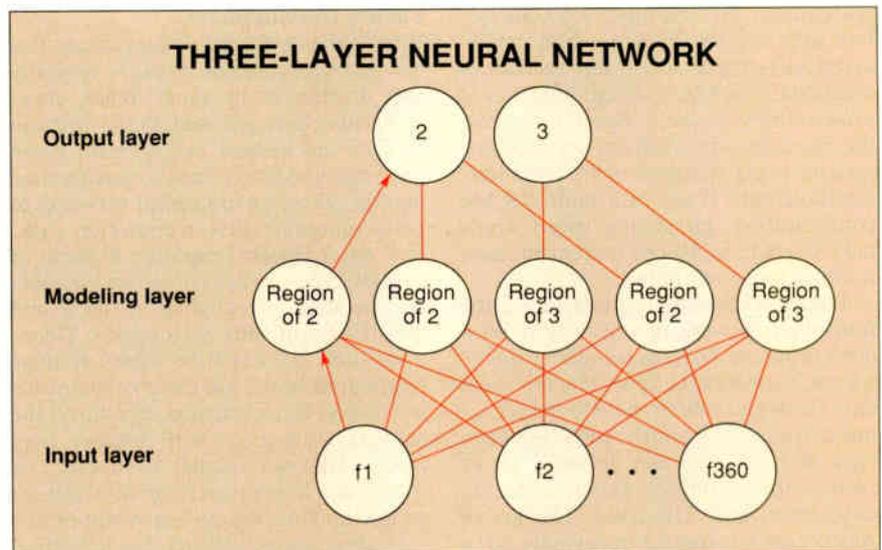
Feature extraction and neural network processing are well suited to parallel processing. There are several ways in which parallelism might be exploited. Since the recognition of each character involves running several neural networks at once, one approach would be to dedicate a processor to each network. However, Nestor has achieved the best results by assigning all processing for each character—both feature extraction and the execution of multiple neural networks—to individual processors in a multiprocessor system.

The NestorReader takes advantage of the flexibility and excellent price/performance characteristics of transputers, which are high-speed, independent microprocessors designed and manufactured by Inmos, a subsidiary of SGS-Thomson Microelectronics. Multiple transputer modules (TRAMs), each with its own memory and communications links, plug into add-in boards that are available for AT, VME, Micro Channel, and other buses. NestorReader, hosted on a PC, recognizes about 10 characters

**T**he system runs several networks simultaneously.

cells. There will be many second-layer cells for class 2; if any of these fires, so does the output cell for class 2.

Can more than one output-layer cell fire? Yes. Given a 2, the network might think it recognizes both a 2 and a 3. In that case, the network is said to be confused, and a higher level of arbitration comes into play. The system typically runs several networks simultaneously. Each starts with a different basic representation: One may begin with the raw bit



**Figure 2:** A feature vector enters the network at layer 1. Many-to-many connections between layers 1 and 2, governed by weights that correspond to spheres of influence in feature space, enable the network to model character-class boundaries during training and to classify feature vectors during execution. Many-to-one connections between layers 2 and 3 map cell activations to character classes.

# Recognizing Script

Jane Morrill Tazelaar

**S**cript recognition is still a long way off, right? Wrong! But handwriting recognition today just means reading hand-printed block letters, doesn't it? This may be true of most U.S. entries in the handwriting-recognition arena, but a small company in the U.S.S.R.—that's right, Russia—has a program that is reading script now. The program works; I have seen it, and it read *my* script, not just the company's test case.

The Moscow-based company is ParaGraph, and the product is CalliGraph, a graphics-tablet-based handwriting-recognition program. CalliGraph works by dissecting your handwriting into component parts: the loops and curves, their angles and sequence. It's really quite ingenious. I saw examples of the angular arcs and lines, and they don't look like

letters, or anything else for that matter. They're just bits and pieces.

These bits and pieces of letters, as well as the overall appearance of the whole letters, are then compared to many different variations of similarly dissected letters to determine the letters you have written. Then the combined letters are looked up in a word list to see if they make up a valid word. As long as the word list is inclusive enough, the odds are good that CalliGraph will recognize what you wrote.

Admittedly, on the particular graphics tablet that I used, I had to write a bit larger than my normal script, but the program had no problem recognizing the first word I wrote, and it did so pretty quickly. The second word was more of a problem, but it turned out that the word just wasn't in the particular

word list that ParaGraph was using at the demonstration.

Pen-based computing has become a buzzword of late in the computer industry. With it come visions of taking notes in raw script and automatically entering them into your computer. The reality in most cases is that pen-based computing is working, but primitively, with block letters and fill-in boxes. ParaGraph has come up with a new twist: handwriting recognition that actually recognizes your *writing*—a glimpse of things to come.

You can contact ParaGraph on BIX through its general director, Stepan Pachikov, as "spachikov."

*Jane Morrill Tazelaar is BYTE's senior editor for the State of the Art section. You can reach her on BIX as "janetaz."*

per second per TRAM.

The transputer-based architecture offers two distinct benefits. First, it provides you with modular, incremental performance options to meet specific requirements. For example, a 60-cps system requires six TRAMs. You can license software to access any number of additional TRAMs; recognition speed grows almost linearly. Second, because the modules are identical, recognition systems using transputers are inherently fault-tolerant. Thus, in a multi-TRAM configuration, processing speed would only degrade in 10-cps increments as a result of processor failure.

The NestorReader user interface to the transputer network is a Microsoft Windows program. Given a scanned image of a form, you mark the zones that represent data fields and submit these to the recognition system for identification. For each type of form, you can define a set of zones—for example, name, address, city, state, and ZIP code. The set of zones can be applied repeatedly to a batch of stored images as long as all the images represent the same type of form. The transputer network separates the contents of each zone into images of characters and then identifies the characters by means of the neural network tech-

nique described earlier. To assist post-process editing, the system can report confidence levels and alternate choices in order of confidence.

## Future Developments

What's the next step? Organizations that handle large volumes of paper typically sort documents by type. When documents have been scanned, the sorting can be semi-mechanical: An operator views an image and then enters a classification number. Why not use neural networks to fully automate this recognition task, too? After repeated exposure to forms of various types, a neural network system will be able to recognize patterns and classify documents accordingly. Documents and faxes will be routed to their destination faster and more economically. Thanks to its learning capability, the network's accuracy will improve over time. Unknown images need only be routed to a human operator who will interactively train the system in real time.

Once a neural network has identified an image, the main task becomes finding the information on the document. Content must be separated from background, a process called *forms subtraction*. In addition to making the characters available for recognition, forms subtraction re-

duces the image size for subsequent storage. For instance, it would be inefficient for the IRS to store millions of tax forms on optical disk when only the content of the forms matters.

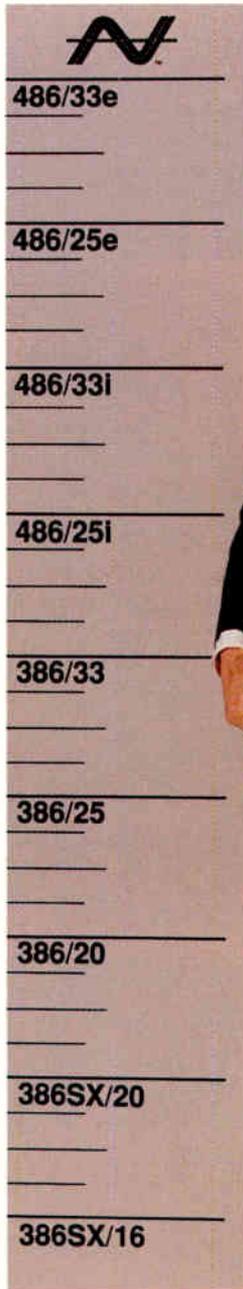
Form backgrounds (templates) can be stored once and merged with content upon retrieval. However, you can't just subtract an image of a blank form from an image of a document. Much of the form's content might be lost in cases where characters overlap background elements. Furthermore, forms are often printed with slight variations. To determine what is data and what is background (so that the correct character images will be used for recognition), you need an intelligent system.

Nestor is now developing neural network tools to solve these field- and form-level recognition problems. In concert with the character-level recognition system described here, Nestor hopes to show that neural networks can help bring the long-anticipated paperless office closer to practical reality. ■

*David P. Wright is director of sales and marketing for, and Christopher L. Scofield is vice president of, Nestor Applied Systems. They can be contacted on BIX c/o "editors."*

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From our spectacular SlimLine 386SX to our our powerful Elegance 486™ file servers, Northgate backs them all with quality in every respect.

Industry's highest performing systems. In an industry overflowing with companies all claiming top performance, only one company is consistently ahead of the pack: Northgate. Since January of 1989 when our first *PC Magazine* Editor's

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Northgate 386 ... computing's most decorated line. Northgate's rise to the pinnacle of 386 technology started in 1988 when *Computer Shopper* readers voted Northgate's 386 Power System both a "Best Buy" and Overall Best Buy. A few months later, *PC Magazine* named Northgate 386/20 and 386/25 "Editors' Choice." Later that year, our 386/33 received the same honor. Along the way, our 386 systems won several *InfoWorld* recognitions as well.

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Often copied, never duplicated! It seems like everyone has jumped on the SlimLine bandwagon these days. Truth is, Northgate pioneered this incredible technology. We were the first to introduce full power 386 systems in a case measuring only 4.25" high.

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Perfect single-user workstation or network terminal. SlimLine is ideal for use where you need full-size 386 power, but space is a premium.

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## Northgate Elegance™: Full-size 386 power and expandability.

The business systems of choice. Elegance's award-winning reputation has made them the choice of Fortune 1000 corporations, government agencies and universities around the world. And with good reason.

Elegance full-size systems are designed to allow you to easily expand your system as your business needs increase. You only pay for the components you need now.

Power for every application. From "simple" tasks like word processing and desktop publishing to advanced CAD/CAE and database management applications, Elegance delivers. To find out what systems are right for you, see next page for system configurations and upgrade options.

## Northgate wins 1990 Micro-computer Marketing Council's Service and Support Award!

- 30-day no-risk trial period
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- Northgate responds to your needs with overnight shipment of parts—at our expense!
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\*PC Magazine, September 25, 1990

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*PC Magazine* then reviewed 486/25 ISA systems. "Only one machine stands out," they said, "you could pay less for a 486 system, but not get the bonuses that are offered with the Elegance"††

Elegance 486/25L Sept. 11, 1990  
Elegance 486/33L Feb. 12, 1991



*Computer Shopper* readers agree! Elegance 486/25i breezed past the competition and captured a 1990 "Best Buy" award. This makes three years in a row a Northgate Elegance system was voted tops

by *Computer Shopper* readers.

Elegance 486/33 ISA makes it a clean sweep! The February 12, 1991 issue of *PC Magazine* declared Elegance 486/33 Editors' Choice saying the system was "a sure winner in its class." They made special note of Northgate's "clear documentation, excellent service policies, top name components and fine performance"

### ISA 486 System Features:

- ◆ Intel 486/25 or 33 MHz processor
- ◆ 4Mb RAM; expandable to 8Mb on motherboard
- ◆ 200Mb IDE hard drive
- ◆ 1.2Mb and 1.44Mb floppy drives
- ◆ 64K SRAM read/write-back cache
- ◆ ISA bus
- ◆ One 32-bit, six 16-bit and one 8-bit slots
- ◆ One parallel and two serial ports
- ◆ Vertical "Power" case (desktop available)
- ◆ 16-bit VGA graphics adaptor with 512K video RAM (expandable to 1Mb)
- ◆ 14" SVGA color monitor
- ◆ OmniKey®/ULTRA keyboard
- ◆ MS-DOS 4.01 or 3.3 and GW-BASIC software installed
- ◆ Microsoft® Windows™ 3.0 and mouse
- ◆ FCC Class B Certified

**\$539900** / **\$629900**  
25 MHz / 33 MHz



## 486 EISA gives you full 32-bit performance!

Performance that rivals RISC-based minicomputers costing thousands more! New 32-bit EISA bus gives you the power to transfer data along your network at burst mode speeds up to 33 megabytes per second. That's a 15-fold improvement over 16-bit AT buses serving medium-to-large networks.

Complete compatibility! Elegance 486e is 100% compatible with UNIX, Novell® and DOS. Plus, Elegance is compatible with existing 8-bit and 16-bit ISA adapters, so you benefit from downward compatibility.

Compare Elegance 486e performance and Northgate service and support with any other vendor's in the industry. You'll find you can't buy better than Northgate! Call now ... let Northgate build your system today!

### True EISA 486 System Features:

- ◆ Intel 486/25 or 33 MHz processor
- ◆ 4Mb RAM; expandable to 32Mb on motherboard
- ◆ 1Mb EISA caching SCSI controller
- ◆ 200Mb SCSI hard disk
- ◆ 1.2Mb and 1.44Mb floppy drives
- ◆ 128K SRAM read/write-back cache
- ◆ EISA bus
- ◆ Eight 32-bit EISA slots; six bus master and two slave
- ◆ One parallel and two serial ports
- ◆ 16-bit VGA graphics adaptor with 512K video RAM (expandable to 1Mb)
- ◆ 14" SVGA monochrome monitor
- ◆ Vertical "Power" case
- ◆ 300 watt power supply
- ◆ OmniKey®/ULTRA keyboard
- ◆ MS-DOS 4.01 or 3.3 and GW-BASIC software installed
- ◆ Microsoft mouse
- ◆ 25 MHz FCC Class B Certified
- ◆ 33 MHz FCC Class A)

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- ◆ Northgate's unique 24-hour toll-free technical support leads the industry — most needs are met with just one call!
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## BYTE ACTION SUMMARY

- **OCR**
- **WHAT YOU'LL LIKE**  
OCR translates hard-copy text into a data file. Most OCR software can generate output directly in word processor formats, often preserving attributes such as font changes and boldfacing.
- **WHAT YOU'LL DISLIKE**  
OCR may not save you time. Even the best packages fall short of perfect recognition.
- **WHAT WE RECOMMEND**  
If your workload justifies a dedicated system, we recommend the Kurzweil K5200. It comes closest to what OCR should be, although it costs a bundle. If your needs are less demanding, choose Calera's WordScan Plus for PCs. It's fast, accurate, and dependable. For Macintosh users, our pick is OmniPage Mac (until the Professional version ships, we suggest you purchase OmniTrain to add trainability to the product).

Mac- and Windows-based software needs scads of RAM—4 or 5 megabytes is a practical minimum. As for scanners, a flatbed scanner with an automatic document feeder (ADF) is highly recommended for serious work.

As an alternative to software-only OCR, consider the hardware-assisted packages. Calera's CDP 9000 is a stand-alone box with a sheet-fed scanner and SCSI, RS-232, and Ethernet ports. The Kurzweil K5200 is a sheet-fed (or single-sheet) scanner and RISC-based processing box. Caere's hardware solution, the Parallel Reader, uses one of three standard scanners driven by a multiprocessor PC. By optimizing the processing power for OCR, these units achieve the fastest recognition with a high degree of accuracy. The downside is price: Hardware solutions typically run \$10,000 or more, enough to discourage casual users.

### Beyond Training

All the OCR programs in this Product Focus claim to be *omnifont*. This means that they can recognize most nonstylized fonts without having to maintain huge dictionaries of specific font information. We chose to focus on omnifont products because of their flexibility in automatically recognizing a variety of fonts. However, a number of trainable packages

# PRODUCT FOCUS

## OCR FEATURES SUMMARY

Prices, platforms, and proofing tools distinguish OCR hardware and software (● = yes; ○ = no).

Product	Caere OmniPage 386 3.0	Caere OmniPage Professional 1.0	Caere OmniPage Mac 2.12	Caere Parallel Reader 1.0	Calera CDP 9000	Calera WordScan Plus 1.0
Platform	PC	PC	Mac	PC	PC, Mac	PC
Price	\$695	\$995	\$695	\$10,995	\$21,950; \$31,950	\$995
Minimum configuration						
RAM	4 MB	4 MB	4 MB	Hardware and software supplied (except for mouse, VGA display, and keyboard)	2 MB	2 MB
Hard disk space	8 MB	8 MB	4 MB		5 MB	6 MB
Other software	Windows 3.0	Windows 3.0	System 4.2-6.0.4 Finder 5.0-6.1.4 Mac II or Mac SE with accelerator card		Windows 3.0 Mac or Sun Unix 286 or 386, mouse Mac II	Windows 3.0
Other hardware	386, mouse	386, mouse				286 386 recommended with mouse
Trainable	○	●	○	●	●	○
Omnifont	●	●	●	●	●	●
Lexical recognition	○	○	○	○	●	●
Smallest readable point size (300 dpi)	6	6	6	6	6	6
Largest readable point size (300 dpi)	72	72	72	72	28	28
Graphic preview	●	●	●	●	●	●
Landscape	●	●	●	●	●	●
Foreign language dictionaries	●	●	●	●	●	●
Deferred processing	○	●	○	●	●	●
Multiple jobs with automatic data feeder	●	●	●	●	●	●
Templates	●	●	○	○	●	●
Automatically parse text and graphics	●	●	●	●	●	●
Reorder text blocks	●	●	●	●	●	●
Decolumnize text	●	●	●	●	●	●
Numeric recognition	●	●	●	●	●	●
Learn ligatures	○	●	○	○	●	○
Dot-matrix support	○ <sup>3</sup>	●	○ <sup>3</sup>	●	●	●
Support for fax files	●	●	○	○	●	●
Retain format						
Type style (bold, italic, etc.)	●	●	●	●	●	●
Indents	●	●	●	●	●	●
Justification	●	●	●	●	●	●
Centering	●	●	●	●	●	●
Columns	●	●	●	●	●	●
Tables	●	●	●	●	●	●
Output formats						
WordPerfect	●	●	●	●	●	●
Microsoft Word	●	●	●	●	●	●
Rich Text Format (RTF)	●	●	●	●	●	●
XyWrite	●	●	○	●	●	●
WordStar	●	●	○	●	●	●
dBASE (.DBF)	●	●	○	○	○	○
Lotus 1-2-3 (.wk1)	●	●	○	○	○	○
Excel	●	●	●	○	●	●
Proofing tools						
Built-in editor	●	●	●	●	●	●
Search and replace	●	●	●	●	●	●
Spelling checking	○ <sup>4</sup>	○	○ <sup>4</sup>	●	●	●
Query on questionable characters	●	●	●	●	●	●

<sup>1</sup> AccuScan requires Scanning Gallery Plus 5.0, which costs \$595.

<sup>2</sup> Requires Image-In Scan/Paint (\$149).

<sup>3</sup> Yes with OmniDraft.

<sup>4</sup> Yes with OmniSpell.

are available, often at lower prices than their omnifont counterparts.

The earliest OCR packages were strictly trainable. Before trainable packages can recognize text, you must teach them each character of a particular font. You have to scan a document, preview the scanned bit map of each character, and identify the character for the program. The program builds a database that assigns each image to its correspond-

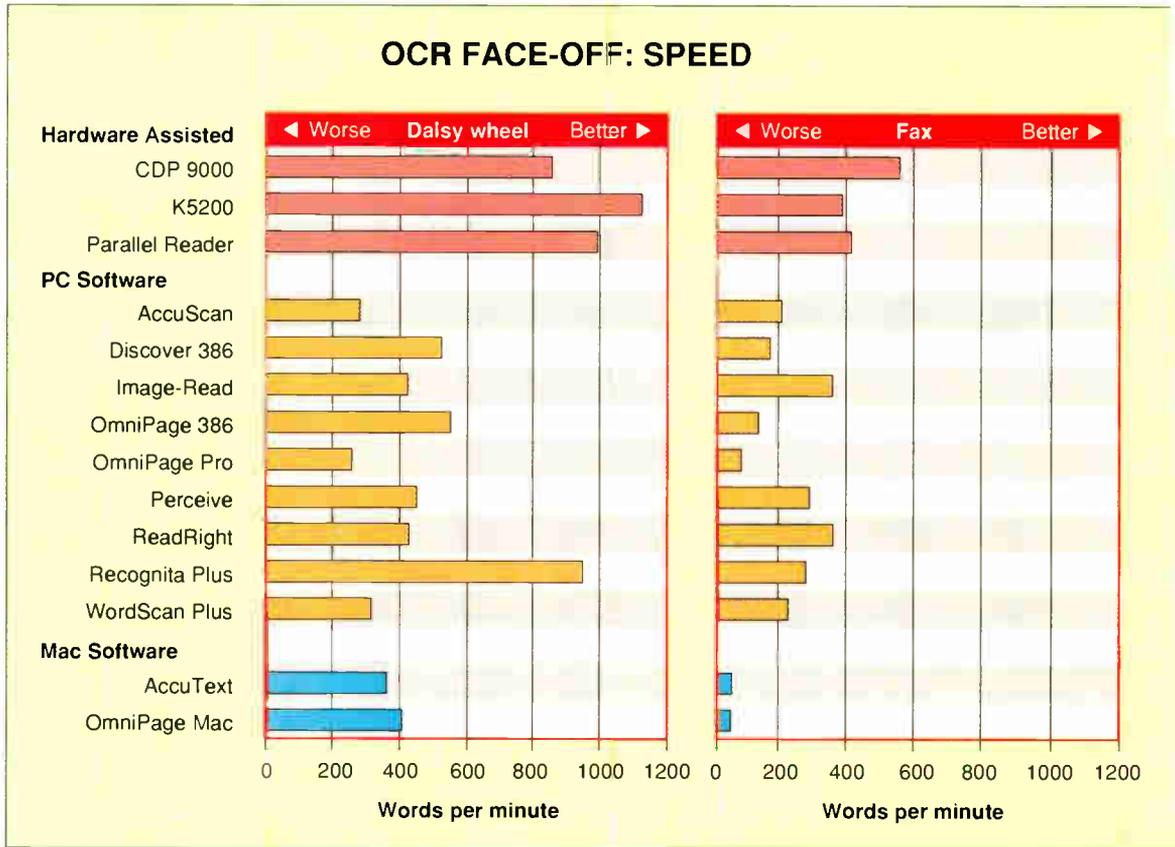
ing ASCII character. On the next pass, the program compares the scanned image of every character with the stored images in its database. If the program finds a reasonable match, it returns the ASCII character assigned to the matched image. This process can be very tedious and time-consuming. It also requires gobs of disk space to hold the font dictionaries that are created.

Omnifont technology changes all that.

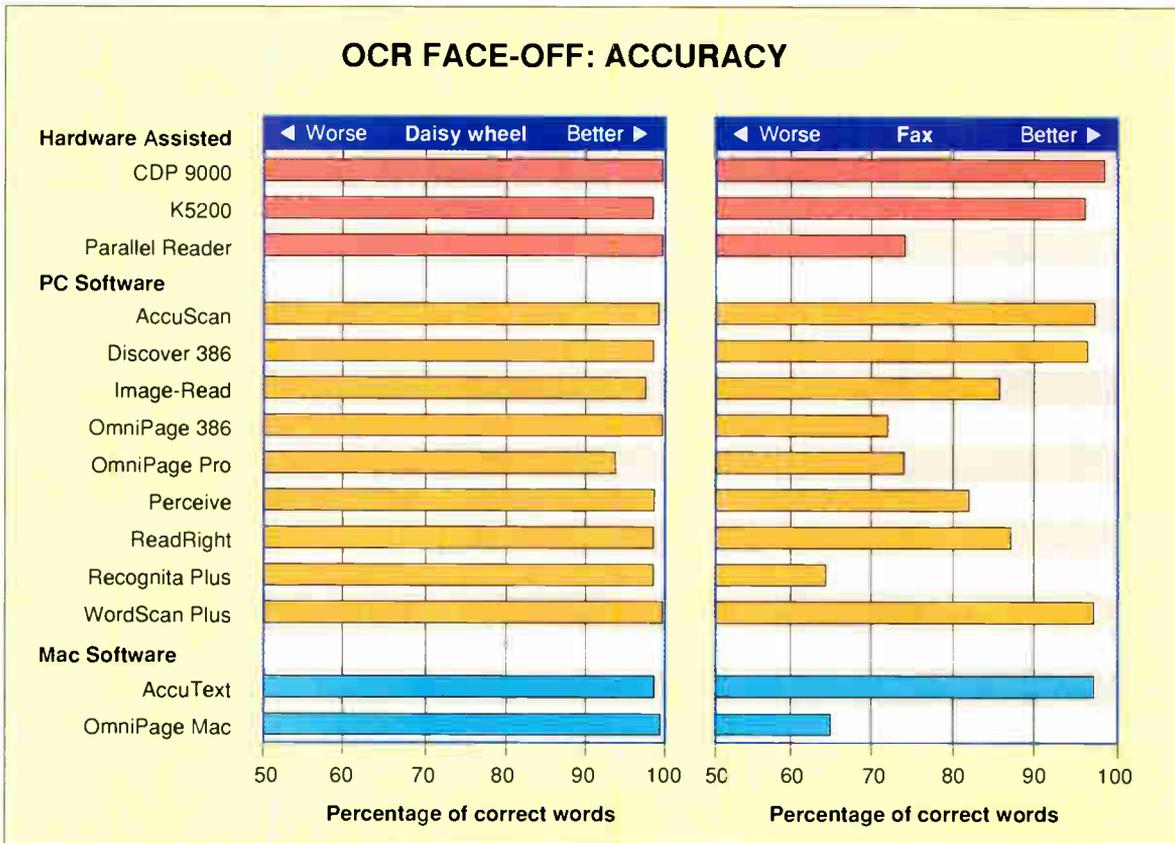
It uses *feature extraction* to recognize fonts regardless of their size as long as an A looks remotely like an A. An omnifont product contains a database of shapes (e.g., lines and circles). The OCR package breaks a character down into its component parts and does not have to contain information on many different fonts. It can recognize a letter by its unique combination of shapes. Theoretically, an omnifont package can understand any char-



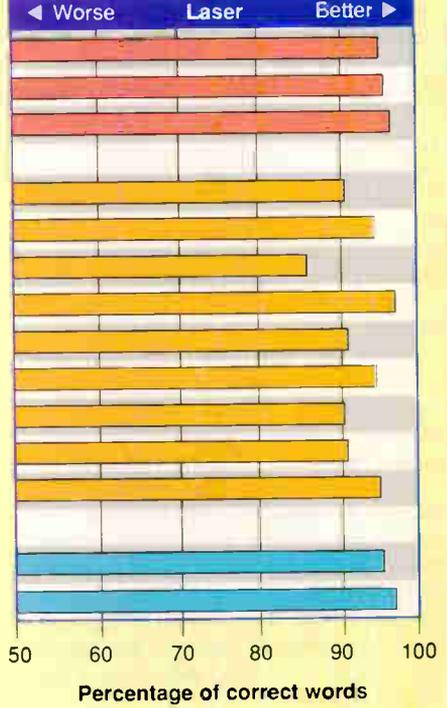
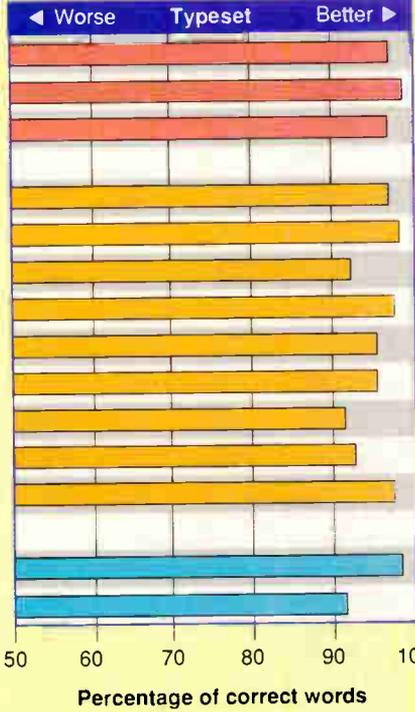
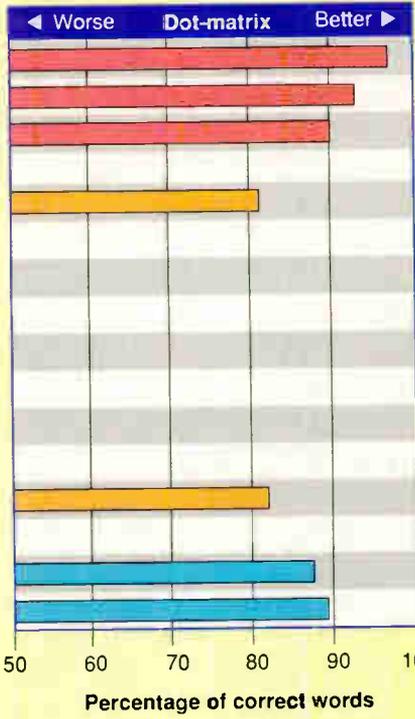
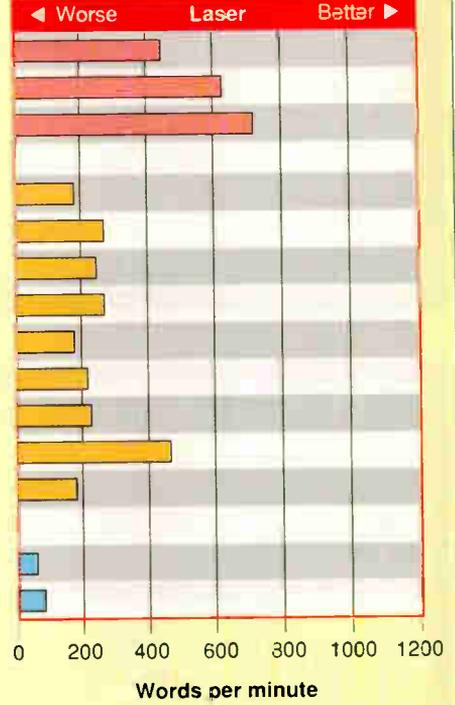
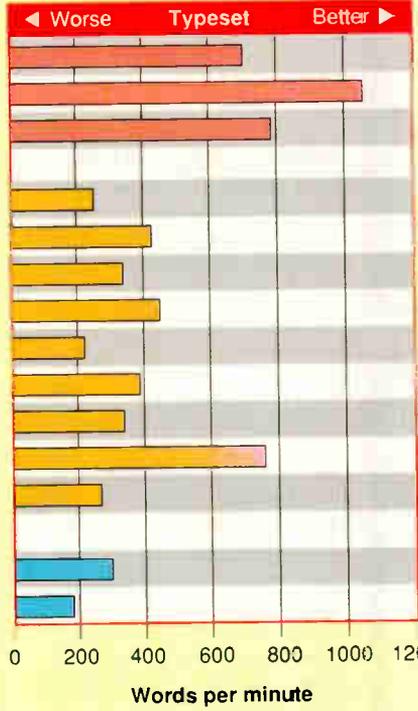
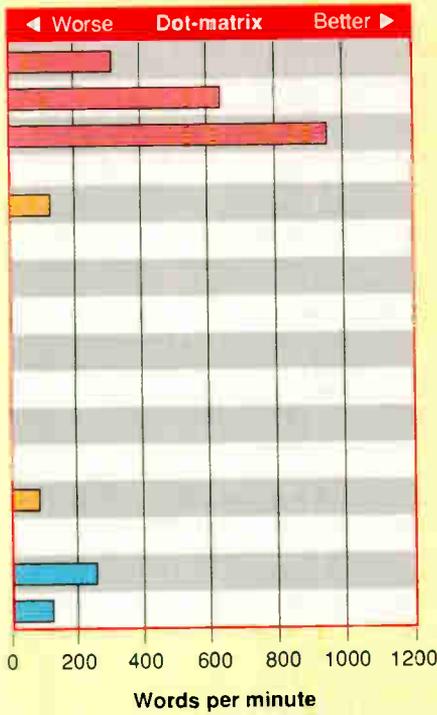
**Figure 1:** As this chart shows, the high-end, hardware-assisted OCR products dominated our word-per-minute speed tests. We used five different types of test documents, and to ensure a fair sampling, we made each document at least nine pages long. (See the text box "How to Recognize a Good OCR Package" for an explanation of the test.)

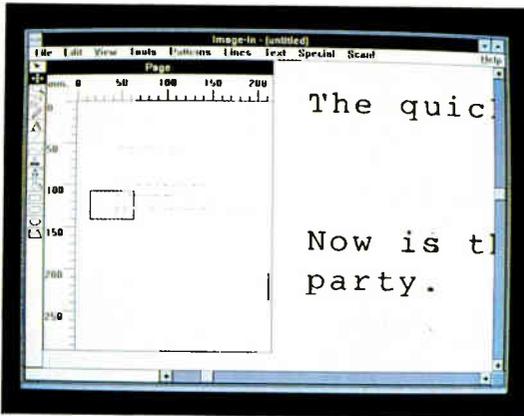


**Figure 2:** Based on data derived from a custom software program developed by the BYTE Lab, this graph shows how accurately each OCR tool recognized our five test documents. If a program failed to sufficiently recognize a document, it received no score for that test. (See the text box "How to Recognize a Good OCR Package" for test details.)

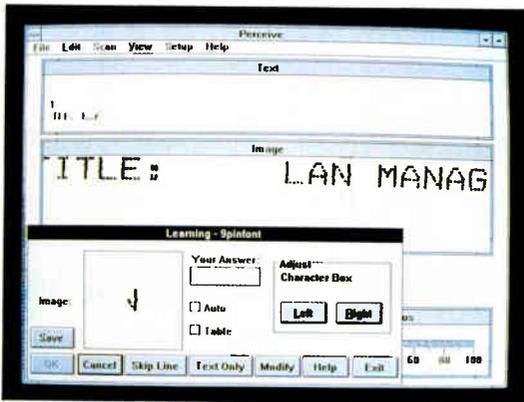


**PRODUCT FOCUS**





**Screen 1:** A typical broken character (T) is displayed in Image-Read's zoom window. OCR packages will usually interpret a broken character as a pair of characters.



**Screen 2:** Because dot-matrix characters are made up of a series of dots, many OCR packages detect the individual dots and interpret them as dashes, periods, or apostrophes. Sometimes, as shown here, only part of a character is read. Perceive's learning facility includes a Character Box, which you can adjust to account for misreads.

Again, this can remove much of the tedium and baby-sitting from the process.

Templates can simplify the OCR process by letting you specify particular areas to be recognized. You can then use the template for every page that follows the same structure. Good OCR packages can automatically create templates and even recognize which zones contain text and which contain graphics. You can also limit zones to the type of entry you desire (i.e., numeric, alphanumeric, or user-defined). This is particularly useful if you are processing spreadsheets or other documents that contain only numerical entries.

When you deal with formatted text, you'll need some special features to ease the conversion process. Make sure the package you choose supports your favorite word processor. Then you can pull the document into your word processor and retain any formatting information. You should also be able to *decolumize* text, that is, convert multiple columns into a single-column file. You'll need this capability if you want to load documents into a text-retrieval package. You should also be able to reorder text zones in any way you specify.

In the context of OCR, *spelling check-*

*ing* enables the software to use a dictionary during the recognition process. The software may run across a letter that could be recognized as either one of two letters. Software without spelling checking will simply make a guess. With a spelling checker, the OCR software will first consult the dictionary to see if either of the spellings constitutes a real word. With the dictionary as tiebreaker, conversion is usually more accurate.

### Get the Recognition You Deserve

The accuracy of an OCR program often depends on how well it can handle special characters and flawed documents. A degraded copy of a document can befuddle the best OCR algorithms. If your scanner hardware supports it, all these programs allow you to adjust the brightness of the scanned image to improve legibility. The biggest pitfall of degraded documents is broken characters (see screen 1). Many times, an OCR program will read a broken character as two distinct characters. Ocron's Perceive handles the problem creatively by placing ambiguous characters within a box. You can then expand this box right or left to cover more of a character's image. By boxing an entire broken character, you

can teach the program to recognize it as a single character.

OCR programs might also have trouble recognizing dot-matrix characters. Since these characters are made up of a series of dots (see screen 2), some OCR packages recognize each dot as a character, usually interpreting the dots as apostrophes, periods, and commas. Many of the programs include special algorithms to recognize dot-matrix characters. For the most part, the programs "connect the dots" to create distinct characters that they can then recognize in the conventional way.

A font's distinctive characteristics, especially *ligatures*, can really cause trouble. Ligatures consist of two or more characters that are joined together. An unsuspecting OCR package will scan the ligature as a single, unfamiliar character. A good omnifont package will recognize the ligature and treat it as its component characters. Most any trainable package can learn to treat a compound character as a multicharacter string.

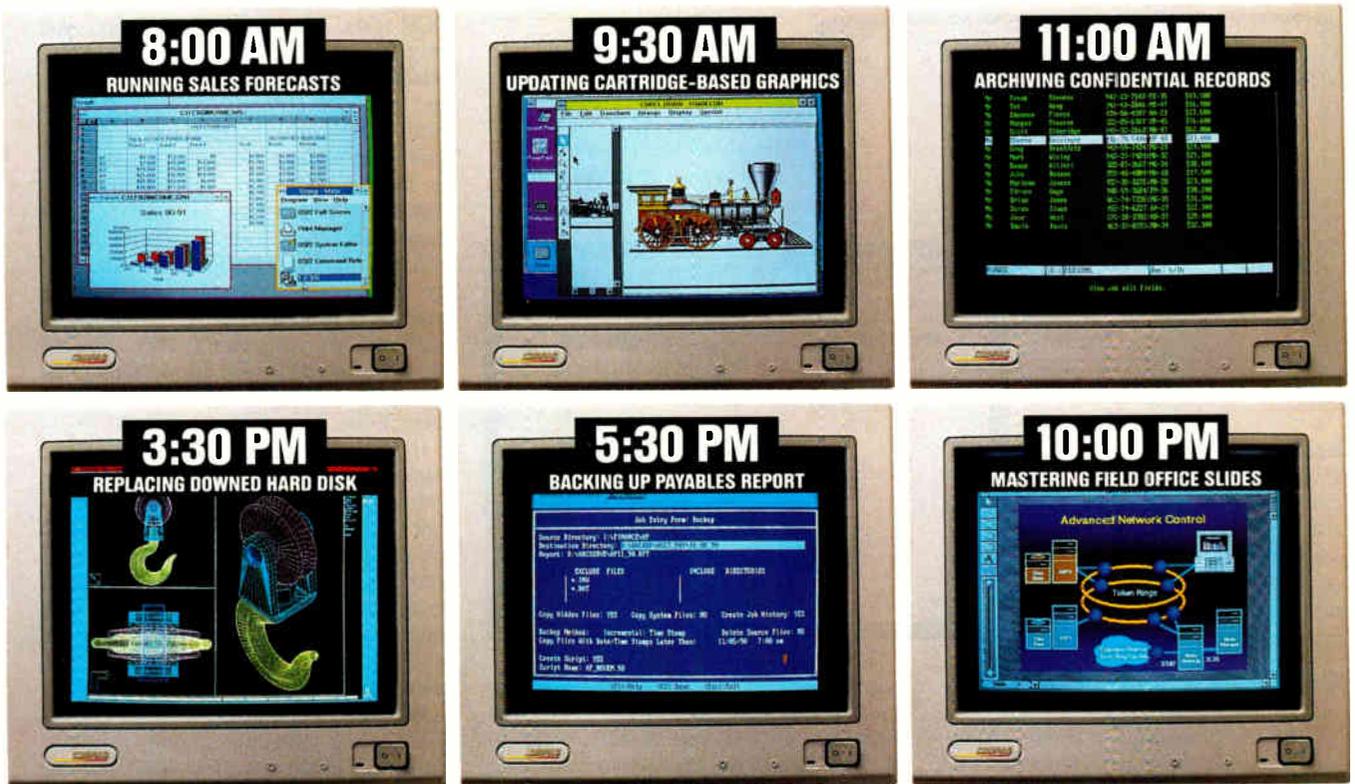
Other stylistic pitfalls include underlined, italic, boldface, and outlined type. We found that underlines caused the biggest problem. Many of the packages interpreted an underlined word as a single character. On the other hand, a good omnifont algorithm can distinguish boldface, italic, and even outlined characters. Since omnifont capability breaks these specialized characters into component parts, style changes are less of a problem. OmniPage handled stylized characters particularly well.

OCR programs also let you clean up an image by erasing designated areas. You remove stray marks and handwritten notes that can confuse the program.

We looked at 14 omnifont OCR tools for the PC and Mac. The text box "How to Recognize a Good OCR Package" on page 230 describes in detail how we tested each product. Benchmark results charting speed and accuracy appear in figures 1 and 2 on pages 224 and 225. See the "OCR Features" table on page 222 for a summary of specifications, including prices and platform support. The text box "A Simple Equation for Choosing OCR" on page 236 summarizes the important considerations to keep in mind as you begin your own evaluations. And because nothing beats long-term, real-life experience, we interviewed executives directly responsible for implementing OCR in a variety of companies, large and small. Their problems, solutions, and advice to OCR newcomers appear in "Voices of Experience," beginning on page 239.

*continued*

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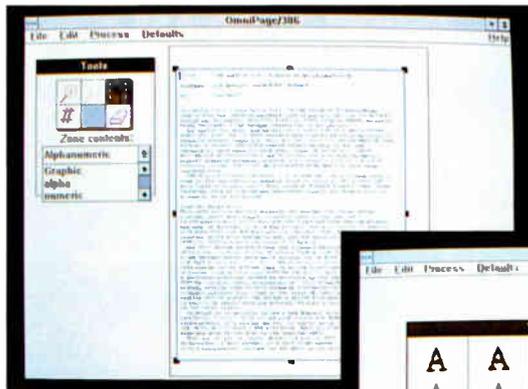
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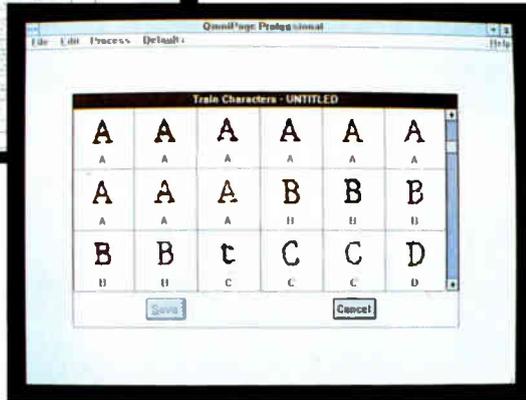
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**Screen 3:** *OmniPage 386 makes it easy to restrict a zone's contents. After designating the zone, you simply choose the zone's type to restrict its contents.*

**Screen 4:** *OmniPage Professional includes the OmniTrain module, which can store many representations of the same character. This can help you process degraded documents.*



**OmniPage**

The three versions of Caere's OmniPage we looked at share the same basic interface and functionality. OmniPage 386 3.0, which runs under Windows 3.0, and OmniPage Mac 2.12 both perform basic OCR chores and sell for \$695 each. To beef up either program, you can add enhancement modules: OmniSpell for spelling checking, OmniDraft for dot-matrix recognition, OmniProof for comparing two versions of the

same file, and OmniTrain for teaching specialized fonts and symbols. The modules fit seamlessly into the OmniPage interface. OmniPage Professional 1.0 (also Windows 3.0-based) delivers all these goodies in one package for \$995. We found that OmniPage Professional performs considerably slower than unenhanced OmniPage, but this is because the full package is doing more work, including a full spelling-checking session once the document has been read.

Using OmniPage is about as easy as

OCR gets. For most documents, you only need to load your scanner's ADF, select "Scan" from a pull-down menu, and watch OmniPage go to work. Caere's omnifont algorithms effectively discern most text without the need for training or, for that matter, any manual intervention. If you do have special needs, OmniPage also offers impressive flexibility. You can manually define zones and easily restrict a zone's output to numeric characters or to any group of characters you specify (see screen 3). You can also reorder scanned zones, but we found that this was rarely necessary after automatic recognition.

If that's not enough, OmniPage Professional (or OmniPage with the OmniTrain module installed) combines omnifont capability with manual training, so you can maintain dictionaries of specialized characters (see screen 4). For most documents, you need not bother with training sessions. For example, while the other packages we tested couldn't handle underlining, OmniPage had no trouble.

We were disappointed with OmniDraft. Even with this add-on installed, OmniPage could not effectively read our dot-matrix document. Admittedly, nine-pin dot-matrix output is a real challenge, but other packages could do the job when OmniPage/OmniDraft could not. Similarly, OmniPage did not handle our fax document very well. Apart from these shortcomings, OmniPage Professional delivers the basic tools necessary for most professional OCR applications.



**Photo 1:** *The Parallel Reader, which packs four 68020 processors working in parallel, supports the Hewlett-Packard ScanJet Plus (shown at left with optional document feeder), the Microtek MS-II (right), and the Fujitsu 3093 (not shown).*

**Parallel Reader 1.0**

Caere's Parallel Reader is based on the same recognition technology as OmniPage, but it doesn't rely on your computer's processor for muscle (see photo 1). Rather, Caere put four 16-MHz

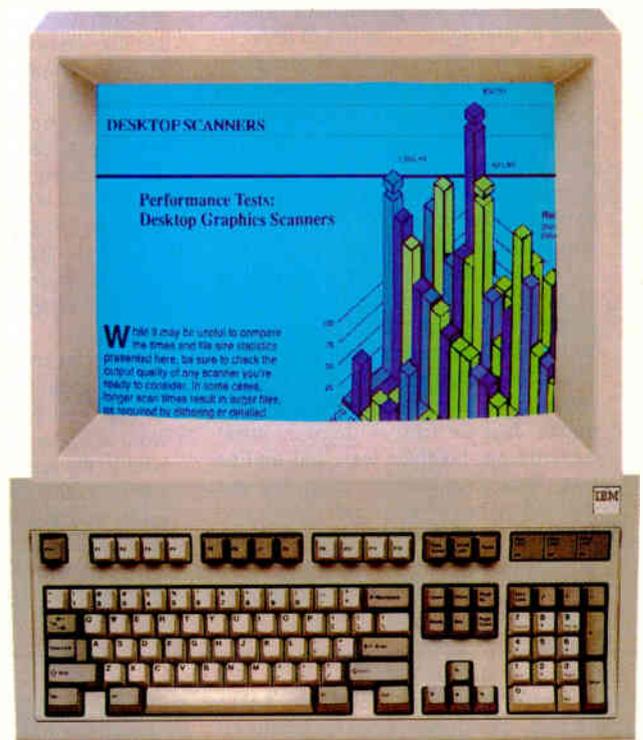
68020 processors into a standard 386SX clone. The 386SX runs the user interface and drives the scanner; the 68020s take turns recognizing pages. On start-up, the Parallel Reader software downloads the recognition code into each 68020. From that point on, the 68020s function as in-

dependent OCR coprocessors, taking scanned pages as input and returning final text as output. You have to pay for this extra power, however; the Parallel Reader sells for \$10,995.

Before installing the Parallel Reader software (PREAD.EXE), you need to install your scanner. The Parallel Reader supports three scanners: the Hewlett-Packard ScanJet Plus with ADF, the Microtek MS-II, and the Fujitsu 3093. You install the scanner interface and software and then choose the correct driver from PREAD's menu. From that point, all three scanners work similarly. We tried both the ScanJet Plus and the MS-II but had better luck with the ScanJet. The MS-II's sheet feeder didn't like the variety of standard copier and typing paper we used. The rough surface on some of the paper caused sheets to stick together, jamming the scanner. The ScanJet Plus worked flawlessly even with fax paper.

PREAD runs under Windows 2.x. We ran it successfully under Windows 2.11,

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# How to Recognize a Good OCR Package

**R**ecognizing a good OCR package is fairly easy once you get it running. It should do a good job of scanning different types of documents (at least the types you're likely to bump into) and do the job as quickly as possible. With that in mind, we challenged the products in this review to a fairly robust series of tests.

We took a 10-page ASCII document and printed it out both on a daisy-wheel printer at 10 characters per inch and on an IBM Proprinter (nine-pin dot-matrix) at 10 cpi. Next we faxed ourselves a copy of the daisy-wheel printed document at 200 dots per inch (i.e., fine resolution) to get a fax sample.

Our next test document was a series of internal BYTE memos that were printed at 300 dpi on an Apple LaserWriter. This document used a variety of typefaces and sizes: Times Roman and Helvetica in sizes ranging from 6 to 24 points. Just for fun we threw in some underlining, boldface text, and outline text. This gave us nine pages for our mixed-font laser output test.

Finally, we went to the Peterborough Town Library and checked out a book printed in a neatly typeset font. The text

was formatted in a single column with a heading at the top of each page and page numbers and footnotes. Ten pages of this became our Typeset test.

If you have been keeping score, that gives us 49 pages of text for each of the 14 products tested. Rather than reading through 686 pages of text for errors, we got the computer to do it for us. We wrote a custom program that compares the original ASCII file to the scanned version, skipping over any stray characters, blank lines, and formatting errors. The software is smart enough to understand when a line of text is missing and resynchronize itself as needed. As it checks the files, the program creates a log file showing each error as it occurred, the error count, and the overall accuracy.

To count errors, we treated a text line as a single unit and compared each word in that line to the original. For each word in the original file that did not appear in the scanned copy, we added one error. At the end of the document, we subtracted the number of errors from the total word count and then divided by the total word count to get the accuracy:  $\text{accuracy} = 100 \times (\text{word count} -$

errors) / word count.

The time it took to scan each group of pages gave us the throughput in words per minute. Because we used the "accurate" word count here, we automatically penalized any product for scanning errors in the process. The graph in figure 1 shows our results in wpm (words per minute); figure 2 charts overall accuracy. Our approach varies a bit from that of most vendors who define accuracy as the number of *characters* correct, not words. Most people will use spelling checkers to correct the mis-scans, and because spelling checkers correct *words*, we thought that word errors would be more meaningful. The average word is about six characters long, so that would mean that one of our errors is about the same as six of theirs. For that reason, our numbers won't exactly match those in the vendors' ads.

When interpreting the graphs, keep in mind that accuracy is probably more important than speed. The purpose of OCR is to enter text accurately. While one product may be faster than another, if you have to spend a great deal of time correcting mistakes, the process could be slower than if you typed the text.

## CDP 9000 and TopScan Professional 1.1

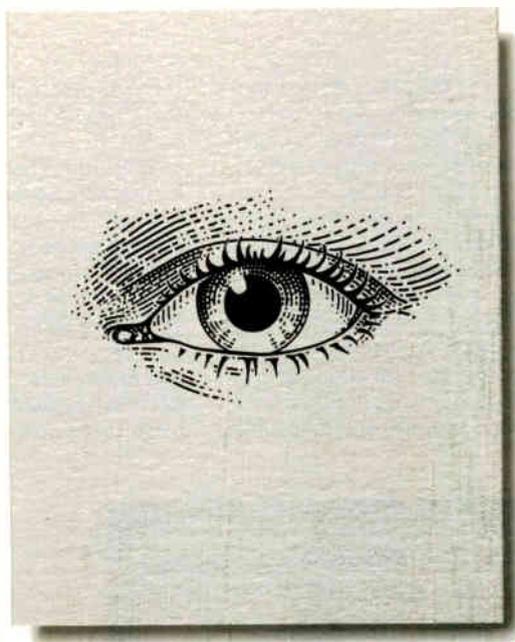
**C**alera has been into OCR for quite some time. That fact was apparent when we took a close look at the CDP 9000: Most of the hardware is dated 1986. The unit itself just says "heavy duty" (see photo 2). The case is heavy-

**Photo 2:** The Calera CDP 9000 contains both a scanning unit and a boatload of processors. Standard interfaces include SCSI, RS-232, and Ethernet. It's not pretty, but when it comes to recognizing text, this beast is a real beauty.

but it wasn't happy under Windows 3.0 in real mode. The screen updates scattered all over the screen. After the program loads, you simply fill the ADF with printed sheets, select the type of document (i.e., standard or dot-matrix, single- or multiple-column), and let 'er rip.

The 386SX scans in a full page and passes it off to the first available 68020. As soon as the 68020 starts, the 386SX grabs the next page for another processor. The display tracks each processor's progress, and with most text, the pages move through the scanner as fast as it can handle them. Our only problem with the Parallel Reader is that it requires the ADF. It would have been nice to lay a book on the flatbed directly, but PREAD doesn't allow it. Still, it performs OCR well and does it fast (see figure 1).





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gauge steel, and the sheet feeder looks indestructible. In performance, the CDP 9000 is no lightweight either. It easily kept pace with the other top performers, particularly on faxed output.

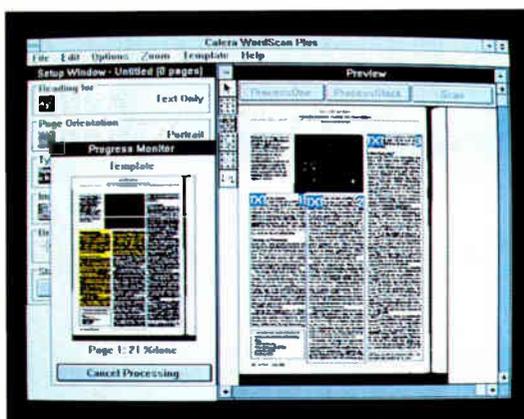
The CDP 9000 connects to a Mac or any PC running Windows 2.x via a Western Digital SCSI card. TopScan Professional, Calera's Windows interface software, controls all operations of the unit through the SCSI connection. Instructions are also included for connecting the CDP 9000 to a Sun workstation through the SCSI port and for communicating

through Ethernet and TCP/IP. We tested the CDP 9000 on a 25-MHz 386 DOS machine.

Whoosh! That's the only way to describe the scanner on this unit. It is sheet-fed only and scarfs up 11-inch pages in about 3 seconds. From there, the unit's internal processors take over. A casual count gave us four 16-MHz 68020s, one 10-MHz 68000, several dedicated support processors, and megabytes of RAM and ROM. After the processors do their job, the finished page and graphic scan move to the host and the next page feeds

into the scanner. The Windows software definitely feels like something out of the 1980s. You use it only to set up the page scans and monitor the OCR progress, but it would be nice to see it running under Windows 3.0.

The CDP 9000 (\$21,950 for the PC; \$31,950 for the Mac) is faster than the software-only products and faster than the Kurzweil and Caere hardware on faxed pages. For large-volume OCR applications, the CDP 9000 seems almost ideal and left us wishing only that it could scan books.



**Screen 5:** Typical of graphical OCR packages, WordScan Plus lets you create templates with just a click and drag of the mouse. During processing, WordScan Plus highlights the regions it has completed.

## WordScan Plus 1.0

Calera's software solution, WordScan Plus, looks nothing like TopScan Professional (the CDP 9000 software). WordScan Plus is a glitzy Windows 3.0 product, complete with all the bells and whistles that you'd expect from a high-end OCR package. To start a

scan, you select the type of text on the page, pick from any predefined templates, and select either preview or automatic mode (see screen 5). In automatic mode, the software just scans each page, recognizes the text, and continues on to the next page.

Preview mode brings up a window with an image of the entire page. Using

the mouse, you select regions of the page in the order you want them recognized. WordScan scans the page and then brings up its Progress Monitor to show you how it's doing.

After the last page, you simply enter a filename. Your file is saved in one of a number of formats, recognized very accurately. WordScan Plus (\$995) consistently beat all the other DOS software products in accuracy, rivaling only the dedicated hardware.

Recognition speed was about in the middle of the pack for DOS/Windows products. There were two other features that appealed to us. The deferred processing mode allows you to scan in a bunch of documents and then run WordScan Plus as a background task under Windows. When you select between portrait and landscape scanning modes, you are given the option of reading the pages upside down. As software-only products go, WordScan Plus's versatility and accurate text scans place it at the head of its class.

## Image-Read 2.0

One criterion for inclusion in this Product Focus was omnifont capability. Unfortunately, omnifont means different things to different vendors. Image-Read from Image-In simply could not effectively read anything we fed it without the benefit of a prior learning session. As a matter of fact, we sometimes couldn't get useful output even after rigorous teaching.

Image-Read is part of Image-In, a modular system that runs under Windows 3.0. To run Image-Read (\$349), you must buy the Image-Scan and -Paint module (\$149). A full package with all the Image-In enhancements lists for \$795.

When Image-Read tried to recognize a document without relying on a learned

font file, the output was often unreadable. The learning facility was easy to use. You define ambiguous letters and numbers by entering the correct character from the keyboard. You can enter up to two characters to accommodate ligatures, and you can build on an existing font file or build a new file consisting of just the new characters learned. You can also access a bit map of an ambiguous character and edit the image so that Image-Read saves the best representation of that character. In fact, the interface and the apparent capabilities are impressive.

Image-Read simply does not do a very good job. All too often, it either fails to read characters or, even worse, reads them incorrectly. It had particular trouble differentiating between lower- and uppercase letters. Processing a multiple-

page document was a nuisance. Most of the other packages automatically build a single file as you feed in one page after another. With Image-Read, you must go through the manual process of setting up a single page each time. You can check an "Append to file" option to add subsequent pages to the original document, but it's still a hassle having to go through the single-page process each time. Image-Read also lacks an integrated text editor.

In the end, Image-Read is not a very usable OCR product. Without learning sessions, it fails miserably. And even after spending an inordinate amount of time teaching it the many characters it misses, you may still be disappointed with the results. If you're looking for a low-end product to perform simple OCR chores, you'd be better off with Read-Right.

