New: **32-bit Color on the Mac (page 99)**

BYTE

JULY 1989

A McGRAW-HILL PUBLICATION

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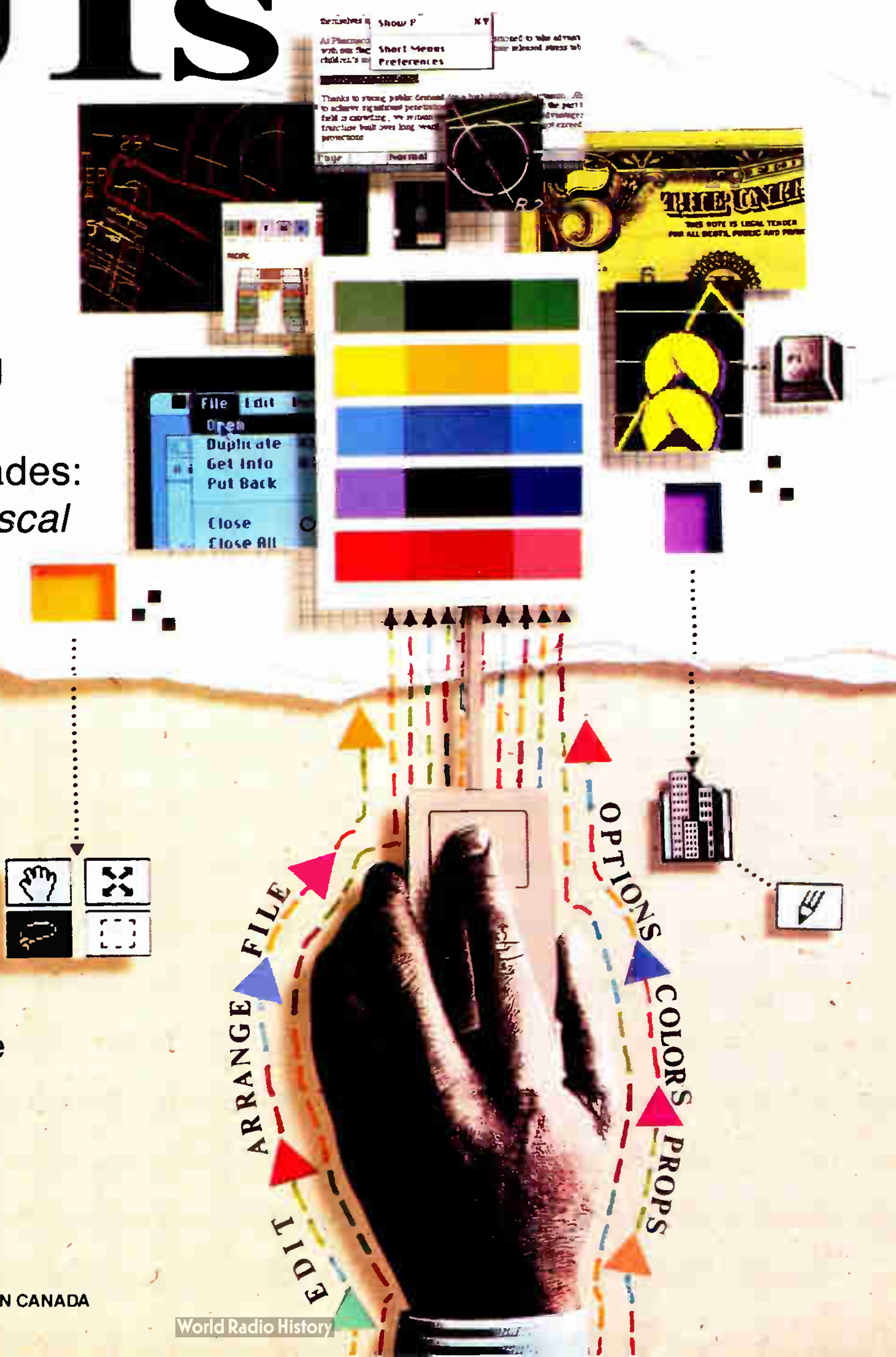
A Color PostScript Printer

PRODUCT FOCUS

Head-to-Head Tests: LAN OSes

THE 12 TOP GUIs

Your Guide to State-of-the-Art Graphical User Interfaces



IN DEPTH

Distributed Processing

Object-Oriented Upgrades:
Microsoft's Quick Pascal vs. Borland's Turbo Pascal 5.5

2 Brand-New Columns

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PI graphics, and have 31
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THE DELL SYSTEM 325
25 MHz 386.

When you need the highest-performance 386 computer, this is it.

STANDARD FEATURES:
- Intel 80386 microprocessor running at 25 MHz.
- Choice of 1 MB, 2MB or 4 MB of RAM* expandable to 16 MB using a dedicated high speed 32-bit memory slot.
- Advanced Intel 82385 Cache Memory Controller with 32 KB of high speed static RAM cache.
- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- Socket for 25 MHz Intel 80387 or 25 MHz WEITEK 3167 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard disk drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 8 industry standard expansion slots.

OPTIONS:
- 40 MB or 150 MB tape backup.
- 25 MHz Intel 80387 math coprocessor.
- 25 MHz WEITEK 3167 math coprocessor.
- 1 MB or 4 MB RAM upgrade kit.
- 2 MB or 8 MB memory expansion board kit.
- Graphics Performance Accelerator GPX 1024.
- Graphics Performance Display GPD-16C, GPD-19C.

***Lease for as low as $199/Month.*
Extended Service Plan pricing starts at $370.

System 325	With Monitor & Adapter			
Hard Disk Drive	VGA Mono		VGA Color Plus	
	1 MB RAM	4 MB RAM	1 MB RAM	4 MB RAM
40 MB 29 ms IDE	$5,999	$5,698	$5,799	$5,998
100 MB 25 ms IDE	$5,999	$6,198	$6,299	$6,498
150 MB 18 ms ESDI	$6,499	$6,698	$6,799	$6,998
322 MB 18 ms ESDI	$7,299	$7,498	$7,599	$7,798

THE DELL SYSTEM 310
20 MHz 386.

The best combination of performance and value available in its class.

STANDARD FEATURES:
- Intel 80386 microprocessor running at 20 MHz.
- Choice of 1 MB, 2 MB or 4 MB of RAM* expandable to 16 MB using a dedicated high speed 32-bit memory slot.
- Advanced Intel 82385 Cache Memory Controller with 32 KB of high speed static RAM cache.
- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- Socket for 20 MHz Intel 80387 or 20 MHz WEITEK 3167 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard disk drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 8 industry standard expansion slots.

OPTIONS:
- 40 MB or 150 MB tape backup.
- 20 MHz Intel 80387 math coprocessor.
- 20 MHz WEITEK 3167 math coprocessor.
- 1 MB or 4 MB RAM upgrade kit.
- 2 MB or 8 MB memory expansion board kit.
- Graphics Performance Accelerator GPX-1024.
- Graphics Performance Display GPD-16C, GPD-19C.

***Lease for as low as $135/Month.*
Extended Service Plan pricing starts at $251.

System 310	With Monitor & Adapter			
Hard Disk Drives	TTL Mono		VGA Color Plus	
	1 MB RAM	4 MB RAM	1 MB RAM	4 MB RAM
40 MB 29 ms IDE	$3,699	$3,898	$4,199	$4,398
100 MB 25 ms IDE	$4,199	$4,398	$4,699	$4,898
150 MB 18 ms ESDI	$4,699	$4,898	$5,199	$5,398
322 MB 18 ms ESDI	$5,499	$5,698	$5,999	$6,198

THE DELL SYSTEM 220
20 MHz 286.

It's fast as most 386 computers. But at less than half the price. The footprint is small, too.

STANDARD FEATURES:
- 80286 microprocessor running at 20 MHz.
- 1MB of RAM* expandable to 16MB (8 MB on system board).
- Page mode interleaved memory architecture.
- LIM 4.0 support for memory over 1 MB.
- Integrated diskette and VGA video controller on system board.
- Socket for Intel 80287 math coprocessor.
- One 3.5" 1.44 MB diskette drive.
- Integrated high performance hard disk interface on system board.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports (integrated on system board).
- 3 full-sized industry standard expansion slots available.

OPTIONS:
- 40 MB or 150 MB tape backup.
- External 5.25" 1.2 MB diskette drive.
- 3.5" 1.44 MB diskette drive.
- Intel 80287 math coprocessor.
- 1 MB or 4 MB RAM upgrade kit.

***Lease for as low as $109/Month.*
Extended Service Plan pricing starts at $264.

System 220	With Monitor & Adapter			
Hard Disk Drives	TTL Mono		VGA Color Plus	
	1 MB RAM	2 MB RAM	1 MB RAM	2 MB RAM
40 MB 29 ms IDE	$2,999	$3,198	3,299	3,498
100 MB 25 ms IDE	$3,599	$3,798	3,899	$4,098

THE DELL SYSTEM 200
12.5 MHz 286.

This full-featured 286 computer runs at 12.5 MHz, and is completely Microsoft MS-DOS and MS OS/2 compatible.

STANDARD FEATURES:
- 80286 microprocessor running at 12.5 MHz.
- 640 KB of RAM expandable to 16 MB (4.6 MB on system board).
- Socket for Intel 80287 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard disk drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 6 industry standard expansion slots.

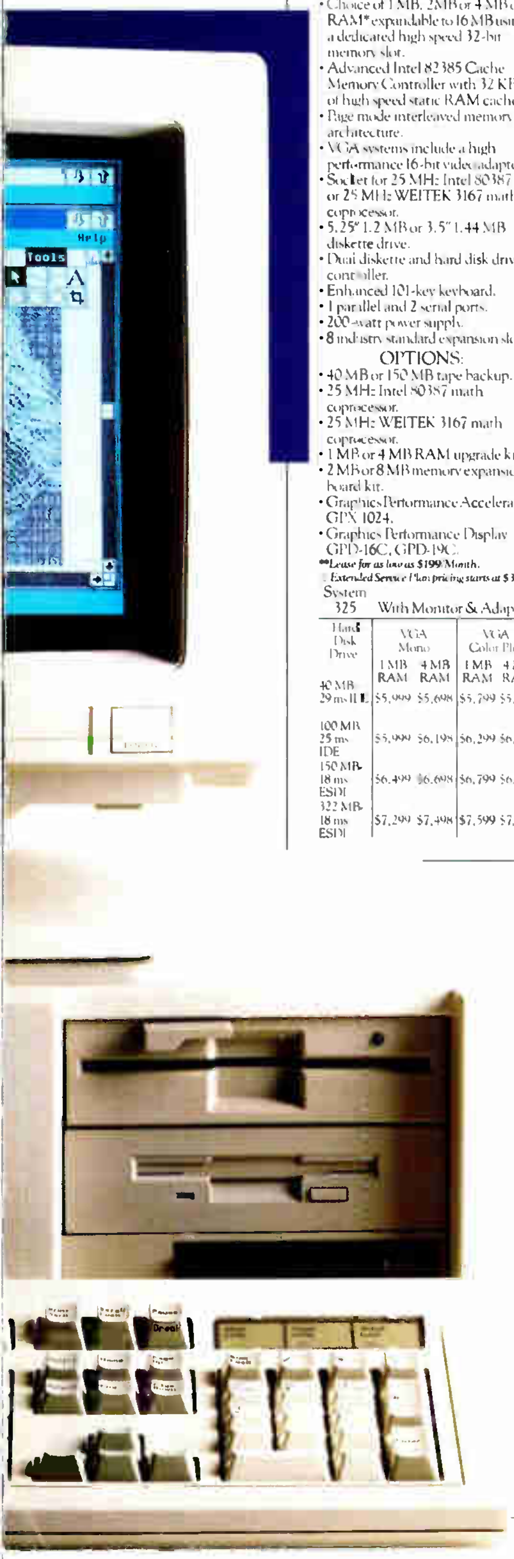
OPTIONS:
- 40 MB or 150 MB tape backup.
- Intel 80287 math coprocessor.
- 512 KB RAM upgrade kit.
- 2 MB RAM upgrade kit.

***Lease for as low as $64/Month.*
Extended Service Plan pricing starts at $166.

System 200	With Monitor & Adapter	
Hard Disk Drive	VGA Mono	VGA Color
40 MB-40 ms	$1,699	$2,099
40 MB 28 ms	$1,999	$2,399
100 MB 25 ms IDE	$2,599	$2,999
150 MB 18 ms ESDI	$3,099	$3,499
322 MB 18 ms ESDI	$3,899	$4,299

****Performance enhancements (Systems 325, 310, 316 and 220) Within the first megabyte of memory, 384 KB of memory is reserved for use by the system to enhance performance.***

4 MB configurations available on all systems. Call for pricing.



OPERATING SYSTEM SOFTWARE.

Dell Enhanced Microsoft MS-DOS 3.3: $99.95
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(Both MS-DOS versions with disk cache and other utilities.)
Dell Enhanced MS OS/2 Standard Edition 1.0: $324.95
Dell UNIX System V/386, Release 3.2:
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THE $3500 DELL 386SX SYSTEM COMES WITH SELF-DIAGNOSTIC SOFTWARE, TOLL-FREE TECHNICAL SUPPORT, 30-DAY MONEY-BACK GUARANTEE AND NEXT-DAY, DESKSIDE SERVICE.

Right away, it's easy to see what makes the new Dell System 316 different from the Compaq^ 386s.

While they both utilize Intel's new 386SX™ chip, the System 316 is a full featured system designed to give you uncompromising 386SX/16 MHz performance.

But for a price that's somewhere in the neighborhood of a 286-based system.

Now, cynics might be inclined to think we achieved this at the expense of expandability.

Obviously these people own the 4-slot Compaq.

The System 316 has a total of seven open slots. Leaving you enough room to add modems or network cards, fax boards, high-performance graphics cards or tape backups. Not to mention all the bells and whistles that'll be coming out next year. And the year after that.

And the year after that.

Point is, the Dell System 316 was designed for the long haul.

Not as a passing fad.

IT'S YOUR CALL.

If the System 316 is beginning to sound like the perfect business computer, it's because it is.

How perfect though is entirely up to you. Because every 316 is custom configured. To give users exactly what they need.

For example, the System 316 comes standard with your choice of 1 MB or 2 MB of RAM. If you'd like more, we can add as much as 8MB to the system board. Okay, we can add another 8MB by installing a memory expansion board.

What about storage? We can set your 316 up with a 40, 100, 150 or 322 MB hard drive. And a 40 or 150 MB tape drive.

Tell us, what type of monitor do you prefer? VGA mono with paperwhite screen, or VGA Color Plus for high resolution colors displayed on a larger screen? Or perhaps you'd like even larger monitors, capable of displaying 1024 by 768 pixel resolution? You've got your choice. You've got your choice of operating systems, too. The 316 can run MS-DOS,® OS/2, or UNIX® systems. Making it extremely versatile, as well as extremely powerful.

Once you've told us what you want, we'll make sure what you want works, by burning-in the system unit.

And even though each and every 316 we build is individually configured, they're all guaranteed dependable just the same.

DON'T GET STUCK IN THE MIDDLE.

Have you noticed how most computer retailers seem to know far too much about sales techniques and far too little about computer technology?

Ask even the simplest of questions and the answer will undoubtedly involve the highest margin item in the store.

And heaven forbid you should ever have to go back there for service.

Well, when you buy from us,

you never set foot in a store.

Because we've eliminated it. Along with the retailer.

Instead, you talk directly with a computer expert.

Someone who can help you configure a system that not only meets your needs, but meets them for about 35% less than you'd pay a retailer.

WE COME WHEN WE'RE CALLED.

One of the things that very clearly sets a Dell system apart from other computers is not just how they're sold but how they're supported.

Overkill was one description used in a PC Week article.

Perhaps.

But then, we think you'll agree, when something goes wrong, you want as much help as possible, right?

Which is why every Dell system comes with self-diagnostic software and a toll-free technical support line. We're able to solve 90% of all problems right over the phone.

The other 10% receive next-day, deskside service. Thanks to our new alliance with Xerox Corporation.

And you get all this help for a full year—whenever you need it—at no extra charge.△

You've probably guessed by now, one of the things that drives us most is customer satisfaction.

So we'd like to give you the ultimate guarantee: Try a System 316 in your office for a month. Run your toughest applications. Put it through its paces, at your pace. If you're not completely satisfied, send it back anytime within 30 days. And we'll refund your money.

No questions asked.

THE $4900 COMPAQ 386S COMES WITH A GUY IN A SUIT.

MAYBE YOU SHOULDN'T BUY ONE AFTER ALL.

No matter how many reasons we give you to buy a Dell system, sometimes it makes more sense to lease one instead.

Whether you need a single computer, or an entire office full, a leasing plan is just like 100% financing. So you don't tie up working capital. Or credit lines. Of course, there can also be tax advantages as well.

And just as we can custom configure your computers, we can see to it you get a custom designed lease plan to fit the exact needs of your business.†

Maybe that explains why over half the companies in the Fortune 500 now own or lease Dell computer systems. And why in the last four PC Week polls, corporate buyers rated Dell number one in overall customer satisfaction, by a landslide.

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The first 25MHz Micro Channel® compatible

Frankie Avalon

6.0 MIPS

Performance is based on the ratings of CPU/ Memory in Million instructions per second, (MIPS) Source Power Meter™ version 1.5 The Data Base Group, Inc. Upland, CA.

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Our proprietary "pre-fetch" FlexCache™ design delivers the most efficient form of microcomputer processing. By combining a true 64-bit cache bus with 64-KB cache memory, performance increases 30% when compared to other 32-bit computers. And 64KB of high-speed cache memory enables you to experience the fastest throughput for sophisticated applications. For those seeking large storage capacities, the MicroFlex 7000 gives the option of 120 or 300MB of disk storage using high-speed ESDI controllers with 1:1 interleave.

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The MicroFlex 7000 includes our super VGA controller with 800 X 600 graphics resolution and the sleek tower chassis offers the most internal expansion capabilities of any Micro Channel system available. Our one-year warranty with unlimited technical support and on-site servicing available from Intel® can't be beat.

So make some waves of your own at the office with ALR's MicroFlex 7000 or any of our 33MHz systems. For more information and the name and number of your local authorized ALR reseller, please call:

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For our Canadian office: 1-800-443-4CAN
For our UK office: 44-1-399-4897
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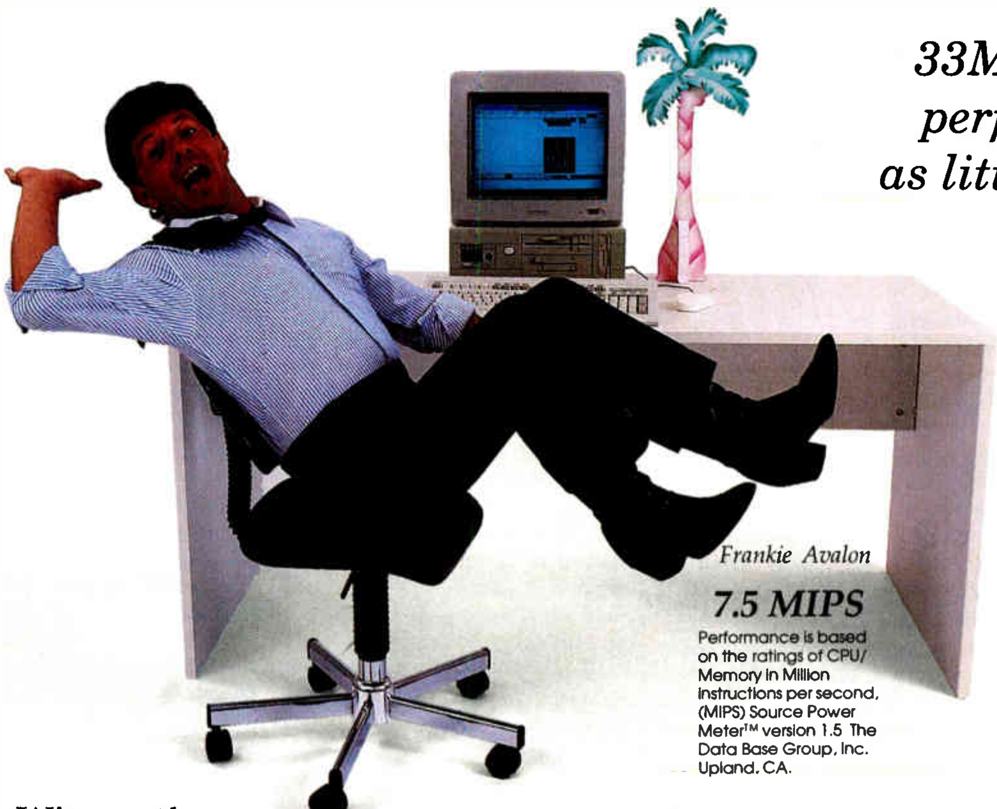
33MHz 80386™ performance for as little as $3995!



Frankie Avalon

7.5 MIPS

Performance is based on the ratings of CPU/ Memory in Million instructions per second, (MIPS) Source Power Meter™ version 1.5 The Data Base Group, Inc. Upland, CA.

ALR California
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Advanced Logic Research, Inc.

Wipe out!

Hang on because ALR's latest addition to the FlexCache 386™ Z-family is cruising at an amazing 33MHz. That's a 20% increase in processing speed when compared to the award winning FlexCache 25386.

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With 32KB of cache memory, award-winning FlexCache architecture and our enhanced 16-bit super VGA controller you better be ready to move.

At prices starting as little as $3995*, the FlexCache 33/386Z delivers the most performance for all power hungry desktop applications like CAD/CAM, desktop publishing or financial modeling at a very modest price. Of course the FlexCache 33/386Z is OS/2® compatible for tomorrow's latest generation of applications. The FlexCache 33/386Z as with all of the Z-Family comes packaged with PC-Kwik®, the award-winning disk caching utility.

With ALR's FlexCache 33/386Z you'll receive unbeatable support backed by an unprecedented three year factory warranty on the main system board, a one-year system warranty, unlimited technical support and optional on-site servicing from Intel.

Limited Warranty 3 Year

For more information on the FlexCache 33/386Z call:

1-800-444-4ALR.

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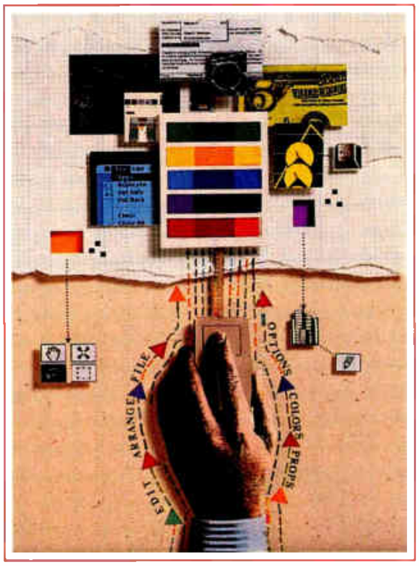
JULY 1989 VOL. 14/NO. 7



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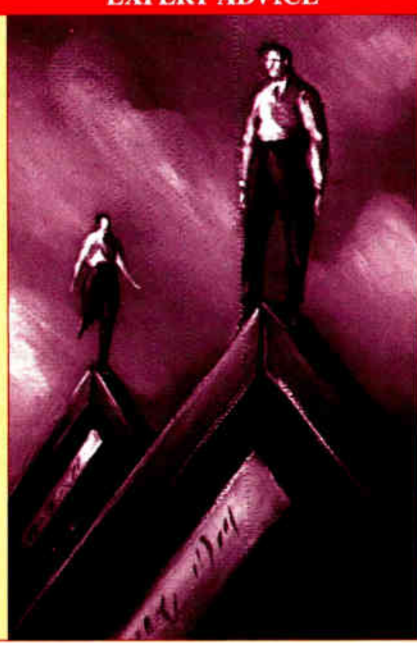

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DEPARTMENTS

READER SERVICE

PROGRAM LISTINGS

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From BYTEnet: call (617) 861-9764

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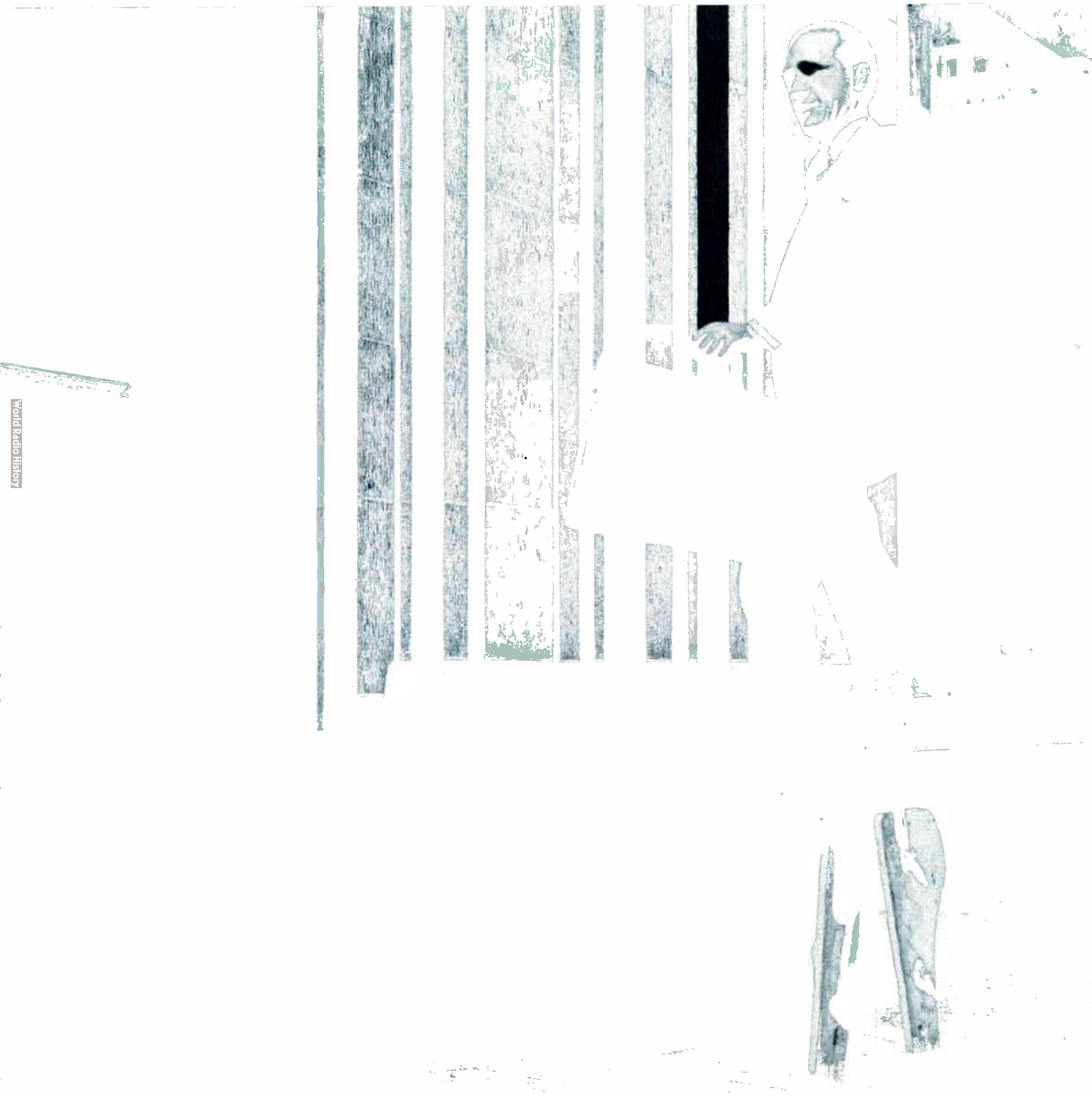

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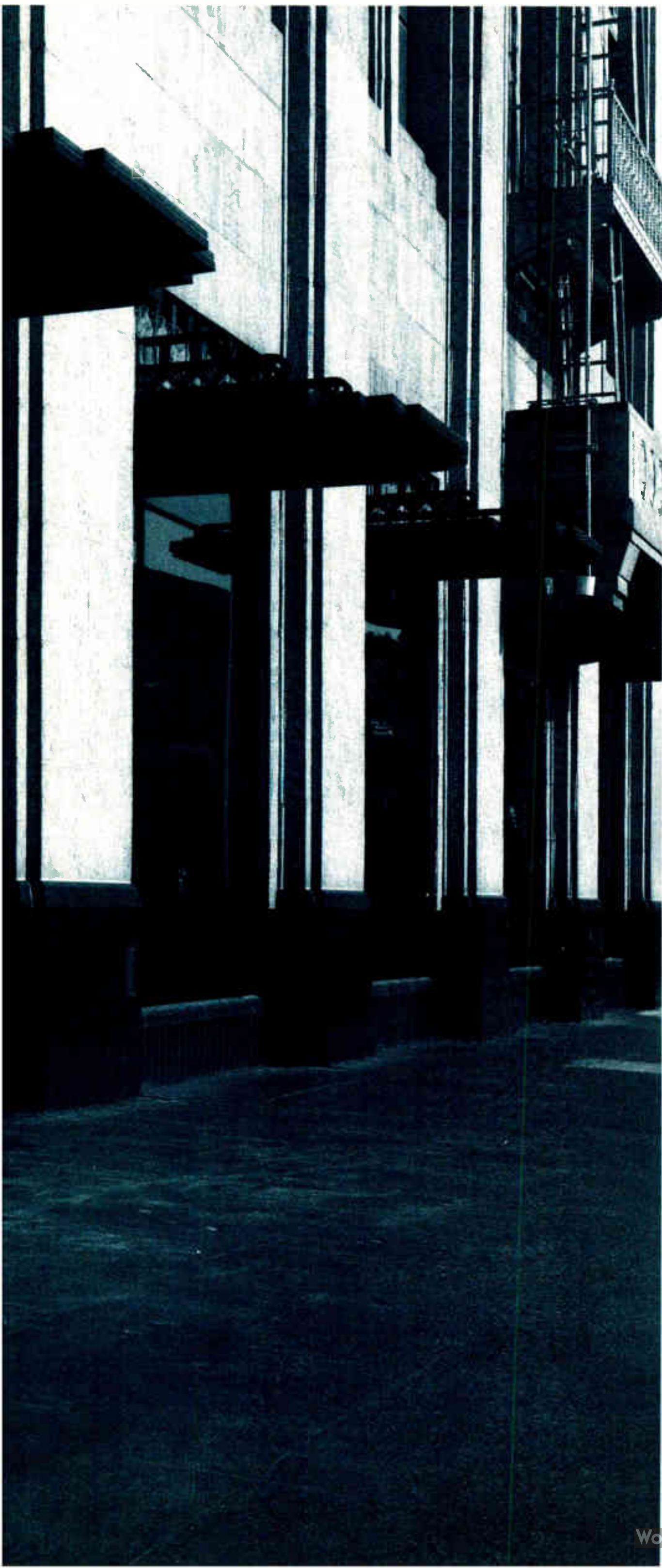

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What's more, you can do it all in record time because our renowned CodeView® Debugger, Linker, Microsoft Editor, and MAKE utility work ingeniously and seamlessly together.

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When you develop under OS/2 systems, you've got options no one else can touch. Like multi-tasking. And blasting through the 640K barrier.

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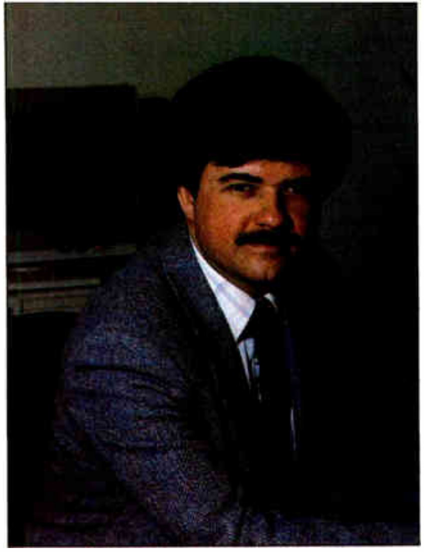


EDITORIAL ■ Fred Langa

NEW UNIX BENCHMARKS

The SPEC group and the BYTE Lab have both been busy creating a new suite of Unix benchmarks

You probably haven't heard a lot about SPEC, the Systems Performance Evaluation Cooperative, but you shouldn't feel bad. It's a pretty exclusive club, featuring companies like IBM, Apollo, Hewlett-Packard, Sun Microsystems, Digital Equipment Corp., Data General, Motorola, and other "heavies" in the field of workstations and high-performance personal computers. SPEC is attempting to standardize and improve Unix benchmarking.

Why New Unix Benchmarks?

Dhrystones, Whetstones, and the old benchmarks still used by many computer publications can't accurately measure the performance of high-end personal computers and workstations. These machines increasingly take advantage of mainframe and supercomputer design concepts like instruction pipelining, multiple execution units working in parallel, large caches, fast memory systems, and optimizing compilers—things these old benchmarks just weren't designed to test. Also, test suites that seek to isolate and benchmark the individual system components and subsystems, or (on the other extreme) the entire system as a "black box," give you incomplete and misleading results.

Most benchmarks in use today fail on at least one of these counts; several of the most heavily promoted computer magazine benchmarks fail on *all* counts. Tests originally designed for small systems simply are inadequate for today's hardware and software. SPEC's new benchmarks will be decidedly heavy-duty, aimed at machines using processors like the 68030/68040 and 80386/80486 and equipped with 16 megabytes of system memory.

The SPEC tests combine low-level and applications-level evaluations. The low-level tests will show the strengths and weaknesses of individual elements in the system; the high-level elements of the suite will give a profile of the entire system working as an integrated unit for different applications.

The only major problem with the SPEC benchmarks is that they are very large and complex. The source code of the entire suite will likely exceed 100 megabytes; many of these benchmarks simply won't run on smaller or less-powerful machines.

BYTE's Unix Benchmarks

The SPEC benchmarks are conceptually almost identical to the second-generation BYTE benchmarks we've been using for about a year now. (BYTE's benchmarks were the first second-generation benchmarks in the industry; the first benchmarks to work across different operating systems and platforms; and the first to combine both high- and low-level testing for a truly complete picture of system performance.)

BYTE Lab's new Unix benchmarks were designed and built on a smaller and more manageable scale than SPEC's; ours can be used to benchmark not only pricey, ultrahigh-performance machines, but also the kinds of machines most of us (and most of our businesses) can afford to use every day.

Some specifics: Our low-level Unix benchmarks are carefully designed not to be defeated by some of the tricks used by new compilers. Our high-level tests are actually custom versions of real database engines and fully implemented standard Unix programs (e.g., editors and compilers). And our benchmarks are designed explicitly to test both single-user and multiuser systems.

For multiuser testing, we adapted techniques from the latest version of the internationally accepted Monash University Suite for Benchmarking Unix Systems (MUSBUS), developed in Australia. The benchmarks feed interactive applications clocked streams of activities from simulated users on each port. The system is then exercised with an increasing load of simulated concurrent users. This lets you see how system performance is affected by an ever-increasing concurrent workload.

For your convenience and ease of use, our new Unix benchmarks (like all our benchmarks) are in the public domain. The new Unix benchmarks should be available for downloading about the time you read this. You can get the benchmarks from BIX or BYTEnet. Information on accessing both systems appears under "Program Listings" in the table of contents.

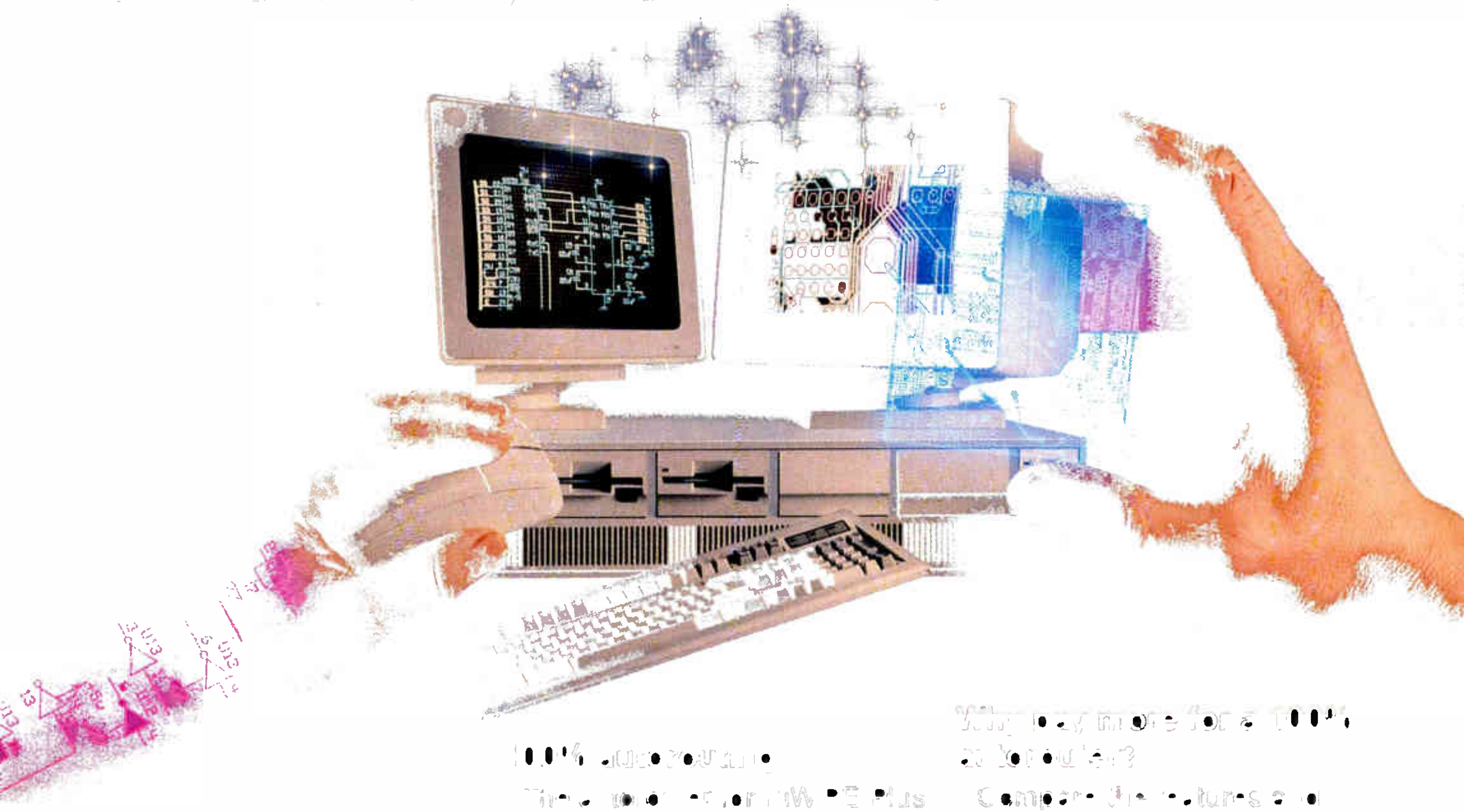
With our new Unix benchmarks in place, we'll soon be benchmarking new systems on every appropriate major operating system: We'll test new 80386 and 80486 machines, for example, under DOS *and* OS/2 *and* Unix. We'll test new high-end Macs under the Mac operating system *and* A/UX. And so on.