*continued*

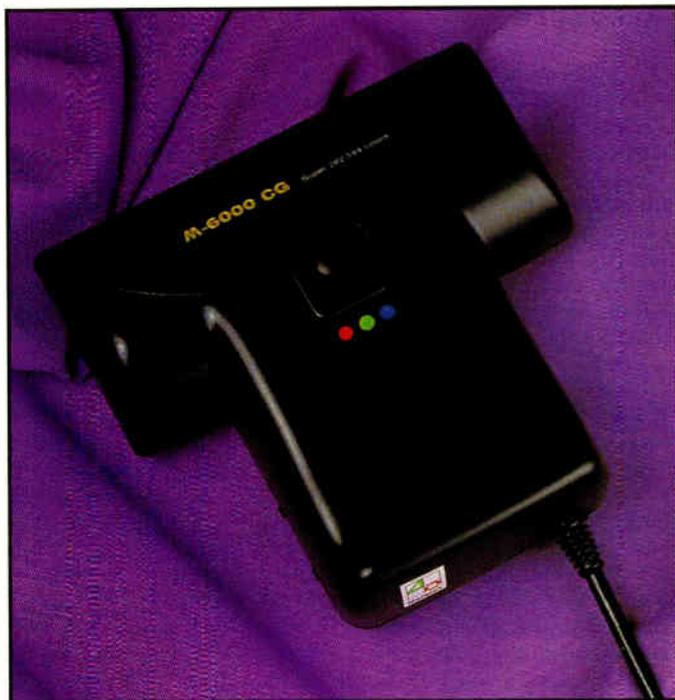
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## AccuScan

**A**ccuScan is a \$595 add-in to Scanning Gallery Plus 5.0, Hewlett-Packard's Windows 3.0 image-handling software for the ScanJet and ScanJet Plus. After you install AccuScan, running Scanning Gallery gives you the choice between text and image processing. We found it easy to run AccuScan without ever cracking open the manual. All the buttons are self-explanatory, and there is context-sensitive help—if you get

confused, select the help function and click on the button you don't understand. AccuScan brings up a clear explanation of the function.

When you're scanning, you have the option of manually selecting text blocks, having the computer select text automatically, or using interactive mode, which lets the system select the text and then pause for you to adjust the regions. AccuScan also has an interesting notching tool that lets you bite the corner off a text region.

What AccuScan isn't is fast. It placed near the low-middle of our DOS pack, with the exception of faxed output. When it comes to accuracy, however, AccuScan is appropriately named. It placed among the best packages, often achieving an accuracy rate of 96 percent or better. Besides recognizing scanned pages, AccuScan can also read TIF or PCX files scanned from Scanning Gallery Plus. The one shortcoming we found was its inability to scan images and text on the same page.

## ReadRight 2.01

**A**s we evaluated these OCR products, we noted a disturbing trend. While the good packages have made impressive leaps in bringing true OCR capabilities to PC-class machines, the poor packages bordered on useless. Unfortunately, the good packages not only carry steep price tags but also require a substantial hardware investment. OCR Systems' ReadRight came closest to bucking this trend.

ReadRight has a lot going for it, not the least of which is its \$495 list price. It can run on an XT-class machine and requires only 640K bytes of memory. At first glance, these "advantages" looked like the kiss of death, but we were pleasantly surprised. ReadRight is capable of

handling most OCR jobs.

ReadRight does not yet run under the popular Windows 3.0 interface (the company announced Windows 3.0 support while we were writing this review but wasn't able to send us a shipping version in time for testing). Still, the existing product is very easy to use. You control options by function keys. The options and associated function keys are clearly listed on the main screen. To select the type of document you'll be scanning, simply press the F5 function key. You can then choose Proportional, Monospaced, or Dot Matrix from a pop-up list. A separate Frame Menu brings up a graphical display of your document. You define a frame with the arrow keys. This process would be easier if ReadRight

supported a mouse. From the main menu, you simply press Enter to initiate a full scan-and-read session.

If you choose this package, you'll have to do without some useful perks. Although you can watch text scroll by as ReadRight goes about its work, there is no way you can interactively teach or even correct characters. In fact, ReadRight doesn't even have a basic text editor, but it addresses this shortcoming by letting you access your own editor directly from the ReadRight menu. ReadRight has an option for reading dot-matrix input, but it couldn't handle our nine-pin test document. We think that OCR Systems has made the right trade-offs to keep ReadRight's price low. You give up perks, not functionality.

## Perceive 1.0.5

**O**mnifont technology leaves you with precious few options if it cannot understand a particular font. Ocron's Perceive combines acceptable omnifont features with a powerful learning facility. On the other hand, the \$595 package lacks other important features.

Perceive runs under the Windows 3.0 interface. As a page is scanned, the program opens two windows, one displaying the scanned image and the other scrolling the text as it is read. This makes it easy to see characters in context. You can disable one or both windows to speed the OCR process.

With the learning feature enabled, an ambiguous character will appear in a dialog box along with a number of possible options. You can type in up to 10 characters to define the unknown character or choose to skip over it. But Perceive goes further. You can move the box surrounding the character right or left to enclose more of the image. Most OCR packages will pick up only a portion of a broken character, get confused, and choke. Adjusting the image enables you to tell Perceive to look at the whole character before saving its definition. This takes care of the tricky problem posed by broken characters. You can also call an extended ASCII table and define an entry by se-

lecting from among this set of unusual characters.

While Perceive's learning features exceed those of the other reviewed products, it falls short in other areas. Even after a complete learning session, Perceive could not handle our nine-pin dot-matrix document. It doesn't do deferred processing, a feature that can make OCR jobs less trying. You can't load more than one font file for a recognition pass, although you can add to an existing font file. You may have trouble if your font files become too bloated. This is a good package, and Ocron has reduced the cost from \$795 to \$595. The new price makes Perceive an attractive low-end offering.

## Recognita Plus 1.1

**W**e looked at the DOS version of Recognita Plus from Recognita Corp. of America. Although we received a Windows 3.0 version of the program, we couldn't get it to work reliably with our ScanJet or ScanJet Plus. The Windows version addresses some of the problems in the DOS version by offering ad-

ditional features, including a text editor and a search-and-replace mechanism.

Recognita Plus includes a sufficient omnifont capability and some interesting learning features. When the program runs into an ambiguous character, it brings up a window containing the character's bit map. It also displays the character in context. It dims surrounding characters while the unrecognized char-

acter is highlighted. In many cases, the program also offers its best guess for the unknown character. You can then tell Recognita Plus to learn the proposed character or skip over it. You can also enter the correct character from the keyboard. The program builds a user tree (i.e., a font file) as you teach it new characters.

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# A Simple Equation for Choosing OCR

The process of choosing an OCR package is fairly straightforward. Ideally, you should take a sampling of documents to your dealer and run them through the packages you are considering. If that's not possible, you are better off sticking with high-end products. Make sure that what comes out closely resembles what goes in. Otherwise, you will be headed for frustration and failure. We can't emphasize one point enough: Nothing can

take the place of accuracy.

Unless you have reams of documents that share a similar font, you should choose an omnifont package. The problem is that omnifont algorithms vary widely. Omnifont capability can save a tremendous amount of time and effort if it works as advertised. For jobs featuring stylized fonts or unusual characters, go with a package that combines omnifont with a learning facility.

Proofing tools can be valuable if you

are working with unusual fonts. An integrated editor, search-and-replace capability, and a spelling checker make it easier to handle OCR errors. A good proofer will also save a lot of time, especially if the alternative is human proofing by eye.

As always, carefully assess your needs. High-volume jobs may require a dedicated OCR system. The dedicated systems are expensive, but if your workload justifies it, it's the only way to go.

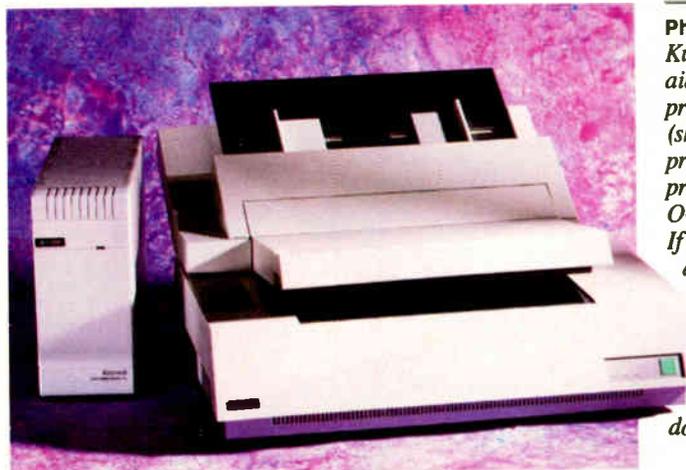
map by clicking bits on or off. This means that you can clean up a character or separate a ligature into two characters. As you improve the character, the program keeps trying to recognize it. Once the correct letter is offered, you can click on the Learn button. Many learning packages let you assign several different bit maps to a single character. In this way, a program can learn to recognize different representations of a character to account for printing anomalies. This is

not the case with Recognita Plus. You can correct an imperfect character in your text file, but you cannot store it for later reference because Recognita Plus retains only one bit map for each unique ASCII character. Therefore, the manufacturer suggests that you teach the program only correct character patterns. Otherwise, you will assign an imperfect character to the font table, and the program may not recognize the correctly printed character later on. This potential

for disaster dampens the effectiveness of an otherwise powerful learning facility.

Recognita Plus uses a hardware device for copy protection. The device attaches to the parallel port, in series with your printer. With the device attached, we had trouble printing reliably to our HP LaserJet III.

Recognita Plus carries an attractive price tag (\$495), but if you're willing to make sacrifices to save some money, we recommend ReadRight.



**Photo 3:** *The Kurzweil K5200, aided by its own processing unit (shown at left), proves that the professional OCR has arrived. If you have demanding documents and can justify the cost, the K5200 can do the job.*

386 (\$599) runs on your PC and uses your scanner and the PC's processor. The \$19,950 K5200 (see photo 3) connects to the PC through a Western Digital SCSI card and is run by a dedicated AMD 29000 RISC processor running at 25 MHz. Our test unit came with 8 MB of RAM installed. Dressed up in Xerox pink and beige, the scanner has a flatbed base with an ADF. You can use the K5200 as an image scanner to scan TIFF files. Because the K5200 comes with its own processor, you don't need a very fast host to support it. We used a 25-MHz 386, but if you're going to dedicate a machine to driving the K5200, this might be a good way to use one of your old ATs.

To scan pages, you just put them in the scanner's document feeder, select the appropriate options, and press Go. There's no preview mode, and you can't see what's happening until the scan is complete. To select from the many options, you press letter keys to move from menu to menu. Once you get the hang of it, it's not too bad, and most documents can be scanned using the default settings. If you find yourself using a special group of

## Discover 386 5.0 and the Kurzweil K5200

Xerox Imaging Systems' Discover 386 and the Kurzweil K5200 Intelligent Scanning System are two birds of a feather: Like eagles, they're swift and sure; like ostriches, they're ugly as can be. The software for both is PC-based character mode with a difficult inter-

face. We found it easy to get buried under piles of obscure menus. The upside is that the software does what it's supposed to do—faster and more accurately than almost any other tool in this review.

The big difference between the two isn't software, it's hardware. Discover

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settings, you can save these and recall them from a file later.

"Impressive" doesn't adequately describe this software. It's incredibly fast and extremely accurate. The purpose of OCR is to convert printed material into

text, and that's clearly where Xerox put its efforts. The only two things we'd like to see fixed are Discover 386's inability to handle dot-matrix text (the K5200 can do it), and the K5200's flatbed scanner. The manual cover for the scanner opens

from one side, not the end, like most scanners. If you're scanning books, you can insert only one side of the page. To scan the other side, you would need to turn the book over, but the K5200 software can't handle upside-down pages.

## AccuText 2.0

**A**ccuText (\$799) is Xerox's OCR offering on the Mac platform. AccuText uses the same Intelligent Character Recognition system as the Kurzweil K5200 and the Discover 386 (described above). ICR combines an omnifont algorithm with lexical context. Using almost any Macintosh text editor, you can build a user dictionary of special terms to help when you are dealing with documents containing esoteric terminology. However, AccuText does not have a learning facility. OmniPage on the Mac took advantage of its learning features to significantly outperform AccuText on the nine-pin dot-matrix test.

AccuText includes a nice utility for deferred processing. You can load your image files into a TIFF queue, order the jobs in any way you choose, and batch them up for processing.

The program also includes a utility for loading AccuText documents directly

into HyperCard stacks. You can put an entire file on a single card, store each page on a separate card, or house each block of text on separate cards. AccuText supports all the major Macintosh file formats.

### Tiger Taming

It's a hard call, but if your OCR workload justifies a dedicated system, we recommend the Kurzweil K5200. It comes closest to what OCR should be. You simply place pages in a feeder, press a key, and watch it go. It's fast, accurate, and—for the most part—hassle-free. Although it costs a bundle, you'll recover a good bit of that expense by avoiding many worker-hours of proofing, rescanning, and troubleshooting. The Calera CDP 9000 and Caere Parallel Reader are also excellent, but the K5200's speed and accuracy gave it the edge.

If your needs are less demanding and don't warrant expensive hardware, you can choose from a number of good soft-

ware products. On the PC side, we really like Calera's WordScan Plus. It's fast, accurate, and dependable. When our co-workers needed an OCR job done fast, we often turned to Calera. For \$995, you get highly accurate omnifont capability and all the amenities you expect from an OCR package.

If you're on a Macintosh platform, we recommend OmniPage for the Mac. At press time, a version of OmniPage Professional was not yet available for the Mac, but it is forthcoming. In lieu of the full package, we suggest that you purchase OmniTrain to add trainability to the product.

OCR has finally arrived, as long as you catch the right bus. A bad package will drive you mad, while a good package will tame the paper tiger. ■

*Stanford Diehl and Howard Eglowstein are BYTE Lab testing editors. They can be contacted on BIX as "sdielh" and "heglowstein," respectively.*

## COMPANIES MENTIONED

### Caere Corp.

(OmniPage 386 3.0, OmniPage Professional 1.0, OmniPage Mac 2.12, Parallel Reader 1.0)  
100 Cooper Court  
Los Gatos, CA 95030  
(408) 395-7000  
fax: 408-354-2743  
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### Calera Recognition Systems, Inc.

(CDP 9000, WordScan Plus 1.0)  
2500 Augustine Dr.  
Santa Clara, CA 95054  
(408) 986-8006  
fax: (408) 986-1440  
**Circle 1402 on Inquiry Card.**

### Hewlett-Packard Co.

(Scanning Gallery Plus 5.0 with AccuScan)  
Customer Inquiries  
19310 Pruneridge Ave.  
Cupertino, CA 95014  
(800) 752-0900  
fax: (208) 344-4809  
**Circle 1403 on Inquiry Card.**

### Image-In, Inc.

(Image-Read 2.0)  
406 East 79th St.  
Minneapolis, MN 55420  
(800) 345-3540  
fax: (612) 888-3665  
**Circle 1404 on Inquiry Card.**

### OCR Systems, Inc.

(ReadRight 2.01)  
1800 Byberry Rd.  
Huntingdon Valley, PA 19006  
(800) 233-4627  
fax: (215) 938-7465  
**Circle 1405 on Inquiry Card.**

### Ocron, Inc.

(Perceive 1.0.5)  
3350 Scott Blvd.  
Santa Clara, CA 95054  
(408) 980-8900  
fax: (408) 980-5100  
**Circle 1406 on Inquiry Card.**

### Recognita Corp. of America

(Recognita Plus 1.1)  
1250 Oakmead Pkwy.  
Sunnyvale, CA 94088  
(408) 749-9935  
fax: (408) 730-1180  
**Circle 1407 on Inquiry Card.**

### Xerox Imaging Systems Datacopy Kurzweil

(AccuText 2.0, Discover 386 5.0, Kurzweil K5200)  
185 Albany St.  
Cambridge, MA 02139  
(800) 248-6550  
fax: (617) 864-4186  
**Circle 1408 on Inquiry Card.**

### Manufacturers of other products used in this review:

#### Hewlett-Packard Co.

(ScanJet Plus)  
Customer Inquiries  
19310 Pruneridge Ave.  
Cupertino, CA 95014  
(800) 752-0900  
**Circle 1409 on Inquiry Card.**

#### Microtek Lab, Inc.

(MS-II, MSF-400G)  
680 Knox St.  
Torrance, CA 90502  
(213) 321-2121  
fax: (213) 538-1193  
**Circle 1410 on Inquiry Card.**

# Voices of Experience

Alan Joch and Rick Grehan

**O**ptical character recognition can be a time- and money-saving alternative to rekeying hard-copy documents or electronic files formatted by an archaic word processing system. It can also be a frustrating technology riddled with its own time traps, especially if you don't understand its limitations, according to some companies that have used OCR for years.

Their advice: Be sure you are clear about what you want OCR to do, and don't expect magic.

"Many employees thought that the OCR system would allow them to place any document in the scanner and instantly receive a usable file ready for the word processor," notes Sunny Anderson, who is manager of the OCR operation at the Denver law offices of Berenbaum & Weinshienk, P.C. "They weren't prepared for the fact that they'd have to perform some cleanup work depending on the condition of the incoming document."

But those who understand OCR's limitations can be rewarded with fewer manually keyed documents, a partial taming of the paper tiger, and possibly, like the State of Delaware, the front end to a document management system. Evan Wilner, public advocate for the State of Delaware, represents the rate and service interests of the state's 650,000 citizens with regard to public utilities. Headquartered in Wilmington, he and his staff often work on cases stretching across several weeks and sometimes generating 2000 pages of text. Wilner's OCR and document management system allow for a central database with full text searching capabilities, so the staff can browse through previous testimony. If, for example, an expert witness recalls only a por-

tion of some crucial evidence, Wilner can instantly retrieve the full text of earlier testimony, refresh the witness's memory, and plan that day's briefs and arguments.

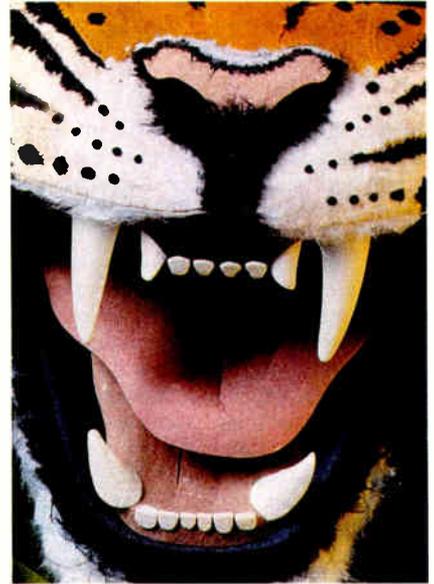
### A Growing Market

A recent survey conducted among BYTE readers tracked interest in OCR used in document storage and retrieval systems (where documents exist as editable text files, not solely as archival images) and in the more traditional hard-copy and electronic-file conversion systems.

Twenty-two percent of respondents said they currently used OCR in their operations, tied primarily to PC-based systems. Macintosh and PS/2 platforms accounted for 23 percent and 20 percent of the systems, respectively. Half of those who already ran OCR said they planned to expand their systems in the coming year. PCs remained the dominant platform, but PS/2-based products outpaced Macs (21 percent versus 17 percent) for those looking toward the future.

Those using OCR ranked document storage, data entry, desktop publishing, and general business correspondence as the primary applications for their systems. Only 5 percent said they currently used OCR as part of a networked document management system, although 15 percent said they planned to install such a system in the next year.

BIS/CAP International, a market researcher based in Norwell, Massachusetts, also identifies potential growth in such systems. According to Jane Stanhope, associate director of the Image Management Systems Service, new installations of all document management systems (archival and editable) in 1990 totaled 1357, with revenues of \$910 mil-



lion, for an installed base of 2841. New installations in 1995 are expected to rise to 22,786, with revenues of \$12.6 billion, for an installed base of 51,557. BIS/CAP expects workgroups ranging in size from 3 to 15 workstations to account for a significant portion of those gains. Installations of that size rose by 446 in 1990, on revenues of \$229 million, for an installed base of 995 systems. But by 1995, the numbers could rise to 6819 new installations, with revenues of \$2.9 billion, for 15,871 systems.

### A Publishing Tool

Reader's Digest Association (Pleasantville, NY) is in the process of implementing a Unix-based accounting system that eventually may depend on OCR, according to Vane Lashua, applications development manager for PC applications. In the meantime, the publishing house uses Calera's WordScan Plus to convert into ASCII files mailing lists and book or magazine manuscripts that lack electronic files.

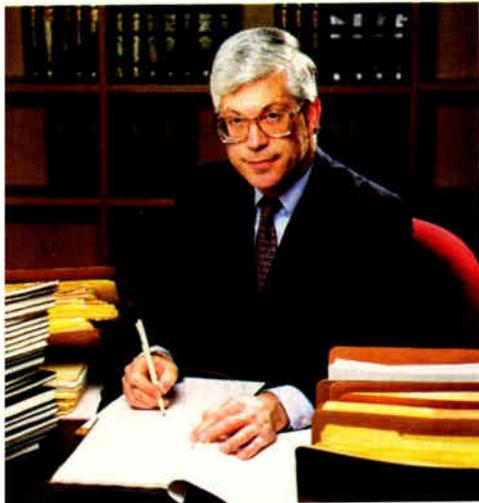
"The editor will just put the manuscript into the hopper [the automatic document feeder on a Hewlett-Packard ScanJet], and in no time, 20 to 30 pages will be scanned in," says Lashua. "We can scan both sides of a stack of paper and collate the pages. Also, if the manuscript is in a two-column format, the scanned file will come out as a single-column galley with the type in logical order."

But over time, Lashua has learned the limitations of OCR as much as its capabilities. "Typically, if we have massive amounts of information to capture, we'll just give someone a manuscript and let

them crank it out by keying the information in on a computer. It's much more accurate and much quicker than scanning because we have less cleanup to do with the files."

The company recently completed a glossary culled from 500 pages of type-written material in a variety of column formats and typefaces. "We made the decision to rekey the job on a word processor rather than using OCR and then going back to clean and sort everything," says Lashua. "Human typists will make accommodations if a column is not aligned properly. If the OCR system sees a column isn't aligned with the others, it will make a new column."

### Power to the Public Advocate



*Evan Wilner, State of Delaware*

The Delaware Public Advocate's office runs "garden-variety" 12-MHz 286 and 16-MHz 386SX machines with Calera's WordScan Plus in both hardware-assisted and software-only versions. The hardware-assisted version—WordScan Plus AT—sits in the slower 286, while the software-only WordScan Plus runs on the 386SX. Evan Wilner also uses Xerox DataCopy internal fax boards to feed information directly to his OCR system.

Wilner evaluated OCR systems based on the time and effort required to convert a document from its original state to being in the word processor "ready to drive the laser printer." Wilner is particularly happy with WordScan's integration with Microsoft Word for Windows. A new macro capability lets him drive the OCR system via a pull-down menu in the word processor.

Today, the considerable enthusiasm

for the OCR system in Wilner's office is spilling over into other departments. Wilner was called into the Delaware Court of Chancery to provide a demonstration of the system.

### Defense Support

Rockwell International's North American Aircraft Division (El Segundo, CA) used OCR to help create technical specifications and manuals for Department of Defense contracts for the B1-B bomber project, according to Sandra Alcorn, computer systems analyst. Each of the approximately 100 engineers in the project engineering group used a Macintosh to produce documentation and correspondence. The individual workstations were connected to a central Oracle database, which Rockwell customized to provide for automatic updates whenever one of the engineers made a change to a drawing.

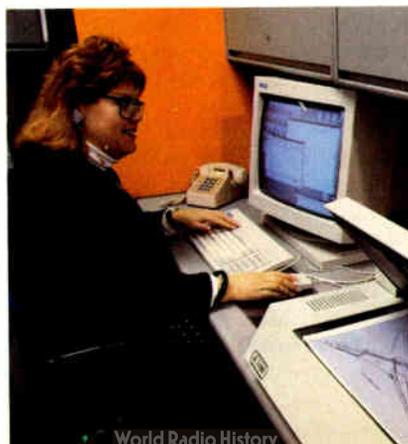
The division ran a networked imaging system that cuts down on the volume of paper generated and speeds access to files. Some documents, however, needed to be altered, and in those cases, the group used a Kurzweil K5200 scanner to convert documents into ASCII or other formats.

"We run Interleaf on four Sun 386is. If we need to make a change on a proposal, I scan it in, convert it to Interleaf format, and enter the changes using Interleaf publishing software," Alcorn says.

The Kurzweil scanner is connected to an AST 386, which holds the OCR software, as do the four Sun Microsystems workstations.

Alcorn says most of the OCR problems she's encountered result from poor originals or text type smaller than 9 points. "I recently tried to OCR 6-point type in a two-column format. Some of it scanned really well, other parts not very well at all. This document happened to be in a

*Sandra Alcorn, Rockwell International*



serif typeface. The system has a little more trouble with serif than sans serif."

Before choosing an OCR system, Alcorn advises buyers to analyze their specific needs carefully. "What's more important for you: text or images? What about formatting? Do you have a large amount of information that's tied to hard copy with no electronic files? Then pay attention to text verification and how well the scanner scans text."

### Directory Assistance

TravelSouth USA (Atlanta, GA) uses Xerox's AccuText 1.1 software running on a Mac IIcx to produce a 500-page directory for an annual trade show of southern travel agents and tour operators. Tricia Sheldon, special projects coordinator, gleans directory information from questionnaire responses she receives from 700 convention delegates. In the past, the company hand-entered all the responses, which included company names and addresses and answers to business questions. "That was a big waste of time," she concedes.

A second element of the mailing is the recording of bingo numbers used by delegates to set up appointments with show exhibitors. That information also had been entered and proofread by the four-person office.

In total, the two phases required about three weeks of staff time. "We spent 15 full days calling numbers back and forth to each other," Sheldon recalls.

After the first run-through using OCR equipment to produce the latest directory, Sheldon says the results were mixed but generally positive. "OCR did some things we wanted and didn't do some other things we had hoped it would do."

Although she designed her questionnaire so that it could be easily scanned using the company's HP ScanJet Plus, the OCR software labored over the inconsistencies that were among the responses. "Some replies were typed in all caps, some were upper- and lowercase." Because of these vagaries, the staff still devoted more time than anticipated to proofing files. Phase two, the entering of bingo numbers, proved more efficient, Sheldon says.

Sheldon evaluated several varieties of software by taking samples to a local dealer and spending about two days testing for accuracy and speed. "AccuText let me select fields. I could tell it to scan this block of information and that block of information. That worked well with our forms," she notes.

OCR Law



Sunny Anderson,  
Berenbaum & Weinshienk, P. C.

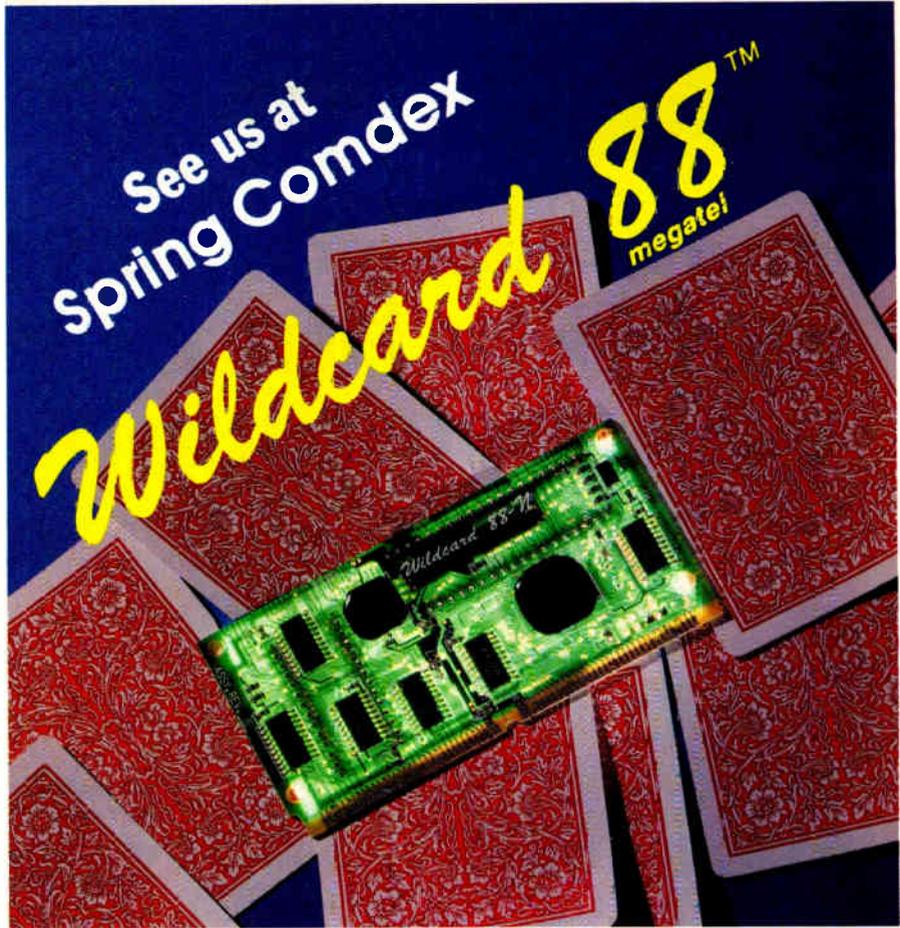
Sunny Anderson, of Berenbaum & Weinshienk, P.C., credits OCR with taming the compatibility problems the office faced when documents arrived from various sources. Anderson says the law firm was continually sending documents out to be scanned or put to disk before it decided it might be quicker and easier to do the work in-house.

The firm uses Caere's OmniPage 386 running on a Morse 386SX with 4 megabytes of RAM and two 32-MB hard disk drives, and a Hewlett-Packard scanner. Occasionally, Anderson also uses HP's Scanning Gallery software for capturing graphics. She says that speed and price were the main selection criteria for choosing the system.

Anderson reports that passing documents through a spelling checker has significantly shortened the cleanup time. She has also built a set of WordPerfect macros that strip out unwanted formatting characters and ready the file for a final pass through the word processor. But the system occasionally misreads some characters—an S for an 8, for example.

Anderson's advice to anyone considering OCR is to determine the volume of documents that will be fed to the system, as well as their overall quality. "And make sure you have someone on staff who is competent and is willing to be trained for the system," she cautions, "because you will become dependent on that person." ■

Alan Joch is a technical editor for the BYTE Lab. Rick Grehan is the director of the BYTE Lab. You can contact them on BIX as "ajoch" and "rick\_g," respectively.



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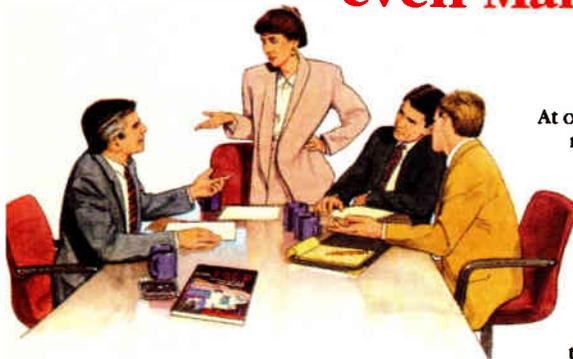
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At our Monday morning staff meeting, I announced I was going to automate our sales tracking and invoicing system later that day.

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On the other side of the room, Tim, a new hire whispered to Richard, "I didn't know the boss was a programmer, too."

"He's not," said Richard. "Couldn't write code to save his life. But he keeps trying because he thinks it's critical to the business."

I'd already tried three times before to program a database: first with dBASE (much too complicated). Then I tried Q&A (not powerful enough). Then I bought Paradox (just like dBASE). All were either too complicated, or not capable enough for our needs.

This time, I was confident. Why? Because I just bought Alpha Four, the relational database for non-programmers like me. I spent 45 minutes over the weekend with Alpha Four's audiocassette tour. So I knew how easy application design with Alpha Four would be, even the first time.

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And I was delighted that Alpha Four is totally compatible with dBASE .dbf files. Our mailing list went right into the new application without even having to convert the files!

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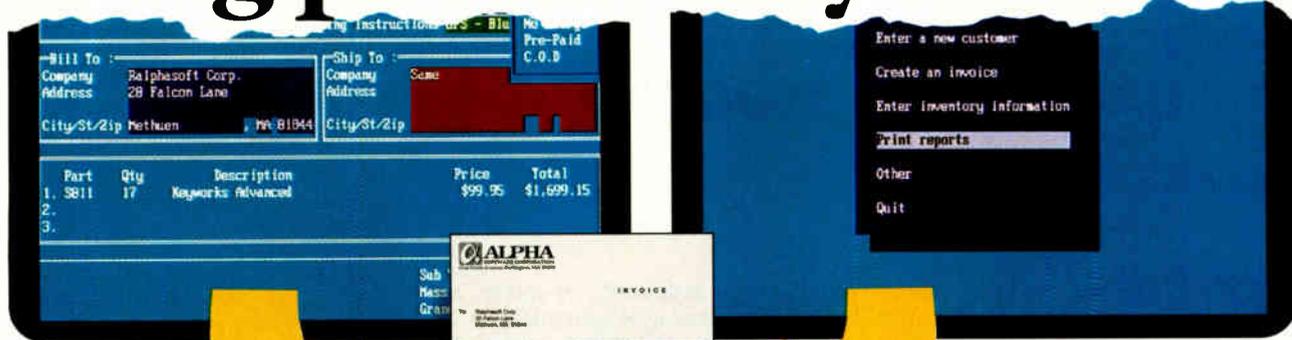
Alpha Four has all the features of an advanced database, but they're all simple enough for me to use. When you enter data, you can automatically change the case of letters from lower to upper. You can display data entry templates for formatted fields like phone numbers, or skip over fields when



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certain conditions are met. Of course, all calculations are performed automatically.

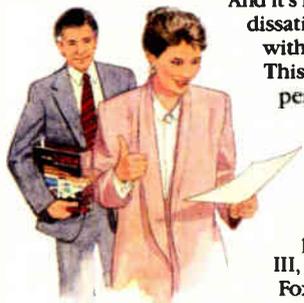
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## Script Languages: The BASIC of the 1990s?

LAMONT WOOD

**Y**ou have data. And you want to make some sense out of it. You want to write a program that will probe, sort, or otherwise arrange all the information. In other words, you need to do some quick-and-dirty end-user programming. Forget elegance. Forget maintenance. You want answers. And you want them now.

Since the late 1970s, we've had BASIC in various incarnations. In 1978, with some excitement and an 8K-byte RAM board, I fired up a 4K-byte version of BASIC and flipped through a dozen pages of stapled instructions—and decided I didn't need to read them. A list of the three dozen command words was enough. Sound familiar?

The rest was then up to you. You slapped on GOTOs and GOSUBs to patch the holes you discovered in your original conception until you had something that worked—although after a point, even *you* couldn't say how.

Tight, cryptic code was in vogue, as restricted RAM meant that you were constantly looking over your shoulder with the free-memory statement (FRE). You'd even overhear schoolkids arguing about how many parenthetical brackets they needed in a particularly monstrous function statement they were hacking out, as if they were conjuring up a spell.

But this is the 1990s. Now we have object-oriented programming (OOP)—some say "hyper-programming"—for the masses. Data, which you probably always thought of as numbers and text, has become *objects* that include graphics and reside in *containers*. GOTO and GOSUB have been banished, and programming languages use a prolix "self-commenting" syntax that reads like the English of strangely dictatorial kindergartners;

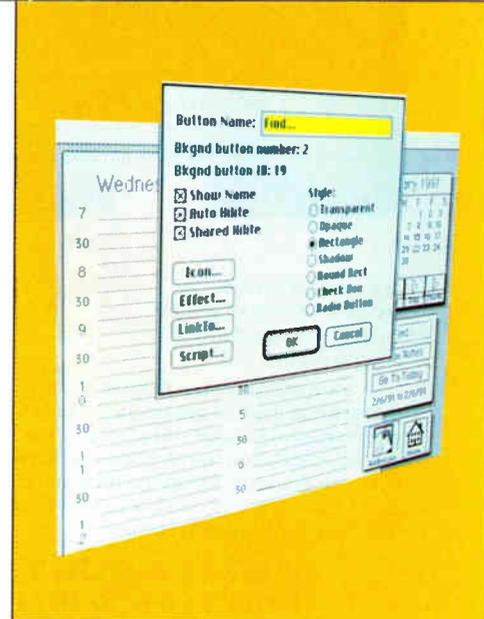
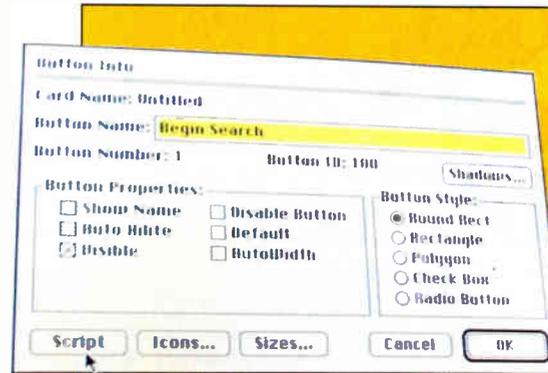
writing those statements, of course, requires the following of tight rules.

Even most conditional commands have fallen from favor, probably because they require analysis from the reader and, therefore, are not self-commenting. You still have to be concerned about memory capacity, but now the talk is of megabytes. Documentation takes the form of book-length manuals, of which there usually needs to be more than one.

So is quick-and-dirty programming still possible? To find out, I wrote a BASIC program for a phone expense problem (see below), and then I tried to solve the same problem using HyperCard, SuperCard, and Spinnaker Plus for the Mac (using a Mac SE and a Mac IIcx) and using ToolBook, Spinnaker Plus, and HyperPad for the PC (using a 16-MHz 386 with a Hercules display). Without going into every feature of these packages, I've tried to provide a comparative perspective of them by using each to create a real-world application.

I used each package to read through a comma-delimited ASCII data file that contained 1944 items (approximately 120K bytes). Each record, which was a line ending with a carriage return, had six fields—internal number, date, numeric amount, code number, comment, and null (which you were to ignore)—detailing expense transactions from 1985 through 1990. The programs analyzed yearly phone expenses by searching through the file for every record that contained the word *phone* or *Phone* in the comment field and adding its amount to the total for that year.

And the answer, of course, is yes, quick-and-dirty programming is still possible. However, it's like working in the presence of your mother, who won't



let you get dirty. As for "quick"—well, that word may have to be dropped from common usage.

### Our Old Friend BASIC

The GWBASIC version of my program consists of 15 lines that take up about 450 bytes on disk. It runs in 15 seconds. The program listing (see listing 1) looks fairly cryptic, but the main thing to notice is that FOR...NEXT causes the program to loop 1944 times between that statement and the following NEXT statement. INSTR checks for the word *phone* or *Phone* in the comment field—the CM\$ string. The MID\$ function extracts the year (5 to 0) from the date field, and VAL changes the year and the amount from text style (as they are represented in the data file) to numeric values. The array (dimensioned in line 40) allows you to refer to data by its position on a list. In this case, although array *A* has values from 0 to 90, I use only 85 to 90.

If INSTR finds *phone* or *Phone*, the

## BYTE ACTION SUMMARY

### OBJECT-ORIENTED SCRIPT LANGUAGES

#### WHAT THEY DO

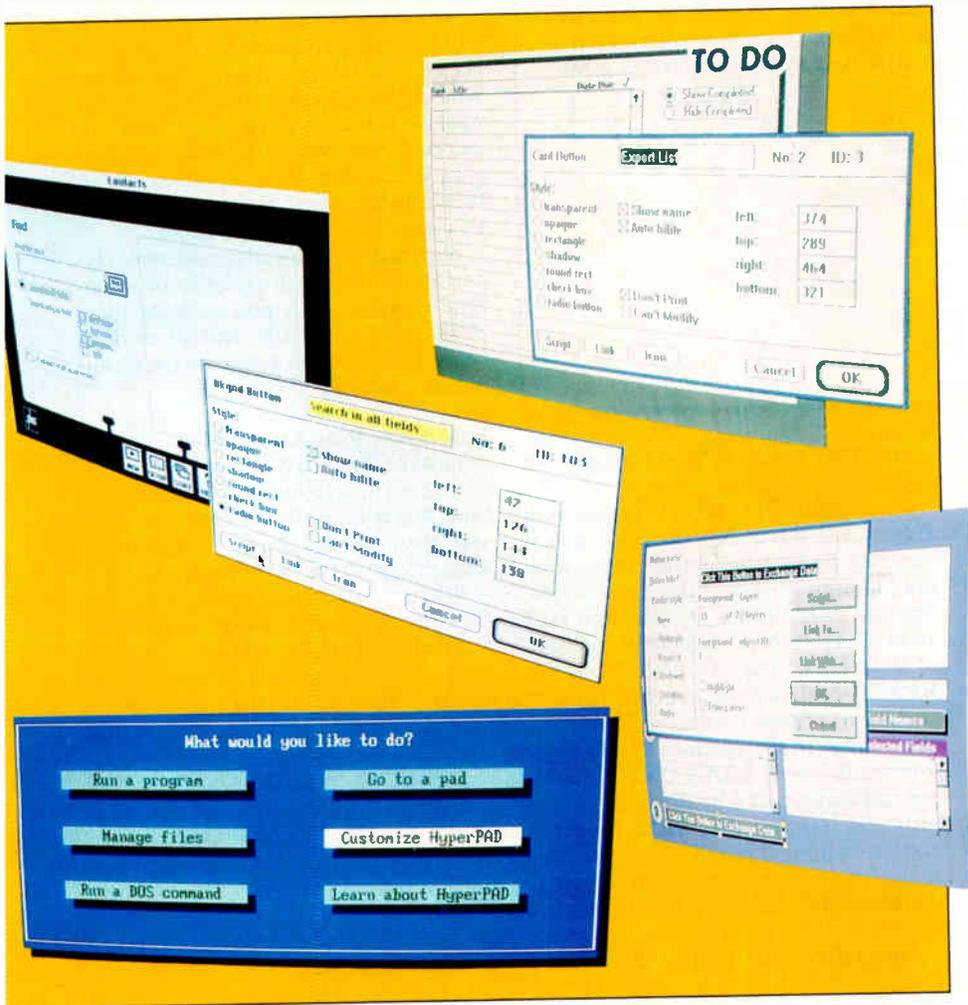
Most script languages provide lavish displays that let you program graphically, using "buttons" and other objects to represent actions defined by "scripts." They offer an alternative to BASIC for building small applications.

#### WHAT YOU'LL DISLIKE

Although programming may become easier, an application written in one of the reviewed object-oriented script languages will run many times slower than the same application written in BASIC. In the test application, the BASIC version ran 16 to 40 times faster than any of the script versions.

#### WHAT WE RECOMMEND

For the Mac, HyperCard is tuned for running applications rather than writing, while SuperCard offers more authoring tools and features. For the PC, ToolBook is likely to become the de facto standard for Windows. And if you need to develop for both the Mac and the PC, consider Spinnaker Plus, which is available in Mac and PC versions.



year value  $D$  is extracted, the amount value (AMT\$ converted to the numeric value  $A$ ) is added to the amount in item  $D$  of list  $A$ , and then item  $D$  and the comment field are printed on the screen.

### The OOP Approach

With OOP, you don't just start writing code. First, you construct a screen, placing *objects* on it by clicking on the software's tool icons. Objects are generally *fields* or *buttons*. A field and a button can each contain a program written in a *script language*, which runs when you click on it with a mouse or when it receives a "message" from another object. (While the script languages don't offer GOTO or GOSUB, you can accomplish major vectoring by sending a message to the script in another object, telling it to take over.) A field also can contain data. Fields come in varieties—for example, for painted or drawn graphics, for formatted data, and for screen labels.

Thus, you have objects, you can assign

data and programs to them, and you can change the data and invoke the programs at will. You can also move them around on the screen (but this is not illustrated by this example).

A further embellishment of the object-oriented script languages I examined is that they have not one but many screens stacked on top of one another. The *background* is the screen page whose contents show on all the layers (or pages or cards—nomenclature varies) stacked above it. Since you can selectively display or turn off the contents of each layer, you have enormous control over what you see. You can even do animation. But for the quick-and-dirty programmer, the multilayer approach can be a nuisance. You probably take no notice of whether you are pasting your fields on the background or on some other layer, which leads to headaches later on when you try to refer to those fields from a script.

That being the case, the first step I took for each package was to lay down

five fields to contain the input data and another six fields to display the results. After I created, placed, and sized the fields, I gave each a mnemonic name that had meaning within the program's context (e.g., "itemdate" and "amount").

The next step was to create a button and write a script for it that would input the date, total the desired numbers, and display them in the results fields. The packages offer syntax checkers or debuggers with error messages. As a program went through the file, the inputs were displayed to reassure me that something was happening and that it was consistent with the BASIC program. If the inputs were not displayed, the run times were about one-third faster.

I found that I could spend an infinite amount of time fiddling with the appearance of a screen; the packages generally

**Listing 1: A BASIC test application.** This program analyzes phone expenses by year. It reads through a comma-delimited ASCII data file where each record has six fields. The data details expense transactions from 1985 through 1990.

```

10 KEY OFF: CLS
20 LOCATE 2, 27: PRINT "VERSION FOR GWBASIC"
30 OPEN "I", #1, "D:DATA.CMA.ASC"
40 DIM A(90)
50 FOR N=1 TO 1944
60 INPUT#1, N$, D$, AMT$, CD$, CM$, NUL1$
70 X=INSTR(CM$, "phone"): Y=INSTR(CM$, "Phone")
80 IF X=0 AND Y=0 THEN GOTO 150
90 A=VAL(AMT$)
100 D=VAL(MID$(D$, 7, 2))
110 A(D)=A(D)+A
120 LOCATE (D-80), 30: PRINT USING "####.##";A(D)
130 LOCATE 15, 15: PRINT SPC(50)
140 LOCATE 15, 15: PRINT CM$
150 NEXT N

```

included optional field borders, button icons, clip art, and elementary drawing and painting tools to spruce things up. It's best to be philosophical about all this: It is said that the majority of effort that goes into any program is put into the display of the information and the intangibles involved, rather than into simple data processing where there are no intangibles. With OOP packages, you just get more results for your tinkering.

The interface screens of each package offer an optional "message box" where you can type in commands for immediate execution to test something in the script language or to adjust the screen. Aside from being self-commenting, the script languages have an interesting concept in common called *chunking*. With chunking, you can say something like "put the first word of it after the third word in the second line of field A," and the computer will understand. This does much the same thing as the BASIC MID\$ statement but can be understood at a glance. The packages can determine if a data item is supposed to be a number or a text string, and you can use *it* as a pronoun to replace the last-used variable name.

### HyperCard 2.0

HyperCard from Claris, a subsidiary of Apple, comes bundled with Mac systems. For an extra \$199, you can get 1400 more pages of documentation suitable for software developers. As the "first OOP tool for the masses," it seems to have become the archetype. Scripts written in HyperCard, SuperCard, and the Mac version of Spinnaker Plus can be cut and pasted to each other and run with minimal editing. You can even use the script language documentation of one package with that of another.

They all ran the test program at the same speed, presumably because they all use the same underlying file access rou-

tines. That speed—a world away from BASIC—was 5 minutes.

Laying down fields and buttons with HyperCard was a breeze. But when it came to writing the script, there were only minimal file handling capabilities. You can only open a text file and read from it—there is no automatic handling of data files. You can have the script READ UNTIL a particular character, or UNTIL a carriage return, or FOR a certain number of characters. The only solution was to have it READ UNTIL a comma and assume that by doing so, it had just read another data field from the comma-delimited file. This worked, but it involved the dangerous assumption that there were no commas within the text of the comment fields.

HyperCard went blindly through the file, extracting what it assumed to be sequential data records and putting them into fields. It seemed to work, but each record was bracketed by quotation marks and a comma. I removed these from the amount field using chunked delete commands so that the software would recognize the contents as numeric values. I similarly chunked the year value out of the date field to let the script know where to add the new amount.

HyperCard 2.0 has numerous improvements over version 1.2, including resizable windows and the capability of importing color graphics. For quick-and-dirty purposes, however, these features are not put to use.

### SuperCard 1.5

SuperCard is a \$299 package from Silicon Beach Software, a subsidiary of Aldus. For the quick-and-dirty programmer, its functionality seems to be little different from that of HyperCard. The main outward difference is that the tool icons are kept on the screen at all times, so you don't have to wade through menus

to get what you want.

The script ran much the same way that it did with HyperCard, with the same file access limitations. The script-editing window includes pop-up displays of commands, words, and functions that you can paste into the script, although there is no explanation of their purpose. Alas, the script language's written documentation was not much more in-depth.

SuperCard's main advantage over HyperCard is that it can create its own runtime versions. This process adds about 300K bytes to the file, and no extra license is required to distribute the resulting applications.

### Spinnaker Plus 2.0

Spinnaker Plus is a \$495 package for the Mac that I also tested in a Windows version. It is noteworthy for having its message box and a selection of tool icons always present at the top of the screen.

When you start programming, you find that Spinnaker offers a database field as well as the "garden-variety" field. You can assign a format to each database field so that their contents are treated as, for instance, currency, dates, signed integers, or text.

The READ command again is limited to text input, which forces the use of the READ UNTIL "," formulation. Also, the script-editing facility has, like SuperCard, a list of commands and keywords you can call up and paste into the script. But it seems no more useful than flipping through the manual.

For another \$495, Spinnaker offers a developer's kit with unlimited distribution of the run-time package. The company stresses that its nearly identical version for Windows allows you to use Mac scripts on a PC and thus avoid programming duplication.

### Spinnaker for Windows

The Windows 3.0 version of Spinnaker Plus does not show the polish that's evident in the Mac version. For instance, the installation procedure in the manual is corrected in the addendum, and that procedure is corrected in the user notes. The user notes suggest that developers must occasionally exit Spinnaker and go back to Windows so that Windows can clean up the memory.

Indeed, Spinnaker occasionally produces inexplicable "out of memory" messages. It often took me two attempts to load the program—the first try would produce an "unrecoverable error" message followed by a soft abort, but an immediate retry would be successful. Simply placing the cursor on the file menu

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## ITEMS DISCUSSED

**HyperCard**

**2.0**..... (bundled with Mac)  
Claris Corp.  
5201 Patrick Henry Dr.  
Santa Clara, CA 95052  
(408) 987-7000

*Requirements:* Mac or Mac II, 1 MB of RAM, and System 6.0.5.

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**HyperPad 2.0**..... \$149.99

Brightbill-Roberts & Co., Ltd.  
120 East Washington St., Suite 421  
Syracuse, NY 13202  
(315) 474-3400

*Requirements:* IBM PC, XT, AT, PS/2, or compatible with two floppy disk drives, 448K bytes of available RAM, and DOS 2.0 or higher.

**Circle 1106 on Inquiry Card.**

**Spinnaker Plus 2.0**..... \$495

Spinnaker Software  
201 Broadway  
Cambridge, MA 02139  
(617) 494-1200

*Requirements:*

*Macintosh version:* Mac Plus, SE, SE/30, II, IIX, IICX, or IICI with 2 MB of RAM, a hard disk drive, and System and Finder 6.01 or higher.

*Windows version:* IBM AT or PS/2 with 2 MB of RAM, a hard disk drive, Windows-compatible graphics and a pointing device, and Microsoft Windows 3.0.

**Circle 1107 on Inquiry Card.**

**SuperCard 1.5**..... \$299

Silicon Beach Software  
9770 Carroll Center Rd.  
San Diego, CA 92126  
(619) 695-6956

*Requirements:* Mac Plus, SE, SE/30, II, or IIX with 1 MB of RAM (2 MB to run color), System 6.0.2 or higher, and Finder 6.1 or higher.

**Circle 1108 on Inquiry Card.**

**ToolBook 1.0**..... \$395

Asymetrix Corp.  
P.O. Box 40419  
Bellevue, WA 98004  
(206) 637-1600

*Requirements:* IBM AT with 640K bytes of RAM plus at least 256K bytes of extended memory, a hard disk drive, Windows-compatible graphics and a mouse, and Windows 3.0.

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sometimes generated continuous hard disk thrashing—something I haven't seen since Windows/386's overworked applications. The company says all this will be addressed in "the next version."

Important nuggets of information are scattered throughout the manual, and I found it not only possible but advisable to consult the HyperCard manual for questions on the script language. Even that was not always profitable, though, since the on-screen error messages are, for reasons not explained, shown in a tiny, curative typeface that is nearly impossible to read on a Hercules display.

The phone expense program ran in 10 minutes, 50 seconds. Still, that's probably better than doing it by hand.

**ToolBook 1.0**

This \$395 Windows 3.0 programming environment shows none of the awkwardness with Windows that Spinnaker Plus shows. ToolBook's maker, Asymetrix, is headed by a Microsoft board member, so you can assume that ToolBook's programmers got the best guidance available concerning Windows. Nevertheless, the fact that it isn't very fast—even its demo programs clunk along—must say something about the basic nature of Windows.

For the purposes of this review, what sets ToolBook apart from the other packages is its powerful "import" command. While with the other programs *import* means to place a graphic or text file into a particular field for display, ToolBook's

importer can handle data files. Each record in the file becomes a page, and each record field from the file becomes a "recordfield" on that page. Importing took 3 minutes, and ToolBook thereupon created a program file more than 700K bytes long, since it incorporated the data with the program.

However, the import function did half my work. All I had to do was size and arrange the resulting fields on the background and then create a button and write a script for it. Well, OK, I also had to assign new font sizes to the text. ToolBook created the field with the largest typefaces available in my system, so that the original screen looked like a string of billboards that each contained a corner of a huge word.

The script used ToolBook's SEARCH RECORDS command to tell ToolBook to start at the bottom of the book and search for a field with the *phone* string. On a page where it struck pay dirt, it added the amount into the appropriate results field. I had to set the contents of the results fields to 0 at the start of the script so that ToolBook would treat their contents as numbers.

The most notable thing about the ToolBook script language (called OpenScript) is that the syntax is more demanding than those of the other script languages. You can't get away with saying "put it into field p90." You would have to say "put it into the text of field p90" to show that you want to manipulate

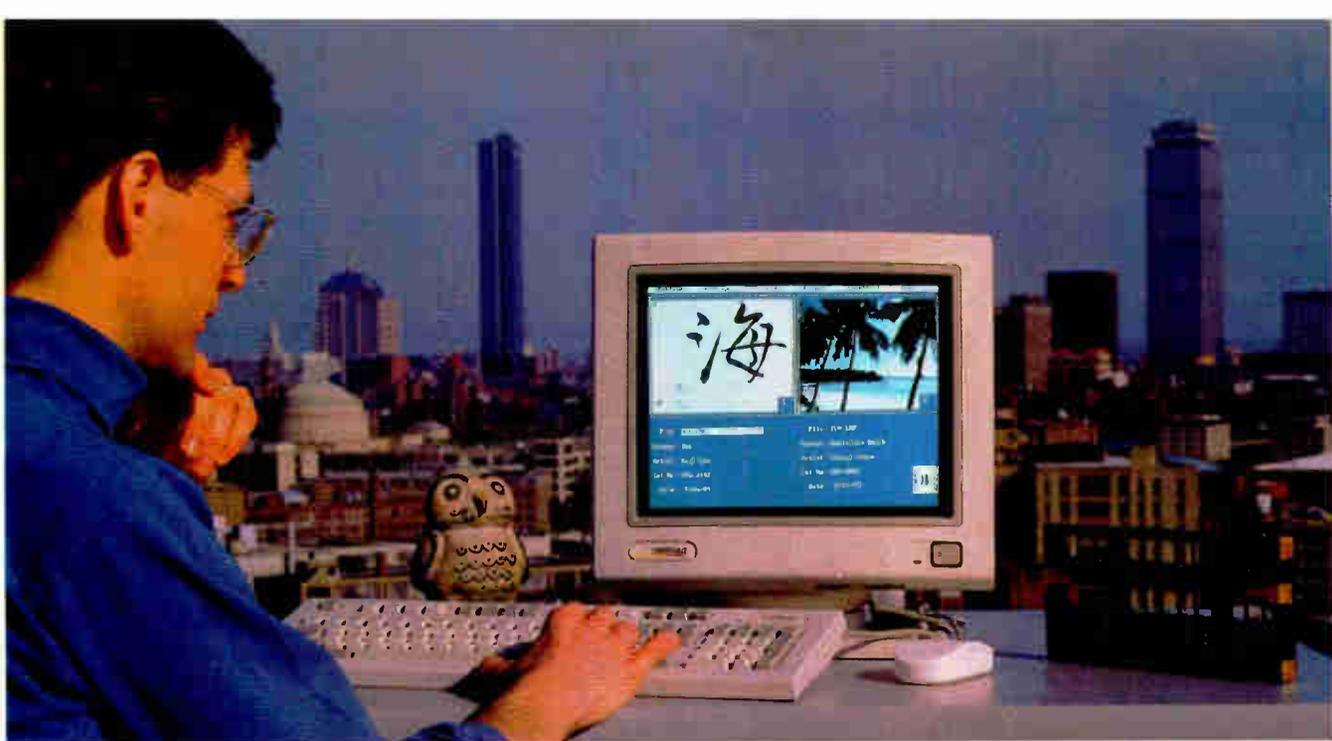
the contents of the field rather than the field itself. Actually, you can't even get away with that; you would *really* have to say "put it into the text of field p85 of this background." (Discovering these little wrinkles can give you gray hair.)

ToolBook offers considerable advantages over the other packages I looked at in that it has more file-handling power. It can import data files directly into a book. It has facilities for using and manipulating dBASE files and for employing dynamic link libraries (DLLs). It also has provisions for using Dynamic Data Exchange (DDE), the Windows protocol that lets one Windows application control another.

Had the data resided in another Windows application that uses DDE, such as the Excel spreadsheet or the IBM Current flat-file database, I could have loaded, say, Excel in the background and used ToolBook's DDE commands to tell Excel to extract and send the data. However, that requires knowing the background program's command structure and data hierarchy, and that's probably beyond the realm of quick-and-dirty programming.

The program ran in 5 minutes, 9 seconds. That's about the same as HyperCard and SuperCard on the Mac IICX and about twice as fast as the Windows version of Spinnaker Plus.

The original versions of Windows 3.0 come with a run-time "reader" version of ToolBook. Asymetrix now sells an



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author's resource kit for \$450, with unlimited distribution rights to the run-time ToolBook and its associated DLLs.