The idea is to multiply your options. Today's mixed computing environment means that each of us has to know more about more machines than we ever did before. BYTE is committed to giving you the comparative, unbiased information that you will need to sort through the welter of options and to make solid decisions about whatever new hardware and software comes down the pike—regardless of brand, architecture, or operating system.

In a nutshell: Single-platform and single-operating-system solutions are passé.

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

At last, an assistant that follows your directions



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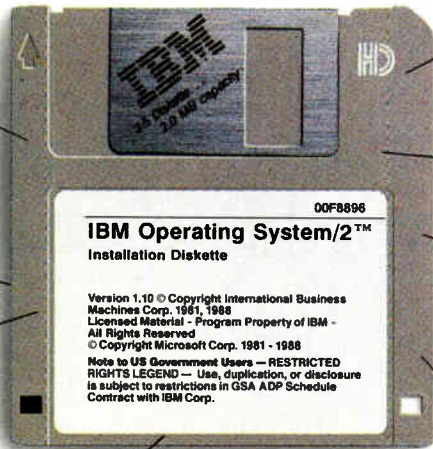

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MICROBYTES

Staff-written highlights of developments in technology and the microcomputer industry, compiled from Microbytes Daily and BYTEweek *reports*

Optical Broadcast Could Break Access Bottleneck

Three scientists at the University of California at Davis are trying to bypass bottlenecks of computer architecture with a hybrid system that combines electronics and optical technology. They're working on something they call Optimul (Optical Interconnect for Multiprocessor Systems), which makes use of "wireless" lasers and a special coating for computer chips. The UCD team thinks its design can solve problems caused by memory contention in shared-memory systems and network bottlenecks in separate-memory systems. With sufficient funding, a crude working prototype of Optimul could be built "in about six months," says Steven Kowel, a materials scientist on the UCD team.

Optical computers would overcome the ultimate speed limits faced by traditional computer designs. But people who have tried to build more or less completely optical computers (as Kowel says, "no silicon except maybe the input/output components") have encountered "startlingly difficult" hardware problems, he adds. Systems that are mostly optical remain "primitive" and expensive, he says.

Within the last five years, though, research has shifted toward a focus on hybrid systems. These systems handle logic, memory, and I/O electronically but use ostensibly faster optical fibers for interconnecting chores. "People have taken chips and glued them board-to-board via fiber," Kowel says. At the far reaches of this approach, some scientists are attempting "intra-chip" optical connections using holographic techniques.

Kowel and cohorts Norman Matloff and Charles Eldering think their idea is more practical than "holographic interconnects." Basically, they want to coat memory chips with a thin polymer film treated for sensitivity to electrical charges and light, producing a result somewhat like an LCD, says Kowel.

A laser beam illuminates the coated memory chip and "broadcasts" a picture of the entire contents of memory at that instant. The broadcast can be picked up by multiple processors at once, and the beam demodulated back into electrical charges and stored as such. This constitutes a kind of "double parallelism," according to Kowel, "across processors and across bits in memory."

In a tightly coupled or shared-memory system, a wireless broadcast solves the problem of contention for memory access, Kowel says.

Another kind of bottleneck arises with networked systems where there is no central memory. Even with high-bandwidth channels like fiber optics in place, a limited number of data pins feed memory contents to the optical channel; Optimul bypasses that constraint by broadcasting rather than channeling data, Kowel says. Writing to memory in Optimul would still be done, at least initially, using electronics, so a data bus would remain part of the overall system. It will likely be many years, the USD designers admit, before coated Optimul-type interconnects might be a standard part of the backplane.

Virtual Memory, "Hot Links" Coming to the Mac OS

Apple Computer has been promising a new operating system that will swing the Macintosh into the 1990s, but some Mac users have wondered if they'd be left behind in the 1980s when the new System arrives. Based on information dispensed by Apple officials at the spring edition of the developers' conference, the company is trying to maintain continuity in the Mac family. System 7.0 will have some impressive capabilities, but perhaps its most important characteristic is that it's supposed to run on everything from a Mac Plus to a Mac IIcx (as long as they have at least 2 megabytes

continued

NANOBYTES

If **OS/2** had a theme song, it could possibly be the old Sam and Dave number, "Hold on, 'Cause I'm Coming." Even **Microsoft** officials admit that the operating system lacks applications to lure users. "Today, there isn't a truly compelling reason to go to OS/2, especially if you want to run a single DOS application," said Microsoft vice president Scott Oki during the recent IBM PS/2 Forum in Boston. "But there will be in the next few months." Oki said the public doesn't see the development going on in corporations, which are converting their own mainframe programs to run under OS/2 on PS/2s. A lot of companies are developing full-blown Presentation Manager versions of in-house applications, using the Common User Access (CUA) interface, which is the name of the "look" that IBM wants across all its systems, from mainframes to microcomputers, via the Systems Application Architecture.

IBM, like any humongous corporation, has gotten a reputation for being somewhat inflexible. But during the PS/2 road show, Big Blue executives said the company is now taking a different approach. "We recognize that, in order to meet your needs, we need to become much more flexible," said Paul Palmer, New England regional vice president for IBM, during a session with computer dealers. Asked to translate, another IBM official said, "It means that we're going to become even more market-driven; we're going to go out and ask our customers what they want, and then deliver that."

Senator **John Glenn** (D-Ohio) is calling for the U.S. to establish the **Advanced Civil Technology Agency** to coordinate commercial science and technology projects. "The time is right for the creation

continued

NANOBYTES

of a civilian counterpart" to the Defense Advanced Research Projects Agency (DARPA), Glenn told Microbytes Daily. Glenn stressed that ACTA is not meant to "step on the toes" of private industry; instead, the agency would augment "projects not adequately addressed by the private sector." Glenn's bill calls for three-year, $300 million funding of a "lean" agency staffed by about 35 "top-level" researchers, scientists, and engineers. Currently, about 100 congressional committees deal with science and technology issues, Glenn said.

The **Object Management Group** has formed to promote a standard object-oriented environment. The OMG environment, which will be based on Hewlett-Packard's NewWave, will run on DOS, OS/2, and Unix systems, and, according to the backers, it will allow new applications from diverse hardware platforms to work together easily. Members of the OMG, based in Westborough, Massachusetts, include HP, Sun, Unisys, Prime, Data General, 3Com, and Gold Hill Computers.

National Instruments (Austin, TX) has a new specification for a 32-bit instrumentation bus interface that it says is faster and more flexible than the GPIB (IEEE-488) spec, which some users say is poky. **MXI** (Multisystem Extension Interface) is a bus-on-a-cable, a protocol extender that will allow systems using the VXI (VMEbus Extensions for Instrumentation) bus to be connected to microcomputers. National has released the spec and hopes it will become a standard.

Toshiba (Irvine, CA) is now sampling a new line of 256K-bit CMOS static RAM chips that offer access times of 20, 25, or 35 ns. Toshiba also has a new video RAM that it claims will "spur development of next-generation high-resolution graphics systems." The VRAMs will be offered in 4- and 8-bit-wide versions with

continued

of memory). "There is no break or discontinuity in our System software," said Apple Products president Jean-Louis Gassee.

Apple said its new System will include virtual memory management, an improved Finder, "hot links" between applications, a new but backwardly compatible type and font model, a new Communications Toolbox, and a Database Access Toolbox for accessing host mainframe databases. In other words, System 7.0 will be Apple's answer to OS/2 and Unix.

Virtually all current Mac applications will run under System 7.0, Apple said. Those "ill-behaved" applications that have used the upper 8 bits of the Motorola 680x0 32-bit address space may not run under System 7.0 (these are applications that are not "32-bit clean").

The only feature of System 7.0 that will not work on the 68000-based Mac SE and Mac Plus is the virtual memory capability, which will allow a portion of the hard disk to appear as an extension of the machine's system memory (RAM). The virtual memory capability will require the paged memory management unit (PMMU) that's built into the 68030 or can be installed on the logic board of the 68020-based Mac II.

For Mac users, one of the big breakthroughs in System 7.0 will be the Interapplications Communications Architecture (IAC), which will support interprocess communications similar to what will be offered by Hewlett-Packard's NewWave environment. IAC's "live copy/paste" will allow multiple applications to share data and dynamically link and update the data. For example, you might use a chart from a charting program in a desktop publishing package. By specifying a "live copy/paste" link, the desktop publishing document will automatically include any subsequent changes you make to the chart using the charting program. This capability is often called "hot links" or "dynamic linking."

While live copy/paste is something for Mac users to look forward to, existing applications will have to be modified to take advantage of it. Most developers of new applications will certainly build in the live copy/paste function. The live copy/paste feature will also work across an AppleTalk network, Apple said, so that data can be shared and hot-linked among multiple machines.

Part of System 7.0 will be Apple's new font format, which will give the Mac a WYSIWYG imaging model comparable to that of Display PostScript (used on the NeXT computer). However, Apple's new font model is in some ways better than Display PostScript—it doesn't require a license, and it will be an open, published specification. Apple's new type fonts simply replace the current QuickDraw bit-mapped fonts with a new library of fonts represented mathematically using a quadratic equation algorithm.

Since the new fonts are represented mathematically rather than by bit maps, they are completely scalable from one resolution to another. They will work on any output device from screens to printers to typesetters. Current Macintosh bit-mapped fonts will still be supported under System 7.0. But new applications will take advantage of the new fonts, which appear crisp even on an Imagewriter printer. Adobe Systems announced that it will offer a utility that converts Apple's new fonts to PostScript so that PostScript printers (e.g., the Apple LaserWriter NT and NTX) will be able to print the new fonts. However, the new fonts are independent of PostScript and will therefore also print well on less-expensive laser printers that don't support PostScript (the LaserWriter SC, for example).

Like System 6.0, System 7.0 will support the MultiFinder multitasking system, which allows multiple tasks to execute simultaneously (e.g., a communications program running in the background and a word processor in the foreground). Because System 7.0 will offer virtual memory, the current memory limitations on MultiFinder will disappear since you'll be able to allocate additional memory on the hard disk.

However, System 7.0 will not support memory protection or preemptive execution of applications. These features, which are offered by Unix and OS/2, protect simultaneously executing applications from interfering with each other or causing the entire system to go down if one application crashes. Without these protection features, there is some risk involved in using MultiFinder, and this risk will remain in System 7.0.

Some of System 7.0's other features include an improved Finder with file

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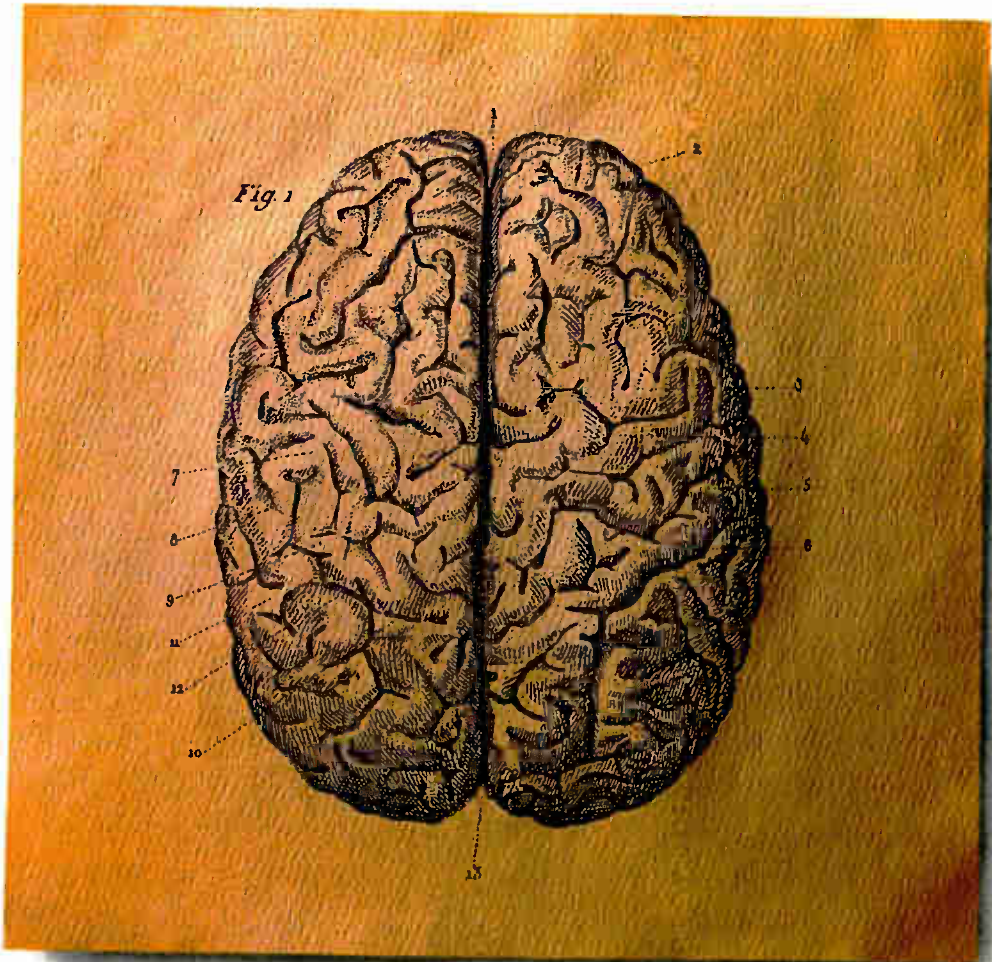

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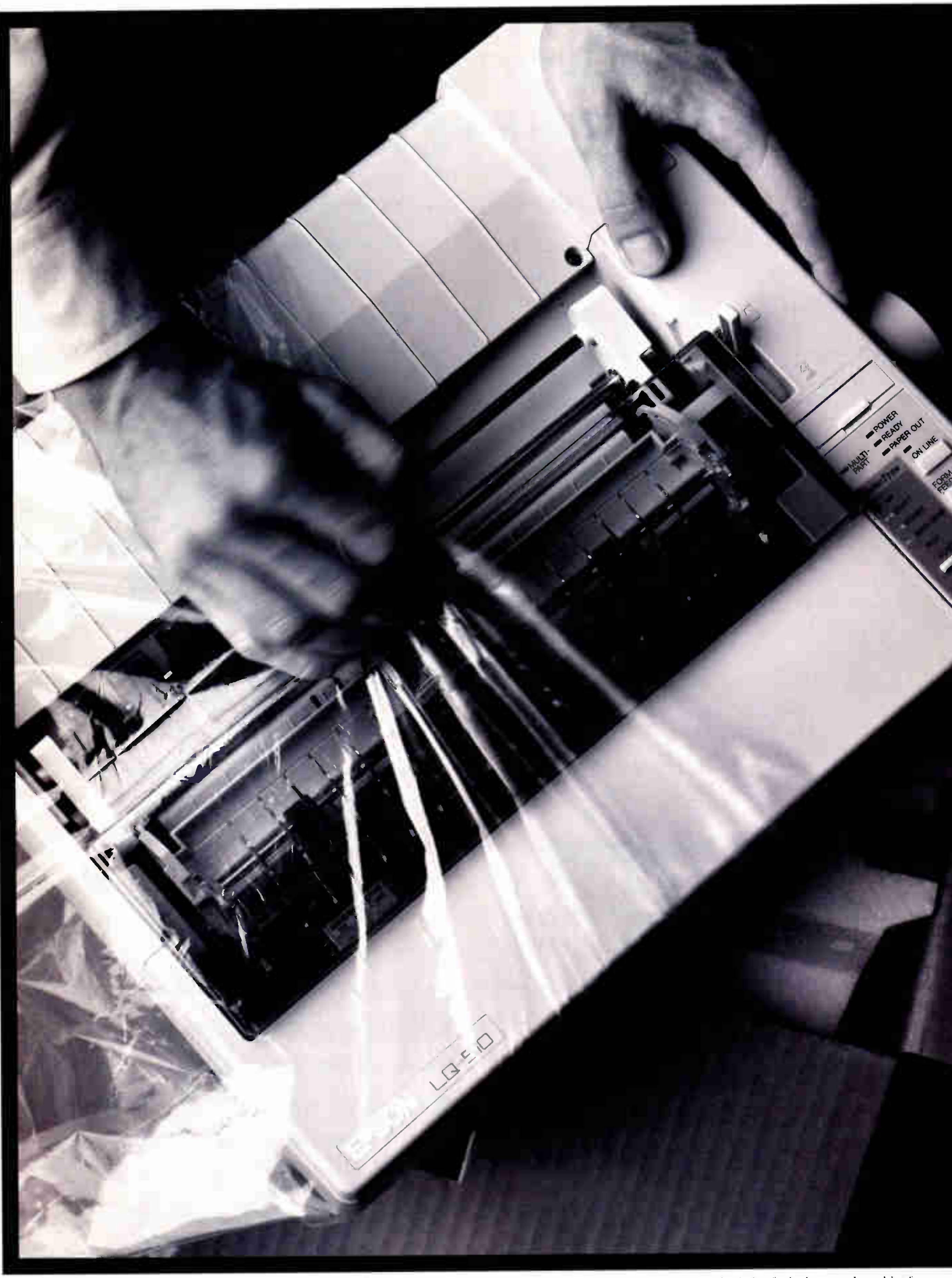

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Elographics (Oakridge, TN) has developed a touchscreen driver that emulates mouse commands. Mousetrap for Windows lets you execute mouse commands by touching the appropriate part of the company's touchscreen (e.g., slide your finger across the screen instead of dragging the mouse across the desk). Elographics says the emulator lets you perform all Microsoft Windows functions, such as moving objects, resizing windows, and activating commands. Mousetrap intercepts the mouse interrupt calls before they reach the application program and directs them to the touchscreen driver, according to an Elographics engineer.

A new survey indicates that **Japan** is not the utopian high-tech-automation society depicted by some people on this side of the Pacific. According to the latest survey by the Japan Institute for Office Automation, there's been a drop since 1987 in the number of Japanese workers who think that office automation is making them more efficient at their jobs. The JIOA questionnaire results were more negative than in the past, with fewer respondents saying that personal computers and word processors were "creating a richer work environment" or making them more interested in their jobs.

Adding yet another acronym to the lexicon of personal computer communications, the **Crosstalk** division of Digital Communications Associates (Roswell, GA) has developed what it calls an

continued

search capabilities and an integrated Font DA/Mover, allowing you to activate fonts and desk accessories simply by dragging them into the System folder. A Communications Toolbox will provide functions for designing Mac-like interfaces to other networks and host computer systems. System 7.0 will also have a Database Access Toolbox, which will allow SQL queries to host databases using the CL/1 interface language (which Apple acquired when it bought Network Innovations last year).

While Apple officials provided a lot of technical details, they wouldn't say when System 7.0 will be ready. The company told developers they would see beta software sometime this fall. Randy Battat, Apple's vice president of product marketing, said the company hopes to ship final versions of System 7.0 a few months after the release of the beta software. Apple declined to release prices but indicated that there would be a "nominal fee."

New DOS Will Be Quicker, Smaller, Gates Says

Microsoft will release a new version of DOS that will be faster and will require less memory than DOS 4.0, according to Microsoft CEO Bill Gates, who said he didn't know "exactly when" this new version would be ready. In a question-and-answer session sponsored by the Boston Computer Society's IBM special interest group, Gates also said that OS/2 1.2, due later this year, will have a more powerful file manager and that the awaited version of OS/2 for the 80386 will arrive next year. A version for the 80486, which Gates called a "significant" chip, won't require many software changes. "There never will be an application that's '486-specific," he said.

Gates predicted that a high percentage of DOS machines, "80 to 90 percent," will become Windows machines.

Despite his assurances that Microsoft will continue to support DOS, Gates made it clear that he feels the direction of desktop computing is in graphical applications. In fact, Microsoft decided not to endorse DOS extenders primarily because "It's like telling people to write more character-based applications," Gates said.

Computer Makers to Release Unix-Based Benchmarks for Motorola, Intel Machines

The Systems Performance Evaluation Cooperative, a group of computer makers better known for competing with each other than for cooperating, plans to release its Unix-based suite of computer benchmarks in September. Computers targeted by SPEC include 68000- and 80386-based machines with about 16 megabytes of system memory, said Jerry Nelson, chairman of the steering committee and R&D manager for Hewlett-Packard's Ft. Collins (Colorado) Workstation Laboratory. "Many of these benchmarks simply won't run on 80286-based machines because some images are 15- to 30-megabyte images."

The porting of the first benchmarks onto other popular operating systems will be encouraged, SPEC members said. "But the more systems-oriented things we get, the harder it will be to move away from Unix," according to John Mashey, a steering committee member and vice president of systems technology at MIPS Computer Systems.

Most of the SPEC benchmarks will measure performance in engineering and scientific applications, but the group expects to also someday release business application benchmarks as well as multiuser, multiprocessing, and parallel processing benchmarks.

Dhrystones and Whetstones don't accurately measure workstation performance, SPEC says, because today's high-performance microcomputers often take advantage of mainframe and supercomputer design concepts. "Today's workstations and servers deliver high performance by using heavy instruction pipelining, multiple execution units working in parallel, large caches, fast memory systems, and optimizing compilers," said Nelson.

A possible shortcoming of the SPEC

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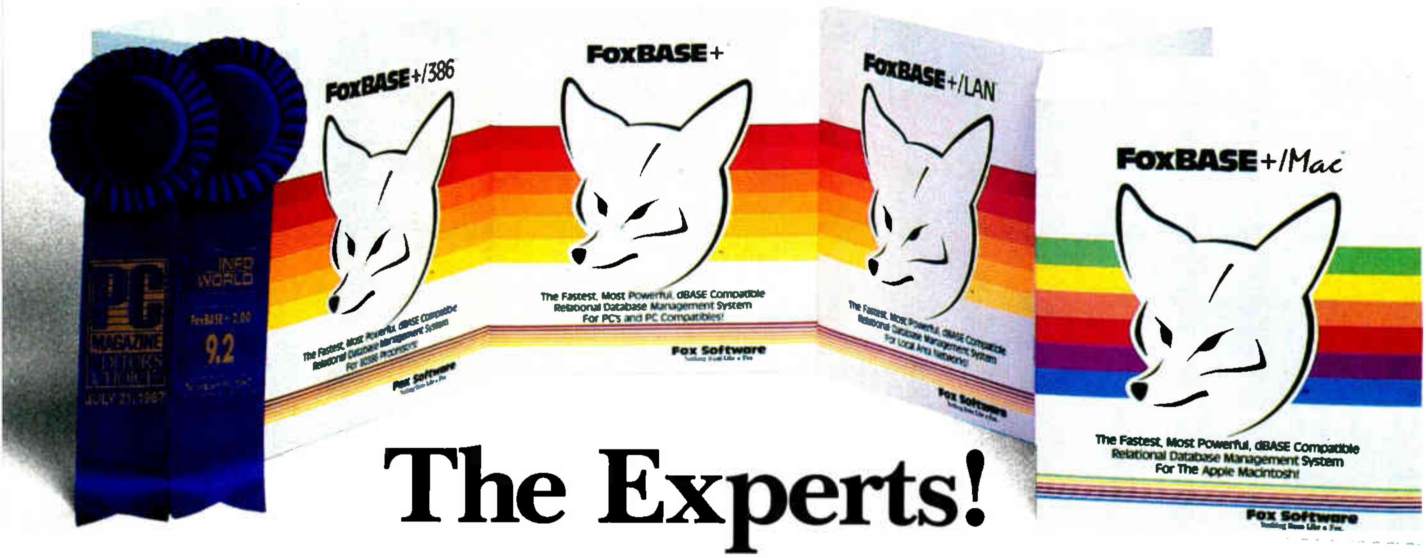

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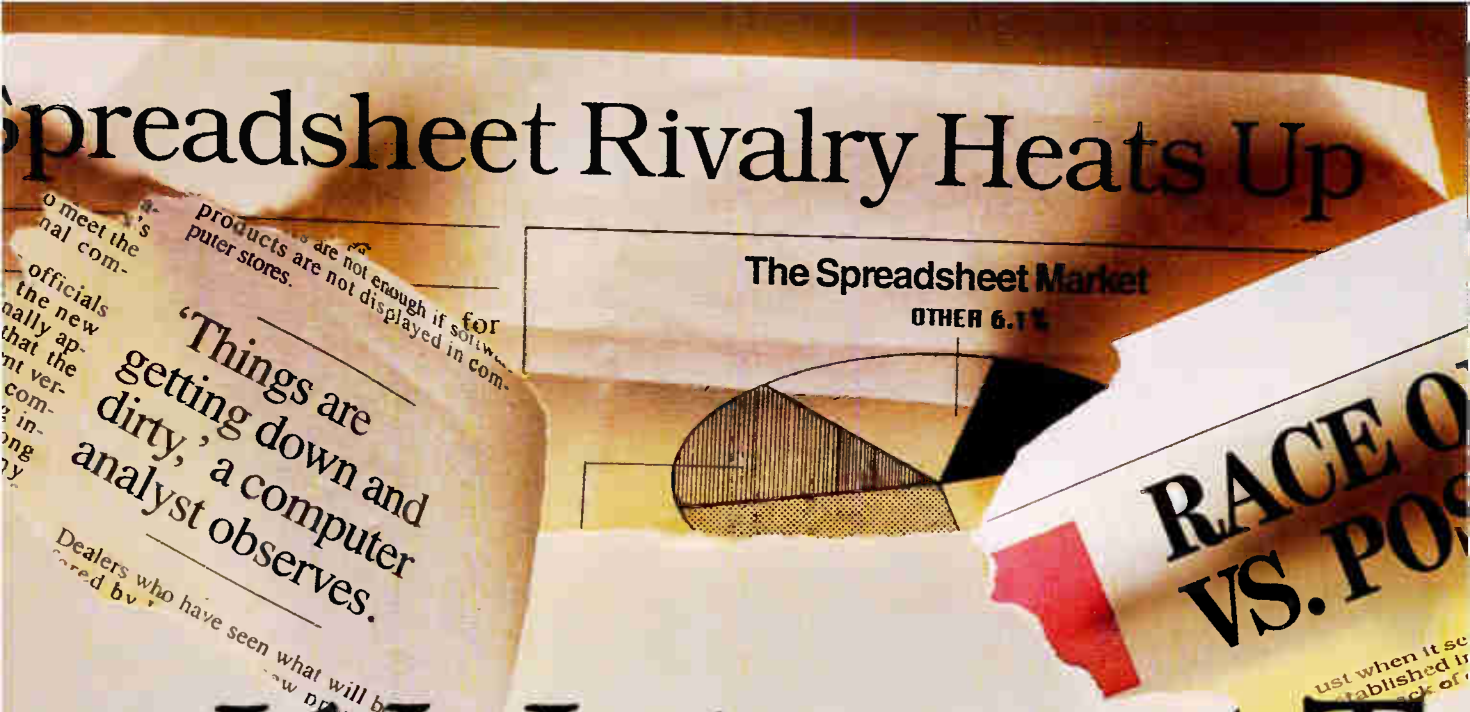

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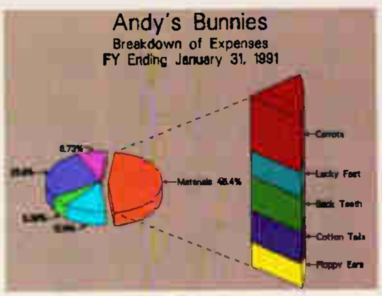

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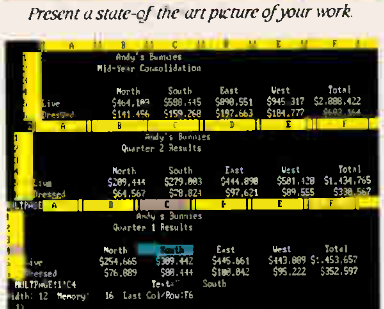

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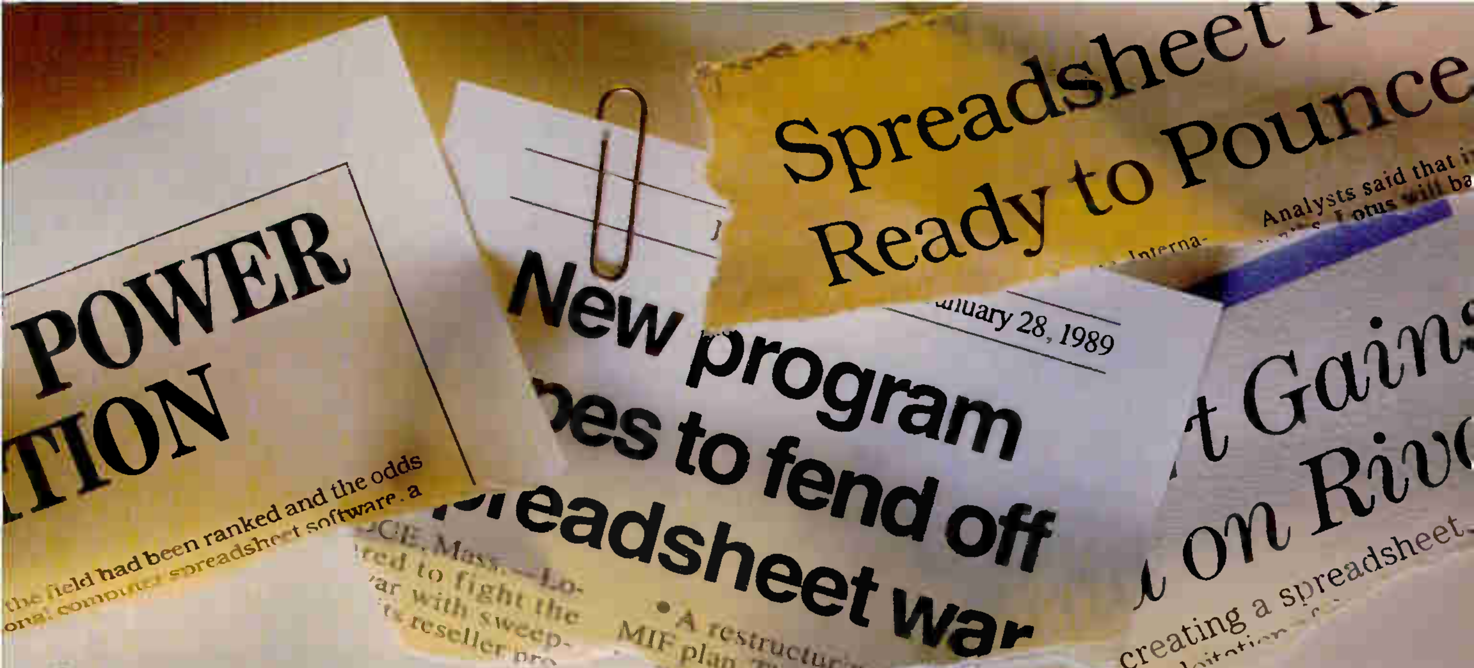

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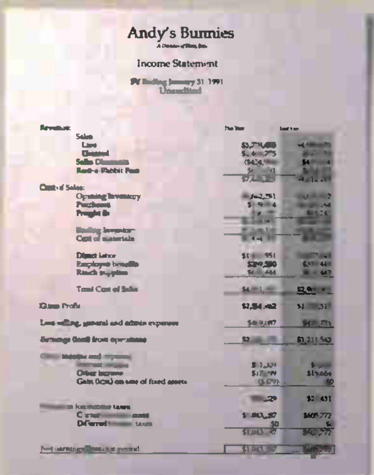
to be precise. Linking either in memory or on disk, either pages of the same spreadsheet or independent, either SuperCalc5's files or Lotus® 1-2-3®'s.



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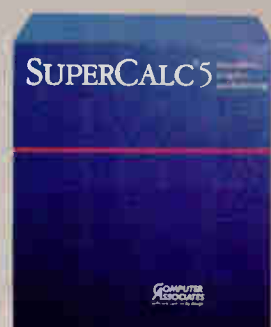

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Asynchronous Communications Server, generally called a modem pooler. A modem pooler allows users on a LAN to share asynchronous devices, such as modems, without each personal computer needing to have its own modem card. The basic ACS software will support as many as four serial devices and sell for $795, said Jeff Garbers, director of software development, at the recent CITEX show in Atlanta. At that time, the software was in final beta testing.

Asked for his reaction to Hewlett-Packard's acquisition of Apollo Computer, which would make HP the world's biggest vendor of Unix workstations, **Sun Microsystems CEO Scott McNealy** said, "That's one less OSF member. It's kind of a nonevent." Both HP and Apollo are members of the Open Software Foundation, which hopes to challenge AT&T and Sun with its own rendition of Unix. McNealy speculated that the merger came about because "one company couldn't go it alone, and the other couldn't catch up."

Speaking of OSF, the group's schedule for releasing components of **OSF/1** is as follows: The Vendor Kit, for members to port the OSF kernel to their platforms, is supposed to be ready in October; the Application Kit, which will provide software developers with the OSF application environment, is slated for March 1990; the University Platform, which will be a functionally complete OSF/1, will be given to universities and other beta sites for testing starting in May 1990; and the Commercial Platform, the OSF/1 for the rest of us, is slated for July 1990.

Avid Technology (Burlington, MA) has a new Mac IIx–based system for editing film and video. The Avid/1 Media Composer digitizes full-motion, 30-frames-per-second National Television System Committee video onto the Mac's hard disk. An editor can then directly manipulate and assemble the digitized "clips" into finished sequences using a dual editing

continued

benchmarks is their size and complexity. The source code of the entire suite will likely exceed 100 megabytes. Each of the hardware-specific applications (compilers, multiprocessor applications, graphic design applications) requires extensive work to port them to new hardware.

The SPEC steering committee represents both sides of the campaign for a standard user interface for Unix, with members that belong to the Open Software Foundation (most notably, HP and Apollo) and members from Unix International (the AT&T loyalist faction). Apollo, HP, MIPS, Digital Equipment Corp., and Sun Microsystems all have representatives on the steering committee. Other SPEC members include Data General, Motorola, Multiflow Computer, and Stellar Computer. IBM, a late addition to the group, will not be on the steering committee until after release of the first suite, according to Nelson. Any company can join SPEC, provided it can afford the $10,000 initial fee and dues of $3000 per year.

Weitek Pushing Its Own Math Chip for Intel's 80486

Intel's 80486 chip will have its own built-in version of the 80387 math coprocessor, so some industry watchers say there won't be much of a market for add-on math coprocessors for the 80486. But that's not so, according to Weitek (Sunnyvale, CA), maker of high-speed FPUs. Weitek has developed its own math coprocessor for the 80486, called the Abacus 4167, that the company claims offers two to three times faster numeric performance than that offered by the 80486.

Despite the built-in 80387 coprocessor on the 80486, Weitek hopes to convince OEMs to provide the 142-pin socket on their 80486 logic boards. Such a socket is required to accommodate the new 4167 coprocessor. According to Weitek product manager Mauro Bonomi, Weitek already has lined up several OEMs to support the new chip. The 4167 offers full binary compatibility with Weitek's 3167 coprocessor, which can be used in several major 80386-based systems, including the Compaq Deskpro 386, the HP Vectra, and the Sun386i.

Compatibility with the older 3167 coprocessor is important because it will allow the chip to run a growing number of applications that support the 3167. These applications include VersaCAD, CADKEY, Mathematica, Ansys, the HOOPS graphics package, and many other products for scientific, engineering, and statistical analysis. Several major vendors of DOS and Unix compilers offer C, FORTRAN, and Pascal compilers for the 3167 (Green Hills, Silicon Valley Software, MetaWare, Lahey, and MicroWay).

The new Weitek chip could fill a need in the market, but industry observers see good news and bad news ahead. The good news is that the 80387 is probably inadequate for some serious number-crunching applications; it's simply not in the same league as RISC processors like the i860 or R3000. This is where Weitek sees an opportunity.

The bad news is Intel's i860, a RISC chip that not only is a fast math coprocessor but also contains an on-chip graphics engine. This is significant since most number crunchers will probably be used in some way with graphics, which basically kills two birds with one stone. Add to that the fact that IBM seems firmly planted behind the i860 (it already has shown an experimental graphics card based on the i860), and you see some rough going for the Weitek chip.

The existing base of software that will work with the 4167 will give that chip at least a temporary advantage over the i860; software that works with the Intel RISC chip is at least a year away. And, according to Bonomi, the 4167 compares favorably to the i860 in scalar numeric operations. Although the i860 is optimized for vector operations, most applications are still designed to perform scalar numeric computations. (Vector calculations involve a scheme in which multiple calculations are performed simultaneously, rather than sequentially as in the scalar computational model.)

The Weitek 4167 will be priced at $565 in 1000-unit quantities, adding between $1000 and $1500 to the retail cost of 80486 systems that include the 4167. The new Weitek chip is supposed to ship in sample quantities in September.