**HyperPad 2.0**

HyperPad, a \$149.99 PC program from Brightbill-Roberts, has a menu structure that looks similar to that of HyperCard (right down to the inclusion of "Save a copy" under the file menu), but there are no graphics. It's entirely character based. Not only do you not run in Windows, you only need 450K bytes of available RAM to run. Thus, older PCs are no longer excluded from the world of OOP.

Despite its lack of graphics, HyperPad still has fields and buttons in boxes, but they are drawn from character cell to character cell with the PC's set of alphanumeric symbols. I found that you can position fields on the screen without using a mouse, but you cannot size them. For sizing, you have to use the "rectangle" command from the message box and give the coordinates of the corners. Rather than going to the trouble of doing this for six results fields, I made one results field and had the totals for the individual years posted on separate lines in the field. (The script languages of the other packages also allow you to address individual lines of a field.)

The script language's READ statement allows an ITEM option, which causes it to automatically separate fields from a comma-delimited ASCII file—no more "read until comma." However, you have to refer to fields by their original identification numbers. Also, each command must end with a semicolon. If it

does not, it means that it is part of a loop or conditional structure (such as an IF...THEN...ELSE statement), and HyperPad looks for the end of the structure and gives you an odd error message if it finds none. It ran the phone expense program in 3 minutes, 55 seconds—not bad, but still 15 times slower than BASIC.

For professionals, Brightbill-Roberts offers two run-time packages with unlimited development rights—one for \$99 and one for \$5000. The second package doesn't produce credits for Brightbill-Roberts, so no one needs to know you didn't do the whole thing from scratch.

**Wave of the Future? Or Wave at the Future?**

The old BASIC way of programming was dominated by loops, arrays, and all-too-clever improvisations to prop up other improvisations, as users struggled to bring a handful of programming tools to bear on the problem. The new object-oriented script-language packages, on the other hand, demand preliminary, thorough analysis of the problem, leading to scripts dominated by dull but comprehensible lists of practically identical IF...THEN statements. Cleverness is less important than a lawyerly knowledge of the script syntax and the hundreds of commands and functions it embodies. Sloppy programming habits are made nearly impossible. Spontaneity, though, is a sloppy thing.

In other words, civilization has arrived, and with it a dull conformity. All the packages I examined offer the same basic approach of fields, buttons, pages,

and scripts. But just as people have written tomes differentiating the various dialects of BASIC, there are differences to be found in the object-oriented script-language world.

HyperCard is part of any Mac's basic software, but it is tuned to running applications rather than writing them, and the necessary documentation is an extra-cost option. SuperCard and Spinnaker Plus offer more authoring tools and features. Spinnaker's advantage is that it offers a Windows twin, although that twin is having growing pains.

On the PC side, ToolBook seems fated to be for Windows what HyperCard has been for the Mac—the first and foremost object-oriented script language. It offers refreshing file-handling advantages, although its script language is more complicated. HyperPad, meanwhile, seems to be neither fish nor fowl. Its lack of on-screen graphics means you cannot have the advantage of easy pictorial representation of your data. True, it runs on older machines that Windows won't run on. But then, so does BASIC. ■

Editor's note: Listings of the application written with the script languages are available in electronic format. See page 5 for details.

Lamont Wood has evaluated personal computers and software for 13 years, authoring more than 200 articles on the subject. He currently writes a computer column for the San Antonio Business Journal. You can reach him on BIX as "lwood."



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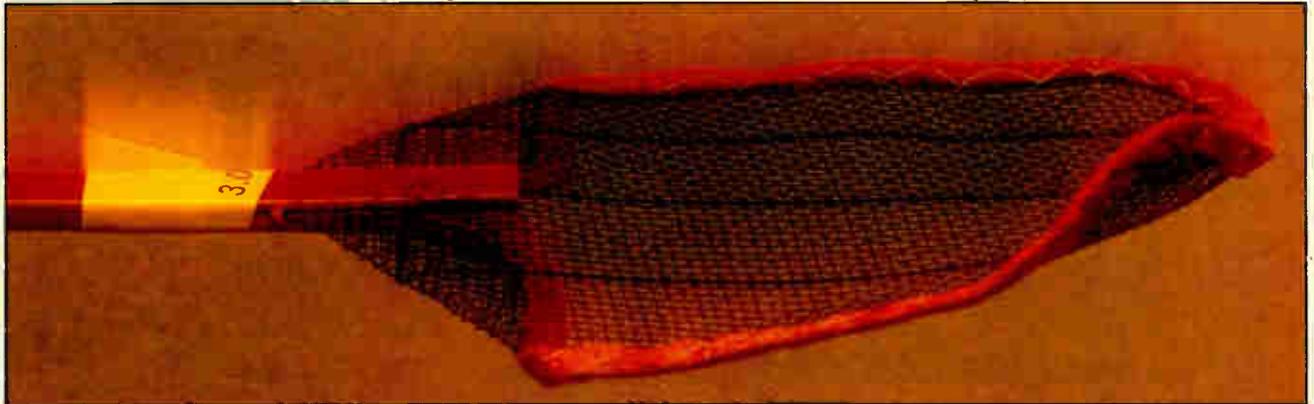
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## SOFTWARE

# Atlantix, Altos Fill DOS-to-Unix Connectivity Gaps

JON UDELL AND TOM YAGER

Today, network administrators have more options for interconnecting DOS and Unix LANs, and the products take vastly different approaches to that connectivity. Atlantix Access and NetWare for Altos Unix turn the Unix host into a PC LAN server to provide file and print sharing and terminal emulation for access to Unix applications.

Access forges these links by bringing the Server Message Block (SMB) protocol and NetBIOS interface to the Unix host. Altos's product is an implementation of Portable NetWare that puts NetWare Core Protocol (NCP) and IPX on the Unix host. The host then acts as a NetWare file server.

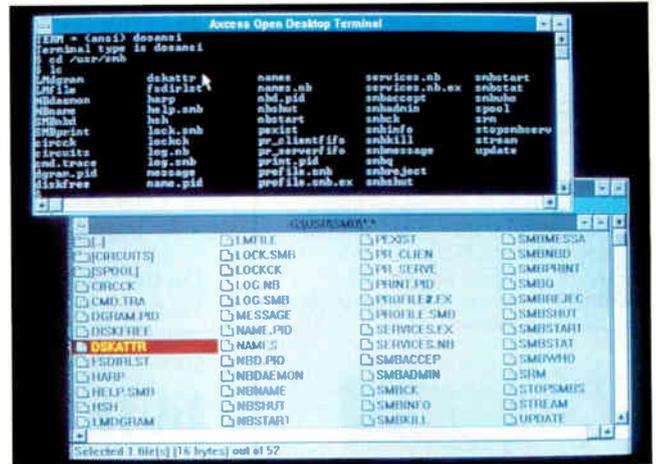
### Atlantix Access 1.0

Atlantix's maiden product, CocoNet, delivered Xenix connectivity to the NetWare LAN (see Reviewer's Notebook, February 1990 BYTE). The company's latest offering, Access, brings Unix into the fold. First out of the gate is a version of Access for SCO's Unix V.3.2 and Open Desktop. Access complies with the LAN Manager 1.0 protocol. Atlantix is not, however, a licensee of Microsoft's LAN Manager for Unix; the Access server was developed independently.

Unix servers for DOS LANs are multiplying like rabbits. The basic architecture—Portable NetWare excepted—is usually the same. Run SMB and NetBIOS on a Unix machine, so DOS clients can see it as a file and print server. Then give DOS users a terminal emulator that talks to Unix over the network, so they can tap into Unix applications and worldwide internetworking.

Given an SMB/NetBIOS foundation, how do you support NetWare clients? Several variations on the basic theme have emerged. Access switches between two transport protocols—NetWare's IPX and its own NetBEUI (NetBIOS Extended User Interface)—using a packet driver. Performance Technology's Powerfusion (see "Powerfusion Provides the Glue for Networking DOS and Unix" in the March BYTE), by contrast, uses a single

*Two views of an Access server from Windows. File Manager browses files shared by the Unix SMB server, while a Unix session proceeds in another window. You can achieve the same result—with a Portable NetWare server.*



transport—IPX—and NetWare's optional NetBIOS interface. Portable NetWare, of course, requires only IPX.

Thanks to the SMB/NetBIOS architecture of Access (and CocoNet and Powerfusion), DOS clients can connect not only to a Unix SMB server but also, for example, to OS/2 LAN Manager servers. Does that matter? You be the judge, but LAN Manager 2.0 has turned a number of heads in recent months. If environments with a mix of Unix and OS/2 servers become more common, Access will fit right in. For NetWare LANs, though, that flexibility comes at a price. A DOS workstation communicating with both SMB and NCP servers has to work harder and give up some RAM.

Access comes with packet drivers for 3Com, Racal-InterLan, Western Digital, and Novell Ethernet adapters. The packet driver insulates the adapter from the transport protocols that use it and enables several protocols to run concurrently. Atlantix supplies two: its own NetBEUI and a version of IPX configured for the packet-driver interface.

With early versions of CocoNet, you had to use Novell's ECONFIG utility to change the packet type of the NetWare server and all IPX shells. That's fixed now. Access doesn't require ECONFIG: The packet drivers will promiscuously accept either generic 802.3 or vendor-specific Ethernet packets.

In fact, we tried it both ways. With IPX set for 802.3-style packets, the DOS

workstation we used was able to see the Access Open Desktop server and a standard NetWare server. Using Novell (type 8137) packets, we could connect to the Access server and to the Portable NetWare server. (Ironically, the "real" NetWare server defaults to generic 802.3 packets, but the Portable NetWare server uses Novell packets.) If we had switched the standard server to 8137, all three servers would have been accessible.

The Access client software requires about 60K bytes of RAM—in addition to the 55K bytes used by the NetWare shell. The protocol stack uses 30K bytes, and the redirector uses another 30K bytes. You must load both to use either terminal or file services on the host. We did succeed in loading them high using QEMM-386, but we had to sacrifice the high-loading of other things on a machine that's normally stuffed to the gills.

Once loaded, Access behaves like any MS-Net-like client. The net use command works in the familiar way. Bear in mind that the Access server treats each drive connection as a Unix user. If that user's account carries a password, you'll have to supply it to net use.

Atlantix bundles two terminal emulators: vtp (virtual terminal) for DOS, and xnterm for Windows. The vtp emulator works nicely but depends to some extent on a terminfo database entry not commonly found on (but transportable to) non-SCO systems. As a result, we were able to run the vi editor in full-screen

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## ATLANTIX, ALTOS

mode on the Open Desktop machine but lost the full-screen capability when we hopped through telnet to a machine running Interactive Systems' Unix.

By the time you read this review, Atlantix should be separately selling a new Windows emulator called WindowView. That is important for two reasons: *xnterm* is a Windows 2.x application that won't run under Windows 3.0, and *vtp*'s behavior under Windows is a bit erratic. In theory, you should also be able to use any Windows emulator that can speak NetBIOS, such as Future Soft Engineering's DynaComm. We tried that, but couldn't get DynaComm to link up with the Open Desktop host. Atlantix was still investigating this as we went to press.

#### On the Server Side

We installed the Axxess server software on the BYTE Unix Lab's 8-megabyte Everex 386/33, which currently runs Open

Desktop 1.0. Things could have gone a bit more smoothly. First, we had to swap out the Everex's Western Digital adapter for a Tiara board supplied by Atlantix. (Support for more adapters, including Western Digital's, is forthcoming, the company says.) Installation then seemed to proceed normally, but when we booted the relinked kernel, its TCP/IP connectivity was missing. The fix was simple enough, once we discovered it. We needed to run the Unix *mkdev* command to register SCO's TCP/IP stack as a client of the Tiara board, alongside the NetBEUI stack that Atlantix had installed.

Server administration is done Unix-style and exploits Unix's user-oriented security. Although you'll likely want to create new accounts for use by Axxess clients, it's not strictly required. A client can map a drive to an existing account and will enjoy the per-file permissions associated with that account. An administrator can use the file *.profile.smb*, located in each user's home directory, to control the client's environment—for example, by specifying a Unix "mount point" for the mapped drive.

While working with Axxess, we experienced a real-life crisis with BYTE's everyday NetWare server. Casting about for a place to dump 200 MB of storage in a hurry, we realized Axxess could help. There wasn't enough room on the Open Desktop machine's own hard disk. But with the help of the Unix Lab crew, we were able to NFS-mount part of another Unix machine's disk and then connect an Axxess client to the extra storage. As the Unix/DOS cold war continues to thaw—thanks to products like Axxess—we look forward to many more peace dividends.

#### NetWare for Altos Unix 1.0

NetWare has long been considered the standard in PC networking. It is fitting, then, that one of the most exciting developments in PC-to-Unix connectivity should come (indirectly) from Novell.

Portable NetWare, strictly speaking, is NetWare 386 for PC Unix systems (see "NetWare 386: Less Pain, Great Gain," March 1990 BYTE). Novell doesn't sell it directly but licenses it to other companies. Altos, one of the pioneers in the microcomputer Unix field, was among the first to bring Portable NetWare to market (it may be available from Interactive Systems by the time you read this). The Altos version of NetWare is called, simply, NetWare for Altos Unix. That's no play on words; this is the real thing.

Unlike traditional NetWare, the Altos Unix version is not an operating system

## BYTE ACTION SUMMARY

- **ATLANTIX AXCESS 1.0**
- **WHAT IT DOES**  
 Unix host runs SMB and NetBIOS to provide file and print services to DOS clients. Also includes terminal emulator for access to Unix applications and services.
- **WHAT WE RECOMMEND**  
 Good solution if you're already standardized on SMB/NetBIOS connectivity, since the Axxess client can communicate with OS/2 and DOS servers as well as the Axxess Unix server. Acceptable for NetWare users, but some extra overhead is unavoidable.
- **SYSTEM REQUIREMENTS**  
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- **WHAT YOU'LL PAY**  
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unto itself. Instead, this implementation makes full use of the resources and structure provided by Unix. It stores NetWare files and directories in ordinary Unix format, so they're accessible to Unix users according to Unix file access rules. NetWare uses the same Altos Ethernet adapter that Unix uses to support TCP/IP networking. In fact, the two protocols can share the same cable simultaneously. This bodes well for installations that have a mix of Unix and DOS systems. With Altos NetWare, you can make both DOS and Unix file services available from a single system.

All this versatility brings with it some responsibilities that go beyond ordinary Unix or NetWare. To use NetWare for Altos, you must understand at least the basics of both NetWare and Unix. NetWare not only uses Unix resources, it depends on them. Adding devices to the system, making backups, starting and stopping the system, and many other administrative tasks must be done from Unix. Those unfamiliar with Unix who are looking to NetWare for Altos only to provide DOS file services must be prepared to dive into some thick manuals.

#### It Lives to Serve

We tested NetWare for Altos Unix on an i486-based Altos System 5000 with 16 MB of memory and an 800-MB hard disk drive. NetWare for Altos runs on other members of the Altos line, but the 5000 is best suited for file serving. It supports multiple independent SCSI channels in its server configuration, and Altos's innovative drivers implement mirroring, drive spanning, and striping. These features are Altos's enhancements to SCO Unix System V. They boost Unix file I/O significantly, and that has a direct impact on NetWare performance. This, along with Altos's long history and experience with Unix, makes Altos hardware a better choice for a demanding application (e.g., file serving) than a brand-X clone with Unix installed on it.

Installation is nearly automatic. The software comes on a quarter-inch tape cartridge. The software is, like other versions of NetWare, sublimely tunable without reinstallation, so the installation process asks very few questions. It takes well under an hour to go from sealed box to running NetWare.

The Altos NetWare server software is partly administered through a simple menu-driven program called `sconsole`. The familiar Novell FCONSOLE lets you perform certain administrative tasks from workstations. Mostly, though, you must use `sconsole` for the nuts-and-bolts

adjustments. From the Unix side, Altos provides a handful of utilities to list users and servers and perform certain emergency administrative tasks without trotting to a DOS client system.

Note that Altos NetWare is a server-only implementation; DOS clients running under Unix (services provided by either VP/ix or DOS Merge) cannot attach to NetWare servers, Altos or otherwise. Similarly, Unix users won't have access to files on other NetWare servers.

#### Making the Connection

Once you've installed and enabled the software, connecting DOS clients is exactly the same as with any other version of NetWare. You run one TSR program (IPX) that supports the Novell protocol, and another (NET3 or NET4) that makes file services available to DOS programs. After that, you can mount preconfigured subdirectories on the Altos Unix host directly as DOS letter drives.

Altos NetWare also includes NVT, a terminal emulator that allows any DOS client to start a Unix remote-terminal session on any Altos NetWare host. NVT is a TSR; pressing a hot key brings up a

### BYTE ACTION SUMMARY

- **NETWARE FOR ALTOS UNIX 1.0**
- **WHAT IT DOES**  
Implementation of Portable NetWare runs atop Altos Unix to provide file, print, and Unix terminal services to DOS NetWare clients.
- **WHAT YOU'LL LIKE**  
An excellent choice for mixed Unix/NetWare installations.
- **SYSTEM REQUIREMENTS**  
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menu of active Altos NetWare servers. NVT hooks into DOS interrupt 14, so you need to run a DOS communications program that performs serial communications through this interrupt. The one drawback of this approach is that it can be slow. A stand-alone terminal emulator that makes more direct connections should have been provided as well.

The NetWare IPX software is compatible with the public-domain packet-driver standard; however, you can make

faster terminal (and other) services available through DOS TCP/IP packages like that from FTP Software. At one point in the tests, we had one DOS client wired up to use NetWare, NFS, and TCP/IP simultaneously. The software played together perfectly, making even more options available to administrators.

NetWare for Altos Unix supports the full range of NetWare 386 commands and utilities. Any Novell-familiar administrator or user should feel right at

home. In tests, connections to the server seemed responsive and reliable—exactly what you'd expect from NetWare.

NetWare-loadable modules *won't* work with NetWare for Altos. That's not too much of a problem, since you can add many of the services that NLMs offer (e.g., tape backup and heterogeneous networking) to Unix.

A NetWare for Altos system can share a network with other traditional NetWare servers, but not without some effort. Altos NetWare uses a network packet type that differs from that of regular NetWare; if you want all your servers to be visible to DOS clients simultaneously, you will need to use the ECONFIG utility to change your NetWare servers and DOS IPX software to use a matching packet type. This operation is quick, but it's an inconvenience for networks with more than a handful of nodes. Altos reports that a future version of its NetWare will have a changeable packet type.

From the moment we installed NetWare for Altos Unix and switched it on, both the Altos hardware and software ran constantly without failure or complaint. Future releases will blend in more functionality, including better support for programming client/server applications. As it stands today, however, Altos NetWare is Novell solid, and it's one of the most hassle-free ways to connect DOS and Unix networks.

### Worlds Apart

Atlantix Access and NetWare for Altos Unix deal with the problem of DOS-to-Unix connectivity in different ways. Access makes the Unix host an SMB/NetBIOS server. For DOS clients who are already on an SMB/NetBIOS LAN (e.g., Lan Manager), Access is a free ride. DOS/NetWare users have to give up a chunk of RAM to use Access, but they gain the ability to use NetWare and SMB servers (of all types) concurrently.

NetWare for Altos Unix, a Portable NetWare implementation, is a natural fit for pure NetWare installations. It doesn't provide NetWare/LAN Manager interoperability, but it's a true NetWare server that's instantly available—at no extra cost—to NetWare clients.

Together, these two products demonstrate that network administrators have a choice in how they interconnect DOS and Unix LANs. ■

*Jon Udell, a BYTE senior editor at large, administers BYTE's editorial LAN. Tom Yager is a BYTE technical editor and manages the Unix Lab. You can reach them on BIX as "judell" and "tyager."*

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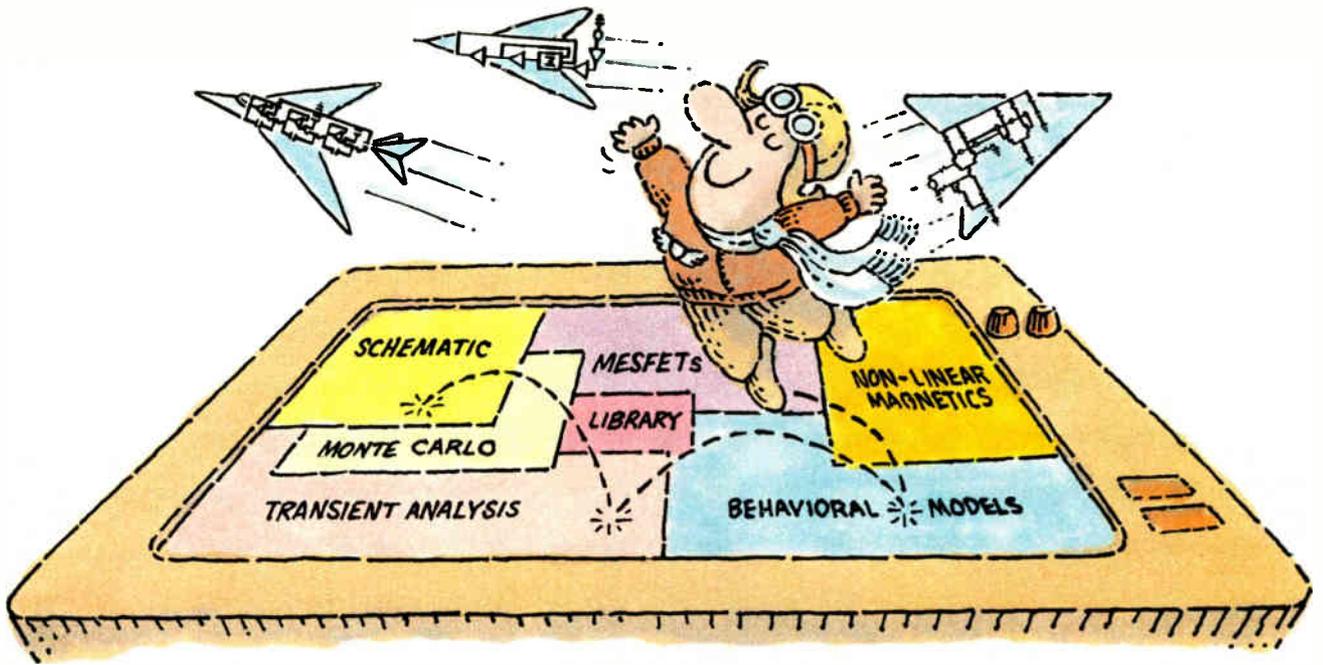
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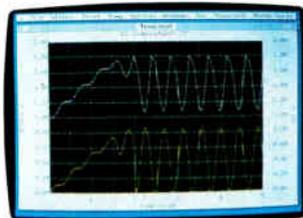
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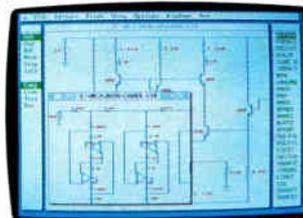
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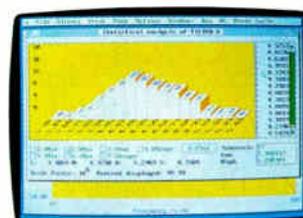
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## APPLICATION

# Low-Cost 3-D Animation Materializes for PC Users

GREG LOVERIA

I first heard rumblings last July that the CAD software giant, Autodesk, was developing a full-featured, professional, three-dimensional animation package to be priced under \$3000. As a die-hard zealot for AT&T's Topas, a 3-D modeling and animation software package, my first reaction was a cynical "Impossible!". After working with Autodesk's new 3D Studio, however, I've had to get used to the taste of crow.

Retailing for \$2995 through certified Autodesk multimedia dealers, 3D Studio is a complete, professional 3-D modeling and animation package for the PC. This package promises to appeal not only to animation and imaging professionals but also to those involved with CAD, design, presentation, and multimedia applications.

### Unlocking the Studio

My evaluation copy of 3D Studio arrived in one of the most unique packages I've ever seen; it has a handle on the large three-ring documentation binder. This foreshadows other atypical design and application concepts displayed throughout the documentation and the program itself. Developed by Autodesk over the course of two years, 3D Studio runs on 386/486 systems with DOS 3.3 or higher, and it implements Phar Lap's 386|DOS-Extender standard. A 386 virtual memory manager pages code and data larger than available system RAM space. Hard disk space can be allocated as additional memory; however, 3D Studio requires a minimum of 3 megabytes of real memory.

Because the software runs in protected mode, a capable 386 BIOS is required; thus, 386SX machines with incompatible ROM BIOSes, older 16-MHz 386 machines, and 386SX add-in cards may not work with it. In addition, a math coprocessor is required. According to Autodesk, a Weitek WTL3067 (for the 386) or WTL4167 (for the i486) improves rendering speeds by as much as 50 percent. I tested 3D Studio on Zeos International's 486/25 EISA tower with 8 MB of mem-



*A finished 24-bit render. Note the completed phone handset object. The human figure wire frame was provided by an early release of a HumanCAD ((516) 752-3568) library of human body models. The photo and screens were produced by Greg Loveria with disk-to-slide conversions handled by Image Center ((800) 433-8829).*

ory and a 344-MB SCSI drive.

The program's main screen defaults to standard VGA (640 by 480 pixels in 16 colors), but internally, 3D Studio performs all image renders with full 32-bit color. Autodesk's Display Interface drivers are used to determine the output device type and resolution in both one- and two-monitor display configurations. You can generate single-frame renders and Autodesk Animator .FLI files in a variety of display resolutions and color depths.

As shipped, 3D Studio has several display hardware drivers: standard and Video Seven video RAM VGA, Truevision's ATVista or TARGA, Everex's Vision 16, and a NULL driver for disk renders. A Hewlett-Packard PaintJet/XL driver is included for color hard copy. For recording animations to tape, Diaquest's single-frame animation video recorder controllers are supported (see the

text box "Testing 3D Studio" on page 262).

Installation of the software is effortless and requires at least 10 MB of free disk space; 20 MB is recommended for optimal performance. I simply typed INSTALL and swapped the seven 5¼-inch 1.2-MB floppy disks when prompted. You start up the program by typing in its acronym, 3DS.

### Modular Modeling

3D Studio encompasses five integrated program modules. The 2-D shaper allows the creation and Bézier spline manipulation of 2-D polygon shapes (including text). The 3-D loftler manages the extruding of 2-D shapes into 3-D mesh objects. The 3-D editor controls scene illumination and camera and object placement. The materials editor regulates object surface textures and attributes, and the keyframer creates object/camera mo-

tion scripts for animation. Each module interacts with the others through user-requested data transfers.

You select commands with a mouse or digitizing tablet from pull-down and side

menus, which is reminiscent of AutoCAD. 3D Studio directly imports and exports both 2-D and 3-D DXF wire-frame models into the 2-D shaper, 3-D lofter, and 3-D editor modules. You can save all working data in the five modules at once as an entire project. As in AutoCAD, commands are organized into trees, with branches for specific options. Each program module also has a subset of icon buttons grouped into an icon panel that controls screen views and module-specific functions (see screen 1).

The 2-D shaper is where most objects are born. Creation of simple 2-D shapes, such as circles and rectangles, is handled directly from the menu. You can create more complex object cross sections using point-to-point line segments. Once shapes are created, you can easily curve or deform them using Bézier spline adjustments. For precision control, you can enter coordinates with the keyboard for point placement or rotation; there is also real-time feedback of the current cursor position or rotation angle. A grid overlay and grid and angle-snap modes make the process even more manageable.

You can create 2-D text in over 20 fonts, ranging from Swiss and Serif to Times Roman. You can determine text size and aspect ratio by sizing a rubber-banded box as desired. The fonts are all ordinary objects, and you can modify them with the spline and point tools.

**Making the Leap to 3-D**

After creating polygons and text in the 2-D shaper, you can pass assigned shapes to the 3-D lofter module for extrusion into 3-D mesh objects. Mesh objects are collections of interconnected vertices and object faces in 3-D space. By default, *lofting* an object amounts to extruding it along a straight path. The lofter supports paths of any shape, however, and it also allows separate paths for the *x* and *y* axes. As a result, even a moderately complex object (like the phone handset shown in screen 2) is a breeze to create.

The lofting process is fast—faster than I had expected—and you can preview an object in the lofter before it is created. Complex mesh objects can cause render times to escalate rapidly. The lofter offers a surprising level of control over the complexity of lofted objects. Many simplistic objects, such as cubes, do not need the cross-sectional geometry required for, say, the phone handset object, and the lofter lets you specify how much detail is needed.

The lofter builds 3-D objects one at a time. To place them in a scene or manip-

ulate them in 3-D space, you pass them to the 3-D editor. As mentioned earlier, you can create simple 3-D mesh objects, such as spheres, toroids, and cubes, directly inside the 3-D editor. The 3-D editor also governs object, light, and camera positioning, along with scaling and rotation in a 3-D scene.

I found placing and adjusting lights and cameras within a 3-D scene uncomplicated and instinctive. 3D Studio lights are adjustable for color and brightness, and they come in three varieties: ambient, omni, and spot. Ambient light ensures a minimum visibility for the entire scene, while an omni light generates an effect similar to that of an uncovered lightbulb or sunlight.

I found the spotlight to be my favorite because its effect can be so dramatic. You can focus spotlights; that is you can adjust the size of the hotspot (brightest area) and falloff (the dimming of the light as it reaches the edge of its coverage). You can aim a spotlight by identifying a target for the light in the 3-D editor.

In addition to several fixed views, the 3-D editor also provides a movable camera view. Cameras have target positioning with a lens focal length that ranges from 15mm wide-angle to 200mm telephoto, and the cameras can be rotated or dollied from any viewport. After creating a camera (a scene can have several), you can make what the camera sees visible by clicking on a view and pressing the *C* key.

In a large scene with complex mesh objects, redraw time of all four viewports can get a bit sluggish. By pressing *Alt-B*, you can display 3-D mesh objects in an outlined box representation in any of the viewports, which makes redraws virtually instantaneous. This feature is particularly helpful when setting camera positions. Clicking and dragging a camera in any of the other three viewports also updates the camera viewport in real time. This made finding that perfect camera angle and position much better than hit-and-miss.

Colors, textures (like glass, chrome, or marble), and other surface type adjustments are made through a pop-up screen of the current materials library. Selecting a material permits its assignment to objects or groups of selected objects in the 3-D scene. 3D Studio includes a library of 105 different materials that is loaded by default. You can add new materials and modify existing ones through the materials editor.

The materials editor maintains user control of ambient, diffused, specular, reflectivity, transparency, and color at-

**BYTE ACTION SUMMARY**

■ **3D STUDIO**

■ **WHAT IT DOES**

3D Studio is a versatile, fascinating tool for producing realistic 3-D scenes and professional-quality animations.

■ **WHAT YOU'LL LIKE**

3D Studio is compatible with a broad range of popular display cards, and it is currently the least expensive way to do professional 3-D rendering and animation on a PC. You can create animations in Autodesk Animator .FLI format for playback on any VGA-equipped PC.

■ **WHAT YOU'LL DISLIKE**

Many properties (e.g., object surface characteristics) can't be animated. 3D Studio's renderer lacks some important properties, including environment mapping.

■ **WHAT WE RECOMMEND**

If you'd like to see your CAD drawings, presentations, and product simulations come to life, 3D Studio is the most versatile and cost-effective way to do it.

■ **SYSTEM REQUIREMENTS**

386- or i486-based PC with DOS, a math coprocessor (Intel or Weitek), 3 MB of RAM, a hard disk drive with 20 MB of free space, a VGA or Super VGA display adapter and monitor, and a mouse or digitizing tablet; additional equipment and software required in most cases.

■ **WHAT YOU'LL PAY**

\$2995

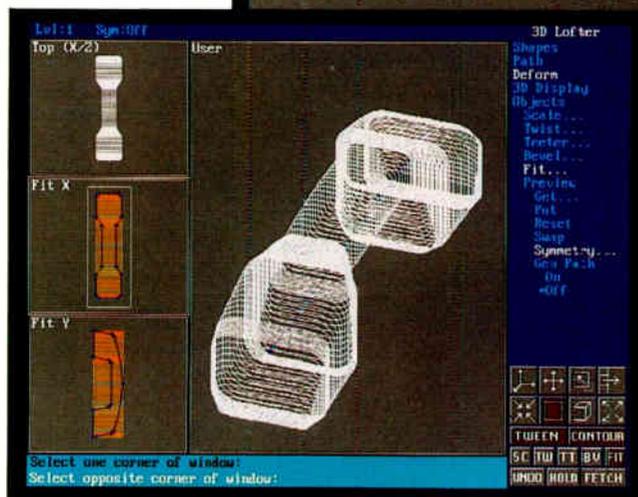
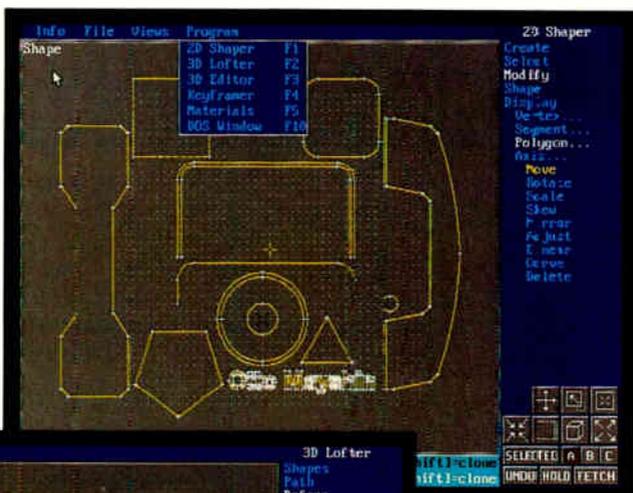
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## LOW-COST 3-D ANIMATION

**Screen 1: The 2-D editor's interface screen shows 3D Studio's hierarchical menus and icon buttons. The drawing area shows the building blocks for some of the objects that appear in the rendered image in the photo.**



**Screen 2: The 3-D loftier shows the lofting of 2-D phone handset elements (shown in the photo) into a unified 3-D object.**

tributes via slider bars. Reflection, opacity, and bump and texture mapping of TARGA and GIF files can also be assigned to a material.

Both *Phong* and *Gouraud* object shading (as well as flat and wire-frame) are controlled in the materials editor through buttons. Of the two, Phong shading produces higher degrees of object realism, but rendering times are longer than they are for Gouraud shading.

I modified the glass, plastic, and chrome materials in the default library for application to objects in the review image (see the photo), and then I saved them under new material names. Changing back to the 3-D editor module, I assigned the new materials to various objects and rendered the camera viewpoint as seen in the rendered review image.

### Exit to Toontown

You can generate a disk or videotape animation for any scene from within 3D Studio's keyframer. Moving and changing objects, cameras, or lights within the keyframer creates keyframes for those items. To generate a 60-frame animation, you just advance to frame 60 (with a

slider) and make the changes you want reflected in the last frame; all movements and adjustments are incrementally interpolated through each frame, from the first frame to the current one. A low-resolution preview lets you see a shaded, real-time version of the animation on the VGA monitor.

After previewing the sequence, I generated an .FLI animation file and uploaded it to BIX. It can be found in the photo/listings conference as 3DSTUDIO.ZIP, and you can play it back on any VGA-equipped system.

3D Studio supports hierarchical object animation. For instance, a flock of birds can all be assigned to follow the motion path of a lead bird while moving in their individual motion paths. These hierarchies can be slaved to invisible dummy objects within the sequence for added realism. Lights and cameras can also be slaved to follow an object's motion path, and you can use any spline path created in the 2-D shaper/3-D loftier as a motion path. By executing the morph command in an animation sequence, I was able to transmute cubes to spheres and fluidly bend columns so that they appeared to be

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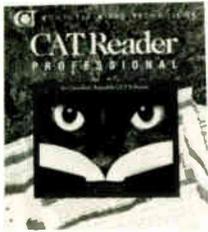
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OCR Feature Comparison Chart

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Built-in Spell Checker	y	n	n	n	n <sup>1</sup>
Full-Page Scanner Driver	y	n	y	y	y
Hand Scanner Driver	y	y <sup>2</sup>	n	y	y
Skew Tolerance	± 10°	1/4°	na	± 5°	1/4°
Dot Matrix	y	n	n	n	y
Automatic Zoning	y	n	y	y	y
Manual Cropping	y	n	y	y	y
Ligatures	y	n	y	y	y
Windows Required	n	n	y	y	n
RAM Requirement	640K	640K	2M	640K <sup>3</sup>	640K
Extra Hardware	n	n	option	n	n
Text Merging	y	y	na	y	y
Under \$500	y	y	n	n	y

<sup>1</sup>y in Windows version <sup>2</sup>Logitech scanners only <sup>3</sup>2MB recommended

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LOW-COST 3-D ANIMATION

# Testing 3D Studio

**L**ike the Video Toaster that was reviewed last month, Autodesk's 3D Studio was tested in the BYTE Multimedia Lab. It performed flawlessly in all my test configurations. The Zeos International ((800) 423-5891) system's default display was served up by Diamond Computer's ((408) 736-2000) SpeedStar Plus, a Super VGA card, for 256-color renders. My renders were speeded by the addition of a Weitek ((800) 468-3167) WTL4167 math coprocessor chip.

I also used the Hercules ((415) 540-6000) Graphics Station Card with Hercules's new 3D Studio Autodesk Display Interface driver software. This adapter allowed me to design models at 1024 by 768 pixels in 16 colors and render them in 24-bit color, all on the same monitor.

Using the higher Texas Instruments Graphics Architecture resolutions requires a multiscan monitor; I tested two multiscan units in the one-monitor display configuration: a 15-inch Relisys ((408) 945-9000) RE-5120 and a 14-inch OptiQuest ((800) 843-6784) with an impressive 0.25-millimeter dot pitch. Both units performed flawlessly, and 24-bit color renders looked absolutely fantastic.

Since I wanted to eventually generate

video-recordable animations, I tested both Truevision ((317) 841-0332) TARGA+ and ATVista+ adapters in two-monitor display configurations. Both generate directly recordable NTSC video (see the review "TARGA+ Lowers Cost of High-End Graphics," January BYTE). I used a Relisys RE-5155 RGB monitor when previewing images and then switched back to NTSC output when I was ready to record the final animation sequences to a Sony ((800) 523-7669) VO-5850, a U-Matic single-frame editing videotape recorder. The recorder was driven by a Diaquest ((415) 526-7167) DQ-50P parallel interface VTR controller board with Action Animator software.

The Diaquest board does all the work of controlling the VTR for animation. After each frame is rendered, 3D Studio tells the Action Animator software to place the frame on tape. The Diaquest board then signals the VTR to perform a one-frame insert edit. This insert edit records the rendered 1/50-second animation frame to tape, precisely on the frame following the previous one. After the edit, the VTR controller software instructs the VTR to rewind the tape to a specific park point and wait for the next rendered frame of animation to be recorded.

dancing. Adjustment of motion fluidity and looping are also provided via pop-up track and key information displays.

I found that a few techniques included in other animation software packages are not available or are cumbersome to use in 3D Studio. Fading objects from one color to another cannot be done directly. Also, true environmental mapping is not possible, so metallic objects can't display surface reflections of objects surrounding them.

Overall, each program module in 3D Studio is bursting with unique control and command parameters. Understanding object creation via the 3-D loft is key to making realistic images. I spent many enlightening hours simply reading, experimenting, and lofting assorted 2-D shapes with strange path variations, and that was just with one module.

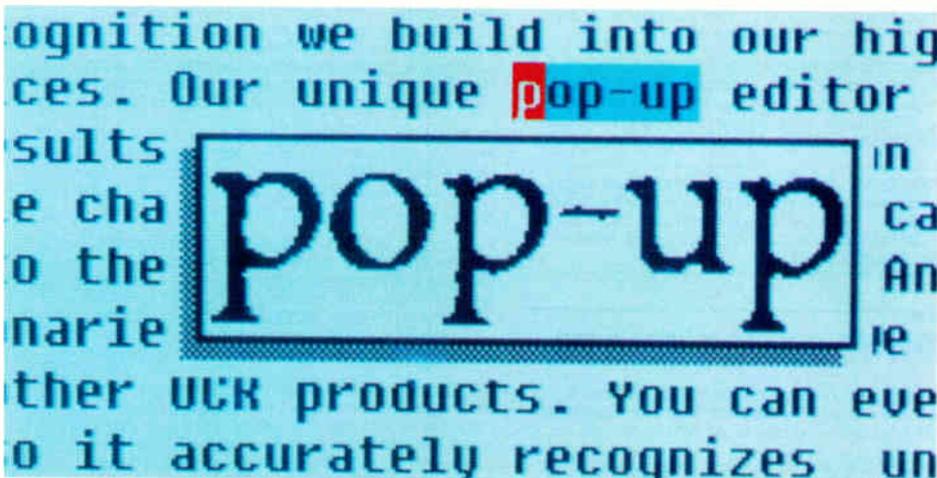
Simply listing 3D Studio's commands without benefit of descriptions would probably fill this entire review. However, 3D Studio's tutorial and massive reference manuals cover every step in profusion. This should make 3-D object modeling and animation a breeze for the first-time user, and I know the software will elicit exclamations of joy from its users at every turn.

At \$2995, Autodesk's 3D Studio deserves a five-star rating. I'm happy that this review has afforded me the opportunity to be one of the first to publicly stand and applaud. ■

*Greg Loveria is a computer graphics and desktop publishing consultant, animator, and technical writer in Binghamton, New York. He can be reached on BIX c/o "editors."*

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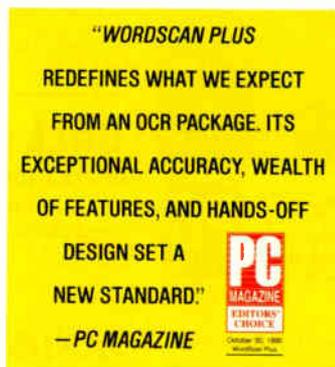
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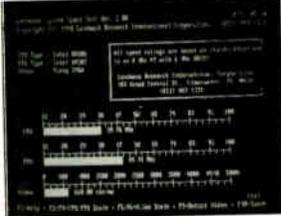
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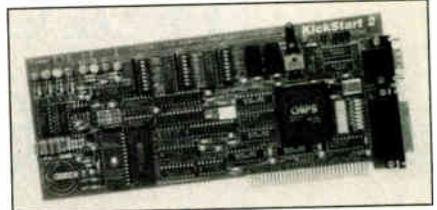
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## SYSTEM

# The Fastest Portable: IBM's P75 Road Warrior

ROGER C. ALFORD



**Photo 1:**  
The Model P75 486's gas-plasma screen displays VGA images with up to 16 shades of orange at 640 by 480 pixels. An integrated XGA controller supports 256 simultaneous colors at 1024 by 768 pixels on an external CRT.

Most of the new powerful 33-MHz 486 systems come in large desktop or tower cases, but faster doesn't have to be bigger. IBM's PS/2 Model P75 486 portable proves that point.

The P75 outperforms any other portable computer BYTE has tested. However, the machine is small only when compared to desktop machines: at 18 by 12 by 6 inches and 22 pounds, this is no laptop. Physically, its design resembles that of IBM's PS/2 Model P70. The keyboard detaches from the case to reveal the display and floppy disk drive, both of which tilt forward when in use.

The base system includes a 3½-inch high-density floppy disk drive, a 101-key IBM Enhanced PS/2 keyboard, an inte-

grated 10-inch diagonal gas-plasma display, an integrated XGA controller, a SCSI hard disk drive controller, 8 megabytes of system RAM, a serial port, a parallel port, a mouse port, four Micro Channel expansion slots, and a 160-MB, 16-millisecond or 400-MB, 11.5-ms 3½-inch SCSI hard disk drive. IBM lists the system with a 160-MB drive for \$15,990; the 400-MB system, which I tested, costs \$18,890. IBM also tossed in a 2400-bps modem (\$462) and IBM DOS 4.0 (\$150), which brought the total system price to \$19,502.

### Rocket with a Handle

The P75 is an impressive example of how much computing power you can cram

into a portable computer. The well-laid-out interior takes maximum advantage of all available space. IBM placed the power supply, hard disk drive, and whisper-quiet fan along the vented bottom of the unit. As you might expect, the system design makes extensive use of surface-mount technology and fine-line traces on multilayer circuit boards to achieve the highest possible integration.

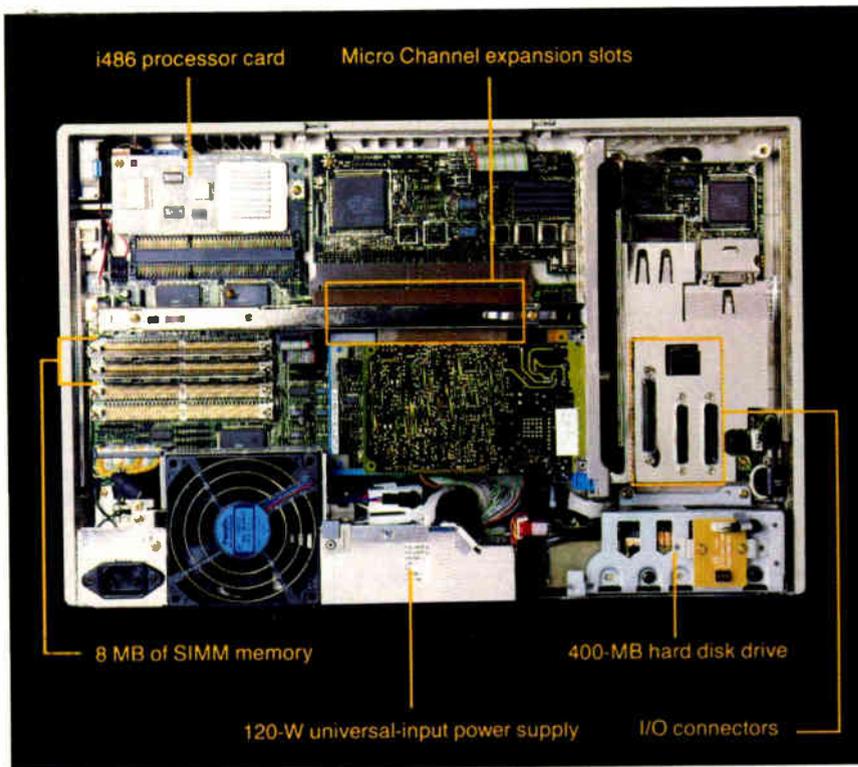
Two half-size 16-bit Micro Channel slots and two full-size 32-bit Micro Channel slots are easily accessible, making it easy to add an internal modem, network controller, or other add-in board. By integrating the floppy disk drive controller, SCSI controller, XGA video controller, and serial and parallel I/O ports onto the system logic boards, the P75 486 has ensured that all four Micro Channel slots are available.

Four high-density (72-pin) single in-line memory module sockets hold the system RAM. The 36-bit-wide memory modules (32-bit memory plus 4 parity bits) that plug into these sockets have a notably wider data path than the 9-bit-wide modules that plug into the more conventional 30-pin SIMM sockets that are found in most of today's systems. Typical 386 and 486 systems have 30-pin SIMM sockets, so you must install DRAM modules in groups of four to support the 32-bit-wide processor data path. With the Model P75, you can install single modules.

Two 4-MB SIMMs of 70-nanosecond DRAMs make up the system's standard 8 MB of memory. IBM offers both 2-MB (\$565) and 4-MB (\$1095) memory upgrade modules to allow total system memory of 8, 10, 12, 14, or 16 MB. You can add more memory by way of a Micro Channel memory board.

Following the latest trend in high-end systems, the Model P75 positions the i486 processor on its own replaceable board. This, presumably, will allow an easy upgrade to a 50-MHz i486 when it becomes available. A heat sink sits atop the i486, secured by a hold-down screw and thermally conductive epoxy. The P75 includes no external cache, and it does not support Weitek's WTL4167 math coprocessor.

*continued*



**Photo 2:** The Model P75's interior makes effective use of limited space by using highly integrated surface-mount technology. The 400-MB hard disk drive and the universal-input power supply are tucked neatly away along the bottom of the unit. A removable i486 processor card (upper left) allows for future CPU upgrades. The I/O ports (right) sit behind a plastic access door.

**Shades of Gray and XGA**

The gas-plasma display is about what you might expect from a flat-panel display: It's merely adequate. The display has a wide viewing angle and is acceptably bright, but the orange-on-black or black-on-orange display options both lack contrast. The display converts colors into 16 shades of orange. This lets you run many graphics programs but compounds the contrast problem.

The gas-plasma display supports CGA, EGA, and VGA graphics, at up to 640 by 480 pixels. To extend display life, you can set the system to blank the screen automatically after an interval of inactivity ranging from 1 to 120 minutes. You restore the screen by pressing the Shift key or by moving the mouse or other pointing device.

The flat-panel display will serve in the field, but you'll want to hook up a real CRT when you're in your office. The P75's XGA video controller includes 1 MB of memory and generates images at up to 1024 by 768 pixels with 256 simultaneous colors, or 640 by 480 pixels with 64,000 colors. For an extra \$82, you can get a 10-foot keyboard cable extension,

which lets you put the system unit on the floor.

An access door at the left rear of the P75 provides access to the XGA video connector, as well as the serial, parallel, and pointing device ports, an external floppy disk drive connector, and a SCSI connector. You access the I/O connectors for Micro Channel boards through this door as well.

In addition to supporting the internal SCSI hard disk drive, the integrated SCSI controller can support up to six external devices, such as a CD-ROM drive, scanner, tape backup system, or additional hard disk drives.

The spring-loaded floppy disk drive automatically pops out to an accessible angle when you remove the keyboard from the front of the case, and the bottom of the gas-plasma display also pulls out to adjust the viewing angle. Three LEDs below the floppy disk drive indicate power on, floppy disk access, and hard disk access. The lightweight keyboard case is flimsy, but the keyboard itself has a good feel, with a soft keyclick feedback. The system also includes a speaker, but the sound is almost inaudible in a

**BYTE ACTION SUMMARY**

■ **IBM PS/2 MODEL P75 8573-401**

■ **WHAT YOU'LL LIKE**

IBM's new portable puts i486 power and top video performance in a 22-pound package.

■ **WHAT YOU'LL DISLIKE**

You'll pay a premium for the Model P75. It's not as fast as desktop i486-based systems in most performance categories, and the system's gas-plasma display doesn't take full advantage of the system's XGA graphics capability.

■ **SYSTEM CONFIGURATION TESTED**

33-MHz i486 CPU, 8 MB of SIMM RAM; 400-MB SCSI hard disk drive, 3½-inch high-density floppy disk drive; 10-inch gas-plasma display with 640- by 480-pixel VGA graphics and 16 gray scales; IBM Enhanced PS/2 101-key keyboard; four Micro Channel slots: two 16-bit half-size and two 32-bit full-length; ports for serial, parallel, mouse, and external floppy disk drive; 60-pin external SCSI port, external XGA; internal 2400-bps modem; PC-DOS 4.0

■ **WHAT YOU'LL PAY**

Base system starts at \$15,990  
System as tested: \$19,502

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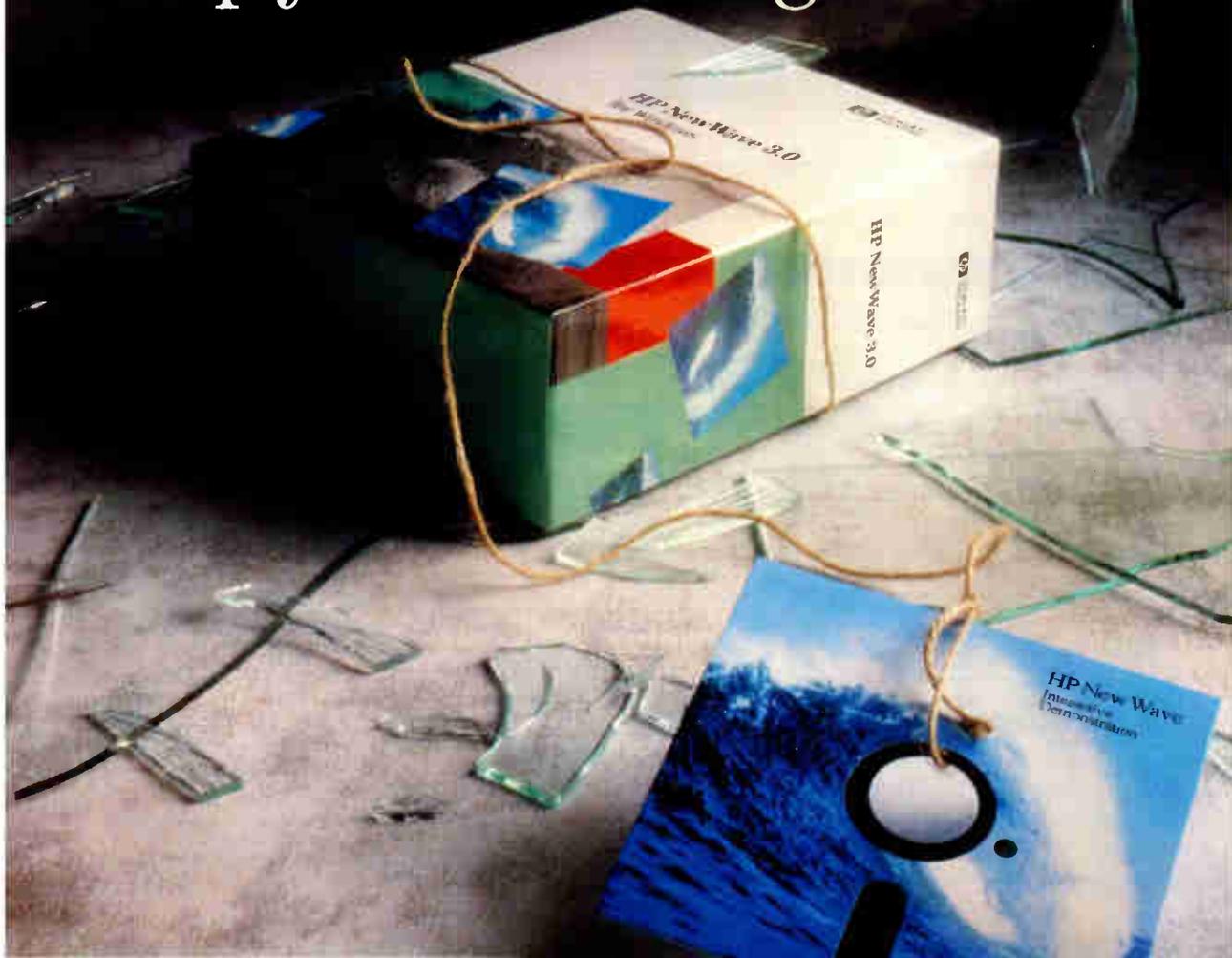
Circle 1221 on Inquiry Card.

room with any background noise.

The Model P75's universal-input 120-watt power supply is easily adequate for a portable system. The power supply accepts 100 to 240 volts input at 50 to 60 Hz, making it usable worldwide. The power cord receptacle is located at the rear of the system behind a sliding access door.

For portability, IBM included a fold-down handle on the top of the P75. An optional molded plastic traveling case

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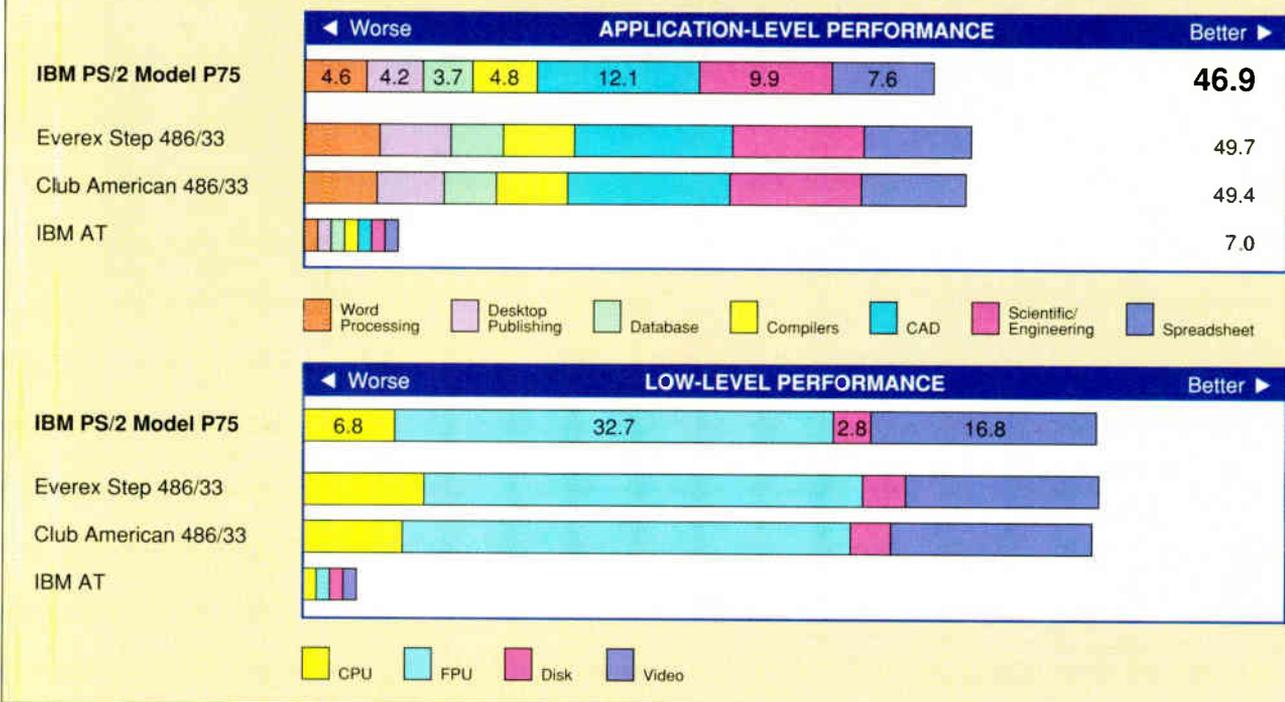
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### DOS BENCHMARKS



For application and low-level benchmarks, results are indexed and show relative performance; for each individual index, an 8-MHz IBM AT running MS-DOS 3.30 = 1. For all benchmarks, higher numbers indicate better performance.

The BYTE low-level benchmark suite identifies performance differences between machines 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: Slata 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 2.0 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.

### CONVENTIONAL BENCHMARKS

	LINPACK (single) (MFLOPS)	Dhrystones (Dhry./sec.)
PS/2 Model P75	0.88440	25488.8
Everex Step 486/33	0.91120	26912.9
Club American 486/33	0.92630	27472.3
IBM AT	0.02105	2317.9

(\$299) includes a handle, wheels, and storage for cables and a mouse.

The system comes with drivers for its XGA interface, and a reference disk with several utilities, including system setup, disk cache, and diagnostics. IBM also includes an informative, well-illustrated quick reference manual.

As expected, the unit showed a high level of IBM compatibility. It ran everything I threw at it. I ran the system using IBM PC DOS 4.0. IBM is working on SCSI drivers for its upcoming release of AIX for the P75.

### As Fast as You Wanna Be

The P75 is the fastest portable BYTE has tested. Most 33-MHz 486 desktop systems are faster, however. In fact, the system came in with the slowest overall performance of the 486/33s tested so far by

the BYTE Lab, excelling only in the video tests. This isn't surprising, since the P75 is a revision of the older 386-based P70 design and lacks an external CPU cache. Still, the system will blow the case off any 386 portable around.

In the low-level system benchmarks, the P75 posted a 6.8 CPU index—well below the 7.2-to-9.0 ratings for the desktop systems BYTE has tested. FPU performance was closer but still brought up the rear. Similarly, the system's SCSI disk subsystem performance—even with IBM's 11.5-ms hard disk drive—is middling. The P75 makes up for its slower performance on those tests with its blinding video speed. Its video performance of 16.8 left the Club American 486/33, at 15.0, a distant second.

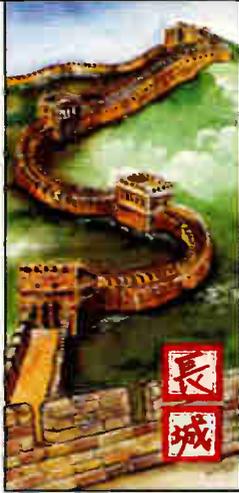
The application-level performance indexes follow the low-level indexes fairly

closely, with the CAD index being the only one where the P75 is not the slowest (see the figure).

The Model P75 is a high-powered portable that gives you the most possible processing power and disk storage on the road. If you need the power and can pay its high-powered price, the P75 might be the right system for you. With the exception of the keyboard, it's well built. On the other hand, \$16,000 will buy you a respectable 386 portable with enough money left over to buy a moderately equipped 486 desktop system. ■

*Roger C. Alford is president of Programmable Designs, a Michigan-based consulting firm. He is the author of Programmable Logic Designer's Guide (Howard W. Sams, 1989). You can reach him on BIX c/o "editors."*

Chinese characters translate as "Great Wall".



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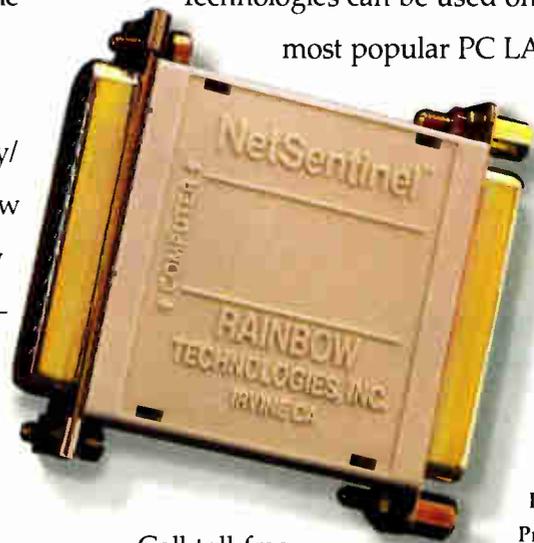
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World Radio History

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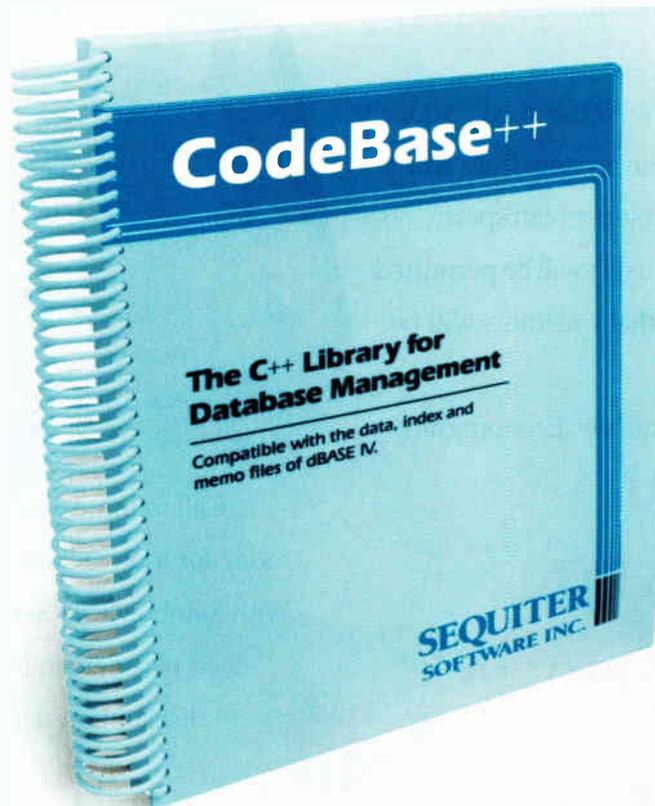
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## APPLICATION

# Access Extended Edition and dBASE Data with InfoAlliance

JON UDELL

I don't want to know where you've stored it, or how. I just want to use the data." That complaint, which is heard throughout the corporate world, defines the problem that Software Publishing Corp.'s InfoAlliance aims to solve. SPC calls the product a "transparent data-source integrator."

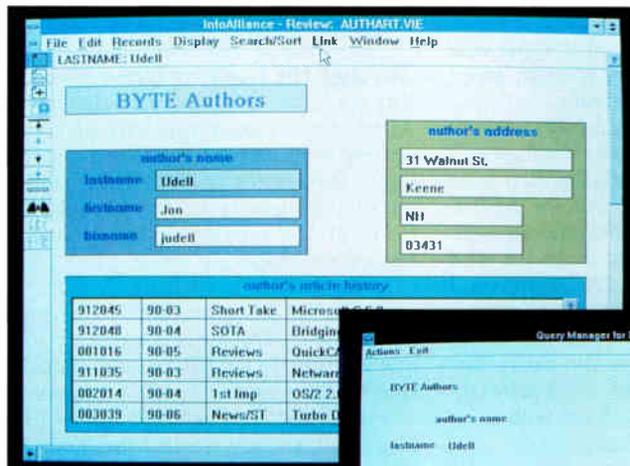
In its current form, that means you can use InfoAlliance to build OS/2 Presentation Manager (PM) applications that read and write IBM Extended Edition (EE) Database Manager tables, .DBF files created by dBASE, FoxPro, and Clipper, and database files owned by InfoAlliance's native DBMS. An InfoAlliance server, or "network data-source integrator," can export such data sources across a LAN to OS/2 clients running InfoAlliance. There's no Windows client yet, but SPC has announced that one will ship in mid-1991. At the same time, SPC expects to deliver support for two additional Structured Query Language engines: Microsoft's SQL Server and IBM's DB2.

My test-bed was a pair of Compaq PCs: a 12-megabyte Systempro and an 8-MB Compaq 486/25 connected by way of Olicom 16/4 token-ring adapters. Since InfoAlliance currently runs only under PM, and since its sole SQL source is IBM's EE Database Manager, I installed OS/2 EE 1.2 on both machines. That, in turn, dictated that the network operating system had to be IBM's LAN Server.

### Trials and Tribulations

In case you haven't worked with an EE LAN before, here's a quick overview. EE 1.2 comes with a LAN requester, a database server, a database requester, and a communications manager. LAN Server 1.2, which is a separate product, provides file and print services. That means that any EE workstation can provide database services to a LAN, can use the database services of any other EE workstation, and can use the file and print services of an EE machine running LAN Server.

The communications manager supports all these connections—and others,



These screens show how a related pair of databases might look using InfoAlliance (left) and Extended Edition's Query Manager (below).

notably sessions with IBM hosts—but does so in different ways. In particular, the file-server-to-client link uses NetBIOS, but the database-server-to-client link requires an advanced program-to-program communications (APPC) session.

My plan was to set up the Systempro as both file server and database server, and the Compaq 486/25 as both file requester and database requester. I wanted to explore IBM's own client/server database arrangement before delving into SPC's. The file server and requester part, mediated by NetBIOS, worked well. (Note, by the way, that neither IBM's nor SPC's client/server database requires a file server. I installed LAN Server only to create a normal network scenario.)

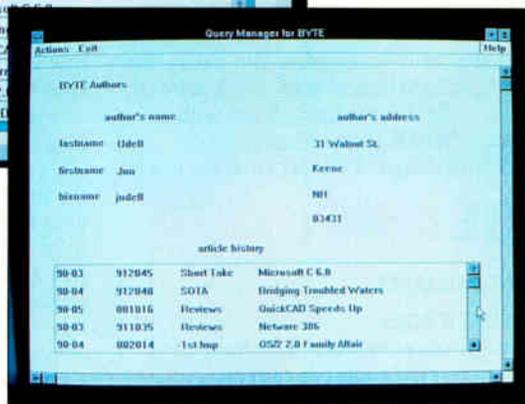
But, although I struggled mightily with IBM's communications manager, I was never able to get the EE database requester on the Compaq 486/25 to speak APPC to the EE database server on the Systempro. I mention this because InfoAlliance, which needs only NetBIOS, did manage to connect my database client workstation to EE SQL tables stored on the server. Lacking the APPC link, I still couldn't run EE's Query Manager on the client. Since InfoAlliance is not a complete substitute for Query Manager, the situation wasn't ideal. Still, I rate the simplicity of InfoAlliance's network

substrate as a key virtue. The fewer moving parts, the better.

### Forging the Alliance

The application in the photos above relates a pair of databases: One describes authors, the other articles. The screens shown exploit the one-to-many relationship of authors to articles, displaying for each author a scrollable list of articles. Separate screens enable the user to add to and update the authors and articles databases. I built the application three ways: first with EE data under EE's Query Manager (I'll call this the EE/EE version), then with InfoAlliance data under InfoAlliance (IA/IA), and finally with EE data under InfoAlliance (EE/IA). The top photo depicts both the IA/IA and the EE/IA versions; they're visually, but not functionally, identical. The bottom photo shows the EE/EE version.

With InfoAlliance, just as with Query Manager, you can build complete PM applications without writing a single line of code. InfoAlliance is clearly the superior screen designer. Query Manager can



only build rudimentary screens with Systems Application Architecture-style menu controls. But InfoAlliance screens have menus, shaded or bit-mapped backgrounds, a variety of fonts, and an icon palette. In design mode, InfoAlliance's graphical editor draws lines, ovals, rectangles, and text, colors these objects, and aligns them with data fields. It lacks the grouping feature typical of drawing programs, but it's well suited to rapid construction of eye-catching screens, and it doubles as the report designer.

After I'd built the data-entry and update screens for the two databases, I filled them with data that I pulled from existing .DBF sources. For the EE/EE and EE/IA versions, that required a delimited-ASCII import to move the data into SQL tables. For the IA/IA version, I ran an import to move the data into native InfoAlliance (.FIL) files. Note that I did that only to exercise the native format. InfoAlliance will work directly with .DBF files (although not with associated dBASE-style indexes).

InfoAlliance's import function is a lot

friendlier than Query Manager's. You can specify the order in which to take fields, and you can merge columns into existing records. When errors crop up, Query Manager points you to a log file and bows out. InfoAlliance, on the other hand, walks you through the erroneous records so you can correct them. It's a nice touch—the sort of added value that SPC's marketing people stress.

**Through the Looking Glass**

I'm sorry to say, however, that InfoAlliance processes errors only when importing to its native files. When importing to SQL tables or .DBF files, you're no better off than if you use the tools that EE or dBASE provide. In fact, you may be in worse shape.

In the case of my EE/EE version, as I've said, EE just pointed me to an error log. In the IA/IA case, I corrected errors interactively. In the EE/IA case, though, InfoAlliance reported only the number of errors and then referred me to EE. Had I not already learned the name of EE's error log, I would have had to repeat the import in EE. Of course, it's EE that does the import anyway, whether directly or under the programmatic control of InfoAlliance (through EE's SQL application programming interface). At a minimum, I would expect InfoAlliance to point me to the error log. But SPC's claims of transparent integration and ease of use led me to hope for more: that data importation to EE tables would work the friendly InfoAlliance way, not the obscure EE way.

At other times, the InfoAlliance/EE relationship was more transparent than I would have liked. In InfoAlliance, for example, you use the design editor to define new fields. In Query Manager, by contrast, the design editor only places fields that you've previously defined elsewhere. When I designed the EE/IA screen shown in the top photo, I planned to merge fields from the table I'd defined for my EE/EE version (see the bottom photo) with the graphical layout that I had created for my IA/IA version (not shown). So I opened the IA/IA design file, selected everything, copied to the clipboard, closed the file, opened the EE table through InfoAlliance (it came up as a fields-only IA design file), and pasted in the contents of the clipboard.

Then I set about replacing the IA fields with EE fields. But the "Cut" menu option was grayed; InfoAlliance wouldn't let me delete the IA fields. Why? InfoAlliance was only acting as proxy. EE's Database Manager can add columns to SQL tables but cannot delete columns.

InfoAlliance, when using EE tables, naturally obeys the same restriction. When I pasted fields from the IA file into the EE table, I indirectly executed a bunch of irreversible "add column" operations. Here InfoAlliance did maintain transparency—in a literal sense—but the result wasn't what I'd wanted at all. I'd rather have been reminded that the current data source was EE and that the paste would be permanent.

One of the key advantages of my EE/IA version, as compared to the IA/IA version, is that the former—thanks to EE—enforces *referential integrity*. The "author name" column that links the authors and articles tables carries a constraint: An author named in the articles table (in a column defined as the foreign key) must appear in the authors table (in a column defined as the primary key).

When I built the IA/IA version, I tried to find a way to enforce the integrity of the link using InfoAlliance's DBMS, which relies heavily on "formulas" embedded in fields. In the end, I could not come up with the right field-validation formula, but so what? With EE at my disposal, I didn't need any procedural shenanigans to achieve referential integrity. It's a property of the tables themselves.

However, while you can add columns to an EE table through InfoAlliance, you can't define primary and foreign keys. That can be done only in Query Manager. In this case, "transparency" evidently means that table definition always works the same way, whether the source is EE, dBASE, or InfoAlliance. But should it? Why hide one of EE's finest features from the InfoAlliance user?

In the same vein, InfoAlliance doesn't encapsulate EE's interactive query tools. After I'd imported real data about BYTE articles into EE tables, I was once again struck by SQL's extraordinary power. Toying with Query Manager's "query-report-form" toolkit, I was able to ask and quickly answer a series of multi-dimensional questions about the cost of manuscripts. The reports weren't pretty—just formatted ASCII text—but they told a fascinating story.

InfoAlliance's forms-based approach is far more restrictive. Instead of working directly with SQL result sets, you spend a lot of time fiddling with forms through which to filter the data. To order and group data from one or more tables, you embed formulas in fields. That's a reasonable approach for .DBF or native InfoAlliance sources. And you can certainly make pretty reports—or mailing labels, for that matter. But it seems a tragic underutilization of a SQL engine.

*continued*

**BYTE ACTION SUMMARY**

■ **INFOALLIANCE**

■ **WHAT IT DOES**

InfoAlliance integrates data from disparate data sources, such as IBM Extended Edition Database Manager and Ashton-Tate's dBASE.

■ **WHAT YOU'LL DISLIKE**

No access to Extended Edition's powerful query language.

■ **WHAT WE RECOMMEND**

If you're planning to move your dBASE (or Clipper or FoxPro) data to Extended Edition's SQL tables, InfoAlliance will ease the transition.

■ **WHAT YOU'LL PAY**

10 users/1 server: \$8500  
35 users/3 servers: \$23,500  
200 users/9 servers: \$99,500

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**Networking the Data**

One goal of a multiuser DBMS is to manage locks intelligently. What happens when two users try to edit the same record at the same time? Here again, unavoidably, InfoAlliance's behavior depends on the underlying engine. LAN versions of dBASE (and compatible programs) exhibit a very high degree of concurrency. They lock contested records automatically and only when necessary. InfoAlliance performs equally well when the data source is a .DBF or native .FIL file. It also reports the name of the user holding the lock.

With EE, though, it's a different story. Since SQL engines work with multitable result sets rather than simple records, it's tough to deliver the high level of concurrency that dBASE and FoxPro users have come to expect. EE's own default behavior isn't entirely satisfactory. When a Query Manager user tries to update a column of a row that another user has open

**S**PC believes in SQL and wants to help bring it to the corporate desktop.

with update access, things stall: Both users see the hourglass, and nothing else, until someone backs off. InfoAlliance, when using EE tables, works the same way. Although it clearly has to work within the capabilities of EE, a more informative message would go a long way toward making a naive user comfortable.

InfoAlliance always requires a data-source integrator. For stand-alone use, there is a local DSI that gives the program access to .DBF or .FIL data on local (or redirected) drives and to EE tables (which must reside on the same machine). The network DSI connects the machine on which it runs to everything that a local DSI can use, and then it exports those connections across the network. I ran the network DSI on the Systempro server; that's how I gave the Compaq 486/25 client access to the Systempro's EE tables.

Any InfoAlliance workstation can export local data by running a network

DSI, and it can simultaneously connect to and use data exported by one or more remote network DSIs. It's a wonderfully flexible system. InfoAlliance maps remote servers into the local file system, so access to them seems familiar. A handy network monitor, which is included with the network DSI, enables administrators to monitor users, open files, and locks. An advanced feature, which I didn't test, allows administrators to roll back incomplete multiserver transactions.

**The Eye of the Beholder**

It's difficult to make sweeping generalizations about InfoAlliance. Everything depends on what sort of data you have, how you use it, and what your long-term plans are. The native DBMS is really quite sophisticated—good enough, probably, for many simple data systems with well-defined modes of access.

For those users who would prefer not to tackle relational database design in its full generality, InfoAlliance files

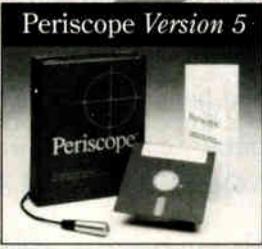
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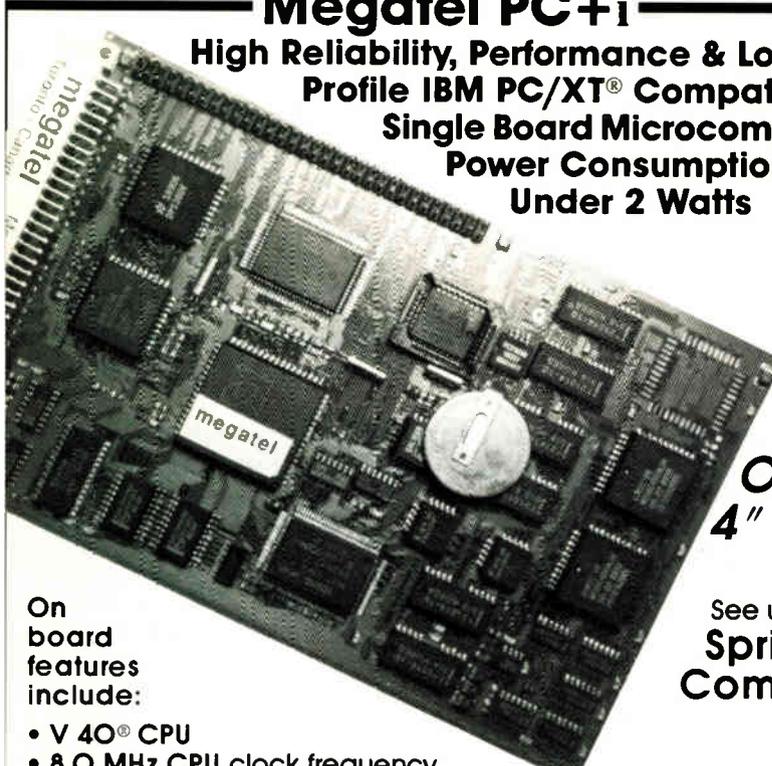


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support "multivalued" fields and groups that implement one-to-many relationships directly. With excellent network support and superb user-interface aesthetics and functionality, InfoAlliance alone—data-source integration notwithstanding—has a lot going for it. A Windows version would certainly broaden the appeal of this option.

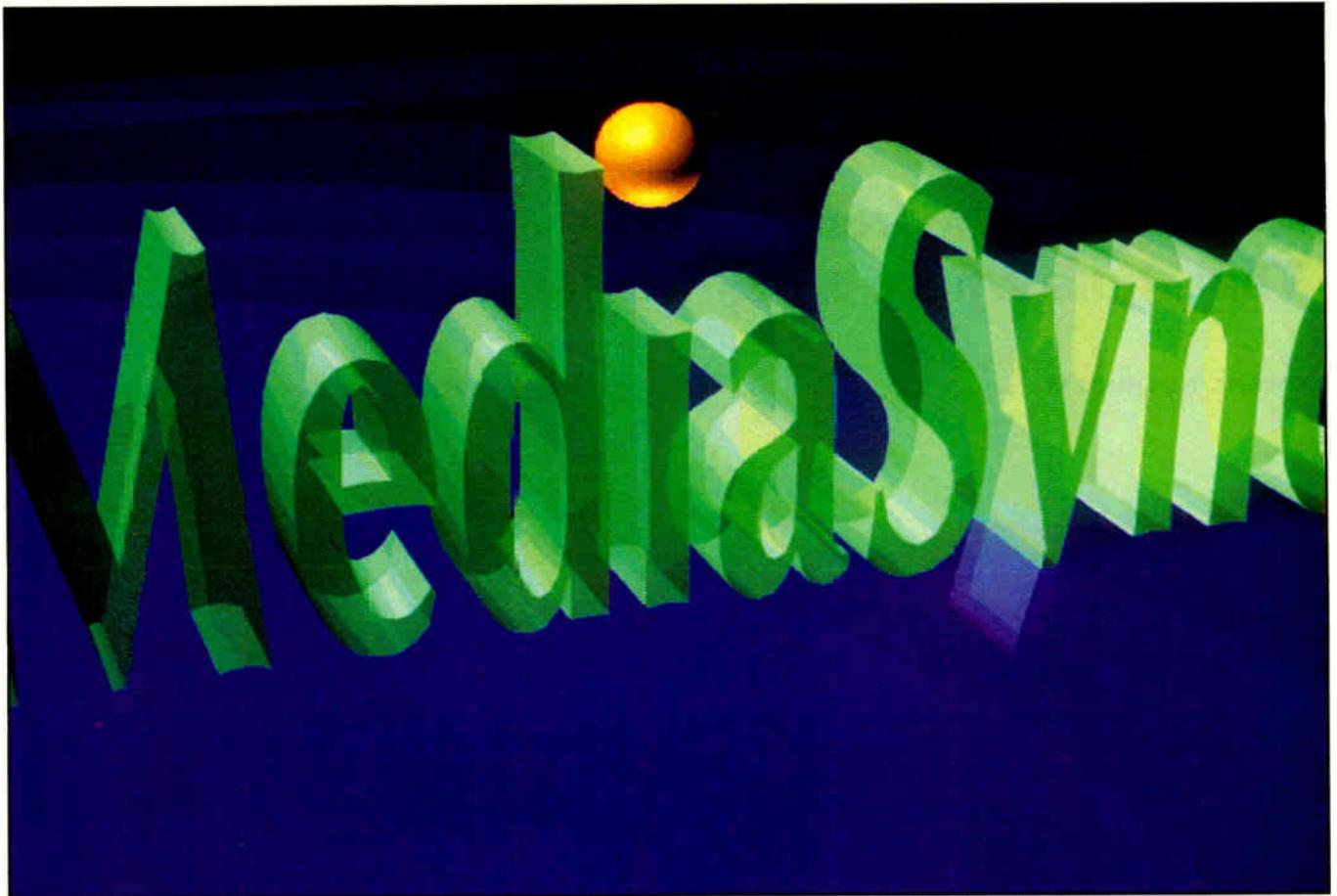
However, SPC does not pretend that InfoAlliance is a serious database engine in its own right. Data-source integration is the real attraction. SPC believes in SQL and wants to help bring it to the corporate desktop—something that we all keep hearing about but few of us have seen. How will that noble and worthy ambition play out? One possibility is a .DBF-to-SQL migration scenario: You train users on an InfoAlliance system that connects to .DBF sources and then cut over transparently to a SQL engine. My own experiments showed me that this is a viable strategy. As a database administrator, I'd want users to run the EE/IA version of the articles-and-authors application to gain two key benefits: enforced referential integrity, and access to the powerful query language.

Today, though, InfoAlliance does not deliver both of these benefits. The referential integrity comes through to InfoAlliance clients, but the query language doesn't—not unless users are also set up to run Query Manager. In addition, the EE/IA version doesn't handle concurrency in the way users may have come to expect.

Despite its advantages, I might have a hard time selling the EE-based version to my users. If I could deliver the query language, too, and an enhanced SQL-oriented query toolkit, that might tip the scales. The paraphernalia that surrounds SQL engines can be pretty scary, but SQL itself really isn't. Access to the query language needn't conflict with the ease of use that is SPC's hallmark. And it would support one of SPC's stated goals: to empower users to work with data directly.

Harnessing engines like EE Database Manager, SQL Server, and DB2, and licensing ordinary users to drive them, is a daunting but essential task. If SPC is serious about this project—and I think the company is—there's much work yet to be done to leverage the full power of the engine without overwhelming the driver. I salute the valiant first effort and look forward to better things to come. ■

*Jon Udell, a BYTE senior editor at large, administers the BYTE editorial LAN. He can be reached on BIX as "judell."*



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## SOFTWARE

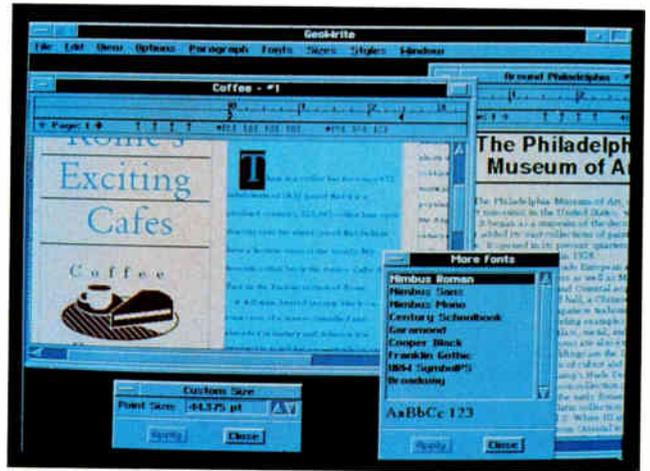
# A Graphical Environment That Runs Where Windows Can't

OWEN LINDERHOLM

### BYTE ACTION SUMMARY

- **GEOWORKS ENSEMBLE**
- **WHAT ENSEMBLE DOES**  
Ensemble is a multitasking graphical environment with bundled productivity applications.
- **WHAT YOU'LL LIKE**  
Ensemble runs well on even the smallest PC. The applications are robust enough to justify running Ensemble, and DOS programs are just a button-press away.
- **WHAT YOU'LL DISLIKE**  
There are not yet any programming tools available, and no third-party applications.
- **WHAT YOU'LL NEED**  
IBM PC, XT, AT, PS/1, PS/2, or compatible; 512K bytes of RAM; a hard disk drive; CGA or better display; DOS 2.0 or higher; and a mouse.
- **WHAT WE RECOMMEND**  
The Ensemble applications are perfect for inexperienced users, and the minimal hardware requirements may help you salvage older PCs and save money on future ones.
- **WHAT YOU'LL PAY**  
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- **FOR MORE INFORMATION**  
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Berkeley, CA 94704  
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*GeoWorks' multitasking and advanced graphics capabilities are exploited in the included GeoWrite application. Note the Motif-like appearance.*



The personal computer revolution is fast leaving behind those users who can't afford to change. Many new blockbuster programs simply cannot run at a useful speed on anything less than a quick 286. Windows 3.0 finally brought a reasonable-quality graphical user interface (GUI) to the DOS masses, but at the cost of leaving all those users with IBM PC or XT compatibles unable to point and click. When GeoWorks brought out Ensemble, with its multitasking graphical environment for IBM compatibles, many hailed it as the savior of the XT, since it not only works on any IBM PC, it works quickly enough to be useful on those older and slower systems.

Ensemble is deliberately very similar to several other graphical environments available on a range of different systems. It most resembles Motif, a popular GUI on Unix workstations. But it includes a trashcan similar to the one on the Macintosh and a suite of user programs similar to those provided with Microsoft Windows. This latter inclusion makes it a little difficult to describe Ensemble as just a GUI, since it comes with several useful end-user applications. These applications are what makes Ensemble worthwhile, since there is currently no provision for end-user programming under Ensemble, and applications from other software companies may be a little slow appearing for an environment from as small a company as GeoWorks.

### The Heart of the Matter

According to GeoWorks, churning beneath Ensemble is an operating-system engine that in some ways rivals OS/2, except that it has better graphics support and much lower hardware requirements. Hidden beneath Ensemble is an underlying operating-system layer, PC/GEOS, that features preemptive multitasking, dynamic memory and object management, and interprocess communications. However, no developer's tools are yet available to fully test those features. Ensemble is only the first of what will be—if third-party support can be rallied—the most powerful applications available for smaller PCs.

Installing Ensemble is a simple but lengthy process, with seven 360K-byte disks to copy. The instructions were clear, however, and the installation program made it easy to select and test all the appropriate drivers for the screen, mouse, and printer.

There are two basic ways to use Ensemble. The first is a novice user's, or "appliance," mode, where a small selection of programs is available. Even beginners will have to move on from this mode fairly rapidly, since the most useful Ensemble applications, such as the word processor, are only available in the more advanced "professional" mode. The appliances include a notepad, a calculator, an address book, a scheduler, a banner printer, and a simple version of

solitaire. The appliance mode does not allow windowing; all the applications run full-screen.

The professional mode uses Motif-style windows and allows plenty of fun customization, including the ability to add your own background (a nice view of a full moon is included) and alter configurations on the fly. It also allows multitasking, including the ability to run communications in the background.

One of the best parts of the professional mode is the file manager application, which is one of the best programs of its kind I've seen. It is intuitive, easy-to-use, and fast. One added bonus of working with files under Ensemble is that all files created by Ensemble applications can have long filenames of up to 32 characters, and they can all have attached comments to explain what they are used for. Unfortunately, this does not apply to files created by other programs.

The other applications in the professional mode are also good. GeoWrite, the word processor, is a fairly basic graphical word processor offering good editing, formatting, and typographical features, but it has few added frills, such as a spelling checker. Its strength is that it is truly WYSIWYG, and it prints scalable fonts even on dot-matrix printers. Ensemble uses Nimbus Q scalable-font technology, and the results are excellent on laser printers and 24-pin dot-matrix printers, and still very good even on nine-pin dot-matrix printers.

GeoDraw is a basic drawing program that uses objects and is resolution-independent. It doesn't have bit-map painting capabilities, and no program that does is included. The two personal-information management programs included are also very good. GeoDex is a flexible Rolodex program that can dial numbers, search, and link with the planner program, GeoPlanner. The planner has clean, simple features and can put in repeating events with some flexibility. The other useful application is a scrapbook that is similar to that used by the Mac. It lets you save copies of frequently used text or graphics and paste them into the word processor or drawing program extremely easily.

GeoComm is a straightforward telecommunications program that can emulate several terminals. It uses scripts that are somewhat basic, but they are adequate for automating many on-line tasks and can download files using the XMODEM protocol. However, I experienced occasional problems when GeoComm attempted to dial or hang up the modem.

Besides providing a graphical environment and some pretty useful applica-

tions, Ensemble also provides a straightforward and easy-to-use DOS shell. This is available from the Ensemble welcome screen, where you also select between the appliance and professional modes. You can either exit from Ensemble to the DOS prompt and run programs from there, or you can install buttons in the DOS mode of the program that allow you to invoke DOS applications simply by pressing the correct button. This DOS shell sits atop MS-DOS, which Ensemble loads after saving an image of itself, so I experienced no compatibility problems on my 386SX-based clone.

The documentation is very good, particularly for beginners. A simple quick-start booklet not only makes it easy to get going with Ensemble but also provides several helpful hints for those not used to working with GUIs. The main manual is also excellent, although the index is a little inaccurate in parts.

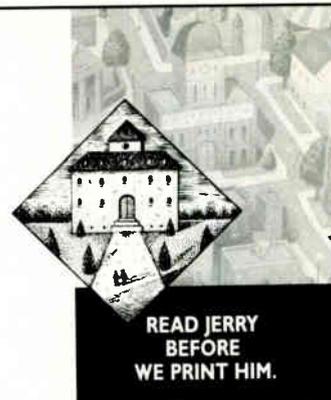
#### An Attractive Ensemble

I had few problems with Ensemble apart from the occasional difficulties with dialing and hanging up the modem in GeoComm. Because of the way it uses color three-dimensional shading, Ensemble does not look very good running on a CGA display in monochrome and doesn't look wonderful on a Hercules display. It does, however, look good on almost any other display.

Another problem is that sometimes the GeoWrite word processor leaves small sections of letters behind when deleting characters, which is unsightly but only a display artifact that does not affect the text file. A bigger concern is the lack of more powerful applications for the environment. There is no database, spreadsheet, or powerful word processor, nor is there a way for end users to program for the interface. All these will be needed, plus a wide range of less commonly used applications, before Ensemble becomes a widely accepted interface.

Prospective users shouldn't let these problems scare them away. For a relatively low price, Ensemble offers a useful word processor, drawing program, Rolodex, planner, and communications program. They all work well together and are tied up in a friendly and easy-to-use GUI that is responsive and good to look at on almost any machine. Finally, the file manager and DOS shell are about the friendliest and prettiest ways you can find to avoid the DOS prompt. ■

*Owen Linderholm is a BYTE senior news editor based in San Francisco. He can be contacted on BIX as "owenl."*



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## SYSTEM

# ALR's Multiprocessing Monster Uses Six i486 Processors

JOHN UNGER

The most obvious way to make a computer run faster is to speed up the CPU, but in a multitasking environment, you can also add processors and have each work simultaneously on a different task. The Advanced Logic Research (ALR) MultiAccess Series 3000 multiprocessor Unix machine uses both techniques. (See the text box "Multiprocessing Explained" on page 281.)

The MultiAccess system holds up to six Intel i486 CPUs running at 25 or 33 MHz. It also keeps a 33-MHz 386 CPU on the SCSI controller busy when that processor is not servicing file I/O requests. The system includes 13 combination Corollary C-Bus/ISA bus expansion slots. The Santa Cruz Operation's Unix/System V/386 release 3.2 and MPX multiprocessing kernel make the package work. (See photo 1.)

MPX lets existing multiuser, multitasking Unix applications run on the MultiAccess system's many processors. All the processors execute a single copy of the kernel and schedule themselves from a run list of processes. MPX is transparent to users and the applications that they run.

ALR offers the MultiAccess system in four configurations. The Models 10 and 20 include one 25-MHz i486 CPU in a tower PC-style chassis. The Models 30 and 40 come with two 25-MHz i486 CPUs and use a minicomputer-style enclosure that accommodates a large uninterruptible power supply, a Model 10-/20-type chassis, and additional room and power for up to seven full-height hard disk drives. The Models 10 and 30 include a 330-megabyte SCSI hard disk drive; the Models 20 and 40 use a 650-MB hard disk drive.

Serious computing power isn't cheap. A Model 10 with one 25-MHz i486 CPU, 8 MB of RAM, a 330-MB SCSI hard disk drive and controller, a VGA adapter, and a high-density 5½-inch floppy disk drive costs \$15,999. My Model 20 review unit had four i486 CPUs, a SCSI controller card with an on-board 33-MHz 386 processor, SCO Unix, five copies of MPX



**Photo 1:** The MultiAccess Series 3000 symmetric multiprocessing system holds up to six i486 processor boards. SCO Unix and the MPX multiprocessing kernel coordinate processor activity.

(one for each processor), SCO TCP/IP, a 650-MB SCSI drive, a 150-MB cartridge tape system, an Ethernet card, and a single memory board with 16 MB of RAM and costs \$50,064. This configuration can accommodate up to 96 users, however. Assuming that those users are running low-cost terminals, the total cost per user isn't unreasonable.

### Proprietary Bus Architecture

The heart of the MultiAccess system is Corollary's proprietary C-Bus. ALR is the first out of the gate with a multiprocessor machine, but other companies, in-

cluding American Mitac and DEC, also have C-Bus multiprocessor computers in the works.

The C-Bus supports processor and shared-memory communications; it clocks in at 16 MHz and supports burst transfers of up to 64 MB per second. The MultiAccess system's backplane has 13 dual C-Bus/ISA expansion slots. Each i486 module sits on a board that plugs into the C-Bus/ISA bus connectors (see photo 2).

The base system comes with a pair of system/CPU boards that occupy two slots. One board includes a 25-MHz i486

**BYTE ACTION SUMMARY**

■ **ALR MULTIAccess SERIES 3000, MODEL 20**

■ **WHAT IT DOES**

This symmetric multiprocessing computer uses SCO Unix's MPX extensions with Corollary's C-Bus to process multiple tasks simultaneously.

■ **WHAT YOU'LL LIKE**

Up to 160 users can access the computing power of the system's six i486 processors.

■ **WHAT YOU'LL DISLIKE**

A fully configured system can cost well over \$60,000, depending on your needs.

■ **SHOULD YOU BUY?**

The system is best suited to environments where many users are running compute-intensive tasks, or where administrators can spread the system's cost across many terminal users.

■ **SYSTEM CONFIGURATION TESTED**

Four 25-MHz i486 CPU modules; 33-MHz 386 on SCSI controller; 16-MB RAM; 256K-byte external cache on each i486 CPU module; high-density, 5½-inch floppy disk drive; 650-MB SCSI hard disk drive; 150-MB cartridge DC-600 tape drive; ALR FlexView 2X Super VGA color monitor; 800- by 600-pixel ALR VGA adapter; 101-key IBM Enhanced-style keyboard; two serial ports; 12 SIO ports; parallel port; external SCSI connector; one Western Digital thick/thin Ethernet port; SCO Unix/System V/386 release 3.2; SCO MPX; SCO Unix TCP/IP Ethernet communications.

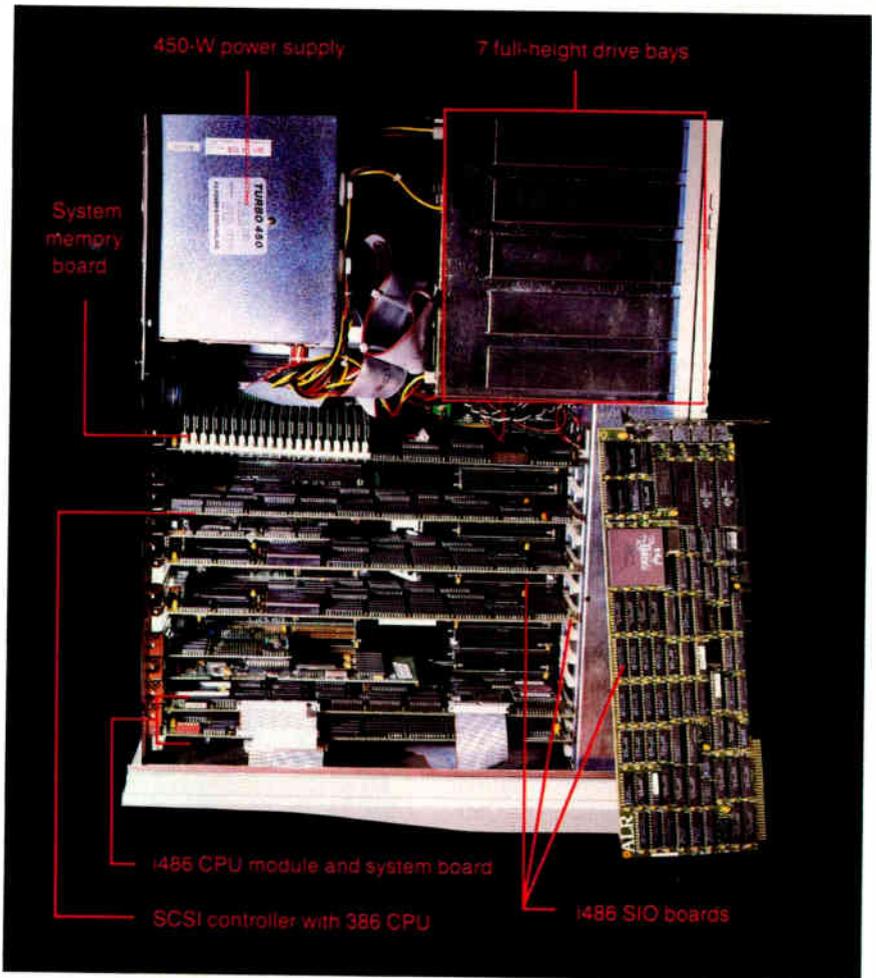
■ **WHAT YOU'LL PAY**

Base system: \$15,999  
System as tested: \$50,064

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**Photo 2:** Inside, the MultiAccess design includes combination ISA bus/C-Bus expansion slots. The C-Bus slots hold up to six i486 processor boards (see lower right), each with its own external 256K-byte cache.

CPU with a 256K-byte external write-back cache. The other holds an AT interface board that contains computer-specific logic, such as DMA controllers, a real-time clock, a Phoenix ROM BIOS, a diagnostic CMOS ROM, a serial port, and the floppy disk drive interface. ALR also includes an Adaptec SCSI disk drive controller card, a VGA graphics adapter, a serial/parallel port card, and a memory card with 8 MB of RAM. These components occupy 6 of the 13 available slots. My heavily loaded review system had only one open slot.

Additional processors, which are called serial I/O (SIO) boards, include an i486, 256K bytes of cache RAM, a cache controller, and four I/O ports. Each I/O port plugs into a terminal concentrator box (\$695) that supports up to 8 users, for up to 32 terminal users per processor board. Memory boards hold up to 16 MB of RAM using 1-MB single in-line memory

modules; the MultiAccess system holds up to 64 MB of RAM on four boards.

The C-Bus uses shared memory, so it must preserve integrity between system RAM and each processor's cache. With ALR's write-back cache design, the most recent values for the data that one CPU needs could easily be located in another processor's cache, in which case the values in main memory would be out of date. The C-Bus controller detects this situation and tells the cache controller with the correct data to pass the values to the requesting processor.

**Multiple Performances**

Because the MultiAccess is a multiprocessor machine, its performance is not directly comparable to that of single-processor Unix workstations. BYTE's standard suite of Unix benchmark programs consists largely of single-threaded or serial applications that spawn only a few

# Multiprocessing Explained

If you run power-hungry applications, you are probably already using multiple processors in your current machine. Numeric coprocessors, graphics coprocessors, and other coprocessors unload some processing tasks from the CPU, but the system can operate on only one task at a time. *Multiprocessor* architectures take the coprocessor concept a step further. These machines use the same serial, or "pipeline," processing model, but they allow you to run separate tasks simultaneously on each of the system's CPUs.

Multiprocessing architectures fall

into two groups: *asymmetric* and *symmetric*. Each processor in the asymmetric design is task-specific. One processor might handle disk I/O while another runs application programs, for example, and system designers would optimize each processor for its specific task. Symmetric systems (e.g., MultiAccess) distribute tasks equally among the available processors: Any processor can service any task.

A single program doesn't execute any faster on a symmetric multiprocessing system than it would on a single-CPU computer. But five programs can run si-

multaneously on a five-processor system and get the same performance as if each were running on its own system.

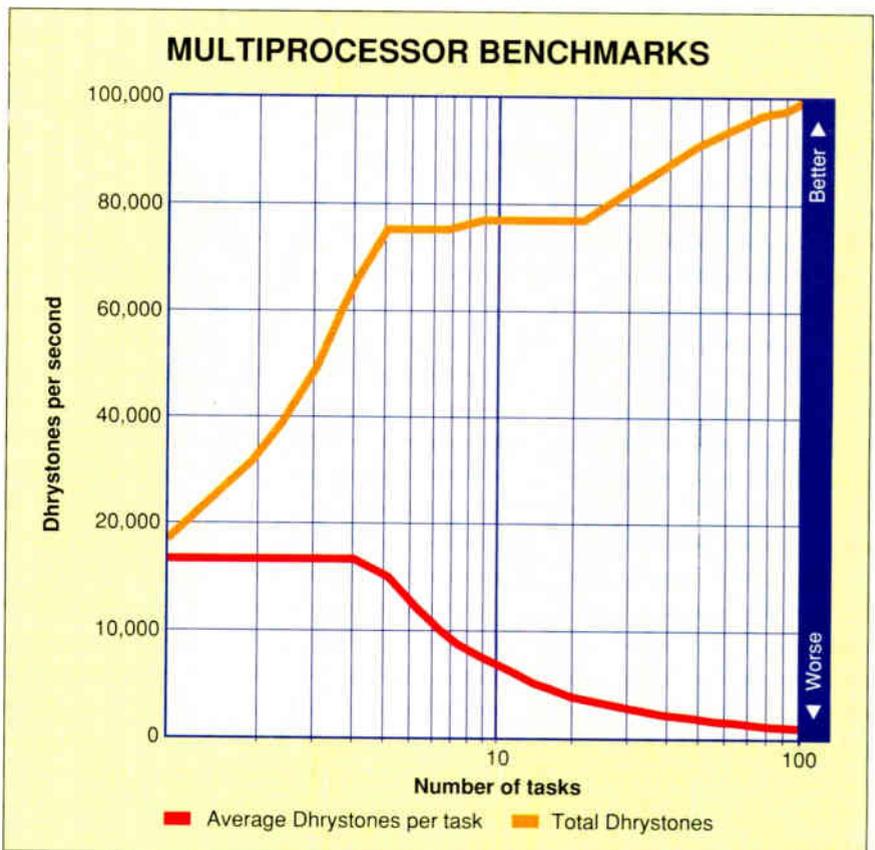
Don't confuse multiprocessing with its more sophisticated cousin, *parallel processing*. Computers that use parallel processing divide a task into many parts, run each part simultaneously on a different CPU, and then combine the results when the program finishes. This approach works well for a single, huge numerical simulation or for any problem that you can break down into separate sections and calculate independently.

processes. They don't take full advantage of this computer's multiprocessing power. When run on the MultiAccess system with the minimum of background multiprocessing administration, the standard benchmarks turn out results that are about the same as those produced on other single-processor 25-MHz i486 computers BYTE has tested.

As an alternative, the BYTE Unix Lab developed a simple multiprocessing benchmark that runs multiple, concurrent copies of the Dhrystone2 test used in BYTE's Unix benchmark suite. (Because of some program changes, the Dhrystone2 results in the Multiprocessor benchmark test aren't comparable to those in the Unix benchmark test.) I ran the test 13 times, increasing the number of concurrent tasks each time until I reached 100. Each test returned a separate Dhrystone result for each concurrent process.

The lower curve in the figure shows the average Dhrystones per task, which begin to drop after five concurrent processes. With five processes, it was clear which process was running on the 386 on the SCSI board. The processes running on the four i486 modules averaged 16,667 Dhrystones per second; the fifth process, running on the 386, generated just 8696 Dhrystones per second.

The higher curve in the figure adds the results for each test to illustrate the total amount of processing power available as a function of the number of processes running. Total CPU power increased linearly as I added up to five



BYTE's Multiprocessor test runs multiple copies of the Dhrystone2 test concurrently. I ran the test 13 times, adding more tasks on each pass. Each instance of the Dhrystone2 returns its own result. The lower curve expresses the results as average Dhrystones per task. The higher curve shows the aggregate Dhrystones for all tasks in a given test. While the average Dhrystones per task decline rapidly after five, the total number of Dhrystones increases until the number of tasks approaches 100.

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## ALR'S MULTIPROCESSOR

processes, after which the total Dhrystones began to climb more slowly, finally leveling off as the number of processes approached 100.

**Compute Server for the 1990s**  
The MultiAccess system is an impressive piece of hardware. With a full comple-

**F**ully configured, the MultiAccess system serves up to 160 users at an average cost of less than \$500 per user.

ment of 33-MHz i486 processors humming away, aggregate system performance should be capable of exceeding 150,000 Dhrystones per second. The system's outstanding performance and capabilities make it ideal for use as a compute server on a LAN, as well as for supporting many terminal users.

The cost of adding a single processor board to the MultiAccess is about what you would pay for a stand-alone i486 computer: \$5999 for a 25-MHz board and \$7499 for the 33-MHz unit. A fully loaded Model 20 with six 25-MHz i486 CPUs costs roughly \$60,000, depending on how much memory you add. Fully configured, the MultiAccess serves up to 160 users at an average cost of less than \$500 per user, excluding the cost of terminals (\$500 each).

The MultiAccess system is well suited to environments where many users must access the same large data sets and then run CPU-intensive analyses of the data. Its centrally located multiprocessor CPUs and disk storage make it easy to manage such a system, and adding new users is as easy as stringing a new serial cable. ■

John Unger is a scientist who works for the U.S. government in the Washington, DC, area. He can be reached on BIX as "junger."

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## HARDWARE

# SX Upgrade Boards: Not for the Fainthearted

STEVEN J. VAUGHAN-NICHOLS

**O**n the face of it, 386SX upgrade boards seem like a great idea. The millions of perfectly good AT-class computers in use are the equal of any 386SX personal computer in graphics, mass-storage, and memory capacities. Their only shortcomings are lack of speed and their inability to run 32-bit applications. Despite this, the market has been quite slow to accept 386SX upgrade boards. Two products that attempt to buck this trend and revitalize the legion of older 286 machines are Cumulus's 386SX and MicroWay's FastCache-SX.

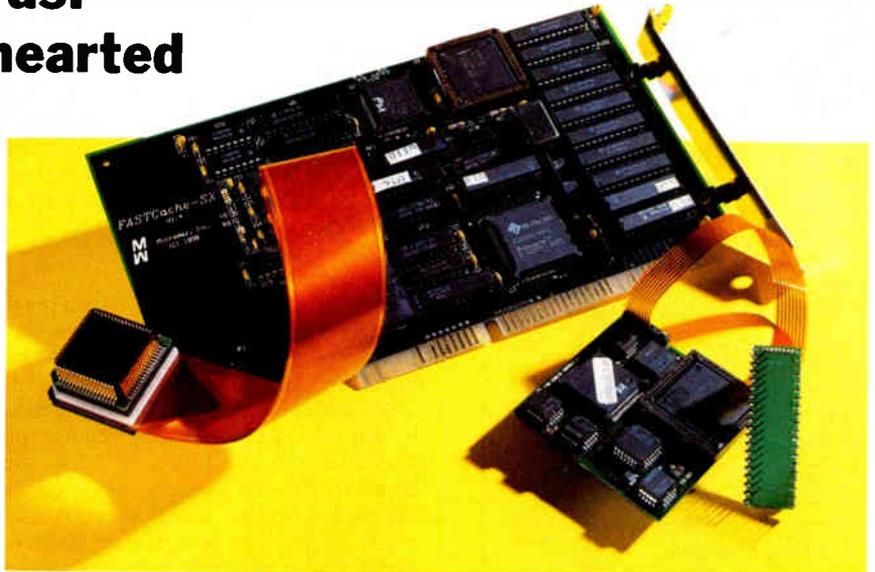
Both products have several strikes against them. Strike one: They're expensive. For the \$495 minimum price of an SX upgrade board, you can buy a brand-name SX motherboard from direct-mail distributors. Strike two: There can be as many potential compatibility problems lurking for users of SX upgrade boards as there are for someone who decides to replace the entire motherboard. I tested both boards on several machines, including a Compaq Deskpro 286 and several IBM PC clones, and recommend that only experienced PC users work with them.

### Cumulus 386SX

The Cumulus 386SX is a daughterboard that plugs into your system's CPU socket. It runs at the same clock speed as the original 286 CPU, so you're buying the advantages of a 32-bit processor and not a boost in speed.

The daughterboard itself is tiny—approximately the size of a 3½-inch floppy disk label—and it includes a socket for an 80387SX math coprocessor. It fits into AT systems that use either the pin-grid-array 286 processor socket or the plastic-leadless-chip-carrier (PLCC) socket. You can't use it in machines that use the three types of leadless-chip-carrier sockets. The daughterboard itself costs \$495. If you want to add a math coprocessor, you'll have to ante up another \$95 for a special cable kit. I tested the board with a math coprocessor installed.

Installation is a snap for old hands at



*The FastCache-SX upgrade board (left) fits into a 16-bit ISA slot and connects to an AT system's 286 socket by way of a special plug and cable. The Cumulus 386SX card (right) plugs directly into the 286 CPU socket. Both accept an 80387SX FPU.*

hardware tinkering, but hardware novices should seek expert help rather than attempt the operation themselves. In some cases, clearance around the CPU socket may prevent you from installing the daughterboard. Assuming you have room to install the card, the first step is to set the 386SX's speed with a jumper. Then you remove the 286 chip (PLCC sockets require a special extraction tool that Cumulus sells for \$50). Finally, you plug the daughterboard into the old socket. That's the basic procedure, but the exact method varies depending on your system's architecture. The installation guide covers these variations in painstaking detail.

That's the good news. The bad news is that merely installing the Cumulus board won't turn your AT into a 386SX-compatible clone. In fact, it may not work at all. Cumulus, like MicroWay, maintains a list of compatible machines. If your computer isn't on it, be ready for trouble. Fortunately, Cumulus will refund your money, plus return shipping, if you can't get the board to work.

Even in "compatible" machines, it's likely that your motherboard won't mesh perfectly with the new processor. This means that while some protected-mode software requires Cumulus software drivers to work properly, other software

(notably Windows 3.0) won't work right with the drivers installed. To the company's credit, a separate sheet documents these and other, more minor compatibility problems.

Another potential drawback with the Cumulus board is that, except for the CPU, it runs at the motherboard's clock speed. The CPU itself runs at twice the speed of the system up to the limit of its inherent capacity. This creates a data I/O bottleneck that keeps you from realizing the full advantage of the higher-speed processor.

You do get some performance advantages, but users looking for a performance boost will be disappointed. As the BYTE benchmarks show (see the figure), a Cumulus-augmented system was sometimes slower than an unmodified Compaq Deskpro 286. Some software, like the PKzip data-compression utility, detects the 386SX chip and uses 386-specific instructions to boost performance, but few other programs do this.

While no one is likely to buy this board for its speed, it does have other advantages aside from enabling the use of 386-specific software. The board comes with drivers and programs that make extended memory emulate LIM 4.0 expanded memory and let you use high memory for memory-resident programs.

*continued*

**BYTE ACTION SUMMARY**

■ **386SX UPGRADE BOARDS**

■ **WHAT THEY DO**

SX upgrade boards replace the 286 CPU in your AT system with a 386SX.

■ **WHAT YOU'LL LIKE**

Both products let you run 32-bit applications that require a 386-class CPU. The FastCache's on-board 16- or 20-MHz clock and 32K-byte CPU cache also make your old 286 system run faster.

■ **WHAT YOU'LL DISLIKE**

Installation can be a nightmare—particularly with the FastCache board—and you may encounter additional software compatibility problems after you get the system running. Both boards are also relatively expensive.

■ **WHAT WE RECOMMEND**

Buy only if the vendor has tested its board with your computer. The Cumulus board offers 386 compatibility but no performance gain; the FastCache offers both. Consider, however, that you can buy a comparable 386SX motherboard by mail order for less than the cost of either of these upgrade boards.

■ **WHAT YOU'LL PAY**

\$590 for the Cumulus 386SX card with connector cable; \$690 for the MicroWay FastCache-SX 20-MHz 386SX board with 32K bytes of SRAM cache and cable.

■ **FOR MORE INFORMATION**

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

Circle 1229 on Inquiry Card.

MicroWay, Inc.  
Research Park  
P.O. Box 79  
Kingston, MA 02364  
(508) 746-7341  
fax: (508) 746-4678

Circle 1230 on Inquiry Card

These procedures aren't as smooth as those of QEMM from QuarterDeck, but they do increase the board's utility.

Another plus for Cumulus is that the technical documentation, while brief, is complete and to the point. Cumulus technical support is provided by a toll telephone line. The knowledgeable and helpful technical staff quickly and promptly answered my questions. Given the array of possible compatibility problems from this type of upgrade, I can't overstate the importance of good support.

**MicroWay FastCache-SX**

Unlike the Cumulus 386SX, which plugs directly into the CPU slot, the MicroWay FastCache-SX is a three-quarter-length board that fits into any 16-bit ISA slot. You connect the board to the CPU socket by way of a cable. This approach uses up a slot in your machine and limits the board to ISA-bus systems. MicroWay's approach also has its advantages: The board includes its own 16- or 20-MHz clock, and it uses a 32K-byte on-board processor cache (problems with correctly monitoring DMA preclude on-board caching with the Cumulus design). The board also has a socket for an 80387SX math coprocessor.

The boards start at \$495 and \$595 for the 16- and 20-MHz versions, respectively. You'll also need the cable that connects the board to the CPU socket. MicroWay sells this separately for \$95. My 20-MHz 386SX board included an additional 32K bytes of cache RAM (\$70), which brought the total price for my upgrade to \$760. As this went to press, MicroWay announced the FastCache Plus, a full-length board that holds a CPU and up to 8 megabytes of system RAM. MicroWay charges a \$100 premium for the board, which should perform memory accesses faster.