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window that puts source and edited material onto the screen. The basic Avid/1 sells for about $50,000 with an 8-megabyte Mac IIx and a 600-megabyte hard disk drive, which can hold about 25 minutes of video.

Meta-Software (Campbell, CA) has ported its **HSPICE** program for simulating analog circuits to 80386-based personal computers. The $4000 software requires an 80387 coprocessor and at least 4 megabytes of RAM.

Microsoft has started shipping version 5.0 of its FORTRAN Optimizing Compiler. This one will support OS/2's 16-megabyte addressing capability and dynamic link libraries. It's also designed to support a wide variety of VAX and VS syntax, the company said. Besides a new graphics library, the $450 compiler package comes with a new version of CodeView for working with OS/2 programs as big as 128 megabytes.

The Instrument Society of America (Research Triangle Park, NC) has a new quarterly magazine, *Industrial Computing*, covering the use of computers on the factory floor.

Informix (Lenexa, KS) says it will develop a version of **WingZ**, the very graphical spreadsheet program that runs on the Mac, for Apollo's line of Unix-based workstations. The program will use **OSF/Motif** as its user interface, a spokesperson said.

Database for chemists: The National Institute of Standards and Technology is offering a new database of 2000 chemical reactions and more than 5000 data entries compiled by NIST scientists. The agency says the database (NIST Standard Reference Database 17, Gas Kinetics) is a good tool for modeling combustion systems or chemical processes taking place in the atmosphere. (Contact the Office of Standard Reference Data, NIST, A320 Physics Building, Gaithersburg, MD 20899, (301) 975-2208.)

ATs Get Boost from IIT's New Coprocessor

Owners of AT-type systems who rely on a math coprocessor are in for a boost, and it isn't coming from Intel. A young company called Integrated Information Technology (Santa Clara, CA) plans to start shipping a chip that will serve as a direct, and speedier, replacement for Intel's 80287 FPU.

The IIT chip, which can run at up to 20 MHz, will plug into sockets that are designed for the Intel 80287, and it is designed to work with exactly the same software. IIT officials told Microbytes Daily that they plan to match their chip's pricing with that of Intel's (80287s currently average on the street in the $200 to $250 range) while offering several improvements.

The IIT chip is virtually a superset of the Intel 80287, but it differs in several important ways. The company says its chip can run all current software that works with the Intel 80287 but also has special matrix instructions, which speed up certain kinds of math operations, including manipulating three-dimensional graphics. (These instructions, however, won't be useful unless software developers design their programs to make use of them.) Perhaps most important, the IIT chip, even at the same clock speed, performs floating-point math "two to three times as fast" as Intel's 80287, IIT officials said. If you have an 80287 in your computer, you could pull it out, pop an IIT 80287 into the socket, and get better performance, IIT engineers claimed.

According to Chi-Shin Wang and Y. W. Sing, the engineers who cofounded the company, they've been able to come up with a faster chip by completely redesigning the coprocessor. Instead of trying to "reverse engineer" Intel's chip, IIT took Intel's specifications and designed the new chip from the ground up, they said. As a result, the IIT chip has a much larger percentage of its area devoted to actually performing floating-point math, and four times as many registers as the Intel chip.

Agilis Squeezes Workstation into Hand-Held Unit

Advances in miniaturization and electronic packaging have yielded the first truly hand-held workstation. The new Agilis System, designed by engineers formerly with GRiD, 3Com, and NeXT, is a modular, battery-powered, 8088- or 80386-based computer that's about the size of a notebook and weighs from 4 to 10 pounds. It has a touch-screen interface connected to Microsoft Windows, which allows the user to operate the system with one hand. There's also built-in Ethernet and an optional radio Ethernet module, which allows wireless Ethernet networking at a range of up to 1 kilometer.

The Agilis System, made from ruggedized plastic, is built on the concept of modular slices, with each slice providing a component of the system. There's a CPU component, or "processor slice," a communications slice, a data storage slice, and a battery-power slice. Data can be stored on memory cards, floppy disks, or the new Prairie Technology 2½-inch hard disk drives. An adapter allows the system to run on 12-volt direct current. The device is designed specifically for use in the field. The wireless networking capability allows the user (say an airplane mechanic) to connect to a host mainframe to retrieve maintenance procedures, for example.

An 80C88 processor slice with display and battery power will cost over $4000. An 80386 system starts at about $8000 and goes up from there depending on the configuration. (Contact Agilis Corp., 1101 San Antonio Rd., Mountain View, CA 94043, (415) 962-9400.)

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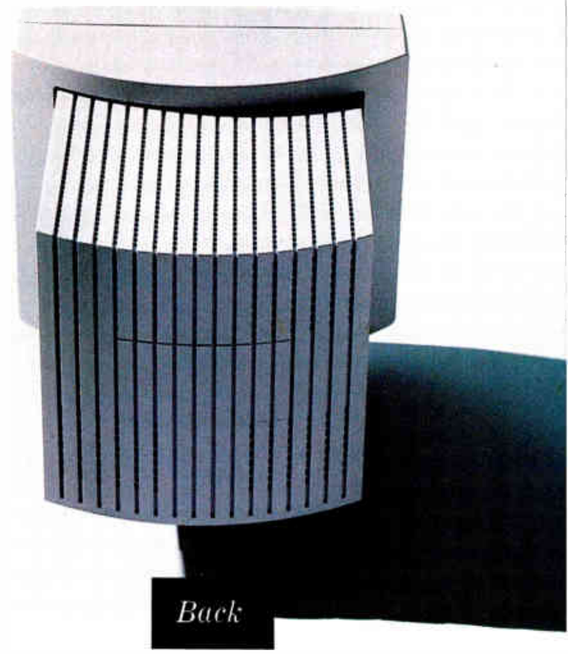

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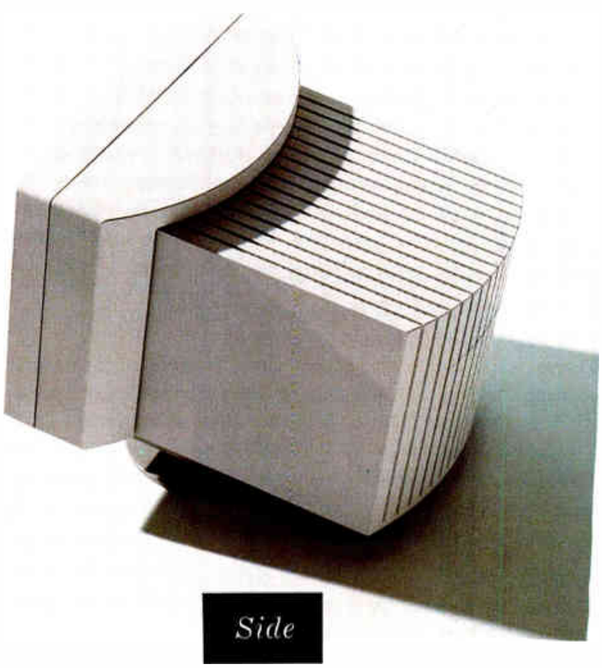

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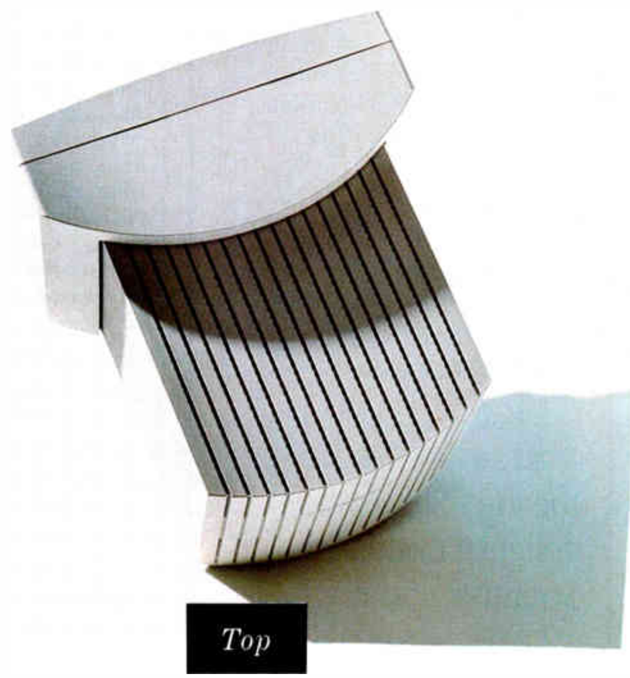

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Setting the Record Straight

A book that attempts to rewrite history should be reviewed with much more skepticism than G. Michael Vose showed in his review of *The First Electronic Computer: The Atanasoff Story* by Alice R. Burks and Arthur W. Burks (September 1988). A reviewer, especially in the pages of BYTE, should acknowledge that this "story" is not just a deeper look at an interesting machine but also a concerted effort to discredit my father, Dr. John W. Mauchly, who is the coinventor of the ENIAC.

In their book, Alice and Arthur Burks make two huge claims—first, that J. V. Atanasoff invented "the first electronic computer," and second, that John Mauchly stole the idea of the computer from him. Both are false, as virtually the entire computer history community agrees. Why didn't Vose question these claims? As a typical BYTE reader, I am well versed in computer architecture, and it is obvious to me that Atansoff's machine was not "the first electronic computer." You can examine each word, one at a time, to see if the description fits.

To be the "first" machine means to be the first machine that actually worked. Surely "the first airplane" is the one that flew, not the one that could have flown had all the bugs been worked out. The ABC computer never ran; it never solved the problem for which it was designed.

Was the machine "electronic"? Well, it did indeed use vacuum tubes for the adding circuit, so it was, in part, electronic. The other part, the memory, was electromechanical. It was a rotating drum, and it took one whole revolution of the drum to read one number—it took one second. Any advantage of the electronic part was negated by the speed of the memory: It was slower than the relay machines of the day.

Claiming today that something is a "computer" should require that it meets the minimal definition of a computer. This means that it be *digital, automatic,* and *programmable*. The ABC was digital. But it was not general-purpose; it was designed to solve only one problem. Running that problem would have required several weeks of constant attention by an operator feeding punch cards in and out in a special order—hardly automatic. Had it worked, it would have been the first digital, partly electronic, special-purpose calculator; however, it never did work.

It is not the elevation of Atanasoff's machine to a new title that bothers me the most, however. It is the attempt by the Burkses to prove that Mauchly stole a certain "idea" from Atanasoff, which would put Atanasoff at the base of the computer's family tree. This is the "idea" of computing electronically.

Now, just the "idea of computing electronically" sounds like "the idea of building a flying machine"; many tried it before someone succeeded. John Mauchly worked and experimented on electronic computing for years before meeting Atanasoff. The wisdom of the day was that vacuum tubes were too unreliable to use in quantity. It took the genius of J. Presper Eckert to make 18,000 of them work in the ENIAC. But to make their "story" work, the Burkses have to make us think that Mauchly stole this unpopular idea from Atanasoff. They attempt to prove that Mauchly never thought about digital calculation in the years before he met Atanasoff.

Unfortunately for them, there is ample evidence to the contrary. There is a letter from Mauchly that states his intention to build a keyboard-operated electronic digital calculator; there is an experimental

continued

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The Burkses commit large sections of their book to proving what a great guy Atanasoff was and what a forgetful, uninventive man Mauchly was. This is supposed to make it look more likely that their accusations are correct. What it actually does is turn what could have been a respectable book into a cheap shot at Arthur Burks's old rival, John W. Mauchly. No wonder the major computer publishers refused to print it.

The Atanasoff Story is extremely well written and well researched. One would assume that it is correct in its conclusions. But the history of computers is still a living, controversial subject. G. Michael Vose should have looked a little deeper before he assumed that history had suddenly been "corrected."

John William Mauchly Jr.
Berwyn, PA

When Is a Desktop Not a Desktop?

I have used the desktop metaphor in several incarnations—on the Macintosh, on the NeXT computer, and under Microsoft Windows. I think that the designers of these environments could significantly improve the genre by simply looking at their own *real* desktops and modeling their metaphors after the real thing.

I am most familiar with the Mac Desktop, so let me use it as an example. The way I use the Mac Desktop isn't anything like the way I use my real desktop. For example, I don't have a bunch of file folders on my desk—I keep them in a filing cabinet. On my desk is a pad of paper or a notebook. I can put anything I want on a piece of paper. On the Mac, however, everything is broken up into incompatible "documents" (i.e., spreadsheet, word processor, drawing, painting, and compiler documents are all completely incompatible and can be combined only in special cases).

With my real desktop, I might take a piece of paper and put some text on it with my writing tools. Then I might get out a set of drawing tools and draw on the same piece of paper. I can also jot quick notes in the margin. I might put a table of numbers on the paper and do math calculations on them using a math tool such as a calculator. I might have a book on the desk that I'm reading from as a reference while I'm writing. All the tools are out at the same time, and all of them are working on the same piece of paper. If I need more tools, I reach into a drawer and put those tools on the desktop, too.

Operating-environment designers don't need to limit themselves to real tools. For example, desktop publishing systems have made us all familiar with the idea of "pouring" text into a frame, although none of us has ever seen a real "text pourer." A text-pouring tool might be very interesting.

All I want is an operating environment that I can draw and write on at the same time, just as I do on my real desktop.

Marshall Brain
Zebulon, NC

continued

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Punish Virus Spreaders

I was disturbed by John Baltzer's letter (April). He seems to suggest that people will stop creating computer viruses if we just pat them on the head and show them what a wonderful world it would be if they would leave our computers alone. Hogwash!

How long will it be before a virus infects a computer system at a hospital, a police department, or a military installation? Will Baltzer be willing to forgive the person responsible for causing a patient to be given the wrong medication? For an innocent person being jailed? For live rounds being used during training exercises? It's bad enough to lose several months' worth of work to a virus that trashes your disks, but to have someone killed by some misanthrope's idea of a little joke is intolerable.

Viruses and other forms of computer tampering are not just a threat to the free flow of information, as Baltzer suggests. They have the potential to inflict enormous harm, and the people who are responsible for them should be subject to criminal prosecution. They are engaging in malicious destruction of property as surely as if they had walked into someone's office and tossed a match into a file cabinet. It's only a matter of time before something much more serious happens as a result of their antics.

I suggest that computer manufacturers, users groups, and magazines like BYTE establish a fund to be used in the vigorous prosecution of anyone responsible for the creation and distribution of malignant code. Furthermore, a portion of this fund should be set aside as a reward to anyone who provides information leading to a conviction in such a case. Education certainly has its place, but deterrence and punishment are necessary for those who refuse to learn.

Paul M. Carlisle
Royal Oak, MI

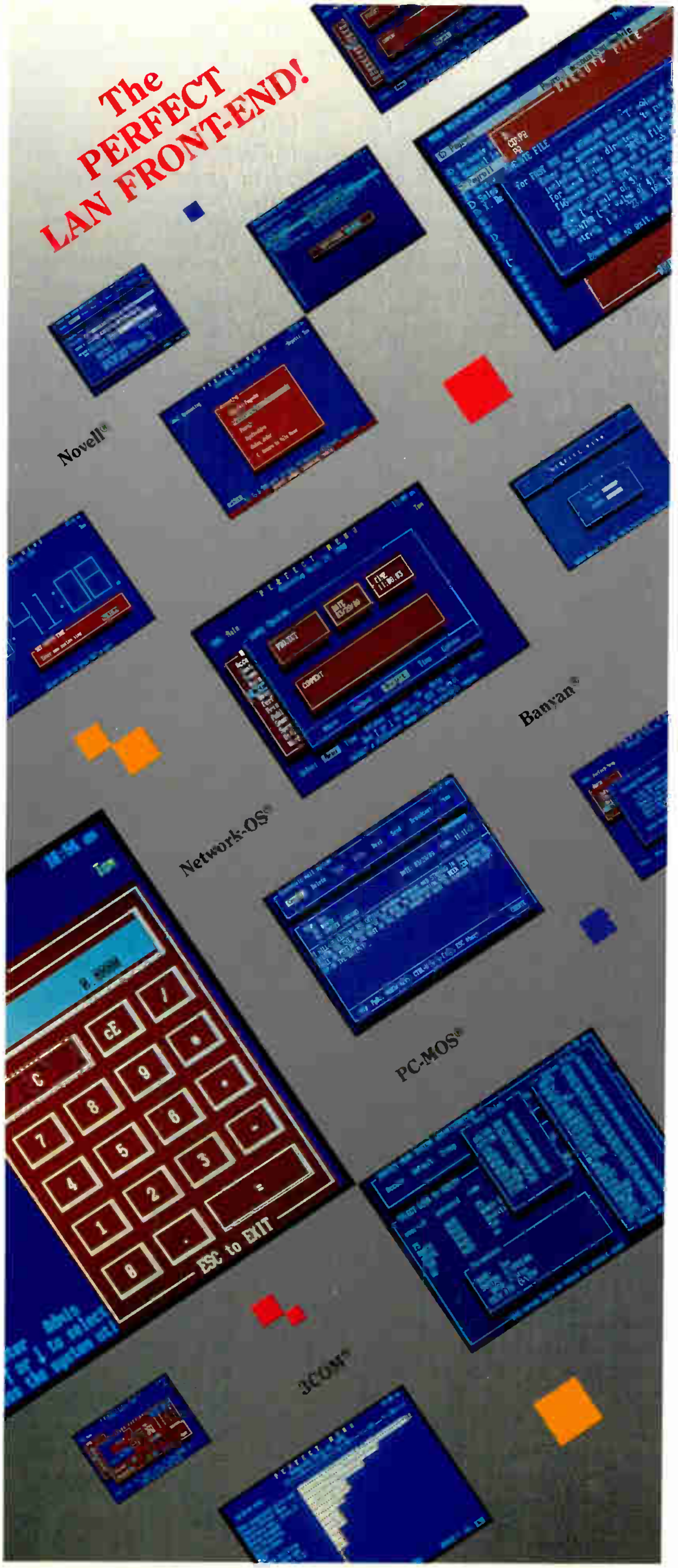
Optimizer Problems

I am writing to bring attention to a problem with versions 5.0 and 5.1 of Microsoft's C Compiler under MS-DOS. The problem appears to be with the optimizer. Consider the following source code:

```
#define items 10

double Ua [items], Va [items],
       Ub [items], Vb [items],
       Su [items], Sv [items],
       Ru [items], Rv [items],
       a;
void calculate(i)
int i;

{
 double temp;

 temp = Ua [i] - Ub [i];
 Ru [i] = temp * temp;

 temp = Va [i] - Vb [i];
 Rv [i] = temp * temp;

 Su [i] = Ru [i] * a;
 Sv [i] = Rv [i] * a;
}
```

When the above code is compiled with the default options of the `cl` command (time optimization on), the resulting code calculates the `Ru [i]` and `Rv [i]` correctly. However, in order to calculate the `Su [i]`, it does not use the value of `Ru [i]` as specified by the program but instead uses the value of `temp * temp`,

continued



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which is incorrect, since the contents of temp have been overwritten during the calculation of Rv [i].

This bug results in numerical errors in the executable code. If all optimization is turned off, the produced code is correct. I wrote a letter to Microsoft about this bug in June 1988. A couple of months later, I received a call from Microsoft's product-support department, saying that the people there were able to reproduce the bug and advising me not to use the optimizer!

Contrary to Microsoft's advice, I keep using the optimizer, but I have stopped using one temporary variable to store different intermediate results, especially results from indexed variables. I just let the optimizer handle the optimizations, and I have no problems, but now I compare the results of the program that have been produced with the optimizer to the results of the same program produced with all the optimizations turned off.

Fotios J. Kehayias
Bohemia, NY

Manzana's Good Enough for Me

Jeff Holtzman's review of advanced floppy disk drive controllers (March) came about a month too late for us, but my wife and I must disagree strongly with some of his findings.

My wife and I have a CompuAdd 80286 IBM AT clone with a hard disk drive and two (1.2-megabyte and 360K-byte) floppy disk drives. Naturally, when I got a PS/2 at the office, it was time to install a third (1.44-megabyte) floppy disk drive in the vacant drive bay to give me convenient work/home compatibility.

We're on a tight budget, so after getting descriptions of the Manzana Mux Card, we decided to cheap out with that card ($99.95 includes the driver software) and a 1.44-megabyte floppy disk drive (Chinon) that CompuAdd sells for $89.

The bottom line to all this is that installation was really no problem. In marked contrast to Holtzman's experience, we found the 1988 version of the Manzana Mux Card manual well written, clear (with pictures of the card and the proper connections), and reasonably easy to follow, even for a non-computer expert like me. We installed the drive and then carefully followed the Mux Card hardware installation procedures. My wife capably handled the software end, and we were up and running in an afternoon. Here, we agree with Holtzman: It has performed flawlessly ever since. We can now read, write, and format both 720K-byte and 1.44-megabyte disks as drive D and can even copy from drive D to drive E. We haven't had any compatibility problems so far with either my office PS/2 or software.

So if your readers with ATs (or XTs) need a cheap but clearly effective solution to the problem of adding a 3½-inch floppy disk drive to a system already loaded with two 5¼-inch floppy disk drives, we highly recommend the Manzana Mux Card and software.

Gene Baizman
Albany, NY

Ideal Keyboard Design

For 13 years, I've been waiting for a computerized keyboard to replace the modified typewriter keyboards of current computers. An ideal computer keyboard would have programmability, several preprogrammed keyboard arrangements, blank keys, and several type-through soft "skins" that contain all the symbols of a particular keyboard. There should be four standard keyboard arrangements preprinted on four separate soft skins: the conventional QWERTY arrangement; the Dvorak keyboard; the Dvorak left-hand keyboard; and the Dvorak right-hand keyboard. The latter two would be for handicapped persons using only one hand. There should also be extra blank skins for personal keyboard arrangements.

I use the Dvorak keyboard arrangement, but, as an author, I want all the keys to be infinitely programmable, so they should be blank. I want to program a blank skin for my own customized keyboard, relocating oft-used keys (e.g., quotation marks, question mark, and exclamation point) under my fingers.

Pharmacists, word processors, accountants, statisticians, engineers, and others could program their own unique keyboards. Changing keyboard arrangements would be as simple as switching soft skins and selecting one of the standard or customized keyboard codes.

The ideal keyboard would be an 8-bit computer with 65K bytes of memory for programming. The four standard keyboards should reside permanently in ROM, and other keyboards could reside in EEPROM. The remaining memory would hold long and involved keystroke sequences, activated by a function key. For some people, especially those who work with graphics, such programming could use all of what remains of the 65K bytes of memory.

The keyboard should be portable and therefore as simple to attach and detach from the computer as a lamp is to line current in a wall jack. On the right and left sides of the keyboard, you could attach—as, when, and if needed—a trackball, a joystick, and a mouse, all by a standard input attachment. All the above is possible and practical, and I think many thousands of persons need such a keyboard now. I hope we'll soon be able to get one.

Edward L. Tottle
Baltimore, MD

Up with UPS

Thank you for the fine editorial coverage afforded ITT PowerSystems in the April BYTE Product Focus, "Curing the Brownout Blues" by Steve Apiki, Stanford Diehl, and Rick Grehan. The article as a whole was extremely impressive. As one outside source said to me yesterday, "When you have a color photo of an oscilloscope screen showing the waveform at the actual moment of cutover—that's in-depth!"

Also, the text box "What Is a UPS?" by Mark Waller is the best explanation I've seen on that subject. I hope you receive many fine compliments on the article.

Charles B. Ballinger
ITT PowerSystems Corp.
Galion, OH

ASK BYTE

Grep This

For the past year, I've been using DOS on my 12-MHz IBM AT with great success. However, since I use Unix at work, I've always had the notion that someday I would get Unix for the AT also. Well, my fascination with DOS has just about run out. It's a reasonable operating system, but I long for multitasking and virtual memory.

I started looking around for a small Unix port—no, I don't want networking; no, I am not rich; no, I have only 1 megabyte of RAM on my machine. The choices seem to be very limited. There is Microport's System V and SCO Xenix, but they are far too memory-hungry and far too expensive (2.5 megabytes for Microport System V, and SCO Xenix costs $1500!).

Isn't there a small Unix kernel out there that will allow the millions of AT owners to use Unix without draining their bank accounts? I've heard of IBM's AIX and a couple of others, but I know nothing about them. My last resort is to

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—MacGuide

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"Philip Welt, group product manager for Microsoft's analysis business unit, conceded that the newest upgrade to Mac Excel is partly the result of competitive pressures coming from Informix. *'Wingz has focused on output and graphics. They've hit us in a place where we haven't moved our product ahead.'*"

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PC Magazine, May 30, 1989

In the May 30th issue PC Magazine reviewed 104 machines from 58 manufacturers. Virtually every '386 in production was tested. The systems were grouped into three speed categories, 16, 20 and 25MHz. In two of the three categories only one company was selected for "overall excellence."

That company is ZEOS International.

We appreciate the recognition. It speaks directly to the goals and objectives of our company. Simply, to deliver to you the very best *value* in computing today. To further quote *PC Magazine:*

"Price is always a consideration. So are benchmark results. But both factors can be deceiving, which is why we consider other aspects that will make the difference months and years down the road. Things like quality of construction, reliability, expandability and ease of service."

We couldn't have said it better. These are the qualities we build into every ZEOS system. That's our commitment. To quality. To performance. To reliability and support. To *Value.* When compared to virtually every other manufacturer in the world *PC Magazine* called it *"overall excellence."*

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Circle 309 on Reader Service Card

buy the source for a small kernel and put virtual memory into it myself.

Paul A. Merrill
New South Wales, Australia

We share the same desire for an affordable Unix for ATs. I make do by using the MKS Toolkit Unix shell and utilities for MS-DOS on my AT. I connect to the Unix minicomputer here at BYTE for doing serious Unix work. Although this does not fulfill my desire for a 10-MIPS workstation on my desk, it does serve the need to keep the working environment familiar from machine to machine. Real Unix requires real resources: memory, processor, licenses, and usually money.

The thought of modifying an operating system to use virtual memory in a dependable way makes me shudder. Don't forget that you have to change the compiler libraries as well as the kernel. However, if you are extending a popular operating system like Minix, the effort will not be a waste of time. Others would love to benefit from your efforts. There's a large community of Minix hackers, but Minix was written primarily for learning operating-system design concepts, and many of the enjoyable features of Unix are missing. Unless you like writing and porting utilities more than you like using them, you should buy a commercial Unix.

Because all real Unix licenses require the developer to license source code from AT&T, they all cost more than $100. The most for the least is probably a Bell Technologies two-user license discounted to about $300. Don't expect much printed documentation, however. (TRC in California, (213) 937-8822, is a source.)

Another excellent way of purchasing Unix is to buy an AT&T 7300 Unix PC. Although the machine is no longer manufactured, support for it continues. I'll grant that the Unix PC is not a high-performance computer, but it is very functional. (Contact Discovery Electronics, 775 Franklin Rd., Suite 100, Marietta, GA 30067, (800) 346-8243.)

Incidentally, the August issue of BYTE will begin a new Unix column by David Fiedler, who has a dragon's lair of public domain programs for Unix. He'll be able to help you keep things inexpensive once you've decided which direction to take.

—B. S.

Temperature-Sensitive

Could you tell me why my three-year-old IBM PC clone doesn't like cold weather? It's a Leading Edge Model D with 640K bytes of RAM, a 20-megabyte Seagate hard disk drive, and a floppy disk drive.

continued

It works fine in warm weather. But when room temperature is below 50°F, this machine cannot be booted. After the power-on self test, it tries to find something from the hard disk with no success. This may be a ROM scan, or perhaps the system's searching for the hidden files. The hard disk light is constantly on. The same thing happens in booting with the floppy disk. But if I turn it off after a few minutes of machine warm-up and boot again, the machine is normally bootable. After that, no problems whatsoever occur for the whole day. Was this machine made for the southern country or something?

Jae K. Lee
Fremont, OH

I don't know whether your disk controller board is one of the hard disk/floppy disk combination boards. If so, my guess is that you have a temperature problem on that board—specifically, a loose solder joint or (heaven help you!) a hairline crack on one of the circuit traces. When your machine is cold, contraction of components causes an open circuit. As the machine warms up and parts expand, the broken connection closes and the machine boots.

Go for the easy fixes first. Try reseating all the circuit boards and data cables. Then try (carefully!) reseating any socketed chips on the hard disk/floppy disk controller board. If those tricks don't cut it, try reseating socketed chips on the system motherboard—again, carefully.

If you're still dead in the water, the next step is to play the continuity game, which may be out of the question if you don't have a logic probe (or at least a volt-ohm-milliammeter). I suggest you locate a trustworthy repair shop or see if anyone in your local PC users group does repair work on the side.—R. G.

Filled to the Gills

I own a 1983 model IBM PC. I recently added a hard disk drive, 384K bytes of memory, and a math coprocessor. I'm out of expansion slots, but I'd like to add even more things. Are there any controller cards that can handle a 30-megabyte hard disk drive and one or more floppy disk drives?

Martin L. Smith
Fairbanks, AK

Plenty of controller cards can handle multiple hard disk drives and floppy disk drives. I suggest that you check the back of BYTE for ads from companies like JDR Microdevices.

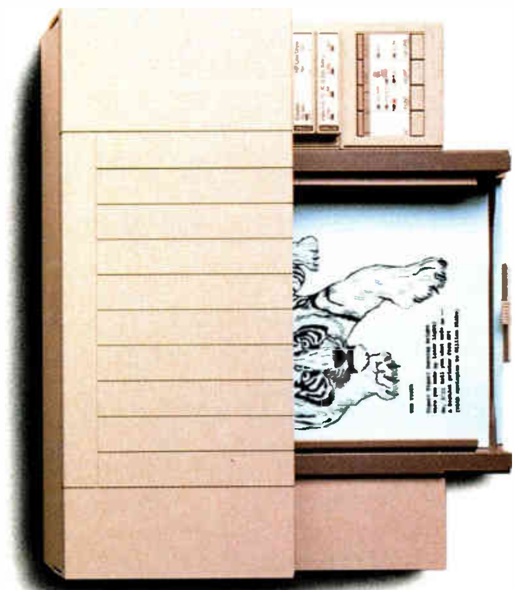
However, if all you're looking at is adding an extra hard disk drive, the board you already have can probably support two hard disk drives as it is. I'm guessing that you're using an ST-506-compatible interface, and most controllers of that variety already have the extra connector for an additional drive. All you need is the proper cabling and an external drive housing. Again, do some mining in the back of BYTE.—R. G.

Senility Sets In

An academic friend of mine has a venerable Kaypro CP/M luggable with a 10-megabyte hard disk drive literally stuffed to the brim with various text files written with a program called Perfect Write. He has never made any backup of this valuable information (he's not what you'd call a power user). I attempted to make a backup for him, but the disk utility somehow got overwritten. All documen-

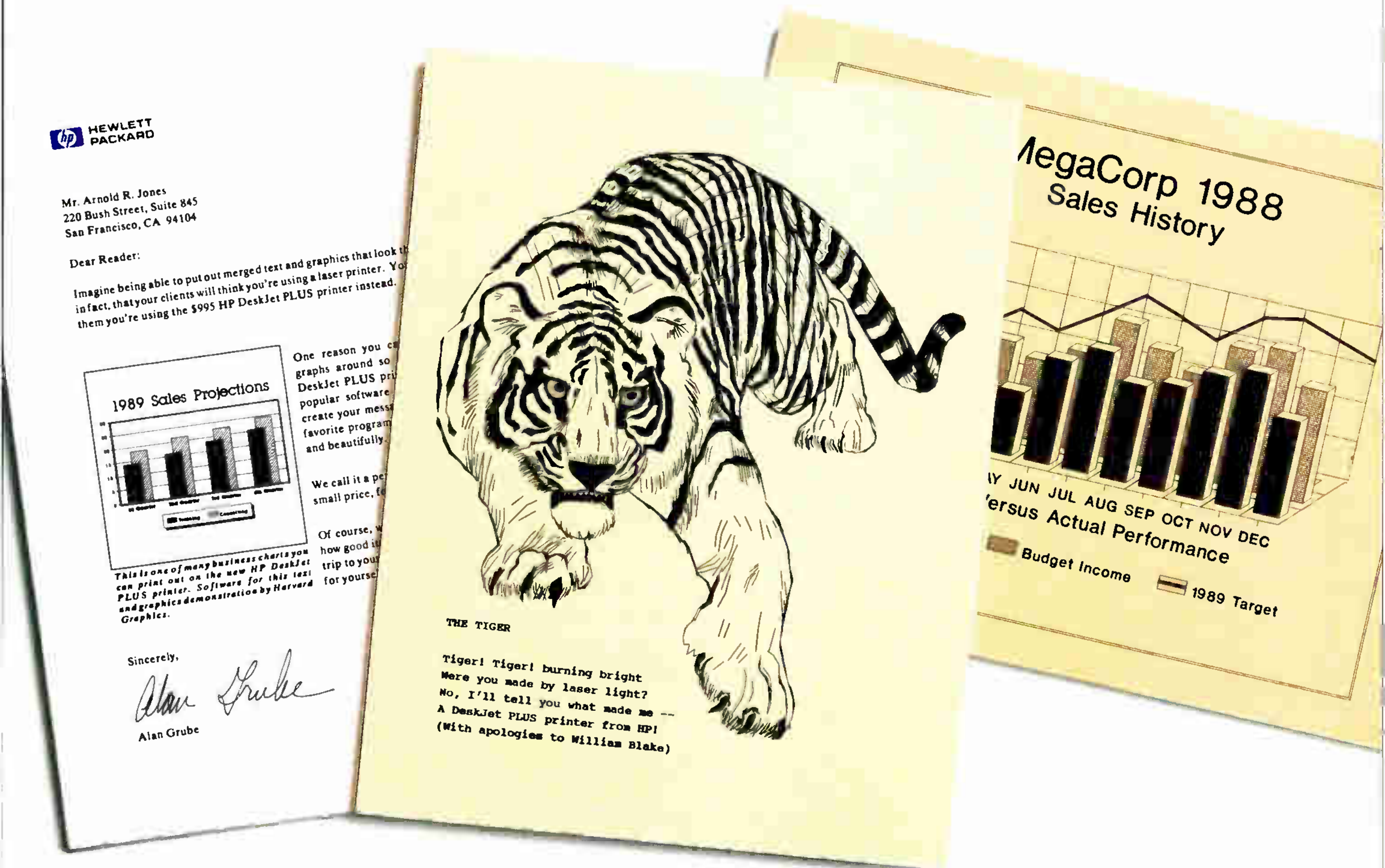
continued

We keep telling people this is not a laser printer.



The new $995 HP DeskJet PLUS Printer.

But they keep looking at the evidence.



You won't believe your eyes (or ears), either. The HP DeskJet PLUS printer gives you the same crisp, black lettering. Clean, sharp graphics. And whisper-quiet operation. But it uses advanced inkjet technology to supply these laser-like qualities for the price of a 24-wire printer.

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HEWLETT PACKARD

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Circle 124 on Reader Service Card

tation and associated floppy disks have long since vanished.

To worsen matters, the machine is getting a little senile. Sometimes it will write to disk, sometimes not. Wild cards seem to exacerbate the glitch. I think that, in order to make a backup, I will have to copy each file to a floppy disk, one by one.

My friend will shortly be purchasing an IBM AT-class laptop with a hard disk drive. My question is this: Do you know of any public domain software that will get his files over to DOS? He'd like to be able to preserve the formatting, if this is possible.

B. J. Lachance
Rochester, NH

The least-expensive way to get files from the Kaypro to the PC is to locate some good public domain communications software packages for each machine and transfer the files via a serial port. This can be somewhat time-consuming, but it gets the job done with a minimal investment in dollars. Check the Public Domain section of the Buyer's Mart at the back of BYTE.

Another possibility that you might look into is Uniform from MicroSolutions (125 South Fourth St., DeKalb, IL 60115, (815) 756-3411). This allows a PC disk to read from and write to disks in virtually all the CP/M formats, and it would certainly be less painful than the serial transfer route.—R. G.

Visual Aid

I am interested in exploring certain Lisp-based AI projects that involve computer "recognition" of objects and people. Inevitably, this involves capturing a frame of video pixels and storing them in memory somewhere so that pattern-recognition techniques can be applied to find out what the camera/computer is "looking at."

Since I already have a Phillips VKR 6850 video camera, it would be nice if I could find some sort of interface card that would permit this camera to feed video information into my PC. Otherwise, I realize that I might have to buy a new camera designed to work with a specific interface card.

Is there an appropriate interface card on the market for this purpose?

David J. Steele
Singapore

Dig out your May through August 1987 issues of BYTE. The Circuit Cellar ImageWise video digitizer may be just what you're looking for. You won't need any expensive interface boards, just a composite output from your camera and an RS-232C port on your computer.

—R. G.