It's not surprising that the FastCache is much faster than the Cumulus board. It zoomed by the Cumulus board on most tests. Part of the FastCache performance is due its 25-nanosecond static RAM cache, which maintains compatibility with the slower motherboard and bus. An Austek controller directs the cache and lets the SRAM function without wait states. You run a utility to enable the cache and determine what system functions to place in it. Once you have determined what options to use, you activate the cache with the appropriate flags in your AUTOEXEC.BAT file.

However, the instructions don't tell you how to determine the appropriate options. Despite an expert knowledge of computers and a careful reading of the

manual, I could only pick up bits and pieces of the answer. Trial and error while running system benchmarks and supplied test programs was the best I could do.

Even with the cache on its best behavior, a FastCache system can run into compatibility problems. You might find interaction problems between extended memory and the board. For such problems, MicroWay supplies a utility that takes over the system services interrupt to improve performance. The problem with this approach is programs like Windows 3.0's SMARTDRV disk cache, which also use this interrupt.

But even these software aids may not be enough to get your system up and running with the FastCache. For example, your BIOS might not be able to cope with the faster processor speed. The most common symptom is intermittent problems with floppy disk drive access. The fix for this, as described in the manual, is to upgrade your BIOS (MicroWay sells a compatible Phoenix 386 ROM BIOS for \$50).

**Installation Blues**

MicroWay claims that you can install the FastCache in any AT. I didn't find this to be the case—and I know my way around under the hood of a PC clone. And the testing engineers in the BYTE Lab are masters at installing recalcitrant hardware. Despite our combined efforts and extensive MicroWay technical assistance, we failed to get the board up and running on AT clones from Austin, Gateway, and Swan. In working to resolve these problems, MicroWay discovered a compatibility problem with 286 systems that use the Chips & Technologies Neat chip set. MicroWay was designing a fix at press time.

We did get the board to work on a Compaq Deskpro 286, but even that was a chore. One aspect of the installation involves inserting a plug into the 80287 socket. In the Deskpro 286, and only in this system, you must cut the connection between pins 25 and 26 on the plug. Another problem is access. In many cases, drive bays and other components block access to the CPU and/or FPU socket, which means pulling the motherboard to complete the installation.

I recommend that only the most grizzled hardware veterans try to install the MicroWay board. The manual won't be much help. It's poorly organized and lacks an index. Luckily, MicroWay has excellent technical support that's only a toll call away. Better yet, you can have TRW, a company specializing in on-site

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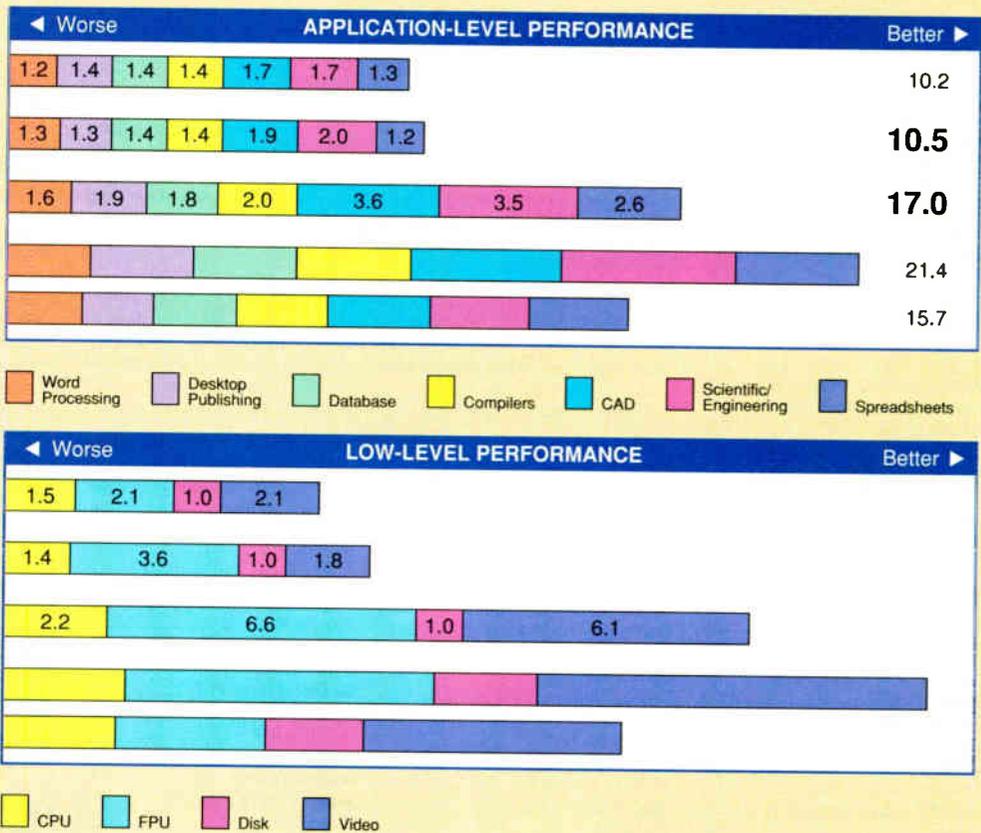
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<b>Cumulus 386SX</b>	0.08	3344
<b>FastCache-SX</b>	0.15	6618
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Zeos 386/SX	0.08	5760

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 performance differences between machines 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 Borland 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 2.0 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.

computer repairs, install the board for you for an additional fee. But why bother? All the help in the world may not be enough. When the FastCache works, it works like a dream. But it doesn't always work.

As stated earlier, the company does maintain a list of systems that the board works with, and you'd be well advised to stick to that list. If you do venture into unexplored territory, MicroWay has a 30-day money-back guarantee and will pay for return shipping if the board does not work.

Three Strikes

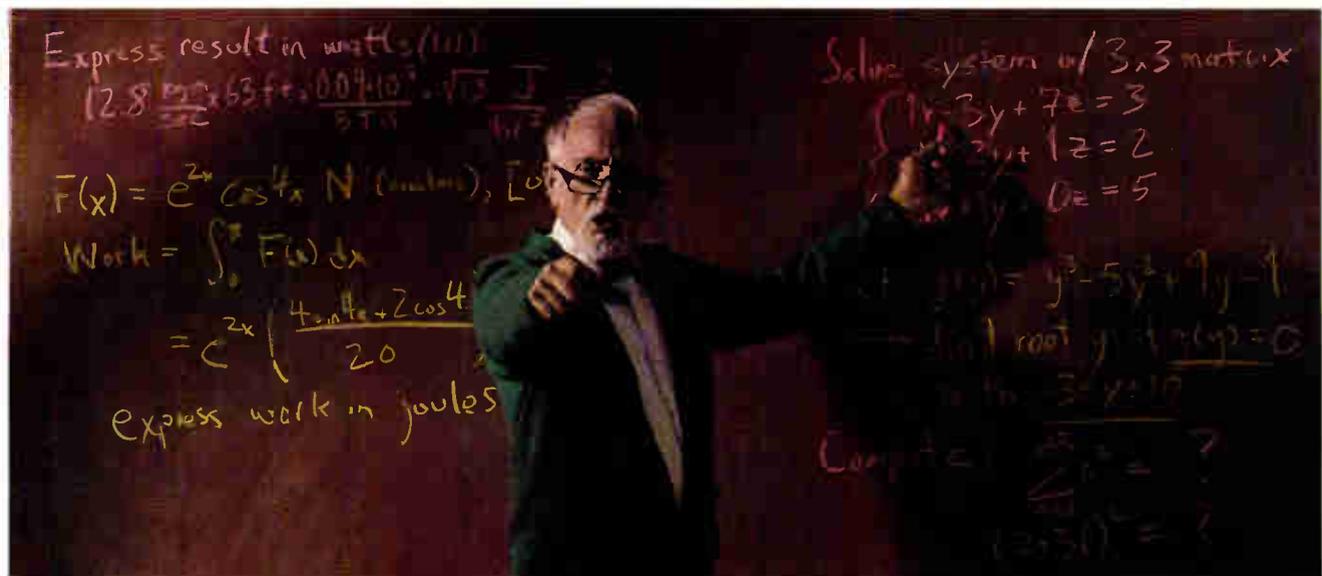
You'll need technical expertise and patience to install either of these boards. Even when they work, you'll probably run into some software incompatibilities. And the prices are just too high for what you get.

However, if you're convinced that an upgrade board is the way to go, and you're not a hardware wizard, the Cumulus 386SX is the better choice. It won't, however, boost performance substantially. If you know the interrupt tables better than the multiplication tables and are

willing to spend extra money for better performance, give the MicroWay FastCache a try. Better yet, invest in a new 386SX motherboard. You can buy a 16-MHz 386SX motherboard and 1 MB of RAM for less than \$400 by mail order. Installing it takes a little bit more work, but you will probably be happier in the long run. ■

Steven J. Vaughan-Nichols is a freelance writer and a consultant in Lanham, Maryland. You can reach him on BIX as "sjvn."

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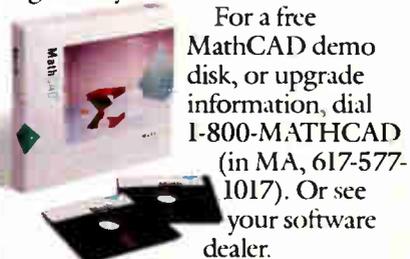
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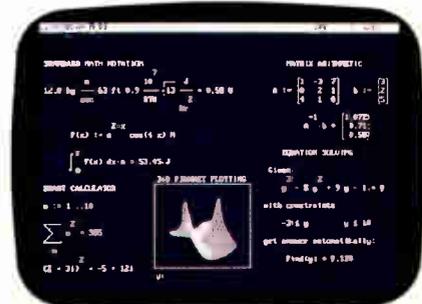
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## Corel Draw Ups the Ante in Windows-Based Graphics



**Photo 1:** Previous versions of Corel Draw stopped at producing flat, two-dimensional text and images, such as the label on the left. Version 2.0 expands these capabilities to include 3-D representations, such as the soup can on the right.

program generated an "Unrecoverable Application Error" message and exited to DOS. The company is now aware of the problem and expects to solve it by the time you read this.

### New Toolbox

In Corel Draw, each part of the screen is active. A mouse-click on the page outline accesses page-layout controls. You can pull the rulers to place guidelines anywhere on the screen. (You can "snap-to" guidelines as well as snap-to the grid.) A mouse-click in one of the ink pots at the bottom of the screen provides a quick way to color outlines and fills.

Corel Draw has few drawing tools, but the ones it has offer many capabilities. The Pencil tool can now draw in Bézier mode. The Text tool sets string text to which you can apply special effects, such as fit to shape and extrude and blend, and paragraphs for large blocks of text. The tool also accesses the 3000-image symbol library. You select a category, scroll through a garden of images, and pick the one you want. You can scale the image before it's brought into the drawing.

The company also enhanced the color in its new version. The program provides only two palettes: process and spot (Pantone) color. However, you can extend the palettes using CMYK (cyan, magenta, yellow, black), RGB, or HSB (hue, saturation, and brightness) color models, or by rearranging the palette display. You can also name the colors.

The Pen tool lets you design your own arrowheads, in addition to the 87 that the package supplies. You can have dotted, dashed, and solid lines, as well as any custom combination.

The new version also gives you more control over fills. You can specify the number of fountain-fill bands and rotate linear fills. You can fill objects with supplied bit maps and vector images, or you can make up your own.

I wrote part of this review in Corel Draw. That's not as crazy as it sounds. Paragraph text can hold up to 4000 characters in one box, with an unlimited number of boxes per drawing. In addition, you can set the number of columns, specify the justification, and determine the font, point size, and leading to make copyfitting a whole lot easier. You can then extract the text from a drawing, run it through a spelling checker, and bring it back to the image. Or you can create the text in a word processor and import it as ASCII text into the drawing.

As you type, Corel word-wraps within

### BYTE ACTION SUMMARY

- **COREL DRAW 2.0**
- **WHAT YOU'LL LIKE**  
The capability to produce three-dimensional text and images, special effects, and Adobe Type 1 fonts within a simple-to-use interface.
- **WHAT YOU'LL DISLIKE**  
Slow redraws of complex objects and a rescaling bug that becomes apparent when working with rulers set in points or picas. Check with the vendor about a bug fix before buying or upgrading.
- **WHAT YOU'LL PAY**  
\$695 (price does not include Windows 3.0, which is required)  
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Version 2.0 of Corel Draw is a major upgrade of the deservedly popular Windows drawing package. (For a review of version 1.1, see "Corel Draw Shows Great Promise" in the June 1989 BYTE.) The latest version addresses the needs of the serious graphic artist and automates the artistic process for those without formal training who often have to create presentations and promotional materials.

Among the new elements in this Windows 3.0 version is an Effects menu for blending two objects, adding vanishing-points perspective, creating three-dimensional extrusions, and *enveloping* (i.e., distorting shapes by manipulating a "bounding" box). Expanded text facilities include extracting and merging text blocks, print merges, and even designing your own Adobe Type 1 fonts. New Tools functions offer greater positioning control, interruptible redraws, full-screen preview, and improved import and export, including the ability to export a portion of a drawing in Corel Draw format. I particularly liked the visual file manager and dialog-box previews that are big enough to see with the naked eye.

However, redraws of complex, filled objects were painfully slow, and my evaluation program wasn't without bugs. When I tried to rescale complex drawings with rulers set in points or picas, the

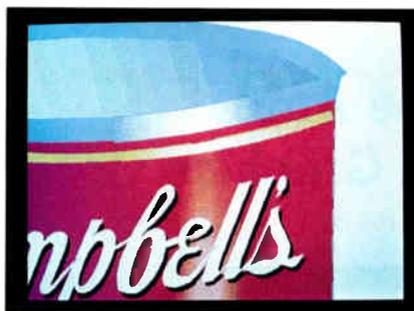
the window box, but you won't see how it looks on the page until you exit the paragraph text window. In the display, you can selectively change kerning, fonts, spacing, and text rotation. Changing the paragraph box size changes margins, not the font size.

**3-D Made Easy**

A picture is worth a thousand words, so to test some of the enhancements in version 2.0, I recreated the 2-D soup can label from my version 1.1 review and turned it into a 3-D soup can (see photo 1). I tested Corel Draw on a Gateway 2000 386/33 with an ATI Wonder+ (800- by 600-pixel, 256-color) driver.

The conversion from 2-D to 3-D was easy. Highlights were simply a matter of blending two objects. Blends were so easy and fast that I kept trying variants, such as adding increments and changing colors. To curve the objects to a can shape and scrunch the sides, I grouped the objects, applied the envelope effect, and used snap-to guidelines to position envelope nodes precisely. Corel Draw did the rest of the work.

The can top started life as an ellipse,



**Photo 2:** *The can top was created by first drawing an ellipse, which was then reshaped using a perspective tool and filled with graded shading.*

and then I reshaped it with a perspective tool and filled it with a 60-degree linear fountain for realistic shading (see photo 2). I tried several ellipses before I got it right. The hardest part was the can rim, which turned out to be trivial once I realized that I could add my own arrowheads to a line. I added a vertical vanishing-point perspective to the complete can so that it would look real, right down to the dent that the supermarket bagger gave it.

By the time I got to the rim, the draw-

ing was complex, and the split-screen redraw was slow. As I mentioned earlier, rescaling with rulers set in points or picas caused Corel Draw to bomb, but the final results more than compensated for any problems.

**2.0 Kudos**

Compared to competitors like Micrografx's Designer 3.0 (see "New Adventures in Graphic Design," August 1990 BYTE), Corel Draw 2.0 is my choice for drawing software. With all its embellishments, it's still easy to use; its interface is still intuitive.

Also, the pictures look great. My boss, who knows the limits of my artistic ability, looked at a printout and asked, "You did that?" I couldn't have done it without this new version. I'm delighted with Corel Draw because it makes me look so talented. ■

—Sue Rosenberg

*Reviewer's Notebook provides new information—including version updates, new test data, long-term usage reports, and reader feedback—on products previously reviewed in BYTE.*

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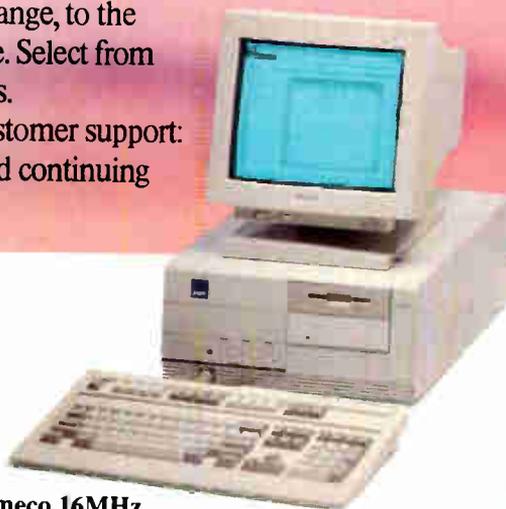
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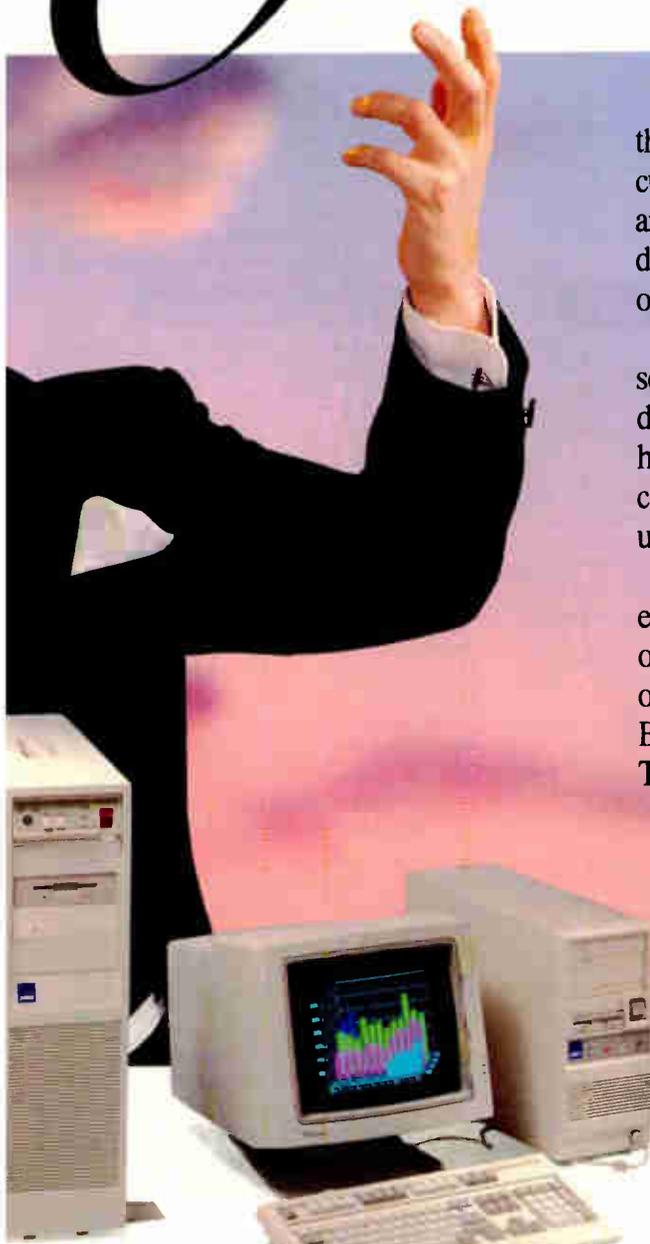
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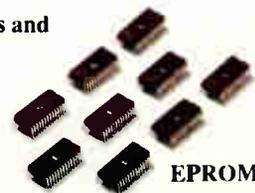


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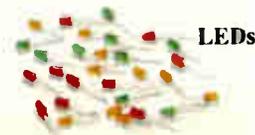
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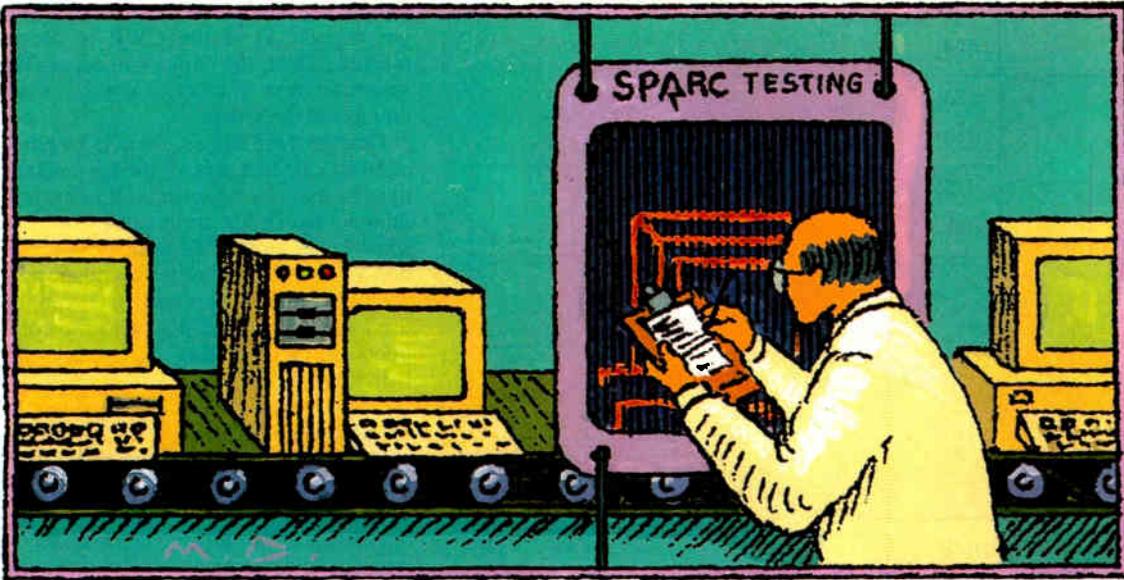
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## SPARC REVEALED



**I**n 1987, Sun Microsystems announced the Sun-4, the first computer system based on a new CPU architecture called *SPARC* (Scalable Processor Architecture). Unlike the Motorola 68000 family of microprocessors in Sun's earlier workstations, SPARC was a RISC processor. The CPU was contained in a 20,000-gate Fujitsu array when most commercial microprocessors were five to 10 times more complex. Also unlike the others, which were second-sourced by few vendors, SPARC was positioned as an open architecture that was clonable by all. Sun hoped this would eliminate dependence on any one chip vendor.

Since that time, SPARC has become more than a CPU architecture. It's a family of standards; an array of chips from at least half a dozen vendors; a vehicle for standardized, shrink-wrapped Unix software; and the foundation upon which dozens of manufacturers are basing new workstation products.

Licenses with current or potential SPARC implementations include Fujitsu, Cypress Semiconductor, Bipolar Integrated Technology, LSI Logic, Texas Instruments, Solbourne/Matsushita, Philips, Harvest VLSI Design Center, and Systems and Processes Engineering. BIT is working on the first emitter-coupled logic SPARC implementation, while LSI Logic, TI, and Cypress are racing to develop next-generation super-scalar SPARCs. Fujitsu's Sparclite chip set is designed to address the embedded market and includes two universal asynchronous receiver/transmitters, an in-

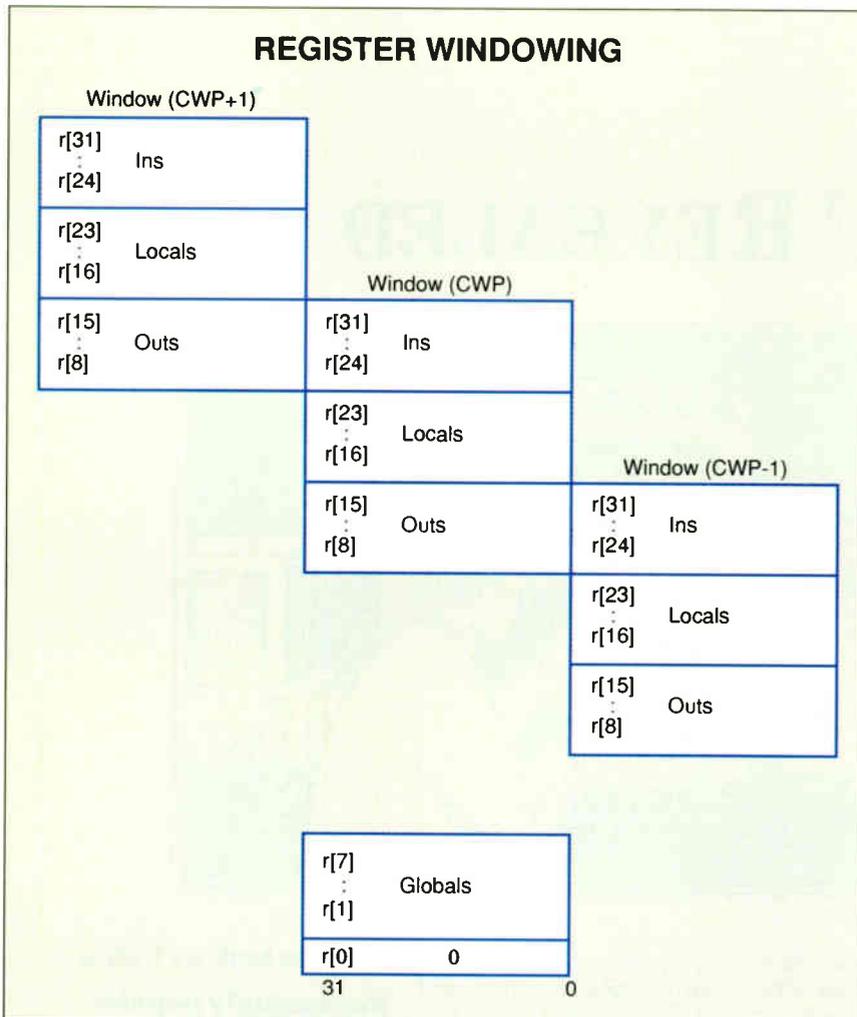
terrupt controller, counter/timers, DRAM refresh, and 2K-byte on-chip instruction and data caches.

Workstation vendors include Solbourne, CompuAdd, Solarix, Mars Microsystems, Opus Systems, ICL, Meiko, Tatung, Toshiba, RDI, and others. Systems range from large file servers, such as ICL's symmetrical multiprocessing servers, to RDI's laptops. Some vendors buy their system boards from Sun or license a design created for LSI Logic by Opus Systems; others have designed unique implementations.

### A Classic RISC

To understand SPARC, you must understand RISC. The RISC architectural philosophy evolved from research projects at the University of California at Berkeley and Stanford University in the early 1980s. Instead of following the trend toward larger and more complex CPU architectures, these research groups favored CPU speed and simplicity. They believed program memory consumption and ease of assembly language programming were justifiable trade-offs for improvements in optimizing compiler technology (which made assembly language coding less necessary) and decreases in the price of RAM (which made it less important to have a

**A close look at Sun's increasingly popular architecture for high-performance workstations**



**Figure 1:** SPARC's register windows consist of 24 32-bit registers each, with eight registers of overlap between successive windows. Because parameters can easily be passed in registers, the register file replaces the processor stack for many applications. (Courtesy of Sun Microsystems)

tightly packed instruction set).

The products of RISC development efforts have many features in common, and all are part of the SPARC architecture (see the text box "RISC Basics" on page 298). SPARC borrows its basic instruction formats and register-windowing scheme from early influential RISCs. Most RISC chips use pipelining to allow concurrent execution, and SPARC is no exception. However, unlike the MIPS chips, which allow software to control the pipeline, SPARC implements pipelining in hardware to allow implementations to work in different ways.

#### A CPU with Windows

An important concept of SPARC architecture—borrowed from the Berkeley RISC chips, the TMS 9900, and other

"workspace" machines—is *register windowing* (see figure 1). At any given moment, a program running on SPARC has access to 32 32-bit processor registers. These include eight global registers (g0–g7) plus 24 registers that belong to the current register window.

The first eight registers in the window are called the *in* registers (i0–i7). When a function, or main program, is invoked, these registers may contain arguments for that function to use. The next eight registers are the *local* registers; these are scratch registers that can be used for any purpose while the function executes. The last eight registers are the *out* registers; the function uses these to pass arguments to functions it calls.

When one function calls another, the callee can choose to execute a SAVE in-

struction. This instruction decrements an internal counter, called the *current workspace pointer*, shifting the register window downward. The caller's out registers then become the callee's in registers, and the callee gets a new set of local and out registers for its own use. Note that only a pointer has changed; the registers do not need to be saved on a stack. The return address also does not need to be put on a stack; the CALL instruction automatically saves its own address in o7 (output register 7), which becomes i7 (input register 7) if the CWP is decremented. Thus, the callee can access the return address whether or not it has decremented the CWP.

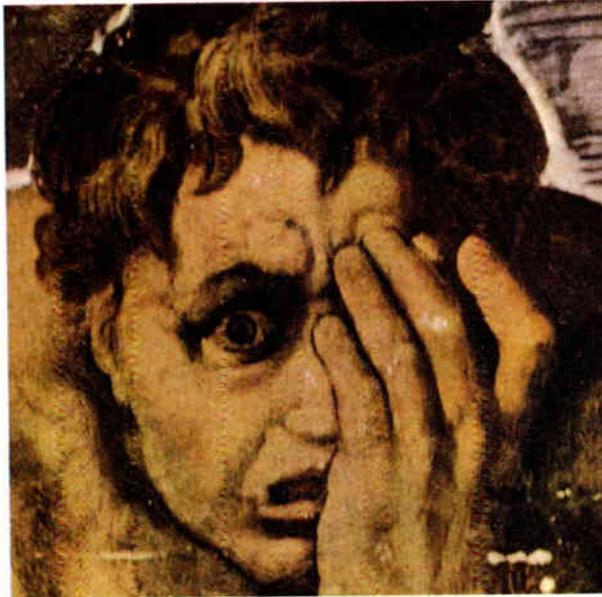
Despite their names, there is no hard-and-fast rule that says all the ins and outs must be used for arguments. If a function does not have eight arguments, it can use some ins as temporary storage if they're not already being used for other purposes. Similarly, unused outs can be used as temporaries; it's up to the compiler and the operating system to establish conventions.

Register windows are also used to save the processor context when traps, or interrupts, occur. SPARC operating systems ensure that there is always an unused register window below the current one. If a trap occurs, the CWP is decremented, and the new window saves the processor context. Traps on SPARC are vectored, making them fast compared with some other RISCs.

The original SPARC chip, as implemented by Sun, had seven overlapping windows, bringing the total number of registers to  $7 \times 16 + 7$  (not counting g0), or 119 registers. (Large numbers of registers are a hallmark of RISC chips.) But what happens if, due to recursive or deeply nested function calls, six levels are not enough? In this case, when the program attempts to decrement the CWP into the last unused window (which must be reserved for trap handling), it discovers that the window has been marked *invalid* in a register called the *window invalid mask* register. This causes a trap, and the processor has an opportunity to "spill" registers to make more room. That is, it writes the contents of some of them out to memory.

Similarly, a long series of subroutine returns can cause a window underflow, which causes the processor to call in a trap handler to fill registers from memory. Application programs don't know—and, in fact, cannot know unless the operating system is willing to tell them—how many register windows the CPU actually has. All spilling and filling of

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# RISC Basics

**W**hat distinguishes a RISC from other CPUs? While there are many variations on the theme, most RISC processors have the following attributes in common:

*Fewer instructions.* Studies in the early days of RISC showed that most compilers used only 30 percent of the instruction sets of some complex instruction-set computers (CISCs), such as DEC's VAX, and of those, they used 20 percent of the instructions more than 80 percent of the time. RISC processors attempt to implement only that 30 percent, allowing the chip to be smaller, cheaper, and (in theory) faster.

*Fewer instruction formats.* To maintain simplicity within the CPU design, RISCs generally have only a handful of possible instruction formats. Usually, all instructions are the same length: one word. Note that instructions and data words are the same size on most processors. This implies that it can take more than one instruction to load an arbitrary constant into a register. This is true on SPARC, where there's no load-constant instruction per se and room only for a 13-bit immediate operand in the arithmetic and logical instruction formats.

How, then, do you load a constant into a SPARC register? You can set the low 13 bits of register `i0` and clear the rest with an instruction such as `add %g0, const, %i0`. (The register `g0` always yields the value 0 when read.) Likewise, you can set the high bits of a register by executing an instruction called `SETHI`, which loads the upper 22 bits and zeroes out the rest. A `SETHI` and an `add` are sufficient to produce any 32-bit constant. However, because most constants used in computer programs are small positive and negative numbers, a single `add` or `or` instruction suffices in most cases.

*Dummy registers.* As shown above,

most RISCs have a dummy register (`g0` on SPARC) that yields the value 0 when read and discards any value written to it. Using such a register as a source operand provides a convenient way to turn an instruction with two sources into an instruction with a single source without complicating the instruction set. Using a dummy register as a destination allows an operation to be executed strictly to set the condition codes. On SPARC, the pseudo-instruction `cmp %i1, %i2` is assembled as the subtract instruction `subcc %i1, %i2, %g0`.

*Load/store architecture.* The only operations available to manipulate external memory are loads and stores; all other instructions affect only the on-chip registers. However, some processors, including SPARC, bend this rule and implement atomic load/store instructions. These instructions, which may include test-and-set or swap operations, facilitate the design of multitasking and multiprocessing systems.

*Limited addressing modes.* A processor that conforms strictly to the minimalist RISC philosophy does all address calculations in registers and has only one addressing mode: indirect through a register. However, most real-life chips, including SPARC, have register-plus-displacement modes. SPARC is unusual among RISCs in that it has a third addressing mode, which forms a memory address by adding the contents of two internal registers. Thus, in systems without memory management units, one register can hold the base address of a process's memory space, while another is used as an index into that space.

*No microcode.* Because one CISC instruction can perform many functions, CISC code takes up less memory space and bus bandwidth than equivalent RISC code. RISC proponents argue,

however, that this is an artifact of the early days of computers when RAM was more expensive than it is now. The RISC philosophy states that better cost/performance can be gained by eliminating microcode and by hard-wiring instruction decoding and sequencing. Simple instruction formats make this approach practical.

*Single-cycle execution.* Most RISC instructions are simple enough to require only a single cycle to execute. Many, however, require multiple cycles for loads, stores, or complex operations such as multiplication and division.

*Many on-chip registers.* Most RISCs, including SPARC, have ample on-chip storage for intermediate results, which minimizes time-consuming memory operations. The first SPARC implementation had 119 32-bit registers.

*Deferred jumps and calls.* Instructions that transfer control from one portion of a program to another are difficult to execute in just a single cycle. Typically, loading the processor's instruction pointer takes one instruction time, while fetching the first instruction from the new routine takes another. To avoid wasted time, many RISCs allow an additional instruction to be inserted into the "delay slot" before the branch is actually taken. SPARC does this; what's more, it annuls (i.e., does not execute) the delay instruction if a conditional branch is not taken.

All these characteristics are typical of RISCs, but experts still differ on precisely what constitutes a RISC and what does not. Since RISC has come into vogue, the RISC-iness of different architectures has become a religious issue, and virtually every manufacturer touts the RISC-like aspects of its products. Even Intel, in its marketing pitch for the i486, claims that this CISC has a RISC at its core. ■

registers is invisible to an executing user program. The program's only responsibility is to allocate space, most often on a stack, to save its registers during a context switch.

Spilling and filling registers is an essential part of Unix multitasking on SPARC. During a context switch, most

SPARC operating systems, including Sun's SunOS, spill the active register windows so that the entire CPU is available to the next process that runs. SPARC critics note that saving so much context incurs a great deal of overhead. However, the designers argue that since function calls are more common than context

switches, more time, on average, is saved than lost by this architecture. SPARC proponents also claim that Unix context switches are so time-consuming that juggling registers consumes only a fraction of that time.

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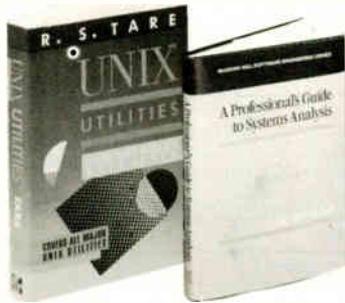
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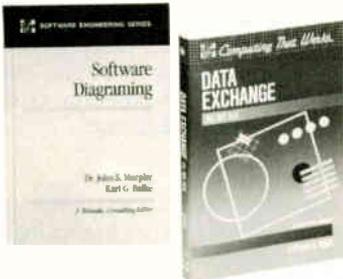
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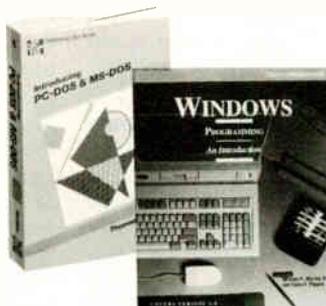
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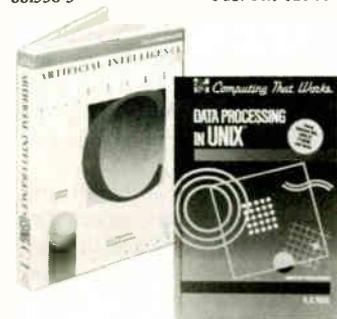
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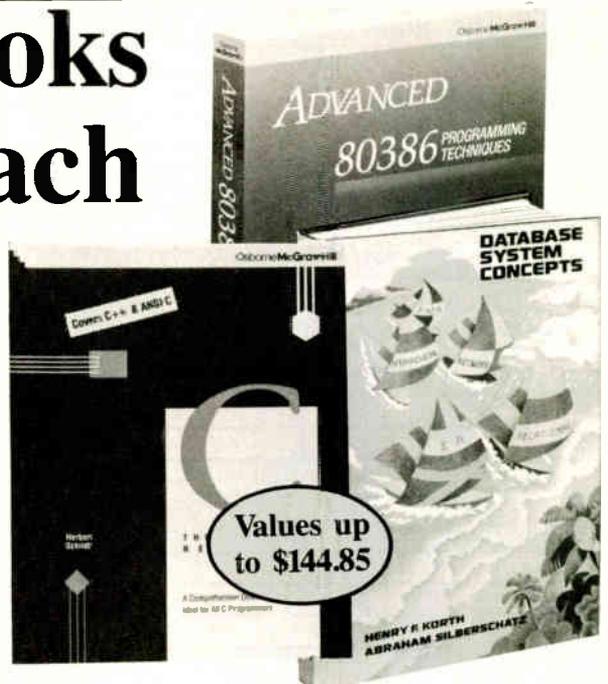
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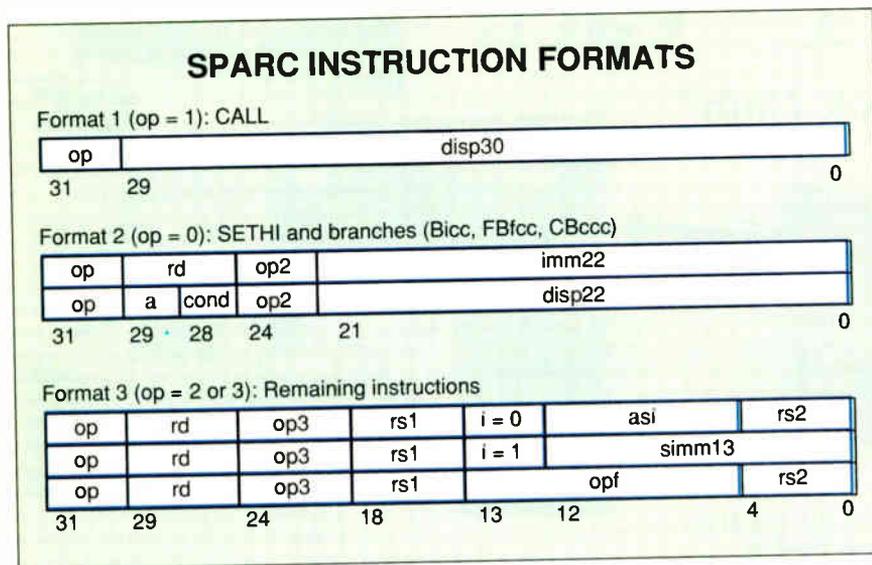
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**Figure 2:** SPARC has only three instruction formats. One is used exclusively for unconditional subprogram calls, while the others are used for SETHI, branches, and arithmetic and logical instructions. (Courtesy of Sun Microsystems)

They can confine each of the processes in a multitasking system to a smaller group of register windows that are always in the processor and ready for use. This mode of operation is not the norm on Unix systems, but it is useful in compact real-time executives such as Ready Systems' VRTX.

#### Why Scalable?

Why did Sun pick the name *Scalable* Processor Architecture? The acronym can be interpreted in three ways—two technical, one anecdotal. First, the on-chip register file is scalable; it can easily be enlarged from eight windows (which is its size in most current implementations) to 32 windows. With a large register file, registers for multiple processes, or *coroutines*, could reside in the CPU concurrently.

Second, SPARC's proponents claim, as do all RISC enthusiasts, that because the architecture is relatively simple, it's easy to scale a particular chip design to use smaller signal paths and transistors, resulting in tinier, faster chips. This is somewhat misleading, since SPARC isn't the only architecture for which this argument is made. All RISC manufacturers claim a similar degree of scalability; even complex instruction-set computer proponents argue (with some justification) that a thoughtfully designed CISC is every bit as scalable as a RISC.

The third interpretation—an interesting historical footnote—is that the *S* in SPARC originally stood for *Sun*. Silicon Valley folklore says that Sun Microsys-

tems changed the official expansion of the acronym when it decided to embark on its open architecture strategy.

#### A Simple Instruction Set with a Few Surprises

The SPARC instruction set is like that of the Berkeley RISC chips in that it has three possible instruction formats (see figure 2) and 74 possible instructions (see the table), including the floating-point operations. Because the architecture standard requires SPARC processors to look the same only to applications (not to the operating system), virtually any instruction can be emulated if hardware isn't present to perform it. For example, Fujitsu's Sparclite, an inexpensive implementation of SPARC designed for embedded applications, emulates floating-point operations in software.

The integer data types SPARC supports are signed and unsigned bytes, 16-bit halfwords, 32-bit words, and 64-bit doublewords. Also, there is a tagged word format in which the 2 least-significant bits serve as flags to indicate the type of the object. In SPARC SmallTalk and Lisp implementations, these bits are both 0 when the rest of the bits contain a 30-bit integer. Otherwise, they flag the uppermost 30 bits as a word-aligned pointer to an object of a different class.

SPARC floating-point numbers can be 32 (single), 64 (double), or 128 (quad) bits long; they conform to the IEEE 754 standard. The quad format—new in version 8 of SPARC and seldom before implemented in any architecture—uses a

112-bit mantissa for applications requiring incredible floating-point precision. The floating-point unit has 32 32-bit, nonwindowed registers, which must be saved on a per-context basis.

Like the 68000, SPARC is "big-endian"—it stores multiple-byte objects in memory with the most significant byte at the lowest address. This was a necessary choice for Sun, because it facilitates the implementation of Sun's "big-endian" protocols: remote procedure call (RPC), external data representation (XDR), and Network File System (NFS). These protocols can put "little-endian" chips, like the Intel 80x86 family, at a disadvantage when communicating—a penalty that was severe enough to motivate the addition of a new "byte swap" instruction to the i486. Floating-point operations are specified so that they can execute concurrently with integer instructions, but they must appear to the program as if everything was done in sequence.

#### Delayed Branches

Among the interesting characteristics of SPARC is the way it handles branching. Many RISC architectures have delayed branches—that is, the instruction following a branch instruction is executed while the processor prepares to transfer control to the destination. SPARC, however, implements a novel feature (seen also on the Hewlett-Packard Precision Architecture): an *annul* bit, which allows the processor to annul the effects of the delay instruction following a conditional branch if that branch isn't taken. On processors that implement delayed branches but cannot annul the delay instruction, the compiler must try to fill the delay slot with a useful instruction whether or not the branch is taken. If, however, the delay instruction can be annulled, the obvious candidate is the instruction that would otherwise reside at the destination of the branch. Thus, SPARC compilers are more likely than those for other RISCs to fill the delay slot with a useful instruction.

A useful feature for unconditional branches is a *branch always* instruction, which can be made to unconditionally annul the subsequent instruction. This is useful for debuggers, where it's desirable to replace a single instruction with a branch to a debugging routine.

#### The Architecture Evolves

The original SPARC architecture was remarkable for its omissions as well as its special features. Most glaring of the omissions was the lack of integer multiply, divide, and remainder instructions.

## SPARC INSTRUCTION SET

Although true to the minimalist RISC philosophy, the SPARC instruction set exposes certain special features, such as register windowing, to program control (N/A = not applicable).

Loads	Stores	Object to be loaded/stored
LDSB/LDSBA	STSB/STSB	Signed byte
LDSH/LDSHA	STSH/STSHA	Signed halfword
LDUB/LDUBA	STUB/STUBA	Unsigned byte
LDUH/LDUHA	STUH/STUHA	Unsigned halfword
LD/LDA	ST/STA	Word
LDD/LDDA	STD/STDA	Doubleword
LDF	STF	Floating point
LDDF	STDF	Double floating point
LDFSR	STFSR	Floating-point state register
N/A	STDFQ	Double (from floating-point-deferred trap queue)
LDC	STC	Coprocessor
LDDC	STDC	Double coprocessor
LDCSR	STCSR	Coprocessor state register
N/A	STDCQ	Double (from coprocessor-deferred trap queue)

A at end of instruction = alternate address space

### Cosmic load/store and synchronization

LDSTUB/LDSTUBA	Atomic load/store unsigned byte
SWAP/SWAPA	Swap register with memory
STBAR	Store barrier
FLUSH	Flush instruction memory

### Special register manipulation

RDASR/WRASR	Read/write ancillary-state register
RDY/WRY	Read/write y-register (used in integer multiply/divide)
RDPSR/WRPSR	Read/write processor-state register
RDWIM/WRWIM	Read/write window-invalid mask
RDTBR/WRTBR	Read/write trap-base register

### Logical/arithmetic

AND/ANDcc	AND
ANDN/ANDNcc	AND NOT
OR/ORcc	OR
ORN/ORNcc	OR NOT
XOR/XORcc	XOR
XNOR/XNORcc	XOR NOT
ADD/ADDcc	ADD
ADDX/ADDXcc	ADD with carry
SUB/SUBcc	SUB
SUBX/SUBXcc	SUB with borrow
MULScc	Multiply step
UMUL/UMULcc	Unsigned multiply
SMUL/SMULcc	Signed multiply
UDIV/UDIVcc	Unsigned divide
SDIV/SDIVcc	Signed divide

TADDcc/TADDccTV Tagged ADD  
TSUBcc/TSUBccTV Tagged SUB

cc = set condition code based on result

ccTV = modify condition codes and trap on overflow

### Floating point

F(i,s,d,q)TO(i,s,d,q)	Conversions between integer, single, double, quad
FMOV <sub>s</sub> /FNEG <sub>s</sub> /FABS <sub>s</sub>	Move between floating-point registers with absolute values or negatives
FSQRT(s,d,q)	Square root
FADD(s,d,q)	Add
FSUB(s,d,q)	Subtract
FMUL(s,d,q)	Multiply
FDIV(s,d,q)	Divide
FCMP(s,d,q)	Compare
FCMPE(s,d,q)	Compare with exception if unordered
FsMULd	Multiply single, result to double
FdMULq	Multiple double, result to quad

### Branches, calls, jumps

Bicc	Branch on integer condition code
FBicc	Branch on floating-point condition code
CBicc	Branch on coprocessor cc
CALL	Call and link (return address < 07)
JMPL	Jump and link (return address < 07)
RETT	Return from trap
Ticc	Trap on integer condition code

### Register window management

SAVE	Save caller's window
RESTORE	Restore caller's window

### Miscellaneous

SETHI	Set high bits of register
NOP	No operation
UNIMP	Unimplemented (causes trap)

### Coprocessor

CPop (implementation dependent)

Multiplication was accomplished by a "multiply-step" instruction (executed several times to multiply two registers together) or by shifts and adds (when one operand was a constant). Division was done entirely in software.

Many of the trade-offs in the original SPARC architecture were based on statistical studies, which showed that certain features—such as hardware multiply—would not enhance performance on an average system. But as Michael Slater, publisher of the newsletter *Microprocessor Report*, points out, the results of such tactics might be similar to "a statistician drowning in a creek whose average depth is 3 feet." Some applications—particularly fixed-point graphics and digital signal processing—showed dramatic slowdowns on machines without hardware multiply and divide features, and some

users reported that their new Sun-4 systems were slower than their old 68000-based Sun-3s.

Fortunately, there was room for the architecture to evolve, and the most recent release, version 8, includes multiply and divide instructions. (Fujitsu's Sparc-lite also implements a divide-step instruction, but this did not become part of the standard.) Programs need to be recompiled to take advantage of these new instructions, but there will be no need to keep two versions of the software around. As with floating point, the new instructions can be emulated on older hardware.

Also in the latest release is a synchronization instruction, called *Store Barrier*, which flushes out delayed writes in multiprocessor systems, and floating-point multiply instructions, which take

two operands of one precision and produce results at the next higher precision. The SPARC-architecture manual now includes, as an appendix, a specification for a SPARC Reference memory management unit. While the MMU isn't actually part of the SPARC architecture, this document suggests an MMU architecture that many SPARC vendors have copied to facilitate operating-system ports.

### A Compendium of Standards

For SPARC products to proliferate, the market requires a well-defined set of standards—preferably more solid, reliable, and verifiable than the de facto set that has grown up around the IBM PC. To this end, several corporations involved with the SPARC architecture have founded a nonprofit organization to serve as the custodian of the standard: SPARC



**Figure 3:** SPARC licenses the name SPARC, with the trademarks shown, to its members. At top is the logo displayed by SPARC International members, and at the bottom is the logo certifying compliance with SPARC Compliance Definition 1.0. (There will be a similar logo for SCD 2.0.)

International (SI), formed in 1989, owns and licenses the SPARC trademarks (see figure 3); tests hardware, software, and systems for conformance to the standards; provides tools that aid conformance testing; and administers joint marketing programs.

Among the key documents published by SI is the *SPARC Compliance Definition (SCD) 2.0*, which describes (and incorporates by reference) several standards that SPARC systems must meet to be considered compliant. Among these are AT&T's System V Application Binary Interface, AT&T's SPARC supplement to the System V ABI, AT&T's System V Interface Definition, and the X Protocol reference manual.

The System V ABI, defined for each processor family by a special supplement, is AT&T's answer to the problem of producing shrink-wrapped Unix software. In theory, any software that conforms to the ABI will work on any system that supports it. SCD 2.0-compliant systems and software must also conform to standards for binary file formats, load-

ing and linking, and installation. SCD 2.0 lists other features as well, like NFS, which are optional but required to run many shrink-wrapped SPARC software products.

**Thou Shalt Conform**

SI will, for a fee, test computer systems for conformance to SCD 2.0. What's more unusual, however, is SI's effort to certify applications software. For a small fee, SI provides applications developers with a package called the SPARC Application Conformance Toolkit, or SACT. This package contains the source-level test, the binary-level test, and the standards databases.

The source-level test consists of a program that parses the C code of an application, performing static validity checks on calls to the operating system. The binary-level test—like Discipline on the Macintosh—monitors system calls at run time, and it performs similar validity checks on the actual arguments passed to the system. The standards databases contain the criteria that the system calls must meet.

SACT can be used for more than SPARC compliance testing. You can also use it to test for conformance to POSIX 1003.1 (aka FIPS 151-1), the X/OPEN Portability Guide Release 3, and the System V Interface Definition. As such, it is an excellent tool for software verification.

**Other Related Standards**

Two other SPARC standards are important to makers of SPARC hardware: MBus, a vendor-independent CPU pin-out standard, and SBus, a peripheral interface for SPARC-based systems. The MBus, or Module Bus, standard grew out of workstation vendor need for plug-compatible CPUs. Chips need to be interchangeable, or system makers will be locked into specific implementations as soon as they've finalized their motherboard designs. MBus, a 40-MHz CMOS interconnect standard, specifies the way CPU modules talk to memory and I/O modules via their I/O pins. Chip vendors have agreed on similar interfaces for EPROMs, ROMs, and RAMs, but MBus is the first industry-wide interconnect standard for CPUs.

SBus, Sun's I/O Interface Bus, is Sun's standard for peripheral boards that ride piggyback on the motherboard of a system such as the Sparcstation. Because signal-path lengths are short, SBus is able to achieve transfer rates of up to 100 megabytes per second, compared with 33 MBps for EISA running at full capacity.

Sun has actively encouraged the development of boards for this bus, since they enhance the functionality of Sun's products, and more than 100 vendors have developed products that work with it. Nearly all SPARC clone vendors have taken advantage of the availability of these peripherals by providing connectors for SBus cards.

**A Good RISC**

SPARC may prove to be more important as a strategy than as a CPU architecture. Many SPARC proponents I interviewed said that SPARC's architecture is not so different from that of other RISCs, and that other chips—including MIPS—currently offer better performance.

It is important to put this information in perspective, however. Most SPARC implementations are still in their first generation, but with the fierce competition among chip vendors, future generations of SPARCs will have the potential to offer truly impressive performance figures.

Because thorough conformance tests and tools are already in place, there will be few surprises when the next generation comes along; shrink-wrapped software bearing an appropriate seal is likely to work without modification on all SPARC platforms. For this reason, buying a SPARC-based system, or writing software for one, is probably a good RISC for the foreseeable future. ■

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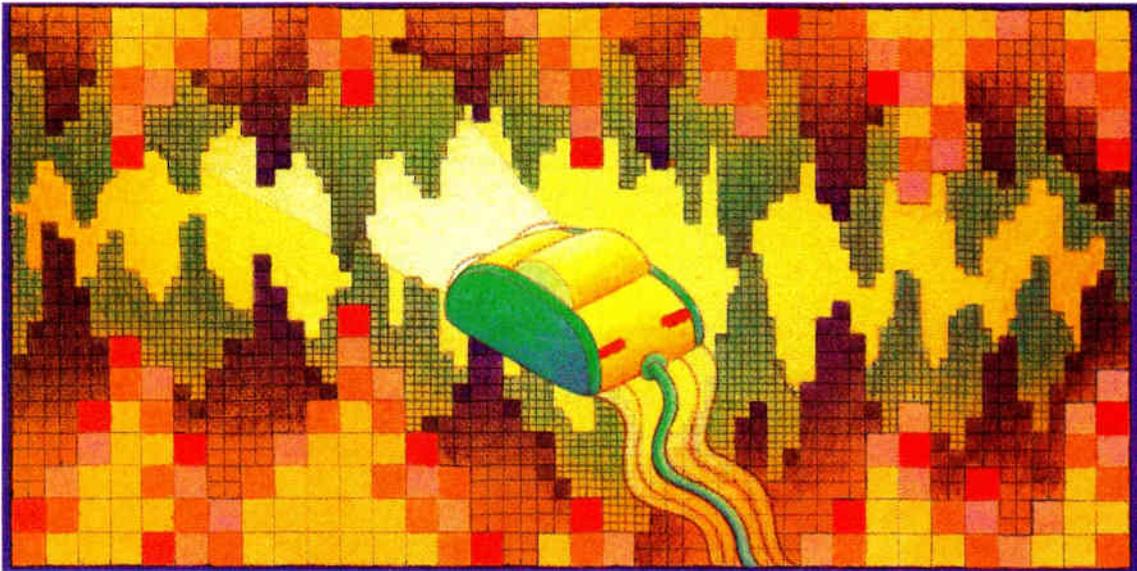
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# MACINTOSH VIDEO REVEALED



**Y**ou usually don't wonder how or why something works until it stops working. However, on some occasions, I get curious about how something operates on the Mac—not because it has stopped working, but because I want it to do something it normally doesn't do. All I wanted one day was an easy way to change the Mac's screen depth; that is, change how many bits "deep" each pixel is on the monitor's screen. (The more bits per pixel, the more colors you can have. One bit gives you black and white, 2 bits gives you 4 colors, 4 bits gives you 16 colors, and so on.) Along the way, I discovered a lot about how the Mac's video operates.

Here's the problem. One evening, I was checking out some new accelerated QuickDraw boards for the Mac. The tests involved running applications and seeing how they performed at various screen depths. I was using a Mac IIx equipped with several monitors and timing how fast I could scroll through a PageMaker 4.0 document chock full of 24-bit color images. If a board enhanced the screen-drawing speeds, the scrolling should go faster. Pretty exciting stuff.

Occasionally I'd take a break and wander into the BYTE Lab to snag a can of chilled Diet Jolt from the environmental test chamber. When I returned to the test equipment, I sometimes didn't remember what I'd left the monitor's screen depth set at. When you're looking at photo-realistic images on a screen with only 256 colors (8 bits per pixel), versus a screen with thou-

sands (16 bits per pixel) or millions (24 bits per pixel) of colors, it's obvious what the settings are. But the difference between 16-bit color and 24-bit color is hard to discern.

Of course, you can go to the Apple menu, open the Control Panel desk accessory (DA), and scroll through the various modules to the Monitors cdev to see how many colors each monitor is using. This approach works fine if you rarely change the monitor settings. However, using the Monitors cdev to obtain this information on a regular basis becomes an ordeal.

There had to be a better way. After all, the Mac knew what the settings were: I was just using the Monitors cdev to call up the information. Could I come up with something that could track down this information and display it? Something easier to use that would work with any number of monitors?

I got out a six-pack of Diet Jolt, a box of crackers, and Addison-Wesley's *Inside Macintosh, Volume 5*—the reference work on Color QuickDraw—and began to read.