FIXES

- Our March What's New item on FlexiCAD (page 94) listed an incorrect phone number for Amiable Technologies. The correct number is (215) 222-9066.
- The price of a μDACS was incorrectly reported in the May What's New (page 78). The price is $10,000, which includes an XT clone, four four-port transceiver cards ($1495 each), and one switching card ($2495). The XT add-in cards can also be purchased separately. Contact Frederick Engineering, Inc., 10200 Old Columbia Rd., Columbia, MD 21046, (301) 290-9000. ■

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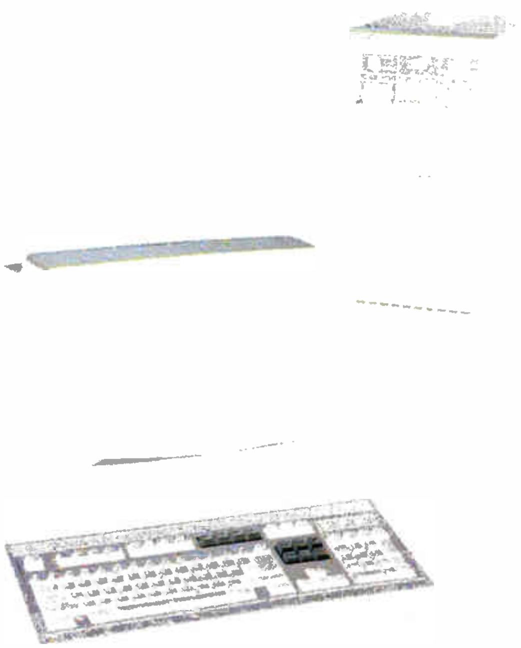

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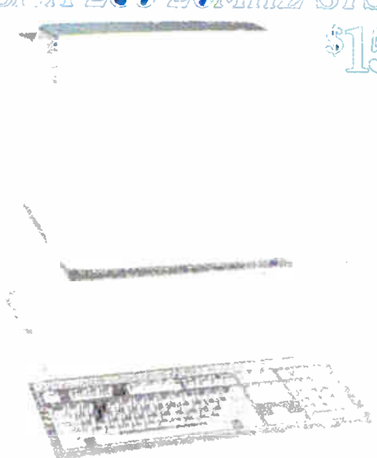

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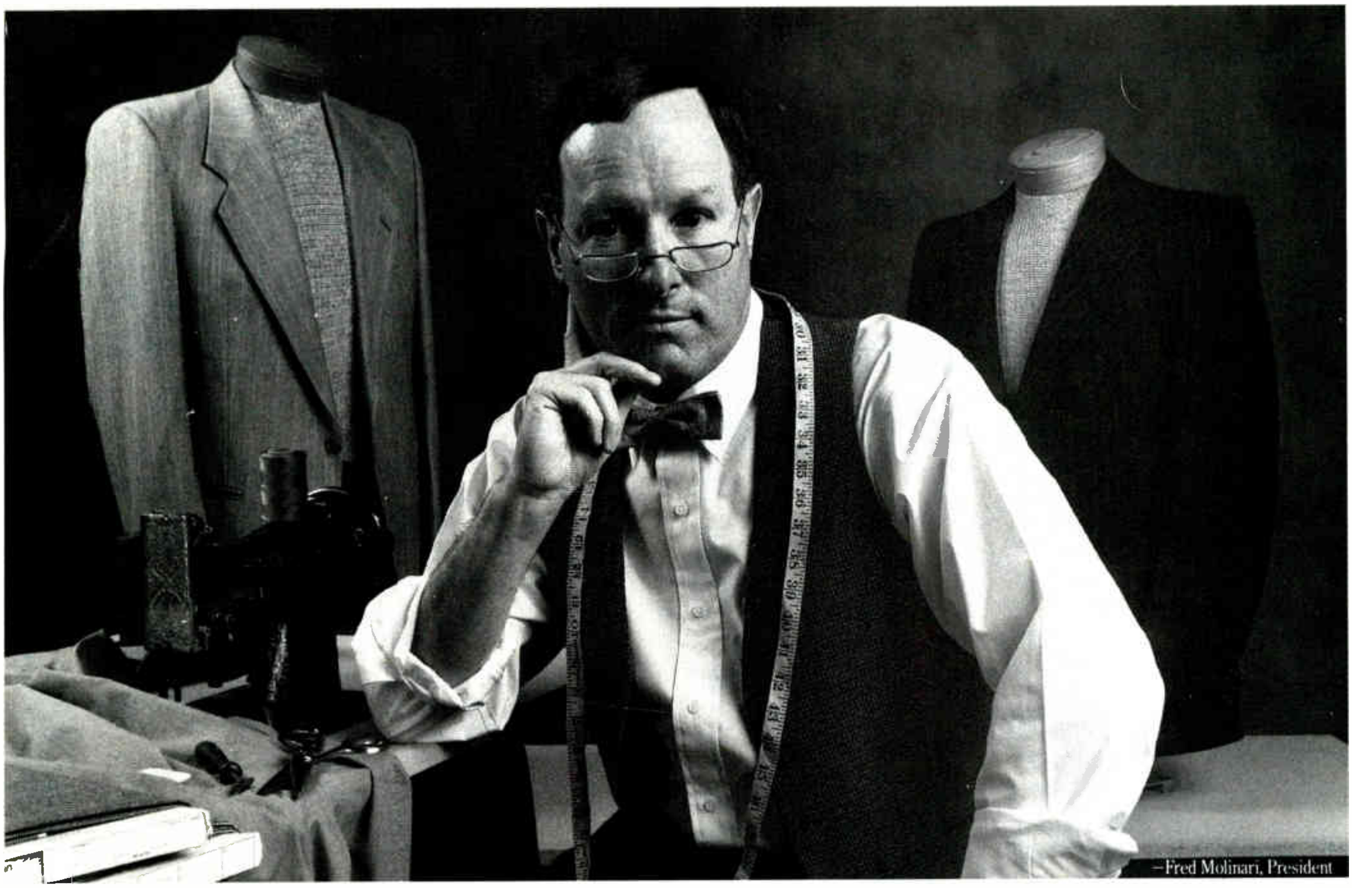

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Circle 82 on Reader Service Card

Chaos Manor Mail

Jerry Pournelle answers questions about his column and related computer topics

Auto Analogy
Dear Jerry,

Your column was a good read, but the analogy was faulty—the Macintosh an automatic and the IBM PC a stick shift ("Stick Shift or Automatic?" October 1988). This analogy subtly favors MS-DOS systems. I don't own a Mac, and I'm quite satisfied with my IBM PC XT clone, so I'm not a Mac nut trying to convert you.

I don't think you appreciate the things that make the Mac so appealing to so many people. For starters, I'd modify your analogy. The Mac is like any car you buy at a dealer. It's a stick shift with some options, but it has a lot of standard features.

The IBM PC, on the other hand, is a car kit that has zillions of options, and you can't even move the thing unless the nice salesperson does a crude assembly. On your way home, you realize that you have to steer by typing in the angle of each turn and accelerate by specifying the proper rate and proportions of gas and air. Needless to say, you immediately stop—not that you were going anywhere—and phone a friend who passes as an expert mechanic. You have to put up with an incessant gush of technical explanations from this person, who hopes that one day you will understand. This friend also leaves you with the impression that you are mentally deficient if you don't learn auto mechanics.

Everything in the IBM has to be installed! Sure, you can buy a steering wheel, but there are so many—you can't just buy one, plug it in, and then go. You have to install it. This means hours, sometimes days, of reading and trying it out. Sometimes it won't even work with the particular model you bought. Then when you finally get a simple system ready and you learn how to make a small trip, you find that you have to go through the misery for every trip because the car works differently for every destination.

Steve Jobs summed up the original Mac philosophy of computers when he said, "Now we know what they use them for." If you want a racing car, build one from scratch or buy a Ferrari—don't buy a Chevette with options. Like a car, the most functional designs are integrated around a known purpose. Windows may seem like the Mac interface, but the most significant difference is that it is an option that will be bypassed or discarded by everyone who thinks he or she has a better way.

The last bastion of IBM's "philosophy" is that the Mac is a mental crutch—if you use one, you'll never learn computing. Engineers see it as a disease and will often not allow one on their premises. Bosses are particularly susceptible to the IBM sales pitch, since many of them believe that employees are half-wits to begin with. "THINK" is hung lovingly on the wall.

André Roussil
Quebec, Montreal, Canada

Well, I'm not sure I agree, but you do have a point.—Jerry

Truth Stranger Than Fiction
Dear Jerry,

Do you remember the good old days when IBM ruled over the whole microcomputer market? Order and peace were everywhere, and users were happy.

Look around you nowadays. What you see is chaos. Why? Because the subjects revolted against Big Blue—their Emperor—and don't agree with its new proposal: PS/2, which, good or bad, must become a de facto standard for everybody, both user and manufacturer, dealing with the Intel 80x86 CPU. Otherwise, we shall all be left orphaned with no more safe landmarks either on the software or the hardware side. (Of course, something of the ancient order is still in place. But just how long will it

continued

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. He can be reached c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "jerryp."

survive? A quarter? A year perhaps. And later on?)

Worse, I heard that the rebels' league is pregnant and will give birth to a child soon. The name of this crossbreed is EISA (Extended Industry Standard Architecture).

I cannot live with this thought in mind, because I'm sure that if division in the microcomputer world starts, it will never end. And it's easy to figure out where that will lead: to a new chaotic era.

So tell me, Jerry, that IBM is going to make use of its dark side of the Force to bring order into the microcomputer galaxy one more time. Tell me that the Empire will strike back again. Tell me all this is not science fiction.

L. Zambotti
Milano, Italy

I fear things will remain chaotic. The Empire will strike back, but the rebels have a lot of strength and power on their side; who knows, we may see the Return of the Jedi, with decentralization and a lot of choices for the user. . . . —Jerry

Q&A Technical Support

Dear Jerry,

I enjoyed "The Revenge of the File Formats" (Computing at Chaos Manor, November 1988), especially when you discussed the file-conversion tribulations and eccentricities of Q&A. I have been doing battle with Q&A technical support over the printing foibles of version 3.0 for six months.

Printing a succession of reports or purchase orders on single sheets in the file mode leads to the same creeping top margin effect you experienced. The so-called workaround is the inclusion of an ASCII formfeed symbol on the last header line in print options. This is easily done with a macro, but printing premodification forms means my data overlaps onto two pages. I also shortened my page length to 61 lines. Shortening all my forms will, of course, destroy data. I plan to redesign my forms and begin the new style on a clean slate soon. Q&A does not truly print three full screen pages of data forms in any case.

I am using the most common of printers, an Epson LQ 1050, so I know that the problem is an omission in the design of the program. I've found some people at Symantec to be very cooperative, but my impression of the company is that there's a lack of internal communication, some confusion in accounts and record keeping, and a black hole when it comes to response from the technical-support people.

It's nice to know there is someone out there who has enough influence to get things moving at Symantec. I hope that a future version of the Q&A database will incorporate all the features of WRITE and repair these small but maddening glitches.

When you get around to testing DESQview, try loading a TSR program in the same window as an application. I've been using Q&A 3.0 with the Microlytics thesaurus, but I can't fit the combination into the available 420K-byte space. The batch-file trick is, of course, moot with a too-small memory segment. Maybe some of the new enhancements (e.g., Phar Lap) for the 80386 will help.

Bill Copenhaven
Richmond, CA

I don't quite understand: I'm writing this with Q&A Write with the Microlytics thesaurus in memory. We have our DESQview jiggered up to give me a 540K-byte maximum window (it takes an 80386 to do that).

Symantec has done several revisions of its print drivers and, I believe, has taken care of all the problems you mentioned; certainly we were able to print with the Kyocera printer set to emulate various others. —Jerry

Furlongs per Fortnight

Dear Jerry,

As an ex-aerospace scientist, I don't remember encountering the whimsical speed unit, furlongs per fortnight (furl/fort), that you mentioned in Computing at Chaos Manor (October 1988). Nevertheless, I couldn't help reaching for my calculator, which came up with a number for the speed of light about a quarter of a million furl/fort lower than yours. Since the difference is a fraction of a part per million (ppm), I suspect you might have inserted an out-of-date value for the velocity of light (c).

Assuming that you applied the international SI Units (SIU) conversion factor of exactly 2.54 for inches to centimeters (and not the U.S.-approved factor of 1/0.3937), I deduced that you used 299,792,500 meters per second (m/s) for the value of c. This is the value given in references (e.g., *Encyclopaedia Britannica*) in tables of physical constants using the 1969 least-squares adjustments: c = 299,792,500 m/s with 0.33 ppm uncertainty.

Knowing that you strive to be in the vanguard, I remind you that the meter (formerly based on the wavelength of krypton 86) was redefined in 1983 as the distance in meters that light travels in a vacuum in 1/299,792,458 of a second. This defines c as 299,792,458 m/s.

With the meter so defined, you must therefore use with the above-noted SIU equivalence (1 inch = 2.54 centimeters (cm), or 1 foot = 0.3048 meter) the value of 299,792,458 for the velocity of light.

The calculation, then, is as follows:

$$\text{m/furl} = 660 \times 0.3048 = 201.168$$

$$\text{s/fort} = 3600 \times 24 \times 14 = 1{,}209{,}600$$

$$\begin{aligned}\text{light speed} &= \text{m/s} \times \text{s/fort} \times \text{furl/m} \\ &= 299{,}792{,}458 \times 1{,}209{,}600 \times 1/201.168 \\ &= 1{,}802{,}617{,}499{,}790 \text{ furl/fort}\end{aligned}$$

The number you gave in your discussion of the Lascaux program displayed the result to a fraction of a trillion furl/fort, viz., 1,802,617,752,326.41. Since the experimental value for c used in the calculation had an accuracy of no more than nine significant digits, the 15 digits of the result are not justified. It should have been truncated to the following: 1,802,617,750,000.

You will observe, however, that the result calculated above is correctly expressed in 13 digits, since no rounded-off numbers entered into the computation.

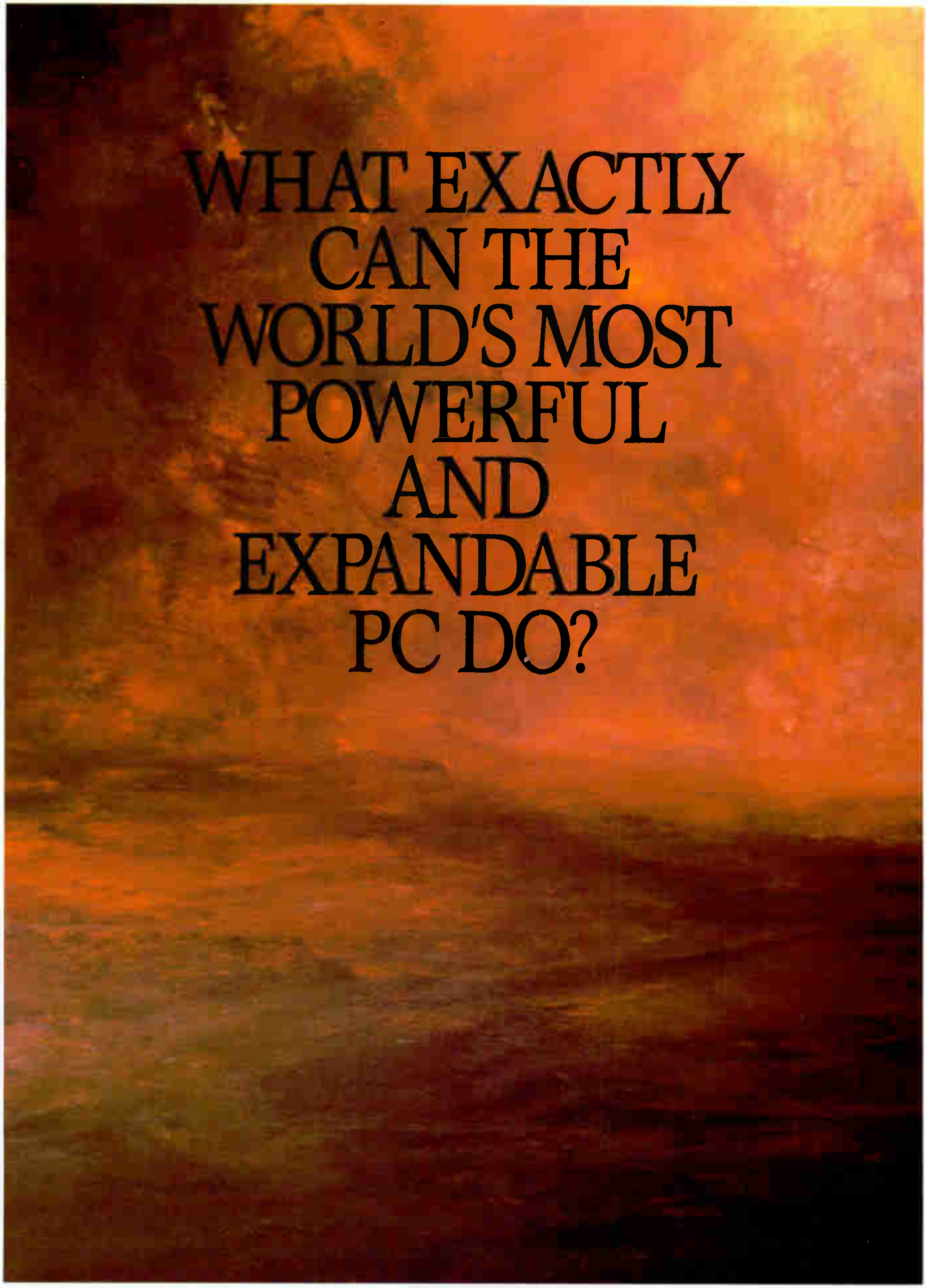
As you know, the U.S. is the only major country that has not adopted the SIU system. The *Wall Street Journal* reported recently that the National Bureau of Standards and the National Oceanographic and Atmospheric Administration recommended that the U.S. stay with its definition of the foot instead of the SI unit. Rather than using 2.54 like the rest of the world, the U.S. uses 1/0.3937= 2.5400508, which differs from the SI unit by about 2 ppm. This is ridiculous, especially since we have already adopted selected SIUs. For example, in 1959 the U.S. abandoned the old definition of the nautical mile (nm) and adopted the international unit, 1 nm = 1852 meters exactly (no longer 6080.2 feet).

William Matheson
Friday Harbor, WA

Well, thank you. Of course, you're right, and I do hope no one experienced navigation errors as a result of my oversight!