## Opening the Toolbox

Color QuickDraw is part of those ROM services called the Mac Toolbox. It's the graphics software that all Mac applications use to draw to the screen. It handles

**A journey to the center of the Mac reveals an elegant design for device-independent graphics**

**Listing 1: The structure of a GDevice and some support calls. Only the support calls used in this article are shown.**

```

/* GDevice record */
typedef struct GDevice {
    short      gdRefNum;          /* Reference number of driver handling this gDevice */
    short      gdID;              /* ID of current port client */
    short      gdType;           /* Device type: 0 = CLUT, 1 = direct */
    ITabHandle gdITable;         /* Inverse color mapping table */
    short      gdResPref;        /* Preferred inverse table resolution */
    SProcHndl  gdSearchProc;     /* Search procedure list */
    CProcHndl  gdCompProc;      /* Complement procedure list */
    short      gdFlags;          /* gDevice attribute flags */
    PixMapHandle gdPMap;        /* Handle to gDevice's pixel map */
    long       gdRefCon;         /* Reference field for device-specific parameters */
    struct GDevice **gdNextGD;  /* Handle to next gDevice */
    Rect       gdRect;          /* gDevice's boundary rectangle */
    long       gdMode;          /* Current mode for this gDevice */
    short      gdCCBytes;        /* Expanded cursor information */
    short      gdCCDepth;        /* Expanded cursor depth */
    Handle     gdCCXData;        /* Handle to expanded cursor's data */
    Handle     gdCCXMask;        /* Handle to expanded cursor's mask */
    long       gdReserved;      /* Reserved for future use */
} GDevice, *GDPtr, **GDHandle;

/* gdFlags bit assignments */
#define gdDevType      0        /* 0 = grays, 1 = colors */
#define mainScreen    11       /* Set if device is main screen (has the menu bar) */
#define allInit       12       /* Set if device is initialized from 'scrn' resource */
#define screenDevice  13       /* Set if device is a screen */
#define noDriver      14       /* Set if device doesn't have a driver */
#define screenActive  15       /* Set if the device is active */

/* Some GDevice support routines */

GDHandle thisGDevice;
thisGDevice = GetDeviceList();          /* Returns handle to first GDevice in list */

GDHandle thisGDevice;
GDHandle nextGDevice;
nextGDevice = GetNextDevice(thisGDevice); /* Returns next GDevice handle in list, or NIL */
/* if no more GDevices */

GDHandle thisGDevice;
short attributeFlag;
Boolean devAttribute;
devAttribute = TestDeviceAttribute(thisGDevice, attributeFlag); /* Tests GDevice for the */
/* supplied attribute */

GDHandle thisGDevice;
short attributeFlag;
Boolean setValue;
SetDeviceAttribute(thisGDevice, attributeFlag, setValue); /* Set the GDevice attribute */
/* to the supplied value */

GDHandle thisGDevice;
long mode;
short refNum;
InitGDevice(refNum, mode, thisGDevice); /* Sets a display managed by the GDevice and */
/* the driver to the specified mode */

```

everything from drawing circles of a certain color on the screen to drawing styled text.

From the start, Color QuickDraw was meant to be device-independent. Color information is handled and manipulated in an internal color space, with routines that convert these colors to and from different color systems—for example, CMYK (cyan, magenta, yellow, black)

and HSV (hue, saturation, value). A Mac screen can be any size, and it can operate at any screen depth. The practical screen size is set by the limits of Color QuickDraw itself. Its coordinates are signed 16-bit integers, ranging from -32,767 to 32,767, so a 72-dot-per-inch screen spanning QuickDraw's limits would be over 75 feet to a side—plenty of room for future growth, I'd say.

Pixel depth is always a power of 2 (i.e., 1, 2, 4, 8, 16, or 32 bits per pixel). Furthermore, Color QuickDraw was designed to handle multiple displays, each of which could have different capabilities and be made by different vendors. (To avoid confusion, a *display* consists of a monitor, a display board that produces an image on the monitor, and any software required to control this equipment. A

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screen is the image on the monitor.)

Apple provided for Color QuickDraw's device independence by defining a logical data structure termed a *graphic device*. Each monitor has a graphical device associated with it that describes the display's characteristics. This is called a GDevice.

The format of a GDevice structure is shown in listing 1. You can see the various entries that describe the display, such as its size and orientation with respect to

**A**pple has defined a logical data structure termed a *graphic device*.

other displays on the computer (gdRect), the reference number of the driver that controls it (gdRefNum), and the screen image, called a pixel map (gdPMap). Some of this information is provided by the monitor's display board at boot-up time; the rest of it is set up and maintained by various Mac OS Managers. Also shown in listing 1 are support calls used to access a GDevice's structure.

These GDevice structures are kept in a linked list, termed a DeviceList. This DeviceList is the key to how the Mac handles several monitors at once. To write to a particular screen, all the Mac has to do is consult the appropriate GDevice in the list to know what screen depth to draw at, what driver to use, and where to draw the pixels.

I'd like to say it was easy to divine this information from *Inside Macintosh*, but it's a reference manual and not a how-to guide. However, I frequently relied on Think C 4.0's source code debugger to bootstrap my understanding of how portions of the Mac Toolbox operate. The source code debugger makes it easy to wander about and examine various structures referenced by the GDevice.

After some spelunking and taking copious notes, and with frequent cross-checks to *Inside Macintosh*, I determined that gdPMap's handle points to the monitor's pixel map, which held information

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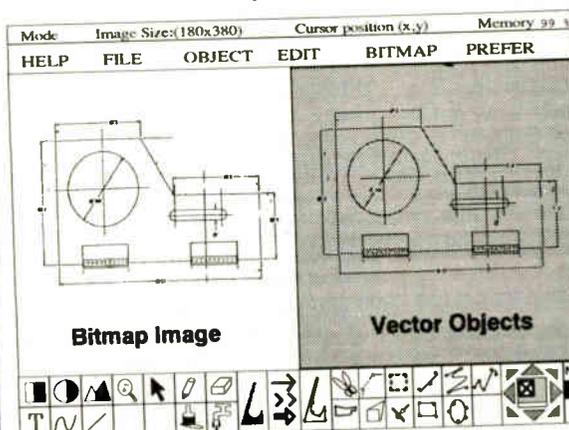
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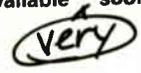
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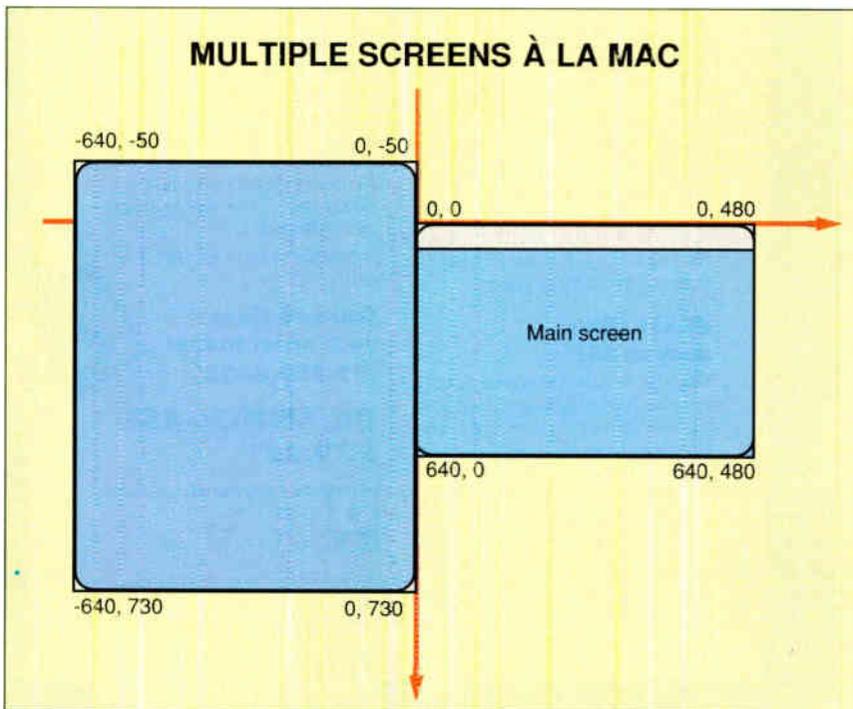
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**Figure 1:** When you use multiple monitors with a Mac, the system selects one monitor's display as the start-up screen. This becomes the system's main screen, which contains the menu bar (here, the screen on the right). The upper left corner of the main screen is designated as (0,0), and other monitors' displays are arranged around that point.

on the screen's depth as well as a pointer to the screen's image.

To obtain information about every monitor, I simply had to walk through the DeviceList. I first used GetDeviceList() to get the start of the list. Next, repeated calls to GetNextDevice() provided subsequent devices in the list. GetNextDevice() returned nil when it got to the end of the list. For each GDevice, I examined its attribute bits (see listing 1) to ensure that the GDevice was managing a physical display. If it was a display, I used the GDevice's pixel map to obtain the screen depth.

Now that I'd determined a way to get each active monitor's screen depth, I had to do two things. First, I needed to find an easy way to start the fact-finding code. Second, I had to show the screen depths in a meaningful way, especially since there could be one or many monitors connected.

The first part was simple: I used an FKEY. An FKEY is a small block of code that's executed when you press the Command and Shift keys and a digit key simultaneously. The decision to write an FKEY wasn't difficult. I had written one before, so I didn't have to break new ground in writing another (see "Stalking

the 8-bit Spectrum," September 1989 BYTE). An FKEY also got to the heart of the original problem: It eliminated the circuitous trek to the Monitors cdev by providing the desired information with just a few keystrokes.

#### Where's That Screen?

The next step was the program display. I puzzled over how I might best present information from one or more monitors. As the code extracts a GDevice's screen depth, it also obtains the QuickDraw coordinates for that screen from gdRect. This let me put the depth display window on the appropriate monitor.

To see how this is accomplished, it is necessary to understand how the Mac sets up its graphical environment. When the Mac fires up, it selects a display device to be the *start-up screen*. This screen is chosen from parameter RAM (PRAM), or, lacking that, the Mac OS scans the NuBus slots from lowest to highest addresses for the first display board it can find.

By default, the start-up screen becomes the Mac's *main screen*: the one that has the menu bar on it. This main screen is important because QuickDraw uses its upper left corner to define the

origin of its coordinate system. Consequently, the coordinates of the rectangles defining additional monitor screens (remember, this information is located in each GDevice's gdRect) are made relative to this main screen (see figure 1).

These screen rectangles can be oriented around the main screen using the Monitors cdev. When the Monitors cdev is closed, these positions are saved as a "scrn" resource in the System file. Other monitor settings (e.g., the screen depth and whether colors or grays are displayed) are also stashed in this resource. When QuickDraw is initialized at boot-up time, it uses this "scrn" resource to orient the screens and set their color and screen depth.

What happens if you yank or add a display board while the Mac is turned off? In this case, the Mac determines that the board IDs don't match those stored in PRAM, and the Mac scans the slots for display boards as described previously. Each board is set to a default operating mode of 1 bit per pixel (black and white). This forces you to again set up the monitor's layout and depths from the Monitors cdev, re-creating a valid "scrn" resource for the new setup.

Listing 2 shows the code used to extract the GDevice information and to convert and display it. The code was written in Think C as an FKEY code resource, with an ID of 7. I used ResEdit 2.1 to paste the resource into a Suitcase file. Either Suitcase II or MasterJuggler juggles the FKEY into the Mac's resource search path for ready access from the keyboard. Pressing Command-Shift-7 pops up a brief display across all the monitors I had connected to the system.

Problem solved, right?

Wrong. OK, I knew the screen depths. But if I wanted to *change* a monitor's depth, I still had to go to the Apple menu, open the Control Panel DA, scroll to the Monitors cdev...you get the picture. Wouldn't it be great if this FKEY could also alter the screen settings, like the Monitors cdev? The support call InitGDevice() looks like a good way of doing this, but it requires an obscure argument called a *mode*. Finding out what a mode was turned out to be a major chore. It requires that I deal with the hardware at a low level here—in the Mac's basement, so to speak.

*Inside Macintosh* has little detail on this low-level information. To its credit, Addison-Wesley has two books (with the jawbreaking titles *Guide to Macintosh Family Hardware* and *Designing Cards and Drivers for the Macintosh Family*) that provide the Mac's basement floor



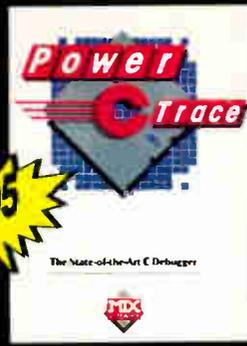
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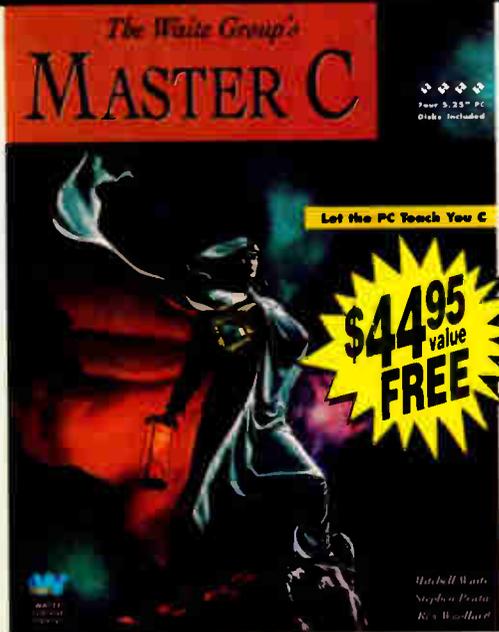
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**Listing 2:** Code fragment used to obtain the pixel depth from every GDevice handling a screen.

```

Rect          dBox;
unsigned char depthString[4];          /* String to display depth (formerly type Str255) */
WindowPtr    depthWindow[6];         /* Windows to display the depth. Only six slots. */
long int     centerHoriz, centerVert; /* Screen dimensions */
long int     frameHoriz, frameVert;  /* Depth box dimensions */
long int     globalLeft, globalTop;   /* Global coordinates to position our windows */
short        i;
GDHandle     nextgDevice, thisgDevice; /* Handles to our devices */
int          thisDeviceDepth;        /* Screen depth in bits */

i = 0;
SetRect(&dBox, LEFT, TOP, RIGHT, BOTTOM); /* Set up Rect for our depth window */
nextgDevice = thisgDevice = GetDeviceList(); /* Get start of list */
while (nextgDevice != NIL)                /* Should always have one active screen */
{
    nextgDevice = GetNextDevice(thisgDevice); /* Get next device, but don't look at it */
    if (TestDeviceAttribute(thisgDevice, screenDevice) && /* Is it a screen? */
        TestDeviceAttribute(thisgDevice, screenActive)) /* Is it active? */
    {
        thisDeviceDepth = (**thisgDevice).gdPMap).pixelSize; /* Get physical size of pixel */
        screenBoundary = (**thisgDevice).gdRect; /* Get screen size for this device */
        NumToString(thisDeviceDepth, &depthString);
        /* Computations to center our window */
        centerHoriz = abs(screenBoundary.right - screenBoundary.left) / 2;
        centerVert = abs(screenBoundary.bottom - screenBoundary.top) / 2;
        frameHoriz = centerHoriz - ((RIGHT - LEFT) / 2); /* Calculate offsets from screen center */
        frameVert = centerVert - ((BOTTOM - TOP) / 2);
        globalLeft = screenBoundary.left + frameHoriz; /* Add back into screen coordinates to get... */
        globalTop = screenBoundary.top + frameVert; /* ...global coordinates on GrayRgn */
        /* Make our window. */
        if ((depthWindow[i] = NewWindow(NIL, &dBox, "", INVISIBLE,
            dBoxProc, (WindowPtr) -1, NO_GOAWAY, NIL)) != NIL) /* Made window OK? */
        {
            MoveWindow(depthWindow[i], globalLeft, globalTop, TRUE); /* Move it to screen's center */
            ShowWindow(depthWindow[i]);
            SetPort(depthWindow[i]); /* Point to our window */
            TextFont(systemFont); /* Ensure we're using Chicago font */
            TextSize(24);
            if (thisDeviceDepth > INDEXED_COLORS) /* Direct colors: need two digits */
                MoveTo(1, 26);
            else /* Indexed colors: only one digit to display */
                MoveTo(9, 27);
            DrawString(depthString); /* Draw depth value */
            i++;
        } /* end if != NIL */
        else
        {
            nextgDevice = NIL; /* Had a problem making a window, halt */
            SysBeep(30); /* Honk the horn */
        } /* end else */
    } /* end if TestAttributes() */
    thisgDevice = nextgDevice; /* Set up for next device */
} /* end while */

```

plan. So don't bang your head on the pipes as we go into the cellar and learn how the Mac deals with expansion boards.

## Slot Manager Basics

To change a monitor's screen depth, you must first know what pixel depths its display board supports. Remember that the Mac knows nothing at all about the board until you plug it into the system. The NuBus standard dictates that an expansion board's address space is determined

by the ID of the NuBus slot it is plugged into. This easily averts any addressing hassles that typically plague PC board installations.

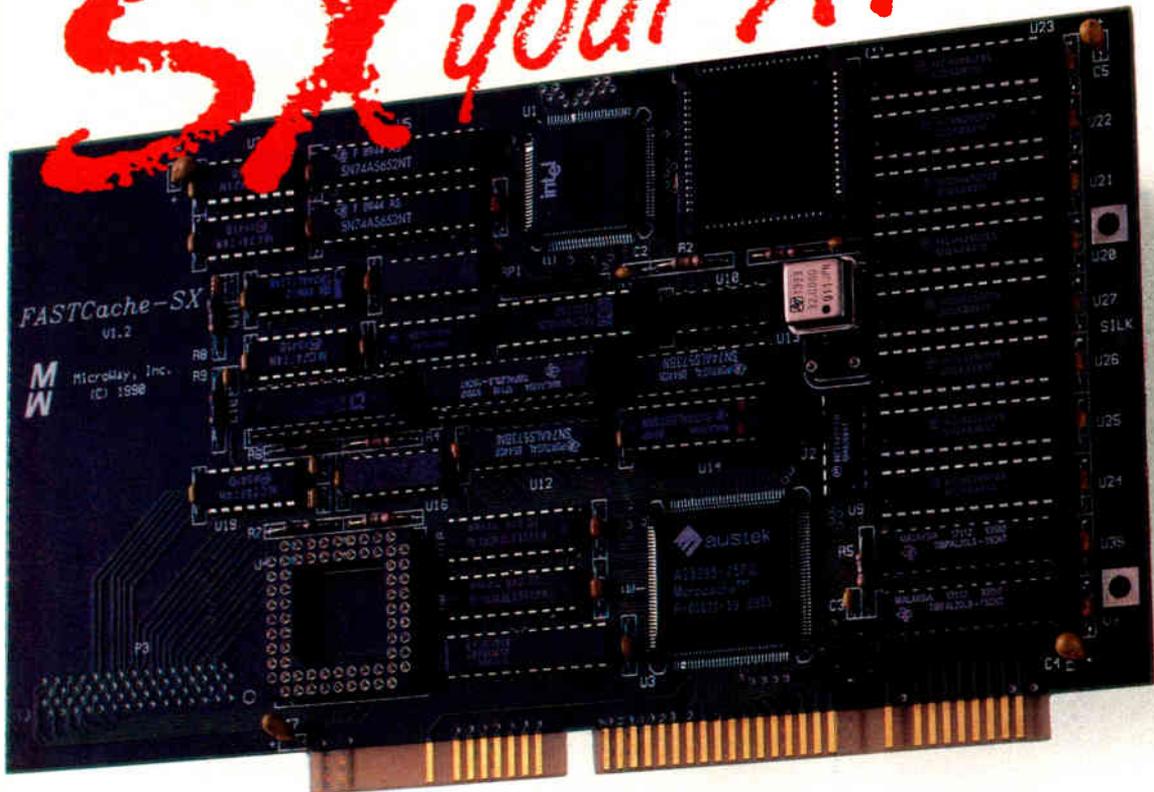
To handle the software side of board installation, Apple created a collection of routines called the *Slot Manager*. At boot-up, the Slot Manager's duty is to initialize any expansion board it finds and to install any drivers the board might require. The Slot Manager provides a number of high-level calls that can query

a board for its type (e.g., video display, network, or modem) and functions.

Naturally, the Slot Manager has to get this information from the board itself. The NuBus standard again requires a *configuration ROM* at the high end of its address space, but it's used only to respond to bus signals. Apple took this idea a step further: Each configuration ROM contains information that identifies the board, describes its functions, and supplies its initialization and driver code.

*continued*

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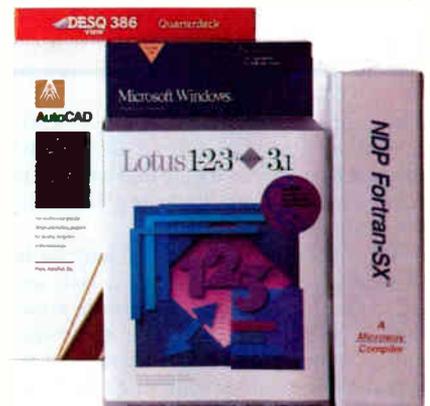
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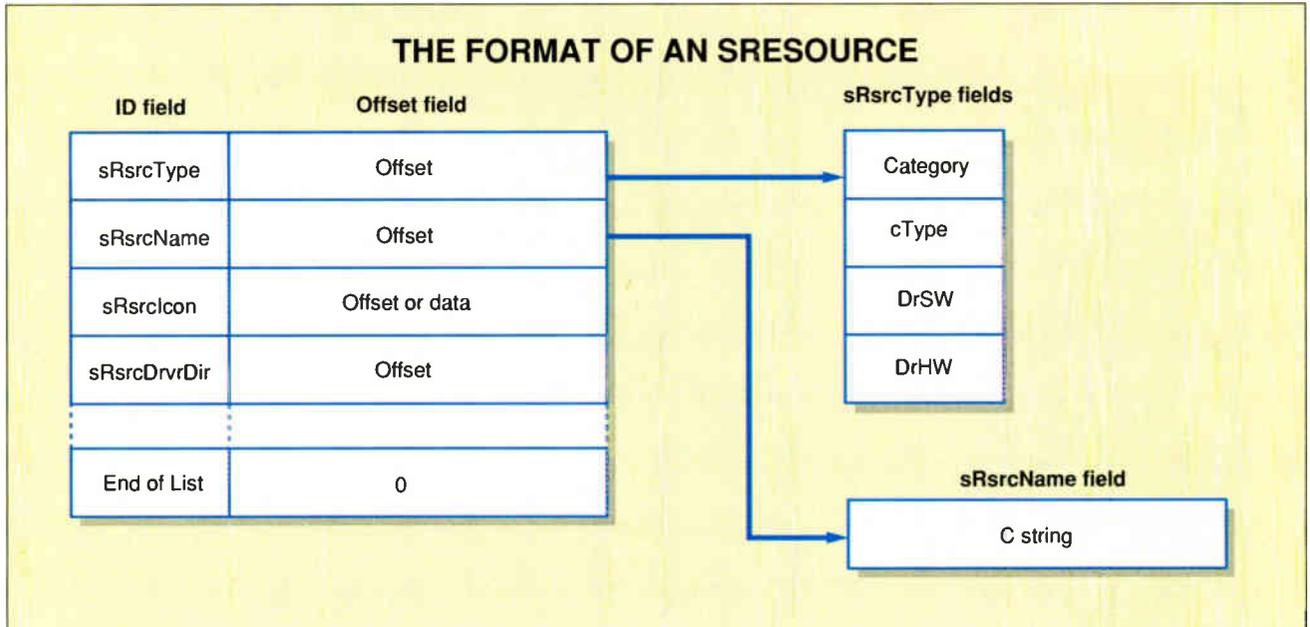


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**Figure 2:** In the Mac, add-in boards are defined using sResources. The format of sResources lets the Slot Manager access information in the board's ROM without knowledge of its location.

**Listing 3:** The structure of a video sResource's video parameter block. It's identical to Color QuickDraw's pixel map structure.

```
video parameter block

typedef struct VPBlock {
    long    vpBaseOffset; /* frame buffer offset */
    short   vpRowBytes; /* width of each row of video memory */
    Rect    vpBounds; /* bounding rectangle for display */
    short   vpVersion; /* pixel map version number (always 1) */
    short   vpPackType; /* reserved */
    long    vpPackSize; /* reserved */
    long    vpHRes; /* horizontal resolution (pixels per inch) */
    long    vpVRes; /* vertical resolution (pixels per inch) */
    short   vpPixelFormat; /* pixel type 0 = chunky; 2 = chunky direct */
    short   vpPixelSize; /* number of bits per pixel (power of 2) */
    short   vpCmpCount; /* number of components in pixel */
    short   vpCmpSize; /* bits per component */
    long    vpPlaneBytes; /* reserved */
} VPBlock, *VPBlockPtr;
```

This configuration ROM code is arranged in a special format that allows the Slot Manager to locate and extract information without knowing its exact whereabouts in the ROM.

What about those Macs that have built-in video (i.e., the SE/30, IIci, IIsi, and LC)? On these systems, firmware simulates a NuBus slot. This lets these machines share common ROM code and respond to System software in a consistent manner.

For example, the Mac SE/30's built-in video uses 64K bytes of video RAM for the built-in screen's frame buffer. This VRAM is located at the same address as

NuBus slot E, and 8K bytes of ROM on the main logic board emulates a video configuration ROM. The Mac IIci, IIsi, and LC operate in a similar way, but the frame buffers live in main RAM. On-board video is accessed as slot 0, which makes sense because the main logic board is always assigned as slot 0.

#### It's in the ROM

The configuration ROM's code and data are organized into objects called sResources (for slot resources). An sResource is similar, but not identical, to a Mac resource. You access both by either their ID number or type using the Slot

Manager or the Resource Manager, respectively.

The configuration ROM is composed of three elements. First, there's a *format block*, which performs several functions. It tells the Mac how to address the information on the board. A cyclic-redundancy-check checksum lets the Mac validate the contents of the ROM. Finally, the format block points to the second ROM element, an *sResource directory*. This directory lists all the sResources in the ROM and provides offsets to each. The third ROM element is the sResources themselves.

The general layout of an sResource is shown in figure 2. As you can see, an sResource's organization is rather simple: It's a 32-bit block composed of an 8-bit ID field and a 24-bit field that contains either data or a signed offset to another data structure. The sResource's ID field provides a unique ID number used to identify it. Numbers in the range of 0 through 127 are reserved by Apple, while IDs 128 through 254 can be used by board vendors.

Each sResource must provide both a name (sRsrcName) and a type (sRsrcType) to identify it. An sRsrcName is simply a C-style string that's up to 254 characters in length. An sRsrcType is an offset to an 8-byte block that uses codes to describe the sResource's category, type, driver software format, and driver hardware. The Slot Manager finds the start of an sResource by searching for its

## A TYPICAL DISPLAY BOARDS CONFIGURATION ROM

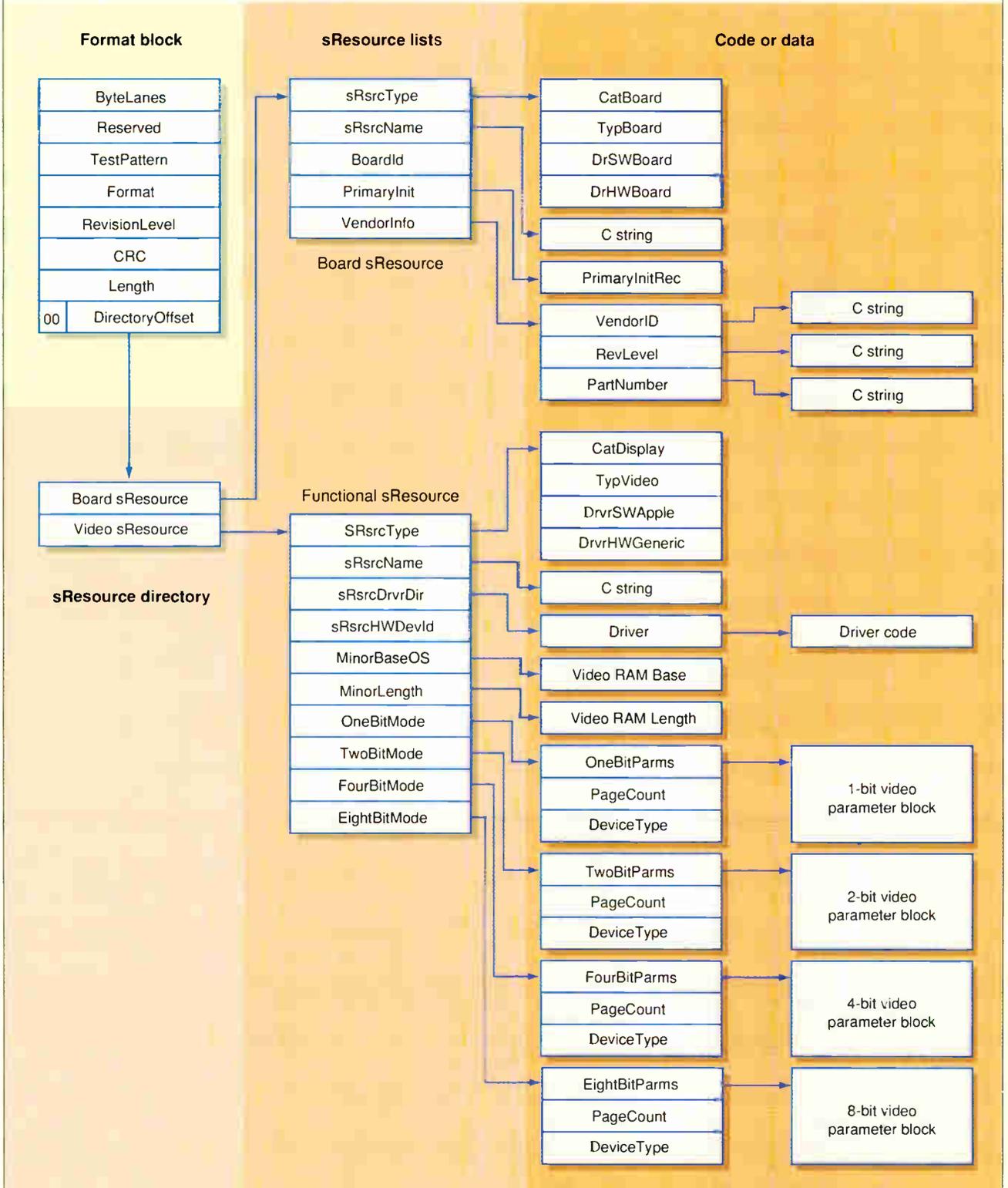


Figure 3: All sResources point to other sResources or to code and data. The video parameter blocks resemble a pixel map's layout. (From a diagram in *Designing Cards and Drivers for the Macintosh Family, Second Edition*, by Apple Computer)

**Listing 4: Some Slot Manager calls and data structures. Not all the Slot Manager calls are shown.**

Slot Manager parameter block

```
typedef struct SpBlock{
    long    spResult;        /* result returned */
    Ptr     spsPointer;     /* pointer to sResource structure */
    long    spSize;         /* size of structure */
    long    spOffsetData;   /* offset data field */
    Ptr     spIOFileName;   /* pointer to IO filename */
    Ptr     spsExecPBlk;    /* pointer to parameter block */
    Ptr     spStackPtr;     /* stack pointer */
    long    spMisc;         /* misc. field */
    long    spReserved;     /* reserved */
    short   spIOReserved;   /* reserved field of slot resource table */
    short   spRefNum;       /* reference number of driver for this slot */
    short   spCategory;    /* category */
    short   spCType;        /* type */
    short   spDrvrSW;       /* driver software format */
    short   spDrvrHW;       /* hardware */
    char    spTBMask;       /* mask for category, type, driver, and hardware */
    char    spSlot;         /* slot number */
    char    spID;           /* ID of sResource to search for */
    char    spExtDev;       /* ID of external device */
    char    spHwDev;        /* ID of hardware device */
    char    spByteLanes;    /* ByteLanes, from config. ROM format block */
    char    spFlags;        /* flags */
    char    spKey;          /* internal use */
} SpBlock, *SpBlockPtr;
```

Some Slot Manager calls

```
SlotBlockPtr SpBlockPtr;
OSErr        error;
```

```
error = SNextTypesRsrc(SlotBlockPtr); /* Returns next sResource of sRsrcType. The slot */
/* number, sResource ID, driver ref. number, and */
/* other values are returned for the sResource. */

error = SFindStruct(SlotBlockPtr);    /* Returns a pointer to the data structure defined */
/* by the sResource ID */

error = SGetBlock(SlotBlockPtr);      /* Copies a block from the sResource list identified */
/* by the sResource ID into a new block pointed to */
/* by spResult */
```

ID number or its sRsrcType.

There are two kinds of sResources: a Board sResource and functional sResources. The Board sResource identifies the board to the Mac. There's only one Board sResource, and it supplies the vendor information, an ID number, and a pointer to the board's initialization code. Functional sResources provide information about the board's hardware functions and point to driver code that must be loaded at boot-up time. Typically, each board has only one function (e.g., a video display function) and thus only one functional sResource. However, support for a multifunction board is possible simply by teaming each hardware function with its own functional sResource.

Now you see how the Mac automatically installs expansion boards. When

the Mac boots up, it uses the Slot Manager to first validate and then initialize each board it finds. Board drivers are also located and installed. If the board initialization fails, the Slot Manager flags that slot as empty, and future Slot Manager calls to the board fail. This prevents a malfunctioning board from being installed or used by the system.

### Using the Slot Manager

If you suspect that the functional sResources are the key to controlling a display board, go to the head of the class. A *video sResource* contains the display board's driver and a list of the display modes. Finally, here's that mysterious mode. A mode is simply a pixel depth. The term *mode* came about because each pixel depth requires that display board to

operate in a different mode. Each mode has its own ID number, starting consecutively at 128. Each mode entry has a *video parameter block*, shown in listing 3, that describes the display's characteristics.

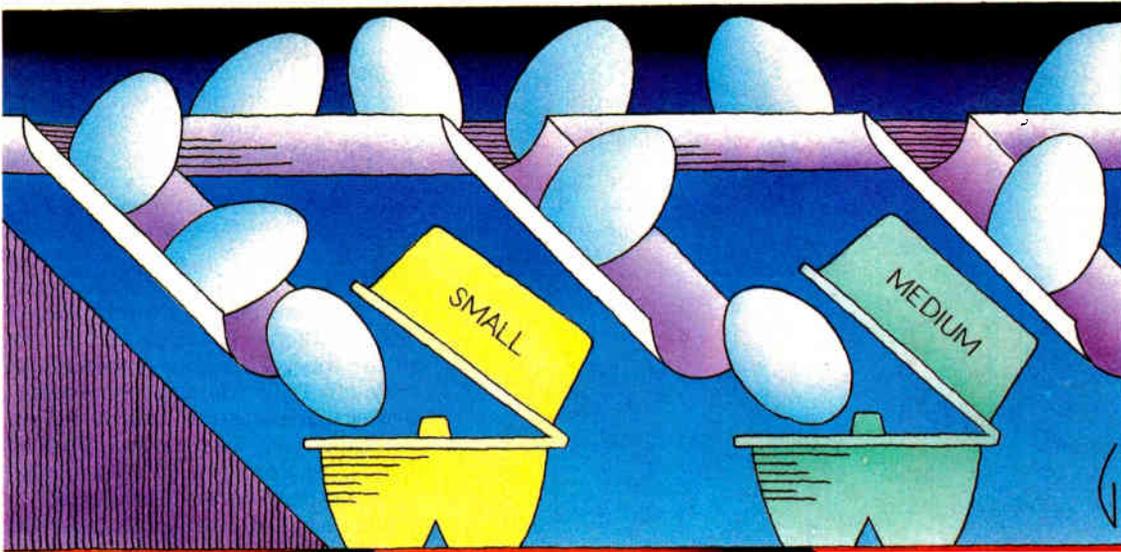
Figure 3 shows the layout of a typical display board's configuration ROM. The astute Mac user will note that this video parameter record resembles the layout of a pixel map. There's a reason for this: When a display's mode changes, most of the corresponding video parameter block is copied to the pixel map of the GDevice handling the display. The video parameter block ties the GDevice's contents to its display hardware.

I'll use Slot Manager calls to query the display board, looking for its video sResource and its mode list. Listing 4 shows

*continued on page 39*

STEPHEN LACEY  
AND  
RICHARD BOX

# A FAST, EASY SORT



**A** bubble sort is the first standard sorting algorithm most programmers learn how to code. Those who continue to write programs for mainframes, personal computers, or even programmable calculators may continue to use a bubble sort simply because it's intuitive, it's easy to write and debug, and it consumes little memory. A bubble sort would most likely be the standard sorting routine today if it were not so incredibly slow for most lists. However, a few simple modifications to this classic routine make it a fast and efficient sort for all kinds of lists.

## Turtles and Rabbits

In a bubble sort, each element is compared to the next; if the two are out of order, they are swapped. It takes many passes through a list to finally get all the elements in order (see figure 1). A bubble sort is finished sorting when it makes a pass that does not require any swaps. This type of sorting routine is called a *bubble* sort because of the way low values appear to "bubble" up to the top of the list.

The comparison of two values can be the most time-consuming part of any sorting routine, and bubble sorts require comparisons proportional to the list size squared, or  $N^2$ . Faster sorting methods, such as Quicksort, require comparisons proportional to  $N \cdot \log_2 N$ .

Bubble sorts are also slow because they are susceptible to the birth of elements we call *turtles*. A turtle (in

an ascending sort) is a relatively low value located near the end of a list. During a bubble sort, this element moves up only one position for each pass (or *stroke*), so a single turtle can cause maximal slowing. Almost every long random list contains a turtle.

On the other hand, a high-value element near the top of a list (a *rabbit*) is harmless. If you reverse the direction of the stroke, turtles become rabbits and rabbits become turtles. The worst possible turtle—the lowest relative value at the end of a list—forces a bubble sort to make  $(N-1)^2$  comparisons. This means that a bubble sort of a 1000-item list could require nearly a million comparisons.

Combsort (see the text box "Combsort" on page 317) is our simple modification of a bubble sort. It eliminates turtles by allowing the distance between compared elements (the *gap*, which is always 1 in a bubble sort) to be greater than 1.

For the first stroke, the gap is the list length divided by 1.3 (the *shrink factor*)—an important value, as we explain later. Before each subsequent stroke, the gap is reduced to the previous gap divided by 1.3; if this quotient becomes less than 1, the gap is reduced to 1, collapsing Combsort into a bubble sort. A swap moves across the entire gap, causing turtles to jump rather

**A few simple modifications to a bubble sort greatly speed up this classic routine**

## A FAST, EASY SORT

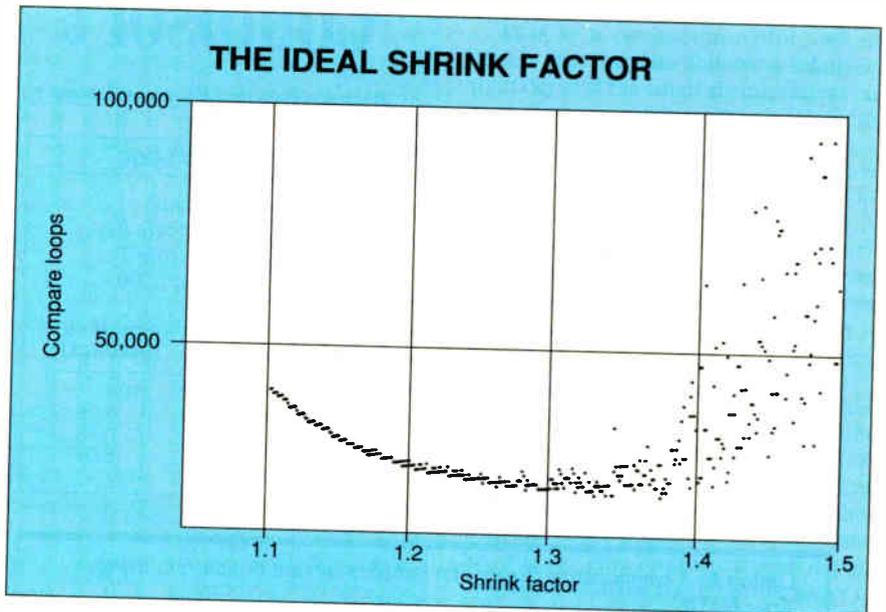
first two cases, about 8 percent of lists have surviving miniturtles, causing the routine to slow by 15 percent to 20 percent. The result is Combsort11, which is described in the pseudocode of listing 1.

You may wonder whether there are nonrandom lists that decrease performance. This is an important question, because certain list types cause some implementations of Quicksort (the fastest known sort) to degenerate into an  $N^2$  sort.

For example, a presorted list is best sorted by a bubble sort, while a reverse-sorted list is the worst case for a bubble sort. Combsort11 sorts both list types faster than it would sort a random list. In fact, all the partially ordered lists we tested sort faster with Combsort11 than a random list does.

Since we were unable to design an algorithm better than Combsort11 to select a gap list, we sought to demonstrate by exhaustion that a better gap list cannot be generated.

We refer to the difference between any list and its sorted counterpart as the *tangle*. At any point in a sort, the tangle is calculated by summing the square of the



**Figure 2:** The number of compares (approximately equivalent to the sorting time) for different shrink factors. The random lists have from 1000 to 1040 elements. There are better shrink factors than 1.3 for individual lists, but 1.3 gives the best balance of consistency and speed for a greater variety of lists. The sorting routine is Combsort11 (see listing 1).

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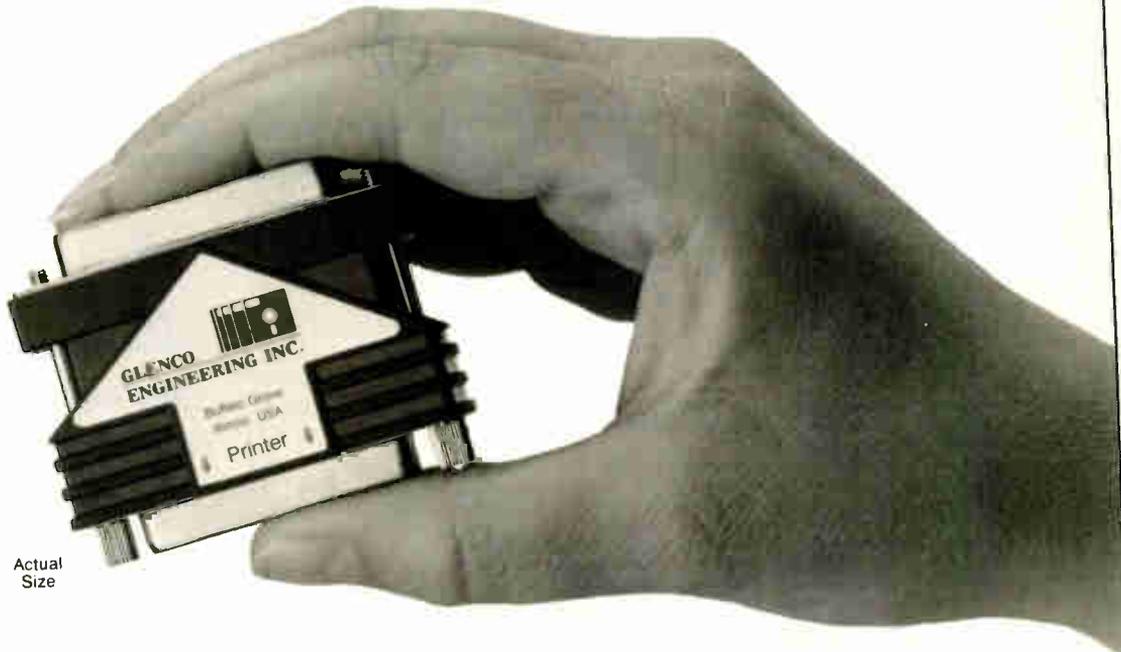
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distance each element currently is from its sorted position. Tangle=0 when the list is sorted. We square the distances to emphasize turtles. The *efficiency* of a stroke for a given gap at any point in the sort is defined as the percent of change in the tangle per comparison.

We plotted efficiency versus gap on a list of 100 elements, trying every possible gap. After the ideal gap had been estimated and applied, the same process of finding the tangle and efficiency was re-

peated for each stroke.

These putative ideal gap lists were all strikingly similar to a gap list generated by 1.3, except that they decreased faster when the gap fell below 13. This failure to follow the Rule of 11 allowed fast sorting in special cases but did not have general applicability. Even our "proof by exhaustion" revealed no gap list consistently superior to the one that was calculated by the shrink factor method using SF=1.3.

### Not a Shell Sort

Although the algorithms for Combsort and a shell sort look very similar (both use a gap and a shrink factor), they do in fact perform significantly differently. A shell sort does a complete sort (until there are no more swaps to be made) for

**A**lthough the algorithms for Combsort and a shell sort look very similar, they do in fact perform significantly differently.

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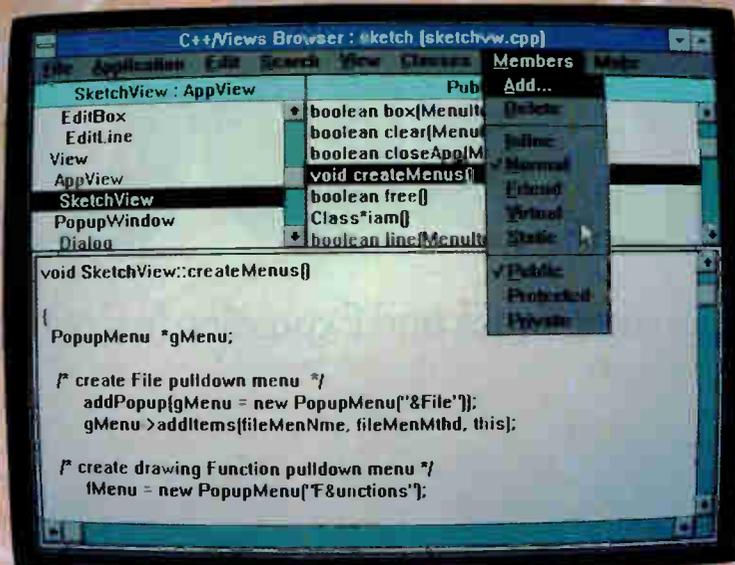
each gap size. Combsort makes only a single pass for each gap size—you might say Combsort is more optimistic. There are other differences that result from this optimism: The ideal shrink factor for a shell sort is around 1.7, compared with 1.3 for our Combsort routine. If you plot sorting time against list size ( $N$ ) for a shell sort, you will see a step function that approximates  $N \cdot \log_2 N \cdot \log_2 N$ , whereas Combsort is not a step function and approximates the flatter curve of  $N \cdot \log_2 N$ .

Combsort and Combsort11 represent a simple modification of a classic bubble sort; a bubble sort is actually a special case of our Combsorts. The stable and fast Combsort11 is an optimized form of the general Combsort. The only known routines that can compete with ours in execution speed cannot compete in coding ease. ■

*Stephen Lacey, M.D., is an assistant professor of internal medicine who also specializes in gene cloning at the University of Texas Southwestern Medical Center in Dallas, Texas. Richard Box is a geophysicist and mathematician working for British Gas in Houston, Texas. Both authors can be contacted on BIX c/o "editors."*

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# ASK BYTE

## Longing for More Accuracy

I mostly use my computer, an XT Turbo, for crunching numbers and number theory. For primality testing, I can't get more than 16 digits of accuracy using compiled BASIC. Beyond that the result is inaccurate. Could I create my own compiler or get some commercially available software to handle larger numbers?

Carlos Baranyai  
Scarborough, Ontario, Canada

*You don't have to create your own compiler. What you need is a better math library. BCD for BASIC from Atlantis Software (2445 Camino Capitan, Santa Fe, NM 87505) supports basic math, square roots, powers, print formatting, and comparison functions for Microsoft QuickBASIC 4.x, BASIC 7.0, and Crescent Software's PDQ library. I haven't tried it yet, but it sounds like a steal at \$30.—H. E.*

## Perfect Writer Isn't Perfect

For several years, my company has used Perfect Writer for its word processing. It is extremely easy to use and very easy to teach within our working environment. The problem we have is that we would like to upgrade our Panasonic KX-P1624 to a laser printer.

What drivers do I use, or do I manufacture them myself using the commands suitable for a laser printer?

Also, I would like to know where I can reach Perfect Software. The phone number is no longer listed, and there is no forwarding number.

Walden Williams  
Huntington Beach, CA

*For the benefit of folks who may not remember Perfect Writer, it was an EMACS-style word processing module from Perfect Software. Teamed up with Perfect Formatter (a fairly powerful Scribe-based formatting package) and Perfect Speller, Perfect Writer formed the core of a very good environment for creating documents.*

*To answer your last question first, Perfect Software went out of business several years ago. Perfect Writer was originally licensed from Mark of the Unicorn (Cambridge, MA), which also developed Mince and Final Word. To make a long story short, Perfect Software ran into legal and financial trouble and went away rather abruptly.*

*Perfect Writer came with a very extensible printer driver set. For example, in your document, you specify a boldface string as "this is @B(boldface) text." The printer driver converts this device-independent syntax to a printer-specific command. Back in 1983, laser printers and proportional-spacing printers were not very common, and Perfect Writer uses overstrikes to achieve a number of its effects. That technique doesn't work on laser printers, so if you do get your new printer to work, you won't get any boldface.*

*Even worse, Perfect Writer uses the mica, defined as 1/10 millimeter, for its measurements. The mica doesn't*



*map very accurately to the more common decipoint (1/720 inch), so your placement of things on the page is going to be somewhat inaccurate. I've been there. I still use Perfect Writer as a programming editor, but I had to abandon it for formatted output when I bought my first LaserJet.*

*It looks like you're going to have to get a new word processor, but which one? The biggest expense in changing software is usually retraining your staff. The EMACS interface on Perfect Writer*

*is very powerful but not very common. Epsilon Text Editor is a programmer's editor with the same front end, but it doesn't have the word processing features you'll need. Microsoft Word and WordPerfect are simply too different from EMACS to make a clean transition. Your best bet is to check out Borland International's Sprint. It comes standard with a Borland-style interface but can be reconfigured with a number of interchangeable front ends; one of these is EMACS. As a word processor, Sprint is more than capable of driving your new printer.*

*Sprint gives you the user interface you need, but, alas, it doesn't handle the Scribe formatting commands. You'll have to convert those yourself or get a custom conversion package written. The only other caveat is that Borland is no longer developing Sprint. It's going to sell and support version 1.0 for as long as there's interest. Even so, that's your best option.—H. E.*

## Homeward Bound

I have a system set up in my office to run AutoCAD. It runs as a workstation on a network. I want to take it off the network and run it as a stand-alone system.

My system, a Compaq Deskpro 386/33, includes a 120-megabyte hard disk drive, two floppy disk drives, a Racal-InterLan 10Base-T network card, and an Artist Graphics XJ10 video controller.

I want to add a printer and a tape drive. Should I leave the 10Base-T card in the system, or should I replace it? What else do I need to add?

I plan to run spreadsheets, database software, and word processors, as well as AutoCAD. I appreciate any advice you can give me.

Ralph D. Adé  
New York, NY

*If you're not using the network card, take it out. It will only make resolving address and interrupt conflicts more difficult when you add new cards. If your company can't use it, wrap it in a static-shielded bag, put it back in the box, and put it on the shelf.*

*The Deskpro 386/33 includes serial and parallel ports on the system board, so you won't need any I/O card to connect to a printer. If you're looking for a good general-purpose laser printer for both printing and printer plotting, check out the Personal Computer Products Laser-Image 1030. We found it to be one of the best low-cost laser printers at handling Hewlett-Packard Graphics Language plots in July 1990's Product Focus ("Laser Printers Get Personal").*

*continued*

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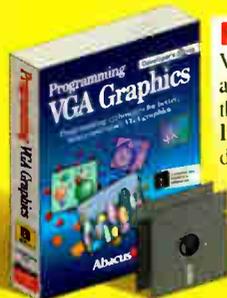
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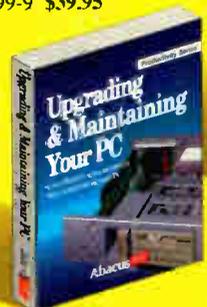
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## QuickBASIC Toolbox

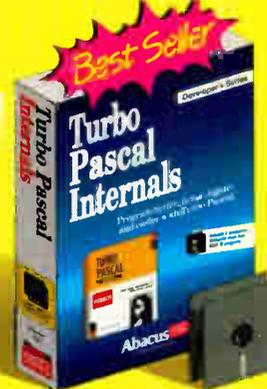
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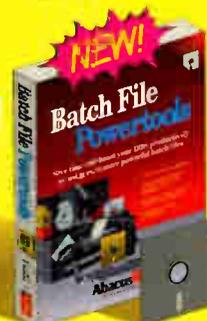
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*I'm tempted to suggest that you contact Compaq for the tape drive. However, if you're looking for a low-cost backup solution, any tape from a reputable dealer with more than 120-MB capacity should suffice.—S. A.*

### Wants His Business to Slide

**I** want to set up a slide and transparency printing business for computer-generated images, supporting the most used graphics programs (e.g., Harvard Graphics, Applause II, and Freelance Plus). This service isn't now available in Portugal. Could you please send me the names of potential suppliers of all the hardware necessary to do it?

Antonio Malveiro Jorge  
Amadora, Portugal

*The easiest way to print from a number of different software packages is to invest in a copy of each. That's not cheap, but it assures you of the best results without having to worry about data loss due to file conversion. That means you'll also need a big enough computer to run anything. I'd suggest a 386 or 386SX machine and enough RAM (maybe 4 MB) to provide extended and expanded memory support. Your hard disk drive should probably be fairly large, too; a lot of software packages take up a lot of room.*

*A number of companies make 35mm slide printers. The list I have shows about two dozen. I've chosen two that have European sales offices. Agfa Matrix has a 4096-by-2732-pixel printer, complete with an interface card and drivers for about 100 software packages. Polaroid recently announced its CI-3000 film recorder, which comes with support for CGM files and direct drivers for Freelance Plus (support for Harvard Graphics and Applause II is coming soon). The CI-3000 handles a variety of film sizes at 2048-by-1366-pixel resolution.*

*As I said, there are plenty of others, with more or less resolution. These printers are not cheap, though. Figure on spending between \$4000 and \$25,000 for any kind of slide printer. The Agfa printer costs about \$10,000; the Polaroid printer lists for \$4500. Addresses for these companies are listed below.*

**Agfa Matrix**  
One Ramland Rd.  
Orangeburg, NY 10962  
(914) 365-0190  
fax: (914) 359-3201

*in Belgium:*  
Agfa-Gevaert N.V.  
032-3-444-3924  
fax: 032-3-444-3923

**Polaroid Corp.**  
Polaroid Presentation  
Products  
575 Technology Sq.  
Cambridge, MA 02139  
(617) 577-2000  
fax: (617) 577-5618

*in Portugal:*  
Polapor  
Av. Eng. Duarte Pacheco  
Torre 1-80. Piso - Sala 4  
1000 LISBOA  
351-1-684055  
fax: 351-1-680819

*Since you're planning to spend a large amount of money, I'd advise you to ask lots of questions and select your equipment carefully. I wish you the best of luck in your new venture.—H. E.*

### Dashed Hopes

**L**ike so many unsuspecting computer users, I bought a Tandy 1000 TX. Although I have no system troubles with it, I had high hopes for using its expansion capabilities. I have written to several vendors that offer the shorter peripheral boards usable in the TX. Alas, more and more, I find this machine is less and less PC-compatible.

My expansion desires are reasonable and simple: a 40-MB card-mounted hard disk drive, VGA graphics (the TX comes with CGA on the motherboard), a 2400-bps modem, any other kind of keyboard, and a larger power supply for future needs. Some sort of accelerator card and faster RAM would be a dream, but with a lobotomized bus and whatever limitations written in the BIOS, this may be too much to ask.

I made a serious investment when I bought my system, and I had hopes of extending its useful life with expandability. Please don't tell me my only source is Radio Shack to get what I'm searching for! If there are no better alternatives, I have heard of a used computer equipment brokerage in New York.

Allen F. Robertson  
Antioch, TN

*I'm afraid the resale value of a Tandy 1000 TX is not particularly high. If your local Radio Shack store can't give you satisfaction, try the following:*

**Computer Peripherals Direct, Inc.**  
409 11th St.  
Huntington, WV 25701  
(800) 328-3387  
(304) 529-0246  
fax: (304) 529-0249

**MegaHaus Hard Drives**  
1110 Nasa Rd. 1, Suite 306  
Houston, TX 77058  
(800) 426-0560  
(713) 333-1910  
fax: (713) 333-3024

**Micro Systems**  
1524 County Line Rd.  
York Springs, PA 17372  
(800) 548-5182  
(717) 528-8802

*These companies sell hard disk drives that are compatible with the Tandy 1000 series of computers. Computer Peripherals Direct has a wide range of upgrade products for Tandy computers.—S. W.*

### There Must Be A Cache

**I** own a Zeos 386/25. I bought the system with 128K bytes of CPU cache, but I have been unable to figure out if the system contains this cache. I have no diagnostic software that will search for such memory, the BIOS doesn't show that such memory exists, and I can't recognize the cache's static RAM (SRAM) chips on the motherboard. When I spoke to the technicians at Zeos

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I currently program in:  COLBOL  PASCAL  Ada  
 BASIC  Other

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International, they were unable to provide me with any answers. Yet, they have been very helpful with any other questions or problems I have had.

Can you help me? I hope there is a way to verify that such memory exists, either through software or physically visualizing the chips. If not, what is to keep manufacturers from advertising a cache when it doesn't exist or there is less SRAM than advertised?

Brian C. Blackman  
Friendsville, TN

*I like these easy ones. The obvious place to start was with Zeos. I called its technical-support group; you were right, they were incredibly helpful. On your motherboard, the SRAM chips should be located near the left front of the machine and have gold stickers on them. If you don't have the SRAM installed, you'll find empty sockets or a spot on the motherboard for sockets.*

*If you still want to check your cache from software, you might try Sofwin's Syswin utility. It's a program similar to Norton's SI, except that it digs much deeper into the system's innards. It measures such things as CPU clock rate, size of the CPU cache, and seek time of the hard disk drive. You can get the latest version from Sofwin (6546 Roseland Court, Reynoldsburg, OH 43068, (614) 759-6324) for \$69.*

*Buying a computer isn't any different than buying a car or major appliance. I wonder how many people actually time the 0-60 mph acceleration of their new car, or measure to see if that new refrigerator is really 21 cubic feet? In general, we don't hear too many horror stories about computer companies cheating customers out of things like CPU caches; it's just too easy to catch them at it. To minimize your chances of that happening, buy from reputable companies, be sure to check the packing slip carefully, and always practice a safe mail-order technique.—H. E.*

### I Want My LCD

Could you help me find a bright and crisp monochrome LCD with Hercules-, EGA-, or VGA-quality resolution? I cannot understand why LCDs are not sold without an attached microcomputer. The technology seems to have advanced enough, and the price should not be exorbitant.

O. Güntzel  
Liebefeld, Switzerland

*Yes, we can help. How about the Safe Monitor? It's a backlit, shielded LCD that—according to its manufacturer—is virtually radiation-free. The company has even removed the power source from the monitor to a bus connector that you can locate at whatever distance you consider safe.*

*Safe Computing's Safe Monitor comes in a variety of models, including CGA, VGA, and Macintosh-compatible versions. For PC operation, you'll need a color graphics adapter. Although the monitor is monochrome, it represents colors either by gray scale or patterns (depending on the model). Prices range from \$995 to \$1695. For more information, contact Safe Computing Co., 368 Hillside Ave., Needham, MA 02194, (617) 444-7778.*

—R. G.

### Harness Racing

I am trying to locate a couple of items. First, I need a special cable. I need a custom Mac Plus analog-logic board wiring harness for my Mac 512KE, only with a standard hard disk drive power cable extension.

My SCSI port is a cable running out of the battery door. Now that low-power SCSI 3½- and 2½-inch drives are available, I would like to install one internally. I need some way to hook up the SCSI cables and still have an external port. I'd like to have an adapter made of a PC board, male and female DB-25 connectors, and a 50-pin stick header. This would fit in an opening in the back of my Mac case with the adapter mounted on the rear chassis rail.

I am also looking for a case to hold three external 5¼-inch full-size hard disk drives or six 5¼-inch half-height drives. The power supply should be able to handle 60 to 80 watts, have connectors for six drive devices, and have a front-mounted switch with an "on" indicator LED. The power supply can be on the top or bottom of the case. I want all drive bezels to be exposed so that I can see the drive indicator lights.

Finally, I need an I/O card for an IBM PC that has COM1, COM2, COM3, and COM4 serial ports and LPT1, LPT2, and LPT3 parallel ports. This would be one card with all the DOS serial and parallel ports. Each port must have an enable/disable jumper. The bracket should have an LPT1 DB-25 connector. All other ports should be cable-attached to header pins.

Anthony J. Oresteen  
Batavia, IL

*The Macintosh adapters you describe should be fairly easy to make yourself. The hard disk drive power connector is very common, and all you'd have to do is identify the correct leads on the Mac cable assembly and splice in the new connector. The same is true for the SCSI adapter: The 50-pin header is a standard item, and you can find a PC board and DB-25 connectors at your local Radio Shack.*

*However, if it were my Mac, I wouldn't do it. The power supply in the 512KE and Plus models is notorious for getting stressed-out and fizzling. Just upgrading a Mac Plus to 4 MB of low-power RAM is often enough to blow the supply; adding a hard disk drive is simply playing with fire. If you insist on doing it anyway, you can probably get any competent repair shop to make the adapters for you. While you're at it, be sure to add a fan to help keep the case cool.*

*I don't know of any PC cards like the one you describe. Putting all four COM ports and all three LPT ports on a single card would prevent you from adding any other cards or internal modems. I'd imagine that most people would rather have the flexibility of mixing and matching. Multiple printer ports are typically used in network print servers, where COM ports may not be needed. Applications calling for multiple COM ports often require more than four; in those cases, cards like Arnet's Multiport boards give you eight (or more) ports.*

*To get all six drives in a single case, the obvious way is to get a standard PC clone tower case. A number of these cases handle eight or more drives and are widely available from mail-order companies for around \$300.*

—H. E.

# ADVERTISEMENT

WHAT'S NEW AT COMDEX

## Springtime in Atlanta

**SPRING '91** is a major new international computer industry event dedicated to information technology solutions.

It's two major shows side-by-side in Atlanta this May 20-23, an expanded **COMDEX** now reaching resellers and corporate end-user management, and **WINDOWS™ WORLD**, the first official conference and expo for Windows computing created in cooperation with Microsoft.

Some 1,000 exhibiting companies and 60,000 attendees are expected, including computer resellers, software developers, distributors and OEMs, plus corporate buyers, MIS/communications managers, CIO/IS executives, workgroup and departmental managers, and 1,000 trade and business press.

**SPRING** will feature a combined Conference program of more than 170 sessions -- the largest and most comprehensive forum ever put together for a computer industry event.

well as customized vendor presentations from leading manufacturers and suppliers.

**COMDEX '91** at **SPRING** will also be the first **COMDEX** event to offer a separate End-User Conference Program with nearly 60 separate sessions. A wide variety of programs and features will also be available to the corporate end-user, from middle managers to senior information system (IS) executives.



*Raymond J. Noorda, President and CEO of Novell, will deliver the COMDEX keynote address. "The spark that Ignites an Industry," an insightful overview of networked computing and its ever-increasing impact on the computer industry.*



*Bill Gates, Chairman of Microsoft, will deliver the WINDOWS™ WORLD keynote address. "Windows: Changing the Face of Corporate Computing," an inside look at the contributions of Windows to corporate computing and a preview of future enhancements to Windows technology.*

than 50 educational conference sessions on Windows computing for corporate users, software developers, system integrators, peripheral designers, value-added resellers (VARs), and other industry professionals.

## Networked Computing

**SPRING Networked Computing Focus** will include exhibitors demonstrating interoperability along with a comprehensive conference program on networking and communications, including a Corporation for Open Systems (COS) certification program.

Networking exhibits will be on both **COMDEX** and **WINDOWS™ WORLD** show floors, and almost 60 networking sessions topics will be offered in both conferences.

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## Highlights of SPRING '91

- 1,000+ **COMDEX** and **WINDOWS™ WORLD** exhibitors.
- 170+ conference sessions in the **COMDEX** and **WINDOWS™ WORLD** Conferences.
- **COMDEX** keynote by Novell CEO Ray Noorda addressing critical reseller and user issues.
- **WINDOWS™ WORLD** keynote address by Microsoft CEO, Bill Gates.
- Special focus on Networked Computing and Multimedia.
- Major new programs including Vendor Presentations, New Product Awareness, User Group Meetings.
- Special focus on Networked Computing and Multimedia.

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**Conner Confusion Clarified**

I have a 40-MB Conner Peripherals Intelligent Drive Electronics (IDE) hard disk drive, just like the one Dennis C. Kornbluh has (Ask BYTE, October 1990). I am afraid the tip you gave him will not help at all.

You told him to perform a nondestructive, low-level format on the hard disk drive. This may work on most hard disk drives, but it doesn't on Conner's. A Conner IDE drive has an on-board, read-ahead buffer (not a cache) to boost its speed. The buffer keeps any software from running a low-level format. This includes SpinRite and Disk Technician. Even a destructive low-level format by DOS FDISK will not work. The Conner drive is pre-low-level formatted and can be low-level formatted only in the manufacturing process, as far as I know. So, unfortunately, the only option Kornbluh has is to get the hard disk drive repaired or replaced.

Frank C. Yang  
 Elmhurst, NY

*Sometimes, when faced with a hardware problem, the solution becomes apparent only after considerable digging. You are indeed correct about not being able to do a low-level format on a Conner Peripherals IDE hard disk drive, but for the wrong reason.*

The Conner drive electronics prevents any software from doing a low-level format. The reason is that the Conner drive uses embedded servo information at the beginning of each sector for locating head positions on the platters. This servo information can be stored on the drive only with specialized equipment at the factory. If you persisted in trying to do a low-level format on a Conner drive, you would destroy the servo information and render the drive useless. Some other brands of drives use a dedicated platter for servo information.

The Conner drives also use a voice-coil mechanism for positioning the heads, so they are less susceptible to head-positioning problems (due to overheating or mechanical wear) than older drives that use stepper motors for positioning the heads.

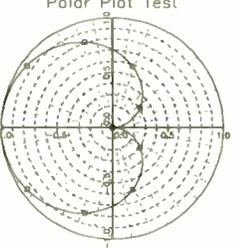
You aren't exactly right about FDISK. It creates a partition sector or bootstrap program at the first sector on the hard disk drive (head 0, cylinder 0, sector 1) and stores the partition information at this location. BIOS loads the bootstrap program into memory, and then the bootstrap program loads the operating-system program from other locations on the hard disk drive. The bootstrap program transfers control to the operating system.

You need a low-level formatting program, such as On-track Computer Systems' Disk Manager, or a formatting program in ROM on some hard disk drive controllers, to do a low-level format of the hard disk drive.

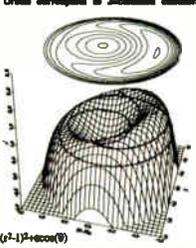
After discussing Kornbluh's problem with the technical-support people at Conner Peripherals, they thought that the 2- to 3-second delay during I/O operations is due to a BIOS timing problem. They have seen this problem with certain early versions of the AMI BIOS.

If the occasional 3-second delay does not cause data-storage problems, they suggest that he either live with the problem or replace his BIOS with a newer version. If the problem continues or grows worse, Conner Peripherals technical support is available at (408) 456-3200.

My original advice is still valid: Back up your hard disk drive!—S. W. ■



Polar Plot Test



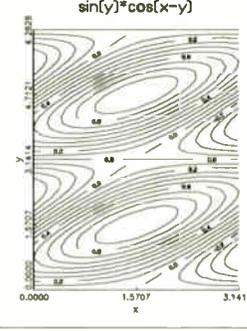
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## An Out-of-Towner's Introduction to the BIX Community

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## From Artificial Intelligence to Zenith Laptops...

Whatever your interest, BIX has a conference for you. Here's a partial list. (In each Exchange, Conference name appears on left, description on right.)

### ■ Amiga Exchange

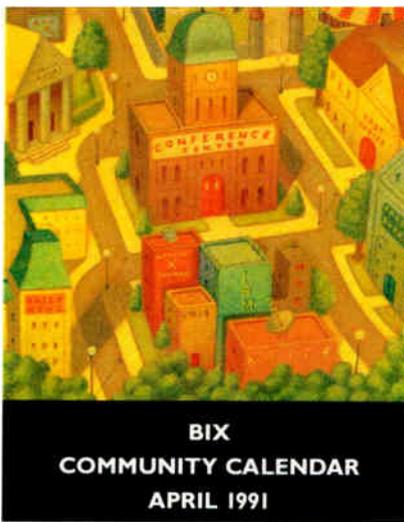
#### Joanne Dow, Exchange Editor

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



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

### ■ Interactive Games Exchange

#### Rich Taylor, Exchange Editor

igx.exchange	What's new in the IGX
bridge	For Bridge lovers
chess	About the game of chess
d.horizons	Role-playing games not based on fantasy
digital.gaming	Computer gaming
fun.n.games	Fun, games, group activities
gaming.college	Learn about role-playing games
other.times	Land for fun, relaxing, and gaming
the.realms	Fantasy role-playing games
town.square	On-line meeting place

### ■ 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

### ■ Telecommunications Exchange

#### Steve Satchell, Exchange Editor

bbs	Dial-up bulletin board systems
conferencing	About computerized conferencing
ham.radio	Computing, digital electronics, amateur radio
international	Telecommunications; the global computer village
networks	Information networks
packet.nets	Packet-switching networks
protocols	Small-computer communications protocols
telecomm.pgms	Telecommunications programs
telecomm.tech	New telecommunications technology

### ■ 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
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education	Computers in American classrooms
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# BIX

## EXPERT ADVICE

Experts from the worlds of IBM, Macintosh, Unix, and networked computing present inside information, advice, and tips for getting the most out of your computer



**DON CRABB**  
Macinations



**DAVID FIEDLER**  
The UNIX /bin



**BRETT GLASS**  
NetWorks



**DOUGLAS A. HAMILTON**  
Beyond DOS

**Don Crabb**

I just spent the better part of a day trying to fix a problem with my friend's Mac SE, and I'm no closer to a solution than I was before I started. I do a lot of "little consults" like this for my friends, especially those I got started on the Mac. This SE is Roger Ebert's, who uses it to write books, film reviews, and part of the weekly script for his syndicated TV show, *Siskel and Ebert*.

The problems with his SE surfaced when I upgraded the machine from 1 megabyte to 4 MB of RAM and from System 6.0.2 to 6.0.5.

Roger currently uses a DataDesk Mac-101 keyboard and a Kensington Microware trackball with his SE, rather than the standard Apple keyboard and mouse. According to him, the DataDesk keyboard has a better feel, and he likes all its programmable function keys.

It's this programmability, however, that has caused the problems. DataDesk supplies special System resources that you dump into your System Folder to make its key programmability magic happen. As it turns out, these resources aren't compatible with System 6.0.5 during start-up, so the machine fails to boot with the keyboard connected. Remove the keyboard, and the machine boots fine. You can then attach this keyboard—gambling that you don't short out the Apple Desktop bus (ADB) chip—and it works.

Roger and I have both gone around the bend trying to figure out what's wrong, and it comes down to a software incompatibility in the DataDesk resources during start-up. Moving to System 6.0.7 didn't fix the problem, although DataDesk thought it would. The Apple engineers I talked to said the problem was that

## MACINATIONS

### Roger and Me: The Quest for Compatibility



**The Mac is a reliable software platform but has its share of compatibility problems**

DataDesk had violated some of Apple's System resource guidelines. DataDesk later confirmed this and sent us a patch disk with new resources. The new stuff doesn't work, either.

Well, that's too bad, you say. Roger should just buy another keyboard with function keys from some other vendor. He can do that, but it misses the whole point of the problem. He shouldn't have had to mess with this at all. This keyboard, like any Mac peripheral, should plug into its appropriate bus (i.e., ADB) and do its thing, without the need to chant incantations.

This has always been the Mac's promise: Software and hardware designed for it by third-party vendors would work right out of the box. MacFolk have learned to love their machines for this fact. You won't catch any of us wasting our time modifying CONFIG.SYS or AUTOEXEC.BAT files. We don't need to worry about memory partitions and

EMS standards and all the other tedious system and software incompatibilities that plague DOS, Windows, OS/2, and Desqview—except, apparently, when vendors violate the System standards that Apple lays down, as DataDesk has done.

But considering that Apple has done this itself on more than one occasion (how many of you out there have had problems with the Apple 24-bit GC graphics board, please raise your hands!), how can you blame third parties for getting a bit lazy? It's tough following someone else's standards.

But that's precisely what Mac vendors must do. They *must* stick to the knitting as defined by Apple. And it's now

*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."*

# HANDS ON

time for Apple to get a heck of a lot more serious about how it defines that knitting.

System 7.0 presents Apple with the opportunity to do this. Apple must clean up any oddities in the System now. As Apple gets its own compatibility/reliability house in order, it should have a lot more clout in dealing with third-party vendors.

Apple has a big lead in the system compatibility and reliability race. It's much farther around the track than any microcomputer operating system you can think of. But now it's time to ratchet the whole enterprise up a notch. Now's the time for Apple to build perfection—in its own System and in its interfaces with third-party products.

By the end of 1991, Roger and me and other Mac users should never again have to waste hours and hours trying

to fix a software compatibility problem.

## Software of the Month: Tiles and TouchBASE

Someone was complaining to me recently that "the small Mac companies just aren't around anymore." I told him to pay closer attention to the Mac software market because there's plenty of great software still being produced by the small guys. This month, I have two new entries to share with you: Tiles from CE Software (sort of a large, small company) and TouchBASE from After Hours Software (definitely small).

CE calls Tiles an "Intelligent Desktop for the Mac," and it's right. With the advent of the much-delayed System 7.0, there is an unfortunate tendency among many Mac developers to not provide any improvements to the Finder

and Desktop, since "Apple is taking care of that." CE's director of R&D, John Pence, however, doesn't believe that for a second. Which is one reason why he wrote Tiles: "Tiles builds on this power by anticipating the needs of the user, automatically organizing information, and presenting it graphically."

Tiles does this magic by creating graphical representations of applications and data files when they are opened. These representations are called tiles. Each tile can be stored in palettes (which are controllable through their own window bar icons) or placed on the Desktop. No matter how you choose to use tiles, you won't have to remember anything about the documents or applications they contain.

Tiles will nearly eliminate filing angst on a Mac. You no longer must remember where

you stored things to use them quickly. For example, suppose you create a project tile to act as a container for your year-end report. This tile can then hold the application, document, and other tiles that relate to the report. When you want to work on that year-end report, you merely double-click on the project tile, which in turn launches the appropriate applications and opens the files. You don't have to remember anything about how the components are stored.

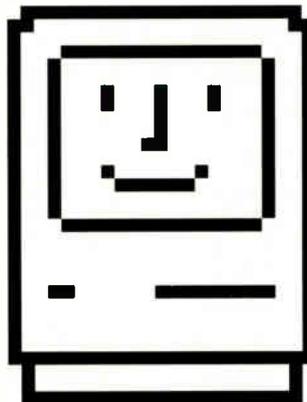
Costing only \$99.95, Tiles is inexpensive, yet it's fully extensible. It's one of those products that the Mac seems to foster, and it will provide MacFolk with an even better working environment than the Finder alone.

TouchBASE, on the other hand, has a smaller target audience. Contact lists are its domain. How many of you keep a

## MEET YOUR NEW UNIX SYSTEM ADMINISTRATOR!

Helios' EtherShare™ file server system lets you do system administration from any Macintosh on your network. Plus it gives you a PostScript® print server, a terminal server and an internet router that uses AppleTalk packet technology. *All for about \$100 per session!*

Field proven in Europe for almost two years, EtherShare provides high speed file access to up to 200 PCs, Macs and your DEC, Sun, Sony or IBM workstations. You can even have several EtherShare systems working on the same Unix host at the same time. It looks like AppleShare to the Macs, but moves data at Ethernet rates, up to



10 Mbits/sec. And it integrates computers with other operating systems like a DEC VAX® under VMS or Ultrix and lets IBM PCs join in the fun, as well.

Obviously there's a big story here. If you want the details, we've prepared a full package of information we'll be glad to deliver to you via e-mail. Just dial up our CompuServe® number 74730, 1004 and we'll get it to you.

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National Sales Manager, contact Paul Lucero at 998 West Lynn Way, Suite 4, Cupertino, CA 95014. Phone 408-255-2503. AppleLink: Helios.USA; or send him e-mail on Internet: lucero@apple.com.



Rolodex of names, addresses, and phone numbers? TouchBASE is the first product I've seen that is actually easier to use than the good old, reliable Rolodex (see the screen shot). I've tried HyperCard's Rolodex stack and products like DynoDex. The problem with them is that they try to act too much like the Rolodexes and Day-Timers they are replacing. Hey, if you've got a computer, why not think of new ways to solve information storage, retrieval, and usage problems? TouchBASE does exactly that.

This little desk accessory allows you to keep your contacts database up and ready to rock and roll all the time. It can do more heavy-duty stuff (e.g., printing labels, envelopes, fax covers, and the like). It can sort. It works in multiuser mode over a network. It can import and export



*TouchBASE is a desk accessory that operates as a contacts database. It comes with a sample file of over 500 Macintosh "top contacts."*

data simply. It includes user-defined fields in addition to the basic ones. It even dials your phone for you. Not bad.

What TouchBASE doesn't do is overwhelm you with meaningless kitchen-sink features that bloat the software

but don't add to its usefulness. More Mac software should be as well defined and compact as TouchBASE.

#### Tip of the Month

I've gotten into desktop publishing in a big way over the

last year, teaching a few seminars on PageMaker and spending some time learning about the issues: fonts/type styles, graphics, color, resolution, printing, and paper. That's the one that was the toughest to pin down because it seems like a no-brainer. If you use a laser printer for your output, you just use any decent-quality bond paper, right? Wrong, as I have learned.

The finish (i.e., texture, smoothness, and coating), water content (paper is mostly water!), and color (there are many "shades" of white) of paper all make a lot of difference in your final output. Some papers hold the toner better than others and keep it from smearing or diffusing. Other papers are biased toward providing the best possible camera-ready image. Still others can be erased, so you

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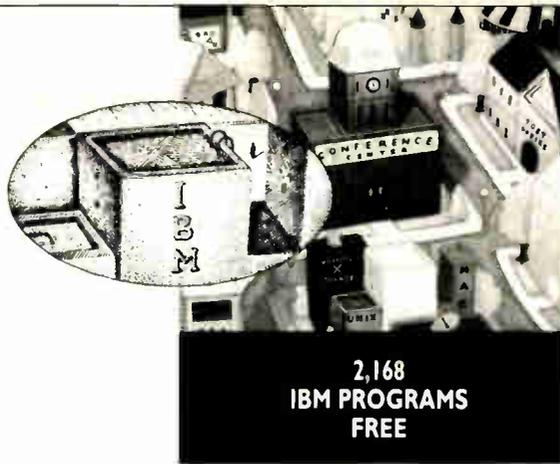
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■ In the BIX community we take care of people who use IBM PCs or their compatibles. For example, our IBM Exchange offers a growing list of programs which you can download for free. These 2,168 programs are the cream of the crop. All of them are tested in advance by BIX moderators so you know you're getting top-quality, virus-free programs. Here are some of the most popular ones:

BIX FILE NAME	BIX CONFERENCE	DESCRIPTION
stars.zip	microsoft	Utility that turns your Windows desktop into a view of deep space. Choose impulse or warp speed and launch several Windows utilities from a floating pop-up menu.
e.arc	ibm.utils	Public-domain text editor, with source code.
secrets2.arc	ibm.dos	Condensed and edited messages from the ibm.dos/secrets topic. Tricks and undocumented internals of MS/DOS.
tetris2.zip	microsoft	KLOTZ, a Tetris® clone for Microsoft Windows 3.
2zip25.zip	ibm.utils	Converts a variety of archive formats (including ARC, PAK, ZOO, LZH) to PKWare's ZIP format.
w3icons.zip	microsoft	40 new icons for the Windows 3 Program Manager.
firework.zip	microsoft	Fireworks display in a window, for Windows 3.
monitor.arc	ibm.os2	Continuous display of CPU load for OS/2 Presentation Manager.
abort.exe	ibm.utils	TSR that aborts any program when you press Alt-C.
dis386.zip	ibm.utils	Full-screen interactive machine language disassembler for 8086, 80286, 80386, NEC V20.

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## THE UNIX /bin

### Lost in the Woods

David Fiedler

**S**ometimes you have to cut a path through the forest so you can see the trees. While using Unix generally doesn't destroy any natural resources (aside from your equanimity, occasionally), sometimes it can make you feel as if you're lost in a forest. This month's column is dedicated to methods of leaving a trail behind you, so you hopefully won't get lost more than once.

#### Do It Right the First Time

In the October 1989 BYTE, I covered some of the basics of running a Unix system. These days, most implementations of Unix have all kinds of built-in utilities to make adding users—and other important aspects of system administration—much easier. But the system designers don't always do things the way you want them to, with the result that you might find yourself constantly rearranging things to fit your preferred method of operation.

It takes a bit more effort than doing nothing, but *auditing* the system defaults will pay dividends in future time saved and security problems and user questions averted. I will use the familiar—and seemingly simple—task of adding a user as an example of the kinds of things I'm talking about. These concepts work well for plenty of other tasks aside from system administration, so it's worth a look.

#### Following Your Instincts

If you are a typical power user on Unix, you have probably made up several short shell programs and aliases that make your life easier. System administrators generally have more of these programs, since they must monitor all kinds of subsystems and file systems on a daily basis. But apart from



**How to set up your system to be ideally responsive to users so you can save time, stabilize your system, and make people happy**

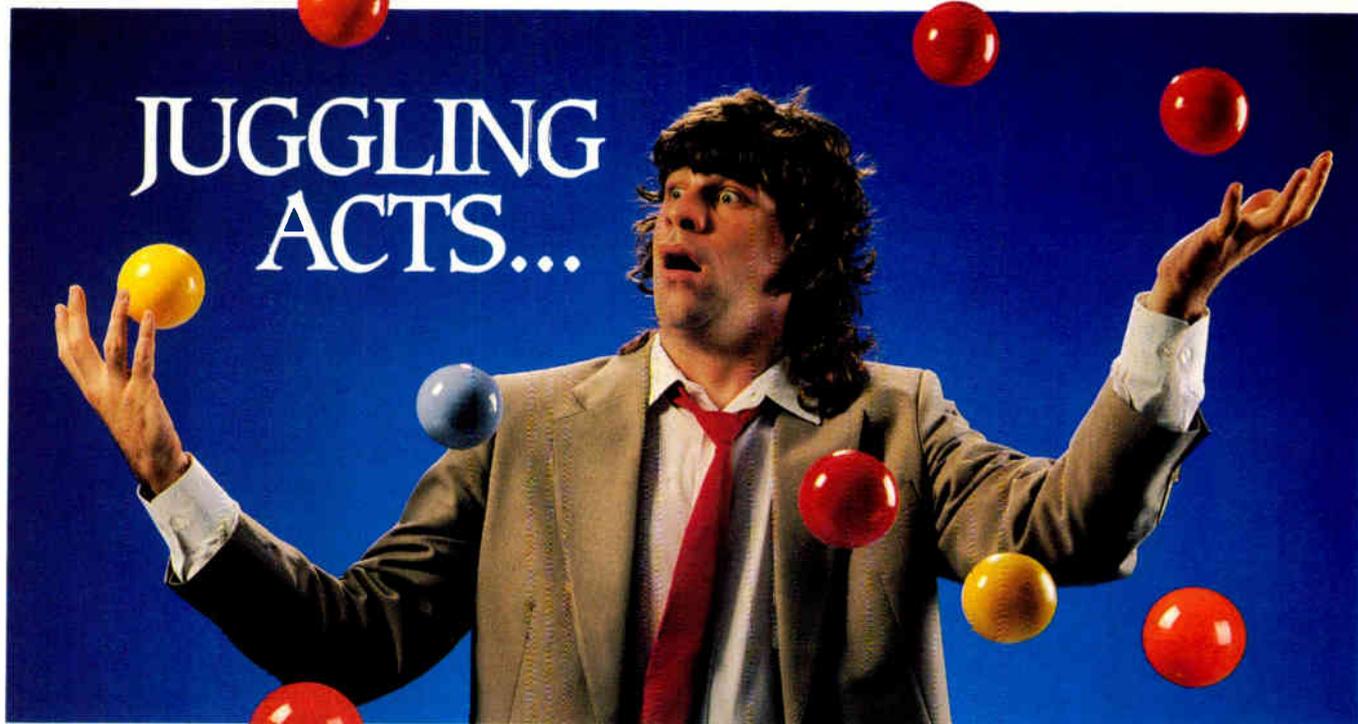
people who simply log directly into an application, virtually all Unix users have one thing in common: They love to customize their log-in environment.

Your log-in start-up files (.profile for Bourne shell users, .cshrc and .login for C shell fans, and .profile and .kshrc for Korn shell folks) are your private little haven. These files give you your own identity, as well as a prompt and default command search path. I have known people who programmed their prompt to say "Yes, Master" before each command, and others who preferred colors, graphics, and Zulu time to the nearest millisecond.

Aside from these little quirks, systems evolve over time, so it is important to keep your start-up files current with the latest programs. For instance, I find that I like the operation of the less pager much better if I change the LESS environment variable to -MCqse, which is done in my .kshrc file. Other variables have become de facto standards on their own. When I set the environment variable EDITOR to /bin/vi and MAILER to /usr/lbin/elm, I know that any of the numerous applications that now check the contents of those variables will automatically let me use my favorite text editor and mailer. And likewise, setting SHELL to /bin/ksh tells vi to spawn a new Korn shell (rather than

*David Fiedler is executive producer of Unix Video Quarterly and coauthor of the book Unix System Administration. He has helped start several Unix-related publications. You can reach him on BIX as "fiedler."*

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



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the Bourne shell default) when I type :sh from v1.

The point is that new users don't necessarily know all the tricks on your local system, even if they've used Unix before. The best way to ensure you have an efficient system is for the system administrator to have a little chat with some of the users who pay attention to these kinds of details and can collect as many handy hints as possible. Even system administrators are not omniscient, especially when it comes to every last flag and file reference in the Unix manuals.

You can then construct an optimum set of shell start-up files that include all the most popular local aliases, search paths, and options. One of the most important things to put in these files is a bulletproof program that, for any user, correctly sets the terminal type so that users can use screen-ori-

ented programs. This usually is a tortuous one-liner involving the tset program, or a shell case statement based on foreknowledge about the kinds of terminals attached to particular tty lines.

Once tested, this set of files should be kept in a nonroot file system (where they won't be written over in your next system upgrade or reload), perhaps with names such as stdprofile and stdshrc. You can then advertise their presence (via the /etc/motd file) so that interested users can study or copy them.

### Make Sure for Yourself

To save even more time, find out where the system gets default start-up files when new users are installed (SCO users should look under /usr/lib/mkuser) and replace the system's defaults with your own improved versions. Save the

originals in case you forget something. To find this information, by all means read the manual but also verify the information (and perhaps learn a few tricks) by looking at the program you execute to actually install new users. Now, every new user will get the benefit of your research, and a little less of the Unix "oral tradition" will be needed.

While you're at it, you can do a complete audit of the new user process. Create a new user the way your system manual recommends, generally via a program called newuser or adduser or as part of a system administration shell. Now log in as that user, and test everything. Do you get the expected shell start-up files? Can you send and receive mail, or do you run into permission problems? Can you, as this ordinary user, get into any restricted system directo-

ries, erase /unix, read other people's mail and files, or cause other mischief? When you create files as this user, do they have the correct owner, group, and permissions? Can you cd to the parent of your home directory? (Losing this capability is a problem when things are not set up right.) Have the correct entries been made in the /etc/passwd and /etc/group files?

If everything works perfectly, congratulations! But consider yourself lucky, as well. If security is of any importance to you (aside from simply correct operation), you can run more extensive tests with one of the publicly available security-checking programs. Now think about this: What is a security-checking program but one that tries, mechanically, the kinds of things that you and other administrators have found to be



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important? Do you see the analogy between this and the automation of the new user process? Can you come up with any similar ways of automating things that you do often on your machine? Aren't these good candidates for shell programs or aliases? See how this is all interconnected?

### Getting Around Obstacles

Sometimes Unix resembles a game of Adventure, where you have to go to different locations to do different things in order. A case in point: While I was writing this article, I had occasion to add a UUCP test account to a system. This account was specified as needing a four-character password. On older, less sophisticated Unix systems, short passwords were discouraged, but persistence won out: If you kept trying, the `/bin/passwd` program would accept a short

one eventually. It was a cute way of getting around the published rules for those who knew the trick, but after all, the sole function of the `passwd` program was to let you change passwords.

But today's Unix systems are built to be tough. The `passwd` program on my SCO Unix system is a huge 90K bytes (I remember when `vi` was that size), and it has an eight-page manual entry and plenty of options and configurable settings. In fact, this new version generates random passwords for you, as well as check your new selected password against the on-line dictionary and a few other databases to ensure that it's not too easy for other people to guess it. It even makes sure your password is not a palindrome.

So how did I get a four-character password past this bar-

bouncer of a program? I read the manual, which indicated that a parameter called `PASSLENGTH`, normally set to five characters as a minimum password length, could be found in the file `/etc/default/passwd`. Naturally, I changed this value to four and tried again, only to come up against the database search algorithm that I mentioned earlier. It turned out that this was contained in a separate program whose path name was also stored in the default file.

Reasoning that a return code would be expected if a different program was being run, I changed the stored path name temporarily to `/bin/true` (which always returns a "good" value). Running `/bin/passwd` again, using this configuration, allowed me to get the short password stored properly.

And if the manual didn't ex-

plain this well, I could have used the famous `strings` program—the last refuge of the desperate—to find out what secrets were hidden in the binary of `/bin/passwd`.

None of this is meant as an indictment of modern security procedures or as an encouragement to bypass them. The point is that as Unix has become more complex, you must learn how to work with—and sometimes around—all the new programs and their features. But this is actually good news, since this means that there are more options open to you for getting your job done. While some installations may not need C2-level security (as has been bitterly debated in the `unix.bin` conference on BIX), it is certainly nice to have it available. My hope is simply that you never find out the hard way as to why you need security. ■

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## NETWORKS

## Windows 3.0 and Networks

Brett Glass

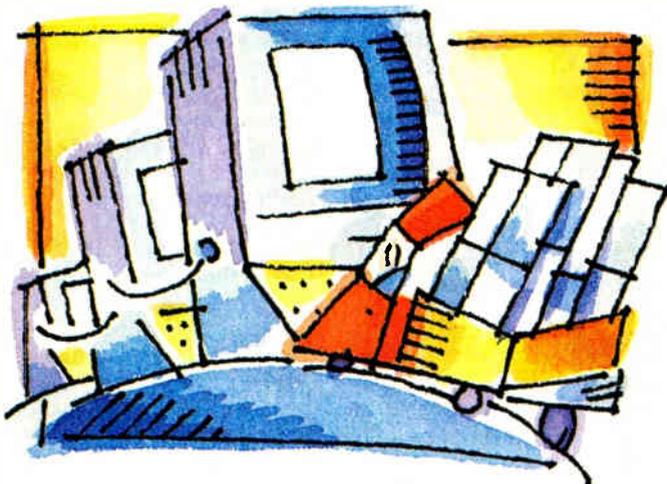
**E**arly graphical user interfaces didn't offer much support for LAN users, but Microsoft designed Windows 3.0 from the start to work with networks. Workstations running Windows can access network disks and printers as if they were local. Network software can multitask or run in the background. It's even possible to modify your workstation's configuration (i.e., to add or delete network disks and printers) without leaving the Windows GUI. The file manager, print manager, and control panel are designed to understand networks and allow you to manipulate them gracefully.

All this power comes with a price, however. Setting up Windows to run on a network isn't simple, and many pitfalls lurk for the unwary. In this column, I have assembled a few important rules, gleaned from discussions with several experienced users, that should help you get (and stay) up and running.

**Rule 1: Install the network before installing Windows.**

When you first install Windows 3.0 on a machine, the Setup program gathers specific information about your system. Among this information is the type of network you're running (e.g., Novell and TOPS). Windows automatically installs its own special drivers for your network. It also remembers the logical drive to which it was installed. And if you set up icons for applications on network servers, Windows saves the path names for those applications—com-

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**What you don't know about Windows 3.0 and LANs can get you into a lot of trouble. Here are a few mistakes to avoid.**

plete with drive letters—in .PIF files. This means that if you change the letters that are used to access network drives, you will get error messages when you attempt to launch applications. Worse yet, you might not be able to run Windows at all. To avoid this problem, you must first stabilize your network configuration and then install Windows.

If you install the network or change network vendors after installing Windows, be sure to run the Windows Setup program (which appears as an icon in the program manager's main program group) to install or update your network driver.

**Rule 2: Put as much of Windows on the workstation as possible.**

There are three methods of installing Windows on a LAN workstation. The first is to install Windows on the workstation's hard disk. This consumes the most hard disk space, but it is by far the fastest way to run Windows. It also has another advantage: Should

the network go down, this is the only configuration that keeps running. I strongly recommend this approach.

The second method is to keep shared Windows files in a directory on the server but also keep files that are unique to each workstation on the workstation's local disk. The Windows manual (chapter 14) explains how to perform this somewhat tedious process; you must manually type in a batch file and then run it individually on each of the five Windows installation disks. You then mark all the files you create on the server as read-only, to prevent corruption. (I recommend Peter Norton's File Attribute utility for this purpose.)

To set up a workstation in this configuration, you can connect it to the Windows directory on the server and type the command `setup /n`. This approach sacrifices performance for hard disk space, and the trade may not be worth it. One user reports that even on a 386SX, it took as long as 2

minutes to load Windows over ARCnet.

The third way to install Windows on a LAN workstation is to place both the common files and the workstation-specific files on the network server. Again, you would use the `setup /n` command. This is the only choice for diskless workstation users that do not have a large RAM disk. Network overhead takes its toll in this mode, though; I'd advise against using a diskless workstation with Windows.

Windows also has the ability to speed operation in 386 enhanced mode by creating a permanent *swap file*. It uses this file, which must be contiguous, as a virtual memory pool. To attain the best possible performance, Windows bypasses DOS and proceeds straight to the BIOS to access this file, sector by sector. So, no matter what you choose to do with the other files, the permanent swap file (which you can create using the swap-file application in the Windows directory) has to reside on a local hard disk.

**Rule 3: Make sure you have Windows-compatible network drivers.**

Windows 3.0 is an ambitious product that cuts lots of corners and takes over much of your machine. For this reason, some low-level system programs, especially network drivers, don't work with Windows. Other programs require updates. For instance, Novell had to update its IPX, NETx, XMSNETx, EMSNETx, and NetBIOS drivers for Windows. If you bought NetWare recently, you already have Windows-compatible drivers. But if you're not sure, check to see if the version numbers on your IPX and NETx drivers are at least version 3.01a or higher.

To find out the version numbers of NetWare drivers and shells, you can invoke each program with the *i* parameter (e.g., `IPX i`, `NETx i`, and `XMSNET i`). The drivers report their version numbers

without loading. The procedure differs for drivers from other LAN vendors.

CompuServe is a good place to pick up the latest NetWare drivers; you can download them from Data Library 16 of the NOVA forum. In all cases, check with your LAN adapter or network software vendor, who may be able to send you updated drivers.

**Rule 4: Avoid running Microsoft Windows on a nondedicated server.**

Some networks—especially peer-to-peer LANs—experience problems if you run Windows on the server. Even if your server is a fast i486, Windows may suck so much wind from its sails that performance is no longer tolerable. Or, worse, Windows may disable it altogether. After I had installed Windows, the server on my Network OS LAN stopped handling net-

work requests entirely. (CBIS, makers of the Network OS, should have a fix by the time you read this.)

**Rule 5: Load your network drivers high, if at all possible.**

Several vendors produce network shells that can load themselves into EMS or extended memory (e.g., Novell's XMSNETX.EXE). Other shells will load high if you have a third-party memory manager, such as QRAM, QEMM-386, or 386Max. If you have these utilities, you should use them. Every TSR you load into DOS's 640K bytes of real-mode memory reduces the amount of memory that will be available in every DOS window—even in 386 enhanced mode. If you want to run large non-Windows applications (e.g., Ventura Publisher) within a DOS window, a memory manager is the only workable solution.

One caveat, however: If you use a third-party memory manager, test it thoroughly before using it with Windows on a regular basis. I am currently testing both QEMM-386 and 386Max with Windows and will report on them in an upcoming BYTE review.

**Rule 6: Beware of memory, interrupt, and port-address conflicts.**

Some network interface cards, such as the IBM Token Ring adapter, have RAM buffers that they map into the address region between 640K bytes and 1 megabyte. This can conflict with Windows' memory management scheme and can cause erratic operation. To keep Windows away from this memory, you may have to add a line, such as

```
EMMExclude=D000-D7FF
```

to the Windows SYSTEM.INI

file. The manufacturer should be able to tell you if—and when—this line is needed.

Another common cause of conflicts is a LAN interface that attaches to a parallel-printer port. Since Windows normally goes directly to the port hardware when printing (rather than going through the BIOS), it can confuse a LAN adapter that is on the same port. The solution: tell Windows to use the LPTx.OS2 printer ports (available on the printer configuration menus). Designed for OS/2, this option forces Windows to perform well-behaved printer operations so that your LAN can re-route them to a network print server.

Are you having any trouble with Windows or the network when you move your mouse or use a communications program? If so, you may have revealed an interrupt conflict.

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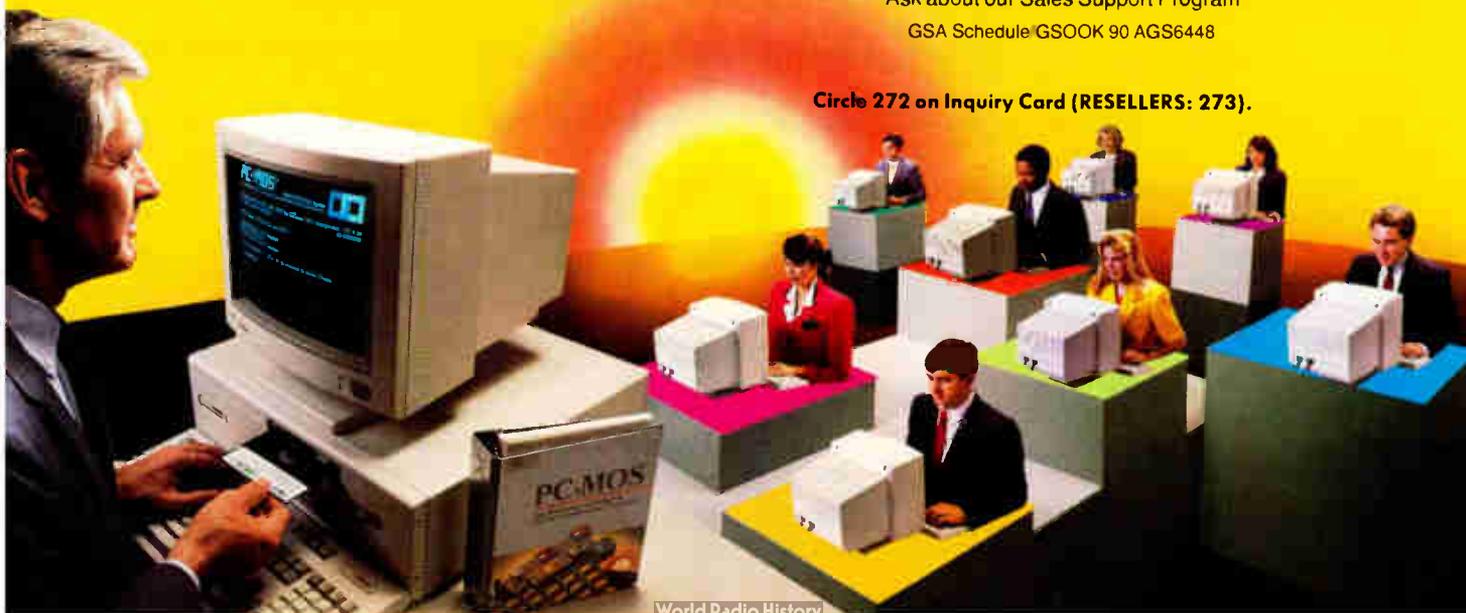
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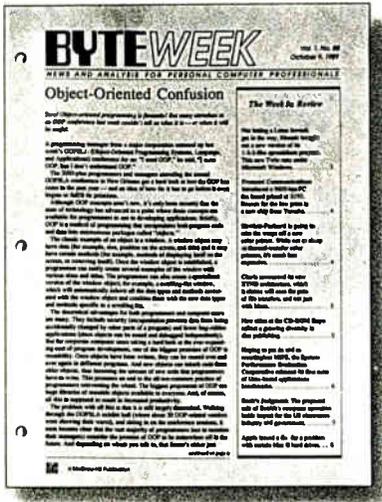
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Two devices can't share an interrupt on the IBM PC. Check the interrupt settings on your peripherals to ensure that this constraint is obeyed, and that your network card's port address is different from that of any other peripheral's. Port 300 hexadecimal, which IBM once documented as the port for prototyping boards, is the most common site of I/O address conflicts.

If possible, avoid using IRQ2 for a network card. This interrupt is more complex to service than the others, and some software doesn't handle it properly. If you have to use IRQ2 and you're using NetWare you can install the file VPICDA.386 (available from Novell with the Windows-compatible shells) to ensure correct operation in 386 enhanced mode.

**Rule 7: Think twice before accessing the same file from two DOS sessions in standard or enhanced mode.**

Any DOS program can ask the system to open a file for its own exclusive use, preventing all other programs from accessing the file. All properly designed networks respect these requests; therefore, if you open a file on the server from one workstation, another program on another workstation will not be able to access that file.

Unfortunately, each system sees Windows as a single application—even though it may actually run several applications. Therefore, if you open two instances of a database program in two separate DOS windows, both can access the same network file at the same time. The result can be seriously corrupted or lost data. I have lost databases that I created using ThinkTank by accidentally running two copies of the program on the same file from different windows.

I hope that Microsoft will address this problem in future versions of Windows. But in the interim, it's wise to keep track of the files and databases that each DOS window uses

and to make sure that there's no overlap.

**Rule 8: If you get stuck, consider going on-line for help.**

CompuServe, BIX, GENie, and all the other major on-line services have forums that cover LANs and Windows. You can join in on the different conferences and post your problems; odds are you'll re-

ceive an answer within a few hours.

### Worth the Effort

I've exchanged E-mail with dozens of Windows and LAN users, and their opinion is pretty much unanimous: Microsoft needs to make Windows less awkward to install on a network. The good news,

however, was the consensus that Windows did perform well once the initial hurdle of installing it successfully was overcome. So take heart and roll up your sleeves: Windows and LANs may not yet be the perfect couple, but if you're willing to play matchmaker, it is well worth the time and effort. ■

## BEYOND DOS: WINDOWS AND OS/2

### A Smaller, Faster OS/2

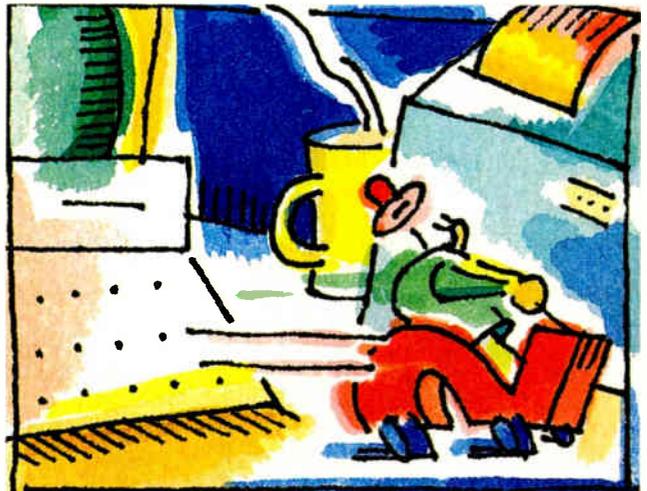
Douglas A. Hamilton

I walked into IBM's Boston office on the day of the OS/2 1.3 announcement feeling like a kid coming downstairs to see what Santa had left for Christmas. I sell software for OS/2, and if you don't have OS/2, you don't have any use for my software. That's a hard way to make a buck, because most of you don't have OS/2.

So I wondered, would this be OS/2's big break? Would printing finally work? Would mere mortals be able to install it? Would IBM finally launch the sort of marketing extravaganza that Microsoft used with such success for Windows 3.0? Just as there had been a \$50 Windows 3.0 upgrade, would there now be a \$50 OS/2 upgrade? To drive home just how reasonable the hardware requirements were, would they show it running on a lowly PS/1? Could this "Ultra Slim-Fast" version of OS/2 that Microsoft had fought so hard to keep off the market be the Windows killer?

The answers, sadly, were mixed. Technically, OS/2 1.3

*Douglas A. Hamilton is the founder of Hamilton Laboratories in Wayland, Massachusetts, and the author of its first product, the Hamilton C shell, an advanced command processor and utilities package for OS/2. He can be reached on BIX as "hamilton."*



### OS/2 1.3 is a technical success but a marketing flop

is everything promised. Given the lackluster marketing effort, though, not many people are likely to discover that.

#### Delivers the Goods

I have been using version 1.3 every day, all day long, for a month now, and everything does work. It's fast and reliable. And because of the inherently superior kernel facilities, it's fundamentally more capable than Windows—and much more appealing to program. It's a fun system to use, and I have no hesitation in recommending it.

The most important im-

provement in version 1.3 is the ability to print. Since many of us use computers to help deforest the planet, an operating system that can't print is obviously at a disadvantage. No more. OS/2 1.3 prints properly. Even the print queues work. Watching jobs go into a queue (and then actually come out on the printer and look like they were supposed to) was almost magical. After three years of frustration, I guess I'd unconsciously given up.

Everything is much tidier now. Your root directory no longer looks like an atom bomb went off after you finish

with the installation. Welcome enhancements include the REXX script language (formerly included only with the Extended Edition), a much wider choice of text fonts, and Adobe Type Manager (ATM). Version 1.3 runs in as little as 2 megabytes of RAM, although with memory now selling for \$45 per megabyte, that may not be so important anymore.

REXX is an interpreted language that has been enormously popular in the IBM mainframe world and is now IBM's official Systems Application Architecture procedure language. Looking a little like PL/I, REXX encompasses and extends OS/2's batch language.

ATM is a popular extra-cost item under Windows 3.0 that comes free with OS/2 1.3. ATM uses outline fonts to let characters scale arbitrarily. Also, it will print exactly as it displays, even on dot-matrix printers, since ATM rasterizes characters for printers that do not have the appropriate fonts built in.

Version 1.3's performance isn't much different from version 1.2's. It was good before, and it's good now. I measured some text window and kernel functions, and I found few changes in speed. I did notice a difference in some large Presentation Manager (PM) applications like Lotus 1-2-3/G, where the start-up times improved by a few seconds.

For a long time, OS/2 has been a big victor in terms of productivity for developers. Coupling these latest refinements with a decent selection of word processing, spreadsheet, desktop publishing, and other core applications, OS/2 is now ready for ordinary end users.

### The Marketing Fiasco

IBM's marketing is not any more aggressive than before. At the Boston office, there was just one machine tucked off in the corner running version 1.3. The marketing representative standing next to it was

unsure just what sort of hardware was inside. Upgrades from OS/2 1.1 or 1.2 were announced as free, but no one knew how you were supposed to get one. A month after the announcement, IBM was still trying to decide whether you needed a dealer's signature or just the title page from your old version to get the upgrade.

Unbelievably, there's absolutely no upgrade path from DOS. At this time, there are only a few hundred thousand OS/2 users—and 50 million DOS users. You don't have to be a genius to realize that if you want to make OS/2 a success, you have got to convert some of those DOS users.

You hear all the time about companies spending anywhere from \$5000 to \$15,000 for a machine, loading it with all sorts of applications at \$300 to \$500 a pop, and having an employee use it all day long. Considering what an employee's time is worth to a company, you'd think \$350 for OS/2 would be the least important consideration. It's a drop in the bucket relative to the other costs involved.

Yet, over and over, people tell me it is a big deal. And I believe them. Look what Microsoft's \$50 upgrade program did for Windows 3.0. Is there anyone who didn't buy a copy? Where's IBM's promotional effort? Last summer, Microsoft spent at roughly the rate the Republicans or Democrats would elect a president. IBM has run a few ads for OS/2, I admit, but you'd have to think hard to remember if you've seen one.

### A Face Only a Mother Could Love

Compared to Windows 3.0, OS/2 still presents a face only a mother could love. Where are the free games like Solitaire or the pretty bit maps for the desktop? Where's the simple paint program or the (however dim-witted) free word processor? The only applications IBM and Microsoft have ever seen fit to include with

OS/2, the File Manager and Borland's SideKick, are both so tediously slow I rarely run into anyone who can stand to use them. About the only good thing that can be said is that SideKick is no longer included and that File Manager is a little less tedious in version 1.3.

Compare also how you choose your colors in the PM versus Windows control panels. PM still uses a silly arrangement of three sliders for color, shade, and amount, which have nothing to do with the decimal RGB values displayed. Nor can you just type in the values you want.

With the Windows control panel, you can choose from a set of predefined colors or create your own by typing in the values as either RGB or HLS (hue-luminance-saturation) or by mousing around on a two-dimensional rainbow palette. To choose what you want to set colors for, you simply click on it. No silly menus where you have to guess what an "Action Bar Outline" is. When you're done, the color settings are saved as ASCII text in the initialization files, so you can see what the heck is in there.

Anyone comparing Windows and OS/2 right out of the box is going to prefer Windows. The technical superiority of OS/2, however convinced we might be that it's there, is simply not apparent at a first look.

### Sell What You've Got

Just for good measure, in case anyone might be thinking, "Ah, it's finally time to move to OS/2," what do you suppose IBM demonstrates to potential customers? Is it version 1.3? Of course not. At the version 1.3 announcement, the demonstration for the whole audience was of OS/2 2.0.

Nothing like pointing out to people that there's really no point in bothering at all with version 1.3 since the "real" OS/2 is going to be out so soon. Adding insult to injury, nothing that they demonstrated

that day couldn't have been done on version 1.3 or even 1.2 or 1.1.

Is version 2.0 coming out so soon? As I write this in mid-January, well past IBM's self-imposed end-of-1990 deadline for the first shipments of it, most of the betting seems to be that version 2.0 may be many months away from reality and that it still lacks the touted binary compatibility layer for running unmodified Windows 3.0 applications.

I've even heard that Microsoft is quietly advising some of its "strategic partners" not to bother at all with version 2.0 development, claiming they don't think IBM will have it ready until the end of this year, only a few months before Microsoft rolls out OS/2 NT (New Technology), the portable RISC version of OS/2.

For all its alleged marketing prowess, IBM may have forgotten that first rule: Sell what you've got, not what you haven't. What's sad about this is that OS/2 1.3 really is a fine product.

### Modern Realities

OS/2 1.3 is, in many ways, the system we were promised back in the summer of 1987. It's solid and fast. The hardware requirements are neither excessive nor particularly expensive. Everything works, and virtually every item on the DOS user's "wish list"—true multitasking, a fast file system, a better scripting language, and virtual memory—is included.

But it's no longer 1987, and there's a lot more competition. Windows looks prettier and comes with more toys to acclimate new users. It's cheaper and far less risky to develop for Windows since the tools are much less expensive and the market is so much larger. Make no mistake, OS/2 1.3 is very good. I use it, and I love it. But IBM is going to have to wake up soon and begin the marketing, promotional, and developer support efforts that are needed to make it fly. ■

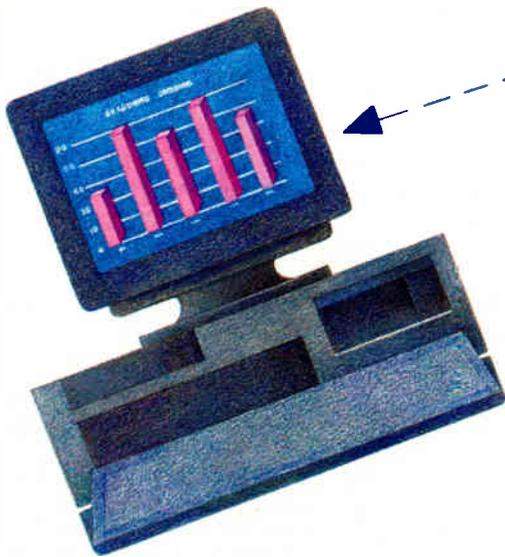
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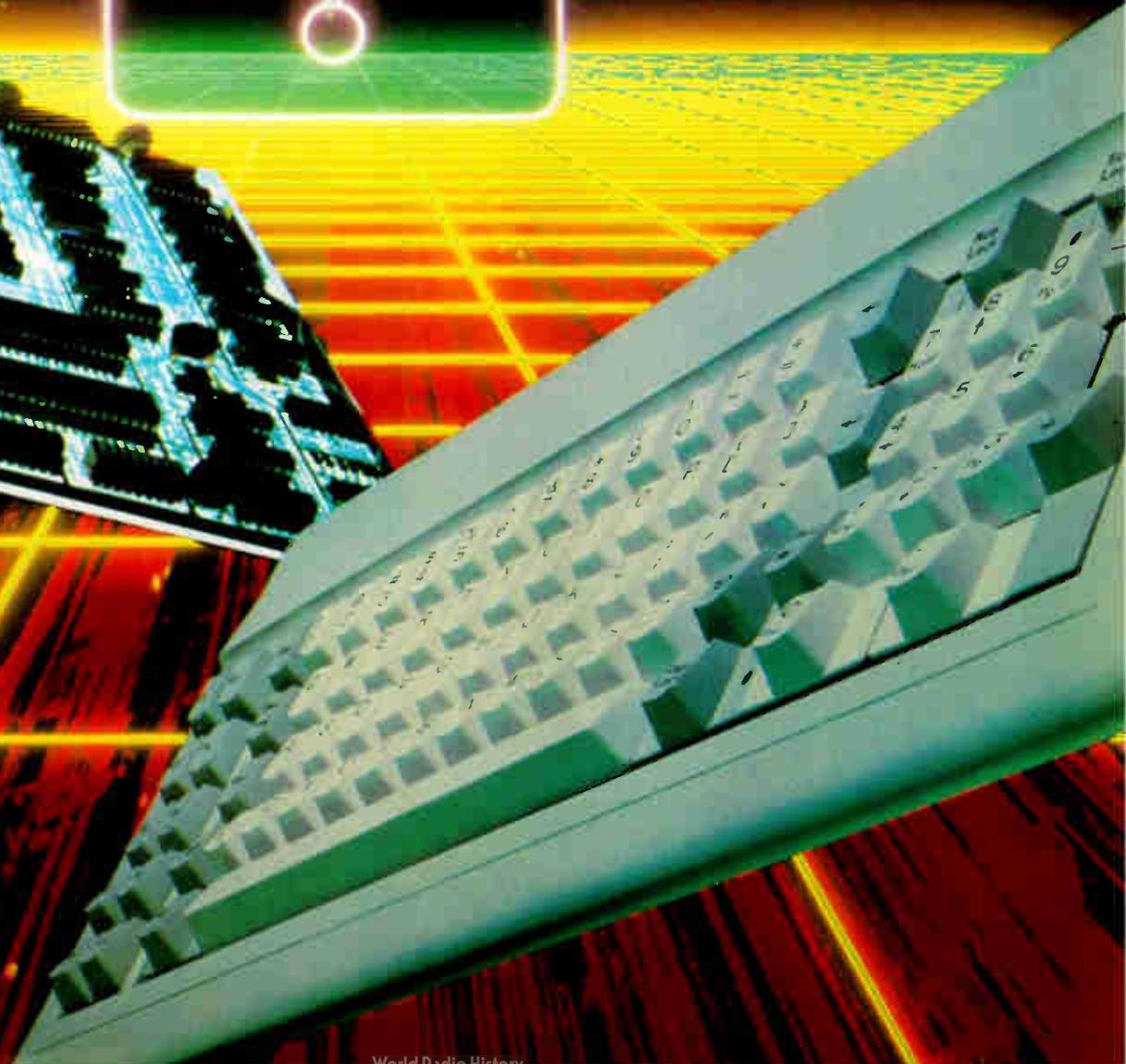
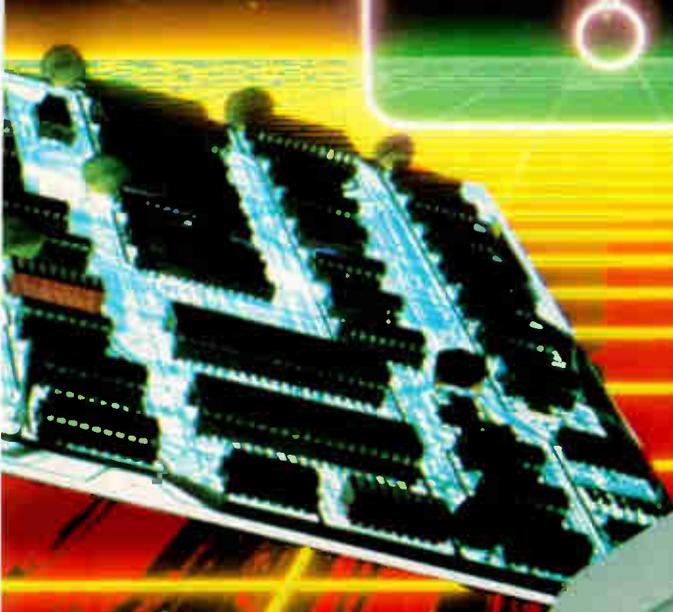
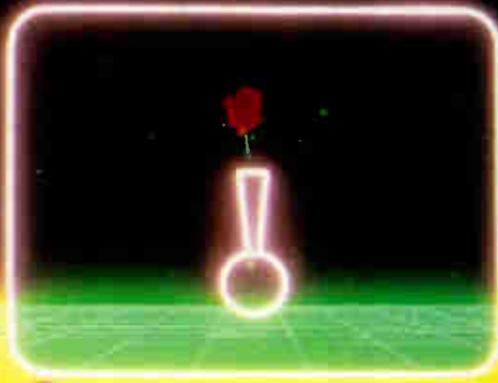
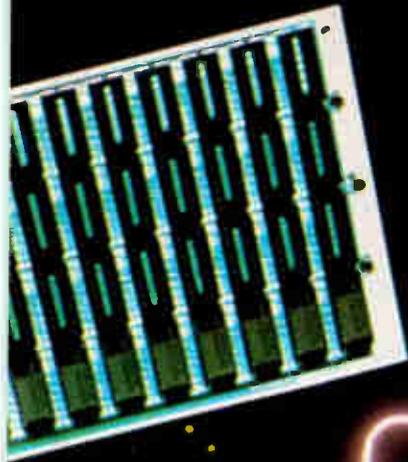


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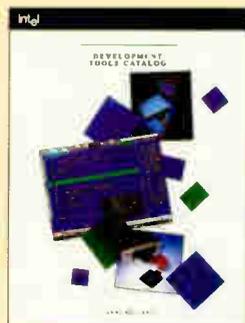
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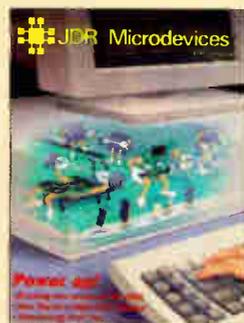
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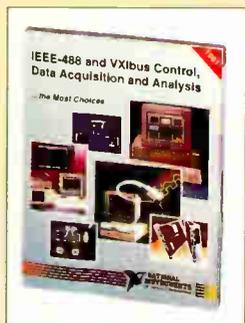
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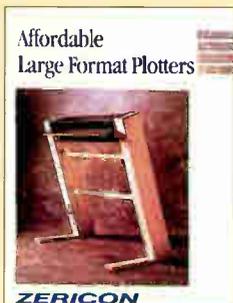
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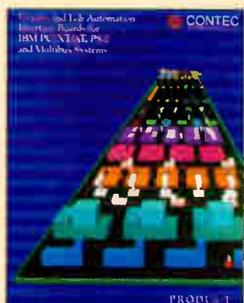
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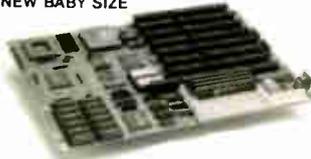


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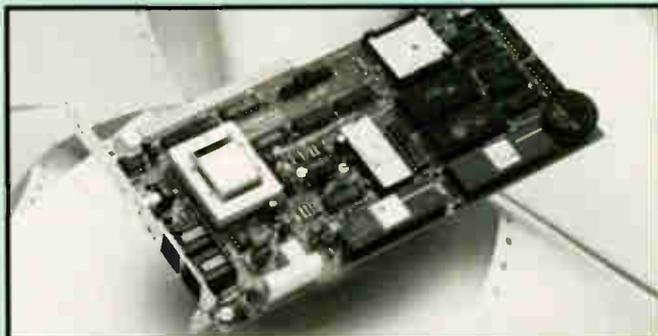
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386SX/20	2MB Module	118689-001	188 <sup>00</sup>
DESKPRO 386/16	4MB Module	118690-001	448 <sup>00</sup>
DESKPRO 386/16	1MB Board	108069-001	299 <sup>00</sup>
	2MB Board	108069 W/71	348 <sup>00</sup>
	1MB Kit	108071-001	138 <sup>00</sup>
	4MB Board	108070-001	699 <sup>00</sup>
	4MB Kit	108072-001	318 <sup>00</sup>
DESKPRO 386S	1MB Board	113633-001	198 <sup>00</sup>
	4MB Board	113634-001	448 <sup>00</sup>
	1MB Module	113645-001	104 <sup>00</sup>
	4MB Module	112534-001	258 <sup>00</sup>
DESKPRO 386/20, 25 286E	1MB Module	113131-001	98 <sup>00</sup>
	4MB Module	113132-001	238 <sup>00</sup>
DESKPRO 386/20E/25E	1MB Board	113844-001	198 <sup>00</sup>
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DESKPRO 386/33, 486/25 SYSTEMPRO	2MB Module	115144-001	169 <sup>00</sup>
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	2MB Kit	107332-001	179 <sup>00</sup>
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LTE/286	512K Module	117077-001	199 <sup>00</sup>
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PORTABLE T3100e	2MB Kit	1PC9-PA8341U	158 <sup>00</sup>
PORTABLE T3100SX	2MB BD	PC15-PA8308U	158 <sup>00</sup>
	4MB BD	PC15-PA8310U	458 <sup>00</sup>
PORTABLE T3200	3MB BD	PC6-PA7137U	298 <sup>00</sup>
PORTABLE T3200SX	2MB Kit	PC12-PA8307U	158 <sup>00</sup>
	4MB Kit	PC12-PA8309U	458 <sup>00</sup>
PORTABLE T5100	2MB BD	PC7-PA8301U	178 <sup>00</sup>
PORTABLE T5200	2MB Kit	PC10-PA8304U	168 <sup>00</sup>
DESKTOP T8500	8MB Kit	PC10-PA8313U	995 <sup>00</sup>

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Zenith Model	Memory Added	Zenith Equiv. Part #	Your Low Price
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PS/2 50Z & 55-SX, 65SX	1MB SIMM	6450603	69 <sup>00</sup>
	2MB SIMM	6450604	129 <sup>00</sup>
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55SX & 65SX	4MB Module	34F2933 or 87F 9977	369 <sup>00</sup>
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50, 50Z, 55SX & 60, 65SX	2-8MB Board	1497259 or 6450609	499 <sup>00</sup>
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PS/2 70-A21 AX1, BX1	2MB SIMM	6450608	139 <sup>00</sup>
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64 x 4	1 <sup>15</sup>				
64 x 4	1 <sup>15</sup>	2 <sup>25</sup>	2 <sup>15</sup>	3 <sup>25</sup>	—
256 x 1	1 <sup>15</sup>	1 <sup>15</sup>	1 <sup>15</sup>	1 <sup>15</sup>	2 <sup>15</sup>
256 x 4	—	5 <sup>00</sup>	6 <sup>00</sup>	7 <sup>00</sup>	8 <sup>00</sup>
1 Meg x 1	—	4 <sup>15</sup>	5 <sup>15</sup>	5 <sup>15</sup>	5 <sup>15</sup>

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HP3 & IID	1MB Module	33474A/B	98 <sup>00</sup>
HPIIP	2MB Module	33475A/B	138 <sup>00</sup>
	4MB Module	N/A	238 <sup>00</sup>
CANON LBP 811, 811R, 811T	1MB Module	N/A	98 <sup>00</sup>
	2MB Module	N/A	148 <sup>00</sup>
	4MB Module	N/A	238 <sup>00</sup>
IBM LASER MODEL 4019	1MB Board	1039136	148 <sup>00</sup>
	2MB Board	1039137	198 <sup>00</sup>

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Description	120NS	100NS	80NS	70NS	60NS
256 x 9 IBM	58 <sup>00</sup>	24 <sup>00</sup>	29 <sup>00</sup>	26 <sup>00</sup>	39 <sup>00</sup>
1Meg x 8 Apple	159 <sup>00</sup>	61 <sup>00</sup>	64 <sup>00</sup>	71 <sup>00</sup>	79 <sup>00</sup>
1Meg x 9 IBM	55 <sup>00</sup>	57 <sup>00</sup>	59 <sup>00</sup>	—	—
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- Output: 2.5 mW (max.)
- Current: 90-150 mA
- Operating Voltage: 2.2-2.5V
- Wavelength: 820nm
- Collimation: .18mrad (typ.)
- Size: 11mm diameter

STOCK # **SB1052** PRICE **\$39.99**

### LASER DIODE (INFRA-RED)



- Output: 10 mW (max.)
- Current: 90-150 mA
- Operating Voltage: 2.2-2.5V
- Wavelength: 820nm

STOCK # **SB1053** PRICE **\$9.99**

### LASER DIODE (VISIBLE-RED)



- Output: 5 mW (max.)
- Current: 65-100 mA
- Operating Voltage: 1.75-2.2V
- Wavelength: 780nm

STOCK # **LS022** PRICE **\$19.99**

### LASER DIODE (VISIBLE-RED)



- Output: 4 mW (max.)
- Current: 20 mA
- Operating Voltage: 2.2-3.0V
- Wavelength: 665nm

STOCK # **LS3200** PRICE **\$99.99**

### POWER SUPPLY



- Input: 115/230v
- Size 7" L x 5 1/4" W x 2 1/2" H
- Output: +5 volts @ 3.75 amps
- Output: +12 volts @ 1.5 amps
- Output: -12 volts @ .4 amps

STOCK # **PS1003** PRICE **\$19.99**

### LASER DIODE (VISIBLE-RED)



- Output: 3 mW
- Current: 85-100 mA
- Operating Voltage: 2.3-3.0V
- Wavelength: 670nm

STOCK # **LS9200** PRICE **\$49.99**

### LASER POINTER



- Output: 3.5 mW
- Wavelength: 670nm
- Power Supply: 2xAAA Batteries (Included)
- Beam: Approx. 3" @ 100 yards

Quantity Discounts Available

STOCK # **LSPOINT** PRICE **\$199.99**

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2708	6.49	6.17	5.55	TMS2564	5.79	5.50	4.95
2716	3.29	3.13	2.82	27C64	3.29	3.13	2.82
2716-1	3.79	3.60	3.24	27128-20	4.99	4.74	4.27
TMS2716	5.79	5.50	4.95	27128	4.79	4.55	4.09
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	4.09
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
TMS2532	5.79	5.50	4.95	27512-20	6.49	6.17	5.55
TMS2532P	1.99	1.89	1.70	27512	5.99	5.69	5.12
27C32	3.79	3.60	3.24	27C512	5.99	5.69	5.12
2764-20	4.29	4.08	3.67	27C1024	12.99	12.34	11.11
2764	3.99	3.79	3.41	68764	9.99	9.39	8.19
2764A-20	3.99	3.79	3.41	68766	12.99	12.34	11.11

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4116-120	1.39	1.32	1.19	4464-120	2.79	2.65	2.39
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4116-200	.89	.85	.77	41256-60	2.99	2.84	2.56
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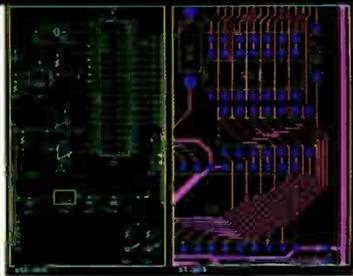
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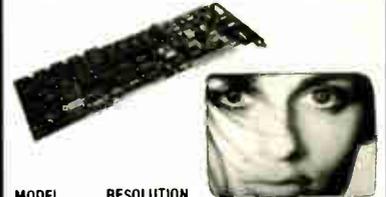
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	4MB MODULE	113132-001	\$ 280.00
DESKPRO 386/20e-25e	1MB BOARD	113644-001	\$ 179.00
	4MB BOARD	113645-001	\$ 479.00
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DESKPRO 386e	1MB BOARD	113633-001	\$ 179.00
	4MB BOARD	113634-001	\$ 479.00
	1MB MODULE	113644-001	\$ 120.00
	4MB MODULE	112534-001	\$ 339.00
PORTABLE III	512K KIT	107331-001	\$ 49.00
	2MB KIT	107332-001	\$ 135.00
DESKPRO 386/16	1MB BOARD	108089-001	\$ 325.00
	2MB BOARD	108089-W/71	\$ 449.00
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DESKPRO 386 PORTABLE	1MB KIT	107651-001	\$ 229.00
SLT/286	4MB BOARD	107653-001	\$ 789.00
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	2MB KIT	MO219	\$ 115.00
	4MB KIT	MO2707	\$ 225.00
	16MB KIT		\$ 1199.00
MACIci	4MB KIT	MO292LL-A	\$ 225.00
	16MB KIT		\$ 1199.00
MAC SE & PLUS	1MB KIT	MO218	\$ 80.00
	2MB KIT	MO219	\$ 115.00
	4MB KIT	MO2707	\$ 225.00
MAC PORTABLE	1MB KIT	MO248	\$ 249.00
	2MB KIT	N/A	\$ 699.00
	3MB KIT	N/A	\$ 899.00
	4MB KIT	N/A	\$ 1199.00
MACIix	4MB KIT	MO376LL-A	\$ 289.00
	16MB KIT	N/A	\$ 1199.00
LASER WRITER I/INTX	1MB KIT	M8005	\$ 85.00
	4MB KIT	M8008	\$ 289.00



Model	Memory Added	Part # EQ	PRICE
BRAWO/286	128K KIT	500510-011	\$ 40.00
	512K KIT	500510-010	\$ 55.00
	2MB KIT	500510-002	\$ 150.00
	4MB KIT	500510-008	\$ 300.00
PREMIUM/286 ADVANCED	512K KIT	500510-001	\$ 55.00
	1MB KIT	500510-007	\$ 100.00
	2MB KIT	500510-002	\$ 150.00
	4MB KIT	500510-008	\$ 300.00
FASTBOARD /386	1MB KIT	500510-007	\$ 100.00
	4MB KIT	500510-008	\$ 300.00
PREMIUM WKST/286	512K KIT	500510-010	\$ 55.00
	2MB KIT	500510-002	\$ 150.00
	4MB KIT	500510-008	\$ 300.00
PREMIUM WKST 386/SX	512K KIT	500510-010	\$ 55.00
	1MB KIT	500510-007	\$ 100.00
	2MB KIT	500510-002	\$ 150.00
	4MB KIT	500510-008	\$ 300.00
PREMIUM 386/16	1MB KIT	500510-007	\$ 100.00
	4MB KIT	500510-008	\$ 300.00
PREMIUM 386	1MB KIT	500510-003	\$ 140.00
	4MB KIT	500510-004	\$ 320.00
PREMIUM 386c	1MB KIT	500510-007	\$ 100.00
	4MB KIT	500510-008	\$ 300.00
PREMIUM 386/25/16ex	1MB SIMM	500718-001	\$ 69.00
PREMIUM 386/33	1MB SIMM	500718-002	\$ 69.00



Model	Memory Added	Part # EQ	PRICE
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PC14-PA8312U	2MB KIT	PC14-PA8312U	\$ 299.00
PC13-PA8308U	2MB KIT	PC13-PA8308U	\$ 175.00
PC-PA8302U	2MB KIT	PC-PA8302U	\$ 175.00
PC-PA8340U	512K KIT	PC-PA8340U	\$ 135.00
PC-PA8341U	2MB KIT	PC-PA8341U	\$ 175.00
PC15-PA8308U	2MB KIT	PC15-PA8308U	\$ 175.00
PC15-PA8310U	4MB KIT	PC15-PA8310U	\$ 459.00
PC-PA8307U	2MB KIT	PC-PA8307U	\$ 175.00
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	4MB MODULE	H33445B	\$ 249.00
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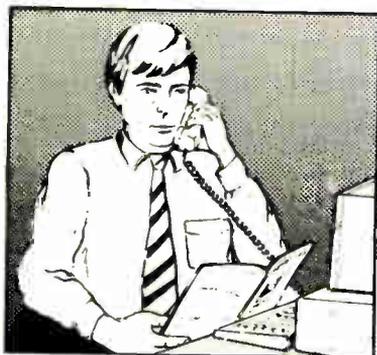
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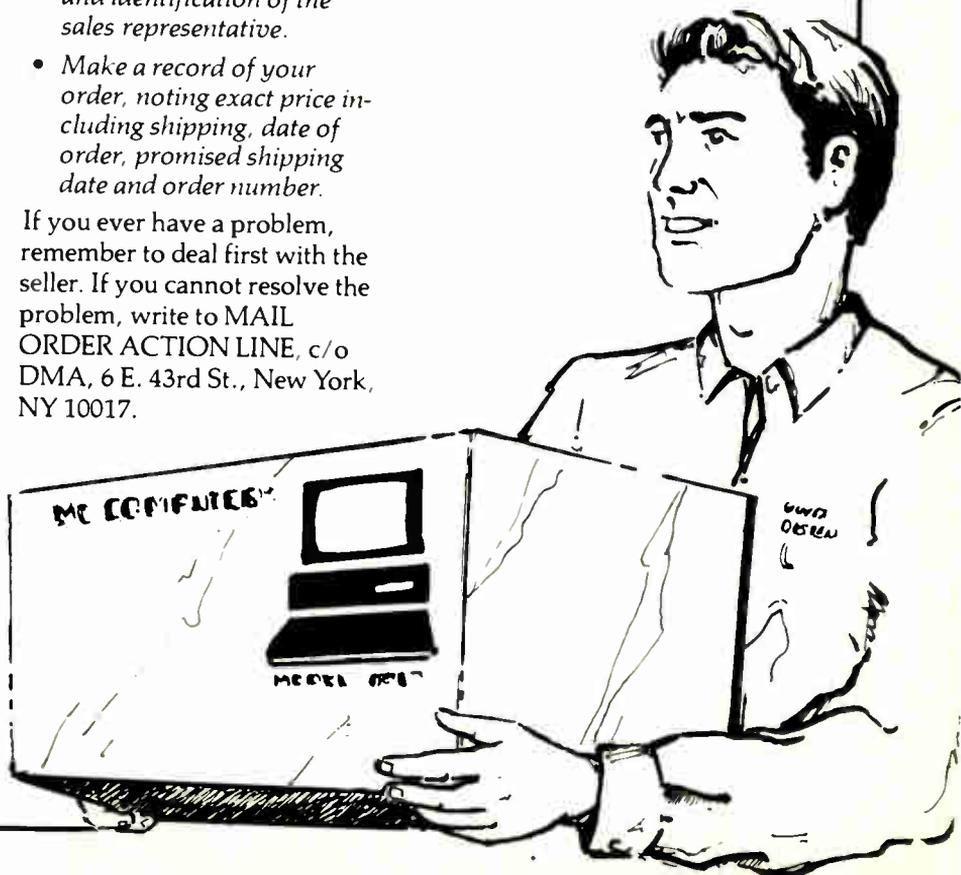
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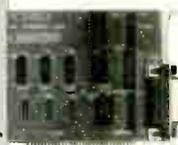
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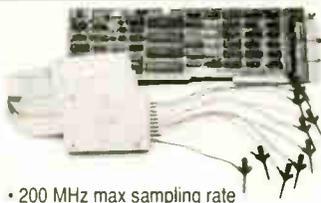
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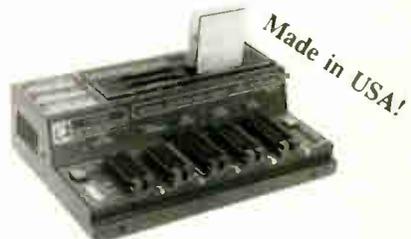
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- 3 Administration/Management
- 4 Sales/Marketing
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- 19 26-50
- 20 51-99
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**Inquiry Numbers 496-990**

**Inquiry Numbers 991-1479**

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## INTEGRATED CIRCUITS DYNAMIC RAMS

PART#	SIZE	SPEED	PINS	PRICE
4116-150	16384x1	150ns	16	1.49
4164-150	65536x1	150ns	16	2.49
4164-120	65536x1	120ns	16	2.89
4164-100	65536x1	100ns	16	3.39
TMS4464-12	65536x4	120ns	18	3.95
41256-150	262144x1	150ns	16	1.95
41256-120	262144x1	120ns	16	2.15
41256-100	262144x1	100ns	16	2.25
41256-80	262144x1	80ns	16	2.75
414256-100	262144x4	100ns	20	8.95
414256-80	262144x4	80ns	20	9.95
*1MB-120	1048576x1	120ns	18	7.95
1MB-100	1048576x1	100ns	18	8.95
1MB-80	1048576x1	80ns	18	9.95
1MB-70	1048576x1	70ns	18	10.75
1MB-60	1048576x1	60ns	18	11.05

## SIMM/SIP MODULES

PART#	SIZE	SPEED	FORM	PRICE
41256A98-80	256K x 9	80ns	SIMM PC	33.95
421000A88-10	1MB x 9	100ns	SIMM/MAC	79.95
421000A98-10	1MB x 9	100ns	SIMM PC	79.95
421000A98-80	1MB x 9	80ns	SIMM PC	89.95
421000A98-60	1MB x 9	60ns	SIMM PC	99.95
256Kx9SIP-80	256K X 9	80ns	SIP PC	33.95
256Kx9SIP-60	256K X 9	60ns	SIP PC	39.95
1MBx9SIP-10	1MB x 9	100ns	SIP PC	79.95
1MBx9SIP-80	1MB x 9	80ns	SIP PC	89.95

## MATH CO-PROCESSORS

PART#	SPEED	PRICE
8087	5 MHz	89.95
8087-2	8 MHz	129.95
8087-1	10 MHz	169.95
80287-XL	12 MHz	199.95
80387-16	16 MHz	359.95
80387-20	20 MHz	399.95
80387-25	25 MHz	499.95
80387-33	33MHz	649.00
80387-SX	16 MHz	299.95
80387-SX20	20 MHz	399.95

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83D87-20	20 MHz	\$319.95	83S87-16 (SX)	16MHz	\$269.95
83D87-25	25MHz	\$419.95	83S87-20 (SX)	20MHz	\$329.95

## EPROMS

PART#	SIZE	SPEED	Vpp	PINS	PRICE
2716-1	2048x8	350ns	25V	24	4.95
2732A	4096x8	250ns	21V	24	3.95
2764	8192x8	450ns	12.5V	28	3.95
2764-250	8192x8	250ns	12.5V	28	3.95
2764-200	8192x8	200ns	12.5V	28	4.49
27128	16384x8	250ns	12.5V	28	3.95
27128A-200	16384x8	200ns	12.5V	28	4.95
27256	32768x8	250ns	12.5V	28	4.95
27C256	32768x8	250ns	12.5V	28	5.95
27512	65536x8	250ns	12.5V	28	5.95
27C101-20	131072x8	200ns	12.5V	32	17.95

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PROGRAMS 27XX AND 27XXX EPROMS UP TO 27512 - SPLIT OR COMBINE CONTENTS OF DIFFERENT SIZED EPROMS (VARIOUS FORMATS AND VOLTAGES) - READ, WRITE, COPY, BLANK CHECK AND VERIFY - HEX TO INTEL HEX CONVERSION SOFTWARE MOD-EPROM

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Many times I am asked the question, "Should I buy a 286, 386SX or 386DX based motherboard?" To partially answer that question, refer to this matrix:

	80286	80386SX	80386DX
RUNS EXISTING 8088 SOFTWARE	YES	YES	YES
RUNS EXISTING 80286 SOFTWARE	YES	YES	YES
RUNS 80386 SPECIFIC SOFTWARE (1)	NO	YES	YES
RUNS EXISTING 8-BIT HARDWARE (2)	YES	YES	YES
RUNS EXISTING 16-BIT HARDWARE	YES	YES	YES
RUNS 32-BIT MEMORY HARDW.	YES	YES	YES

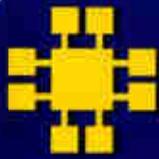
No provision has been made for comparing speed of execution for the three processors. Existing benchmarks usually run 8088 code which is unfair to the 286 and 386 based boards. Even 80286 code will penalize an 80386 processor because it fails to take advantage of its expanded capabilities.

When upgrading from an 8088-based computer, be aware of the following: 1) You will probably need a new keyboard. 2) Most of your hardware will work in a new motherboard with the exception of some serial ports (which can usually be upgraded to work). 3) If you move an existing 8088-based hard disk controller to a 80286 or greater machine, you should tell the set-up routine that no hard drives exist.

DERICK MOORE, DIRECTOR OF ENGINEERING

(1) 80386 software includes specific versions of Unix, Xenix, Network operating software, OS/2, Windows, DesqView, and many high-end scientific solutions including CAD/CAM/CAE. (2) Some 8-bit hardware won't operate at higher bus speeds

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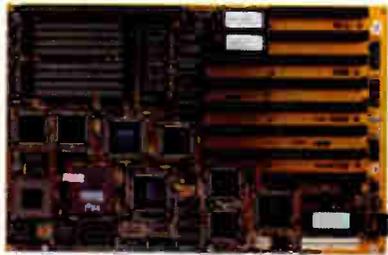


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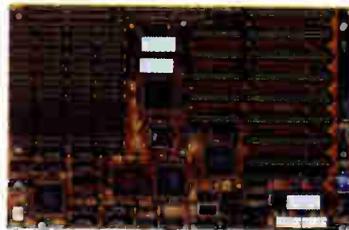
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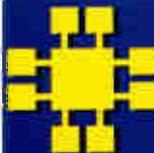
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3-1/2"	ST-125A	21.4MB	IDE	28MS	\$259
3-1/2"	ST-125N	21.4MB	SCSI	40MS	\$299
3-1/2"	ST-138	32.1MB	MFM	40MS	\$269
3-1/2"	ST-138R	32.1MB	RLL	40MS	\$289
3-1/2"	ST-138A	32.1MB	IDE	28MS	\$269
3-1/2"	ST-138N	32.1MB	SCSI	40MS	\$299
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5-1/4"	ST-251N	42.8MB	SCSI	40MS	\$399
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3-1/2"	ST-157A	48.6MB	IDE	28MS	\$299
3-1/2"	ST-157N	48.6MB	SCSI	40MS	\$359
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5-1/4"	ST-277-1	65.5MB	RLL	28MS	\$349
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5-1/4"	ST-296N	84.9MB	RLL	28MS	\$449
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continued from page 314

**Listing 5:** A code fragment that shows how to locate the video parameter block for a display board.

```

#define VIDEO_TYPE           1           /* videoType */
#define CATEGORY_DISPLAY    3           /* displayCat */
#define APPLE_FIRMWARE_FORMAT 1
#define IGNORE_HARDWARE     0x01       /* Mask to exclude hardware in sResource search */
#define FIRST_VIDEO_MODE    128       /* First video mode ID in sResource list */
#define VIDEO_MODE_PARAMS   1           /* ID of video mode block */

int      devRefNum;                /* Driver ref. number for video board's slot */
OSErr   error;
short   i;
SpBlock SlotBlock;                /* Our slot parameter block */
SpBlockPtr SlotBlkPtr;            /* The pointer to our block */
int      theseDepths[6];
long    theseModes[6];
AuxDCEHandle thisDeviceDCE;        /* Device Control Entry (DCE) table for this slot */
int      thisMode;
Ptr      videoModeListPtr;

error = 0;                          /* Will go nonzero when done */
devRefNum = (**thisGDevice).gdRefNum; /* Get screen's device ref. number */
thisDeviceDCE = (AuxDCEHandle) GetDCtlEntry(devRefNum); /* Get device's auxilliary */
/* control table */

SlotBlkPtr = &SlotBlock;           /* Point to our local SpBlock */
SlotBlock.spSlot = (**thisDeviceDCE).dCtlSlot; /* Fetch slot number from DCE */
SlotBlock.spExtDev = (**thisDeviceDCE).dCtlExtDev; /* ... and its external number */
SlotBlkPtr = &SlotBlock;           /* Point to our local SpBlock */
SlotBlock.spID = 0;                /* IMPORTANT: Clear resource ID */
SlotBlock.spCType = VIDEO_TYPE;    /* Set the board type we want */
SlotBlock.spCategory = CATEGORY_DISPLAY; /* ...Now its category */
SlotBlock.spDrvrSW = APPLE_FIRMWARE_FORMAT; /* We can only deal with this format */
SlotBlock.spTBMask = IGNORE_HARDWARE; /* Don't care whose video board it is */
error = SNextTypesRsrc(SlotBlkPtr); /* Look for video sResource */
if (!error)
{
    videoModeListPtr = SlotBlock.spsPointer;
    thisMode = FIRST_VIDEO_MODE;    /* Video mode sResources start at ID 128 */
    while (!error)                  /* Loop until we get all video modes */
    {
        SlotBlkPtr = &SlotBlock;    /* Point to our local SpBlock */
        SlotBlock.spID = thisMode;   /* Plug in new mode sResource ID */
        SlotBlock.spsPointer = videoModeListPtr;
        error = SFindStruct(SlotBlkPtr); /* Get pointer to video mode sResource */
        if (!error)
        {
            SlotBlkPtr = &SlotBlock; /* Point to our local SpBlock */
            SlotBlock.spID = VIDEO_MODE_PARAMS; /* Want parameter list for this mode */
            error = SGetBlock(SlotBlkPtr); /* Copy the data to where we can use it */
            if (!error)
            {
                theseModes[i] = thisMode; /* Save modes board supports in array */
                theseDepths[i] = (*(VPBlock *) SlotBlock.spResult).vpPixelSize; /* same for depths */
                DisposPtr((Ptr) SlotBlock.spResult); /* Throw away the copy */
                i++; /* Bump array index */
            } /* end if !error */
        } /* end if !error */
        thisMode++; /* Look for next video mode */
    } /* end while !error */
} /* end if !error */

```

the data structures and Slot Manager calls I'll use. One potential problem is that to use the Slot Manager calls, I must first supply a slot number. The solution is to use the GDevice's driver reference number. I use this value with a Device Manager call to fetch the driver's device

tables. (The Device Manager is a set of routines that handle the Mac's device I/O.) For a driver handling an expansion board, this device table provides the board's slot number.

Listing 5 is a code fragment that shows exactly how it's done. I start by using the

board's video sResource to find its mode list. Since the mode list IDs start at 128 and ascend in order, a loop walks me through this list. For each mode entry I find, I make a temporary copy of its video parameter block to get the mode's pixel depth. I dispose of the temporary

copy and search for the next mode by incrementing the mode ID number. Once I run out of parameter blocks, the Slot Manager reports an error, and I exit the loop. I stuff the mode IDs into an array for later use.

### Controlling the Board

Now that I have the mode information in hand, I'm (at last!) ready to put it to use. But I've got one more pipe to duck before I'm done. I need to change the mode. Apple defined a specific set of Device Manager calls that the display board has to respond to—and in precise ways. This lets the Mac not care what's in the board driver it installs, yet at the same time QuickDraw and other software have consistent control functions available to it. I've summarized these Device Manager calls in the table.

QuickDraw itself doesn't use device I/O calls to draw to the display. Instead, for performance, it uses a pointer to write directly to the board's frame buffer. This pointer is provided to QuickDraw by the board's driver (see the table). If this seems a bit un-Mac-like, remember that Mac applications always use QuickDraw to write to the screen. QuickDraw handles getting the application's pixels into a frame buffer, whether it's located in RAM on the Mac ILCi, VRAM on the Mac LC's main logic board, or VRAM on a NuBus board inside a Mac IIfx. QuickDraw uses the device I/O calls in the table when it changes the display's color tables or changes the display's mode at boot-up time.

Having said that, you'll be surprised to find that I won't make the device I/O calls myself to change the screen depth. Instead, I let `InitGDevice()` do that by calling it with the corresponding mode value. Changing a display from colors to grays or vice versa requires that you use `SetDeviceAttribute()` on the `GDevice` while setting the appropriate flag.

I wrote both an application and an FKEY to change a monitor's screen depth. The application presents a dialog box showing the depths supported by the board. Clicking on a different screen depth has the application call `InitGDevice()`, using the appropriate value from the mode array. The code has worked reliably with every display board that I've used so far, including boards from RasterOps, Radius, and SuperMac Technology, and it works with A/UX 2.0 and an early beta version of System 7.0. The source for the application is available in electronic format (see page 5) as `DEPTH.SIT`, a StuffIt archive file.

There's enough information here to

### DEVICE MANAGER CALLS

*Device Manager control and status calls as defined by Apple for display boards. Not all the calls are shown.*

#### Codes for PBControl()

- 0 The board is reset to its initial state: the default pixel depth (1 bit per pixel). The video RAM's base address is returned to the caller.
- 1 All current and pending I/O requests are killed.
- 2 For a video mode ID provided by the caller, the board changes to the corresponding display mode (pixel depth).
- 3 For an indexed color board, its color lookup tables (CLUTs) are changed to those provided by the caller. This has no effect on direct (24-bit) boards.
- 6 For an indexed color board, the CLUT maps either to actual colors or to gray values, as determined by a mode value sent by the caller. A mode value of 0 maps the display to colors; a value of 1 maps to grays. This has no effect on direct boards.

#### Codes for PBStatus()

- 2 The board returns the current video mode.
- 3 The board returns the board's CLUT to the caller.
- 4 The board returns the video pages available in this mode.
- 5 The board returns the base address of the video page supplied by the caller.
- 6 The board returns a 0 if operating in color and a 1 if using gray scales.

get you started on examining the secrets of other expansion boards in your Mac. I recommend Jasik Designs' Debugger V2, an industrial-strength debugger for the Mac, when you're working with the Mac at this level of detail. At \$350, it isn't cheap, but its multiwindow display for examining data structures and disassembling code will pay for itself by the time it saves you on debugging jobs.

Interestingly, since I started this project, Apple has introduced two new calls, `HasDepth()` and `SetDepth()`, which are described in Tech Note #276. These two calls let you easily obtain a board's various modes and change the mode without going through the Slot Manager. These two new calls are available in System 6.0.5 or higher.

### Toward a Virtual Machine

As you can see, I learned a lot about how the Mac makes plug-and-play installation of display boards possible. The Mac's basement is remarkably well organized: Applications are able to examine and access expansion-board features by using high-level Slot Manager calls. Even something as hardware-dependent as display board I/O can be handled through the Toolbox's Device Manager calls. In those instances where an application might have to directly access the board, the address can usually be ob-

tained through the Device Manager.

Any Mac application that uses the Mac OS exclusively should run on any Mac, regardless of its hardware configuration. That's because you let the Mac OS worry about how and where it directs your I/O. This way, your application should operate across the entire Mac product line, including future Macs. The best example proving this concept of good application design is Consulair's Edit. Although written in 1986 (the Mac Plus era), it runs on the Mac Classic, IIsi, and LC without problems today.

This embodies the concept of a virtual machine: a computer whose hardware details are hidden from view and that you deal with only through well-defined operating-system calls. This virtual machine concept makes a move to a future RISC-based Mac possible. If the Mac Toolbox is fully implemented in RISC code, porting a Mac application to the new processor would be simply a matter of recompiling the application using a RISC compiler. ■

*Tom Thompson is a BYTE senior editor at large with a B.S.E.E. degree from Memphis State University. He can be reached on BIX as "tom\_thompson."*

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

HUGH KENNER

## Poets and Sleepwalkers

Is programming more like poetry or mathematics?  
Several new books and journals take sides in the debate.

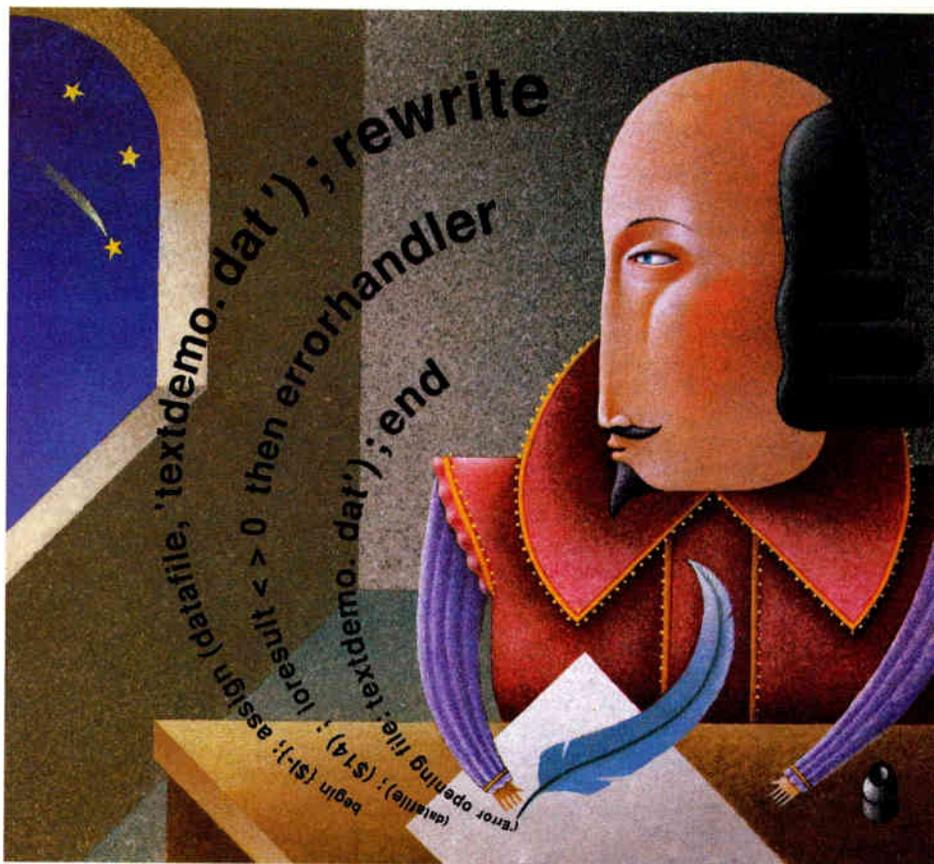
Remember the early 1980s? Back then, small-system computerdom, still impelled by fun, o'er-soared the mere dull ground. And learning what could be done within 64K bytes of memory... well, compare the Renaissance passion for testing the limits of the 140-syllable sonnet. John Donne in the 1620s packed an apocalypse into a sonnet. Likewise, hobbyists developed assembly expertise just to fit mainframe games of Adventure into laughably tiny address space.

And as Elizabethans bought books of sonnets, so in gone years many of us bought packaged Adventure, and we too had our reward. Programmers, though, like the sonnet-makers, were enjoying a different fulfillment. In doing nothing conspicuously useful—just coding recreations—they themselves felt recreated by what they happily called “recreational programming.”

But recreational programming, if we trust the magazines, now seems to have followed the sonnet into limbo. Journals that once enticed tinkerers with something that was frankly meant just to allure, are strict now in their targeting of “professionals.” And when *Scientific American* not only consigned A. K. Dewdney's Computer Recreations column to mere bimonthly status but changed the word *Computer* to *Mathematical*, grim handwriting was plainly on the wall. Sure, computers everywhere, the message ran. But they're now for work.

So Dewdney's *The Magic Machine* (W. H. Freeman, 1990, \$15.95) seems a souvenir of a lost time. Like his *The Armchair Universe*, which I reviewed in the August 1988 *BYTE*, it repackages a sampling of those golden columns; themes include chaos, viruses, and artificial landscapes. Meanwhile, he has started his own 28-page bimonthly newsletter: *Algorithm* (Algorithm, P.O. Box 29237, Westmount Postal Outlet, 785 Wonderland Rd., London, Ontario, Canada N6K 1M6, US\$29.95 for six issues). It's reached issue 1.7 as this is written, and back issues from 1.1 can still be had.

An address like Wonderland Rd. does suggest fantasies, and what *Algorithm* peddles is fantasy, broadly defined. Nowadays that tends to mean graphics, which, like the fractals I've mentioned here more than once, can yield a visual experience quite



unhitched from their mathematical rigor. *Algorithm* 1.1 offered “Inside the Mandelbrot Set” by IBM's Clifford Pickover, and if you think there is nothing inside that set but a heart-shaped black hole, you have a surprise coming. What we've normally marveled at consists of samplings “from the area just outside the set, near its infinitely complicated fractal boundary.” But we can get *inside* by trusting a 13-line algorithm, which leaves details (e.g., choosing parameters and coloring points) to eager readers.

And such is the way of *Algorithm*, which calls itself “The Personal Programming Newsletter.” Supplement lucid principle with a rigorous but compressed recipe, the kind that specifies nested loops, boundaries, and plottings. Let each recreational programmer ad-lib the details, in some language of choice, with an eye to whatever hardware is available. And if half the fun is viewing the result, the other half is making the

thing work, and then making it work better.

Pickover has a regular column called Personal Programs. So has Michael W. Ecker, who calls his Easy Pieces. Those are so easy he'll even illustrate via BASIC code (yea, antient BASIC, ye olde kynde with lyne numbers). And, every issue, Dewdney in top form.

The ad pages offer news, too. Ecker, I learn, runs a magazine of his own, *Recreational & Educational Computing*, of which I've yet to see a copy (not his fault, mine). And what a number of fractal implementations! Fractals now lure programmers as Adventure once did. The most original version I've seen recently is *Fractal Grafics* (Cedar Software, Rt. 1-5140, Morrisville, VT 05661, (802) 888-5275, \$79). I'll be reporting when I've used it enough to feel comfortable. The most elegant presentation is *Nature's Chaos*, 103 wonderful color photos by the late Eliot Porter, with text by James Gleick (Viking, 1990, \$29.95). Porter shows you ferns, cracked mud, tree trunks, lava, flowing water, some 2000 flamingos, as you never saw them before Mandelbrot adjusted your eyes. Gleick helps persuade you that, yes, numbers can describe these images, chiefly by fractals.

And as numbers can describe images, words can prescribe numbers. Such a prescription, set forth as sparsely and exactly as possible, is what we mean by an algorithm. The Pascal language, when it left Niklaus Wirth's hands, was a teaching device that let you spell out algorithms in near-English. The Pascals that we buy have been vastly complicated by hooks to operating systems and hardware, details Wirth was in a position to finesse. He said that a compiler could be made to understand unambiguous instructions written in English. The intent of the language was to define "unambiguous."

And here we encroach on controversial ground. In using "recipe" for "algorithm," I've implied that the ensuing code depends greatly on the chef. But in *Binding Time: Six Studies in Programming Technology and Milieu* (Ablex Publishing, 1990, \$27.50), Mark Halpern alludes to a sect he calls the calculists, who'd wish for much austerer claims. Calculism causes its victims to suppose (1) that there exists a seamless transhuman domain called mathematical discipline; and (2) that computerdom should aspire to that realm. And the most humane of computer theorists—even Edsger Dijkstra, father of structured programming—have not always been immune to calculism.

Halpern's other word for calculists is *sleepwalkers*: "People doing good work in pursuit of illusory goals." May waking them be dangerous to their productivity? No, he's confident he'll not wreak that order of damage. "The ability of seasoned sleepwalkers to shrug off signals from the waking world is impressive." But he has hopes of immunizing the rest of us to their decades-old incantations. Himself a theme-weaver since at least 1963, he's not squeamish about citations from 30 years back. For, "It's only when the sailor looks back on his wake that he can see that he's been going in circles."

In what circles? Well, the ones that chase their tails in pursuit of mathematical perfection. The calculists say, "First, programming languages should be recast along the lines of mathematical notation, so as to capture that notation's rigor, precision, and economy—and perhaps even its supposed creative power. . . . Second, programs can and should be validated and proved correct, by means very similar to those used in the proof of a mathematical theorem." And, "Nuts!" says Halpern.

Oh, he does say it more politely. He's after all a software development executive (also one of the few people to have re-

signed from IBM twice). But throughout the book his norm is natural language. Math notation is but an encoded subset of that, and a math proof (surprise!) is a natural-language prose narrative—"Let  $F(x)$  be a  $y$  such that. . ."—with symbolic summaries interposed along the way. Those do not carry the burden of the proof; they serve to let readers "forget everything that preceded so as to clear their minds for the next step." Thus, symbols "isolate for inspection important milestones," but no reader is likely to dwell on them unless out of suspicion that an error lurks.

So, "Calculism is based. . . not on achieved insight, but on a mere hope that if we mimic the outward forms of mathematical practice, insight will follow." And the sole sound basis for computer programs—here I elide countless details Halpern confronts explicitly—remains natural language. ("How unprofessional!" You can hear the snorts.)

Yet Isaac Newton, who was no calculist, wrote the *Principia Mathematica* in a language natural to the learned of his time, Latin. He dealt with the ambiguities inherent in natural languages the way all sensible writers do, by keeping a hawk's eye on his phrasing. Page through the *Principia* and you're looking at prose, interspersed with diagrams and rare equations.

It follows that the correctness of programs *cannot* be proved. (The notion that they can be derives from the notion that a proof just tumbles through formalisms.) It follows, too, that an algorithm can't be proved, either. You find out how well it works by testing it. For draw a deep breath and imagine what you'd be trying to "prove." That it does what it's supposed to do? Hah, write your rigorous specification for *that*. "Algorithms, like executable programs, are unverifiable because they are themselves the best attempts we can make at expressing our intentions; there is nothing we can test them by, because if we could come up with better expressions, *they* would be our algorithms/programs."

(And it's doubtful if any two Dewdney fans write exactly the same code for anything. There are many ways to get a principle working. None is bug-proof.)

The text formatter I still use comes from a disk dated 19 July 1983. For some months before that, I was a beta-tester. One bug I chanced on was a lockup should a \ happen to alight on the first tab stop. How foresee such a flaw? Where locate it, in the intricate transactions among algorithm, DOS, C compiler? Well, it did get found and swatted. That's how "software development" works. Halpern has ideas about how it could be made to go less chancily. For those, read his book; and let object-oriented programming fans pay special attention. He promotes an expanding inventory of small, tight, reusable "boxes," energized like ballad stanzas, and would savor OOP more could it dispense with the "neologisms and misnomers" its promoters troll for attention.

So we head back toward programming as poetry, even as fun. Let miseries be left to the law courts: beasts a-circling, eyes aglare, fangs bared. Today, at ease with megabytes of memory, feel free to aspire beyond the sonnet: if not to the epic, at least to a polychromed ode. ■

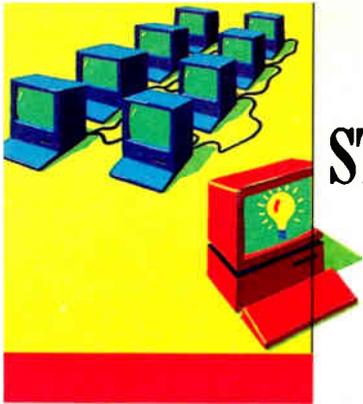
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## **F**ractals now lure programmers as Adventure once did.





## STOP BIT

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# LET MY PCs GO

**I**s the personal computer revolution really over? Remember when, several years ago, we stomped into our department supervisor's office, slammed a stack of smeary, green-striped printouts on the desk, and demanded a personal computer? We were sick of the temperamental, bug-ridden software available on corporate minicomputers and mainframes, sick of the uncooperative attitude of corporate MIS staff, and weary of their promises that the capabilities promised in the system specifications would actually be delivered real soon now.

### In the mad rush to connectivity, have we forgotten the point of the PC revolution?

Then we pulled out a copy of BYTE. Indicating a review of a Z80, an Apple II, or an IBM PC, we explained that these machines were self-contained and were so cheap that we could set up a system without involving corporate computer departments, their policies, or their budgets. With tools like Microsoft BASIC, WordStar, VisiCalc, and dBASE, we could develop in-house applications, saving time and effort.

The PC revolution was on its way.

As the combined PC activity of individual departments came to rival or even outrun that of the corporate mainframe, corporate MIS management found their empires (and budgets) threatened. Unable to compete with the PC revolution and unwilling to join it, they attempted to retain control by becoming the corporate regulators of PCs.

At first they had little success. Then the PC world provided MIS managers the break they had been hoping for: "connectivity," the PC buzzword of the mid-1980s. Connecting all the PCs, in all departments, letting them access each other's data and peripherals—that was surely a corporate function. A single corporate voice was needed to settle questions of communications protocols, cable routing, and network procedures. Who better to do this than the established corporate computer staff?

It was a small step from standardized computer connections to standardizing the computers themselves, and then the software, printers, graphics cards, and so on. Soon there were corporate directives on subdirectory names, organization of subdirectories, and even the color of the floppy disk labels. The counterrevolution was rolling.

On the heels of networks came another lucky break

for the regulators—viruses. Warnings were soon circulated: Infection by nonstandard software can bring the corporation to its knees. Sure, it's not very likely. Most well-publicized cases of virus or worm attacks have involved the exploitation of operating-system deficiencies on intensively managed and regulated systems.

The counterrevolution was close to complete. IBM launched OS/2 with the promise of PC-to-mainframe links. Unix running on PC networks started to look like the banked minicomputers of yesteryear. Over the horizon came the MIS manager's dream: the diskless PC, a terminal in all but name.

Sure, modern PCs are more powerful than ever. But the PC revolution was about freedom, not power. The first PCs were puny compared to the minicomputers and mainframes of their day, yet they offered us, the users, a new personal freedom of choice. We could shop for and configure our own computer systems, select or develop our own software, and use it all in a way that suited and enhanced our natural creativity. We made our own choices on how to enter, organize, process, output, and occasionally trash our own data.

In response to our enthusiasm, hardware became more reliable, compatible, and easy to install. Software became easier to use, better documented, and cheaper. Now there's more software out there, but we are restricted to choosing it from corporate stockrooms or a few bulky and expensive library boxes tastefully arranged on the pastel shelves of computer stores.

What worries me most is that networks are bringing corporate computer management style from major corporations into the smallest, most innovative companies. I've seen companies in which even four or five PCs are linked, and some "system manager," under the guidance of network consultants, handbooks, or columnists, is writing procedures, establishing standards, and ruling over accessibility to the network.

There is no doubt that network management is necessary. Let's just be sure that control of the machines doesn't mean restricting the creativity of their users. ■

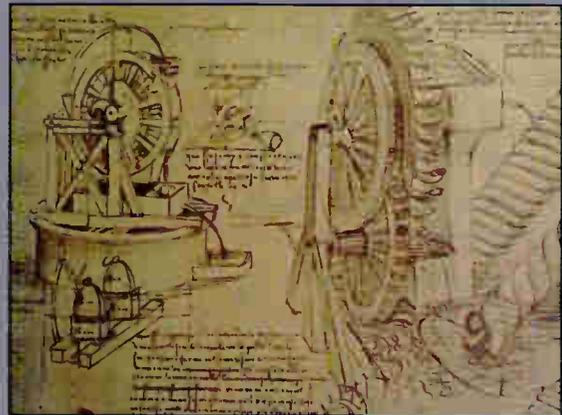
*Alun Whittaker is an author of technical documentation and video scripts. He can be reached on BIX c/o "editors."*

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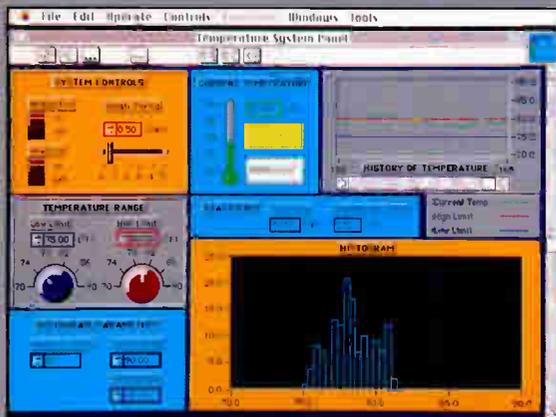
# Leonardo's Career Combined Art and Science



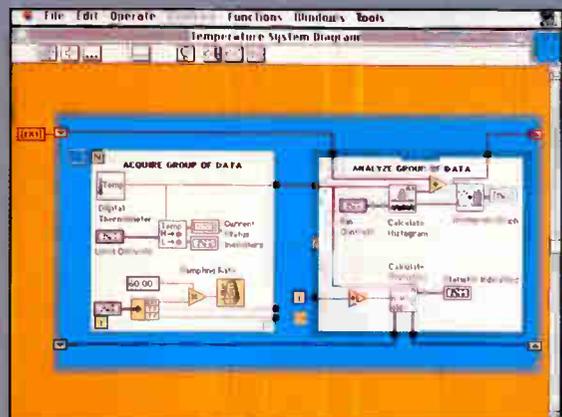
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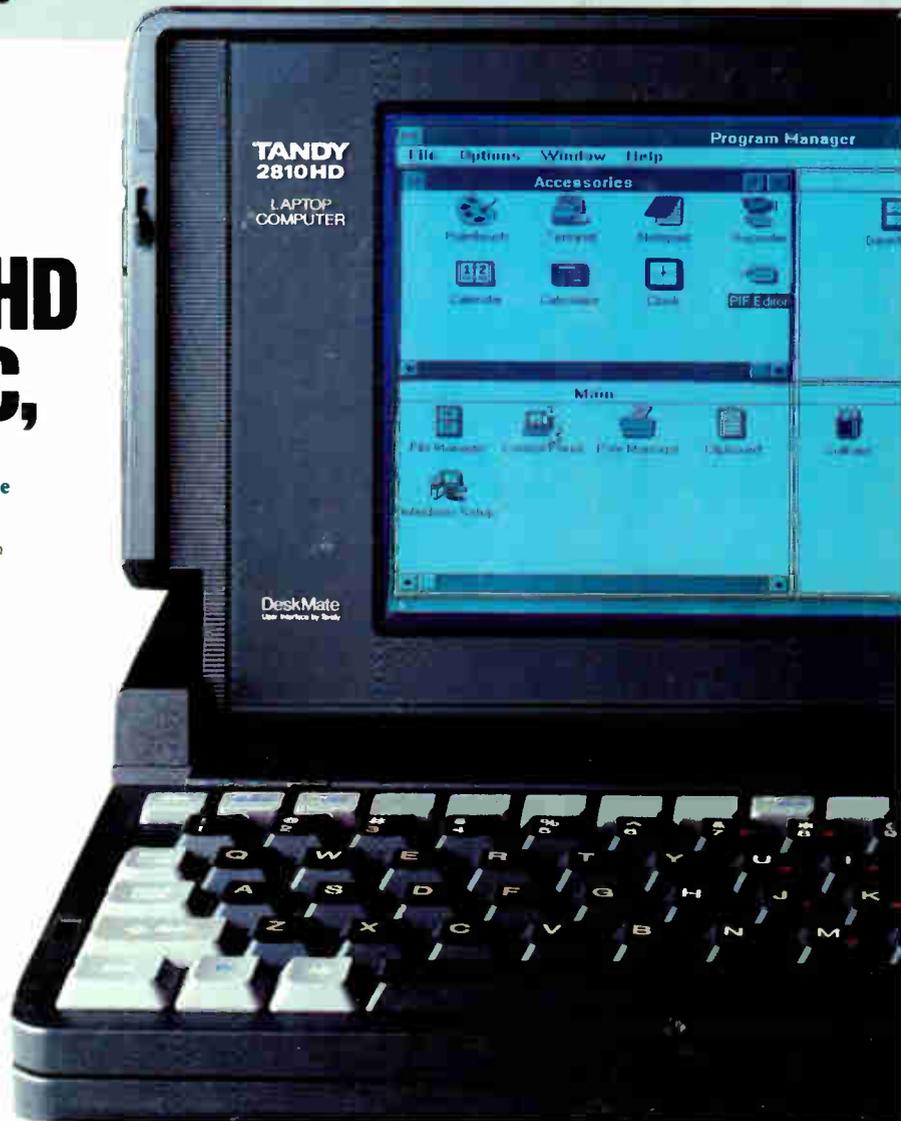
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