—Jerry ■

Editor's note: *We have calculated that c=1,802,617,499,785.254116 furl/fort, rounded off to 19 digits of precision.*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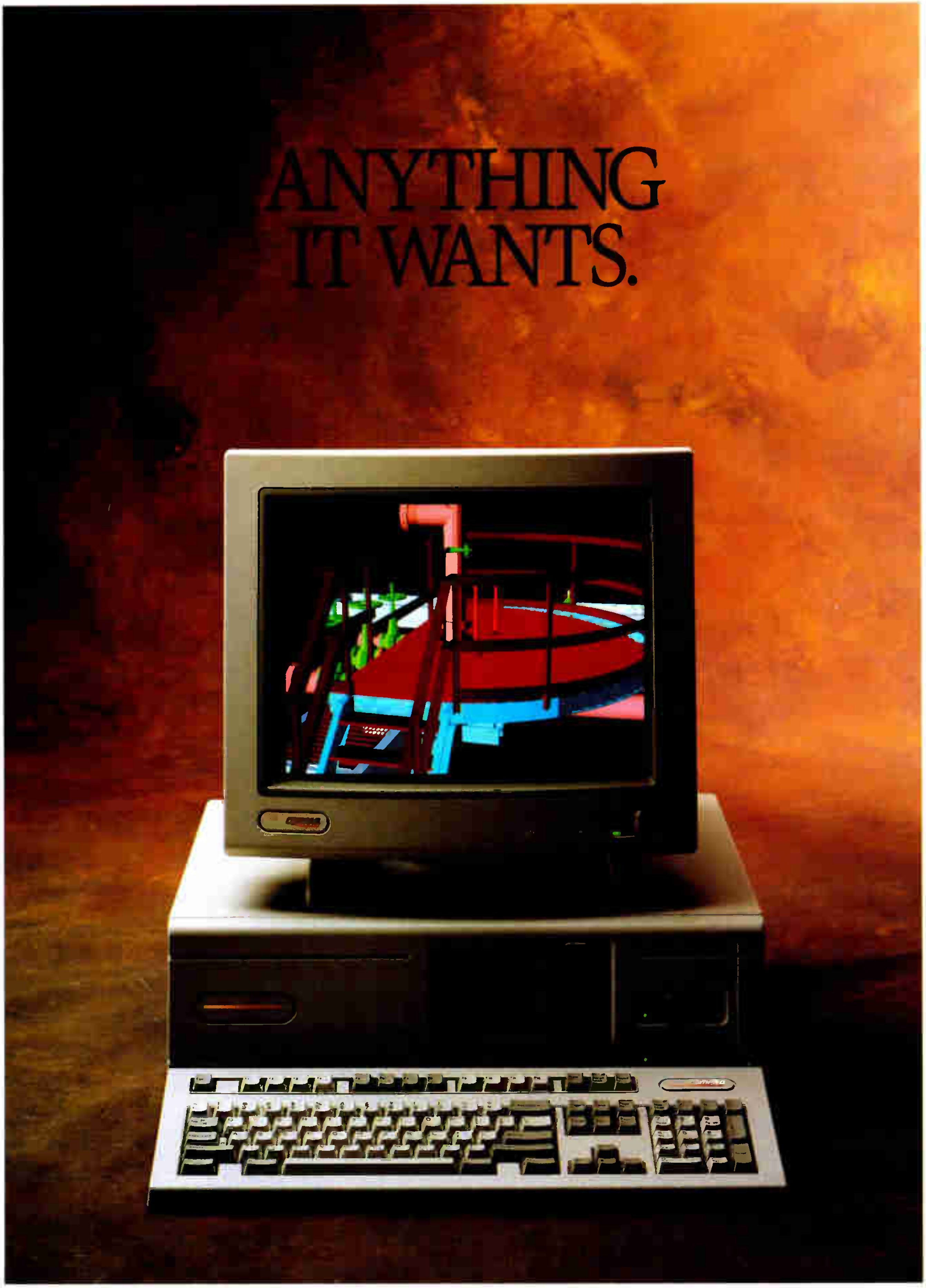
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At the heart of the system is the Intel 386™ microprocessor. Running at a blazing 33 MHz, it works in concert with a series of technological advancements. Like a 33-MHz cache memory controller with 64K of high-speed static RAM. Interleaved memory architecture. And the exclusive COMPAQ Flexible Advanced Systems Architecture.

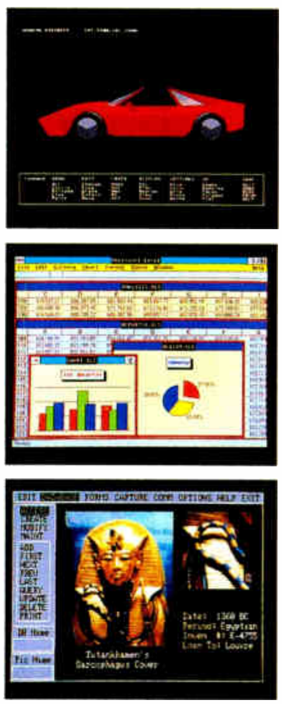
This high-performance combination delivers a 35% performance improvement in CPU-intensive applications over 25-MHz 386 cache-based PC's.

Or said another way, nothing will slow you down. No matter what you want to do.

You can expand the 2 MB of standard RAM up to 16 MB using the high-speed 32-bit slot. That leaves up to *six* industry-standard slots free to customize the system to the demands of the application you're using.

Built-in interfaces make it easy to connect pointing devices, printers, plotters or other peripherals without using an expansion slot.

If your job is particularly demanding, you can use up to five high-performance internal storage devices to hold up to 1.3 *gigabytes* of data. And if that's not enough, bring total system storage to 2.6 gigabytes with the optional COMPAQ Fixed Disk Expansion Unit.



High-speed VGA graphics are built in. And for greater graphics capabilities, add the optional COMPAQ Advanced Graphics 1024 Board.

There's more. You can run MS-DOS®, MS® OS/2, Microsoft® Windows/386 and the XENIX® and UNIX® operating systems. Access memory over 640K under DOS with the COMPAQ Expanded Memory Manager that supports Lotus/Intel®/Microsoft (LIM) 4.0. And speed through calculations with 33-MHz Intel 387™ and Weitek 3167 coprocessor options.

All the new advancements engineered into the COMPAQ DESKPRO 386/33 deliver an unmatched level of power, expandability and storage.

To do anything you want.

COMPAQ

It simply works better.®

IN 386 PERSONAL COMPUTING, YOU'RE LOOKING AT THE MOST WANTED LIST.

In 1986, Compaq introduced the world to personal computers based on the 386 microprocessor.

Since then, we've made it possible for every level of user to work with this powerful technology. In fact, more people work with COMPAQ 386-based PC's than any other 386's worldwide.

Today, Compaq offers the broadest line of these high-performance personal computers. Each delivers significant technological advancements developed by Compaq engineers. Each delivers optimum performance for the needs of different users. And each is built to the highest standards for compatibility and reliability.

For power-hungry users who want 386 performance to go, the COMPAQ PORTABLE 386 Personal Computer does things normally reserved for a desktop 386 PC. Without compromise.

For people considering 286 desktops, the COMPAQ DESKPRO 386s Personal Computer is an affordable way to move up to 386 performance. And if you have a 286 that you've outgrown, the COMPAQ DESKPRO 386/20e Personal Computer is an easy step up to the power and capabilities of a 20-MHz 386 machine.

For the increasing needs of today's 386 users, the COMPAQ DESKPRO 386/25 Personal Computer offers advanced performance. And for those who desire the most power and expandability available in a desktop PC, the COMPAQ DESKPRO 386/33 stands alone.

For a free brochure on COMPAQ 386-based personal computers and the location of your nearest Authorized COMPAQ Computer Dealer, call 1-800-231-0900, Operator 93. In Canada, 1-800-263-5868, Operator 93.

COMPAQ

It simply works better.®

Mission Cyrus's portable PS/2 clone.

U.S. Newcomer Introduces First PS/2 Portable

The Darius ProPortable from Mission Cyrus is the first PS/2-compatible "portable," the company says.

But since it weighs in at a hefty 20 pounds, it's better characterized as in the "transportable" category. Mission Cyrus says the product will be 100 percent compatible with the IBM PS/2 Models 70 and 80. It also includes two Micro Channel slots.

Based on an 80386 processor running at 25 MHz, the ProPortable uses a static RAM cache and has sockets for both 80387 and Weitek math coprocessors. One megabyte of RAM is standard, expandable to 16 megabytes on the motherboard.

Both SCSI and modified frequency modulation hard disk drive controllers are also included, as is a 10-Mbps Ethernet controller. There's even a built-in ink-jet printer that a company spokesperson says is based on Hewlett-Packard's "drop on demand" technology.

The VGA monitor displays a 16-level gray scale, or you can use a standard hookup for an external VGA monitor. Options include 40-, 100-, and 200-megabyte hard disk drives and a 2400-bps internal modem. A built-in tape backup drive is also an option. Mission Cyrus promises fax and cellular options soon.

Price: About $10,000.

Contact: Mission Cyrus Group, 1505 South 192nd St., Seattle, WA 98148, (604) 432-7727.

Inquiry 1129.

One-Pound MS-DOS Laptop Makes Debut

The personal computer has reached a new level of miniaturization, according to Atari. The company now has a QWERTY-keyboard-based, 1-pound, MS-DOS personal computer.

The Portfolio has most of the standard features you've come to expect in a laptop. For transferring files to your full-size system, you can use an optional expansion chassis with serial and parallel ports.

The 4.92-MHz 80C88 microprocessor supports 128K bytes (expandable to 640K bytes) of system memory. For the BIOS and a half-dozen applications, each Portfolio has at least 256K bytes of ROM in a cartridge that's connected to the bottom of the computer through a 64-pin connector.

The keyboard, with tiny calculator-size keys, fits easily into the 8- by 4- by 1-inch chassis, as does the monitor with its resolution of 240 by 64 pixels. The LCD display produces an 8-row by 40-column platform, except in Lotus 1-2-3 mode, when figures are displayed in a 255-row by 127-column platform.

Battery power comes from three AA batteries and is rated at 48 hours of continuous use or four to six weeks of casual use. Bundled applications that run off MS-DOS 2.11 include a basic word processor, a spreadsheet that's Lotus 1-2-3 compatible, an address book, a calendar, and a calculator.

Price: $399.

Contact: Atari Computer, 1196 Borregas Ave., P.O. Box 3427, Sunnyvale, CA 94088, (408) 745-2000.

Inquiry 1127.

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We'd like to consider your product for publication. Send us full information, including its price, ship date, and an address and telephone number where readers can get further information. Send to New Products Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Information contained in these items is based on manufacturers' written statements and/or telephone interviews with BYTE reporters. BYTE has not formally reviewed each product mentioned. These items, along with additional new product announcements, are posted regularly on BIX in the microbytes.sw and microbytes.hw conferences.

Kiss a Portable 80386

There's a new display option in the fast-changing world of portable computers: Kiss Computer has incorporated a flat-panel, DC electroluminescent (EL) screen into a new 20-pound 80386 "tower" portable called the PX386.

The tilting amber screen, which measures only 4 inches high, 9 inches wide, and three-fifths of an inch deep, uses the same amount of power as a backlit LCD, yet it is faster, more rugged, and longer lived, Kiss claims.

The PX386 is available in several configurations. The motherboard supports a 16-, 20-, or 25-MHz CPU, with or without a math coprocessor, and it can include up to 8 megabytes of RAM (2 megabytes is standard).

Mass storage options include hard disk drives ranging from 20 to 383 megabytes and half-height 5¼- or 3½-inch floppy disk drives.

Kiss says the DC EL screen, made by Cherry Electric, is an improvement over older AC EL screens, which were fragile and suffered from flicker and an audible buzz. The new screen offers advantages over LCD as well, Kiss says. It can be read easily from the side and is very fast, with no visible ghosting.

The display has 640- by 200-pixel resolution using the CGA standard. Support for Hercules and VGA is planned for late summer.

Price: Base system, $3995.

Contact: Kiss Computer Corp., 2604 Washington Rd., Kenosha, WI 53140, (800) 438-5477 or (414) 652-5477.

Inquiry 1128.

continued

Kodak's Portable Printer Gets Fortified

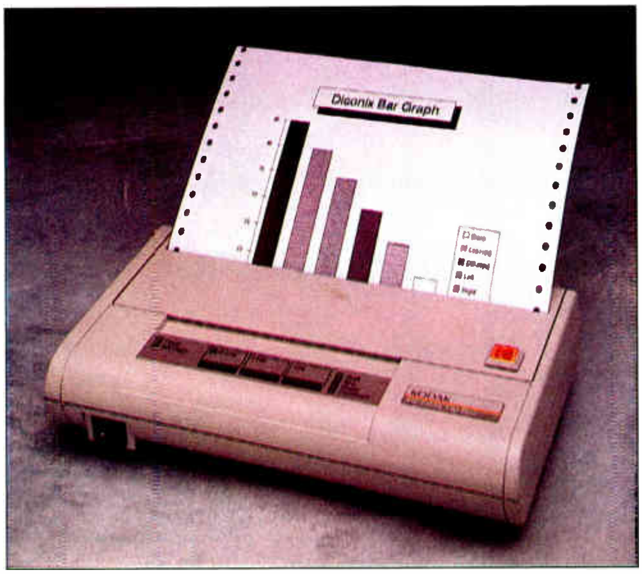
The office-dictionary-size (10⅗ by 6½ by 2 inches) Diconix 150 portable printer, which doesn't exactly tip the scales at just over 3 pounds, now has even more features. The Diconix 150 Plus is a new version with several improvements that make it an even more useful companion for your laptop computer.

First among the improvements is that the Diconix 150 Plus doesn't need special thermal paper anymore. The print mechanism has been changed from thermal to ink-jet, so you can use plain single-sheet or continuous-form paper. The speed has been improved, too. The 150 Plus now prints at 180 cps in draft mode, about 30 percent faster than its predecessor.

The Diconix 150 Plus comes with ink-jet-optimized pica and elite type styles, as well as draft, near-letter-quality, quality, condensed, and superscript/subscript modes. Kodak has also increased international character set support from eight to 14.

The printer is powered with standard C-cell rechargeable batteries, which Kodak claims will print about 150 pages per charge. Another new feature is that you can recharge the printer while it's in use. Software senses when data is being received from the computer, and charging gets temporarily stopped.

The Diconix 150 Plus emulates the IBM Proprinter and the Epson FX series and prints graphics at up to 192 dpi. It's available in both serial and parallel versions.
Price: Parallel, $519; serial, $499.
Contact: Eastman Kodak Company, 343 State St., Rochester, NY 14650, (716) 724-4000.
Inquiry 1132.



The Diconix 150 Plus: a featherweight that doesn't need thermal paper.

A Monstrous Monitor for Desktop Publishing

Tatung's Model MM-1580 monitor screen measures 15 inches diagonally and features a flat, square CRT to eliminate glare and distortion. It has a paper-white phosphor display for gray-scale graphics and a resolution of 1024 by 736 pixels. Its horizontal scanning frequency is 74 kHz, the vertical scanning frequency is 70 Hz, and the maximum bandwidth is 108 MHz.

According to Tatung, you can drive the MM-1580 with any IBM PC-compatible graphics card.
Price: $599.
Contact: Tatung Company of America, Inc., 2850 El Presidio St., Long Beach, CA 90810, (213) 979-7055.
Inquiry 1135.

Add Storage to Your Mac

If your Mac II's hard disk drive isn't up to the capacity you need, Micropolis has a new series of internal hard disk drives that offer a variety of storage options.

The MacPAK (for Macintosh performance advantage kits) are available in capacities ranging from 76 to 668 megabytes. Micropolis claims the 668-megabyte model is the highest-capacity 5¼-inch hard disk drive available for the Mac.

These kits contain the Micropolis SCSI disk drive, cables, mounting hardware, installation/formatting software, and a complete installation manual.
Price: 76-megabyte drive, $1250; 150-megabyte drive, $1795; 340-megabyte drive, $2995; 668-megabyte drive, $4495.
Contact: Micropolis Corp., 21211 Nordhoff St., Chatsworth, CA 91311, (818) 709-3300.
Inquiry 1134.

continued

Low-Cost Page Scanning

The Complete PC has rounded out its product line of microcomputer peripherals with The Complete Page Scanner, which the company claims is the lowest-cost full-fledged page scanner on the market. The unit's image resolution is either 200 or 300 dpi, and it uses a simulated 16-level gray scale with three dithering patterns.

The Complete Page Scanner handles originals up to a full 8½ inches wide and 14 inches long. It comes with a quarter-size add-in card that fits any standard 8-bit slot on an IBM PC or compatible.

SmartScan software, included with the scanner, scales your images from 10 percent to 200 percent of their original size and lets you crop, rotate, scale, and pixel edit. You can also convert images to a wide variety of graphics formats, including PC Paintbrush Plus (.PCX), Microsoft Windows Paint (.MSP), Dr. HALO II and III (.CUT), TIFF (.TIF), GEM (.IMG), and fax.

An optical-character-recognition (OCR) program is also available for use with The Complete Page Scanner. Developed by Computer Aided Technology specifically for the scanner, The Complete PC claims that Complete OCR/Page reads virtually all monospaced, proportionally spaced, and typeset material.

To use The Complete Page Scanner, you need an IBM PC, PS/2, or compatible with at least 512K bytes of RAM, a hard disk drive, a graphics adapter, and MS-DOS 2.1 or higher.
Price: $899; Complete OCR/Page, $495.
Contact: The Complete PC, 521 Cottonwood Dr., Milpitas, CA 95035, (408) 434-0145.
Inquiry 1133.

After centuries of practice, mankind perfects engineering calculations: MathCAD.

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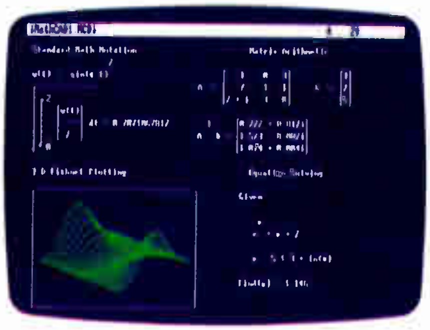

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It has over 120 commonly used functions built right in, for handling equations and formulas, as well as exponentials, differentials, cubic splines, FFTs and matrices.

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But don't take our word for it; just ask the experts. PC Magazine recently described MathCAD as "everything you have ever dreamed of in a mathematical toolbox."

PC MAGAZINE EDITOR'S CHOICE
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**If you purchased MathCAD 2.0 between 5/1/89 and 6/16/89, you can get a FREE upgrade to version 2.5 (otherwise, the upgrade cost is $99.00 until June 30, 1989; afterwards, the cost will be $149.00).*

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Available for IBM® compatibles and Macintosh computers. TM and ® signify manufacturer's trademark or manufacturer's registered trademark respectively. PE

Circle 169 on Reader Service Card

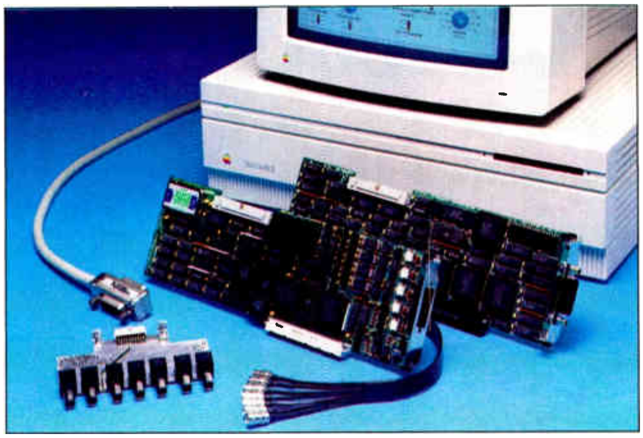
A Speedy Analog Board for the Mac II

For data acquisition applications on the Mac II, National Instruments has a new solution. The NB-A2000 is a high-speed board that uses a precision 12-bit converter and analog input circuitry to monitor multiple channels at up to 1 MHz.

The board uses four independent circuits to simultaneously track and hold multiple analog signals. The NB-A2000 can sample one channel at 1 million samples per second, two channels simultaneously at 500,000 samples per second, or four channels concurrently at 250,000 samples per second.

Once you've acquired your data, you can transfer it directly to Mac II memory or to National Instuments' NB-DMA2800 block-mode direct-memory-access board. The NB-DMA2800 can approach the upper NuBus bandwidth limit of 37.5 megabytes per second.

National Instruments says it has enhanced its LabDriver software to control the NB-A2000. The driver uses high-level software routines that you can call from any programming language that can make Macintosh Device Manager Toolbox calls.



The NB-A2000 Mac II board monitors channels at up to 1 MHz.

Another unique feature of the NB-A2000 is that you can use it to emulate a digital oscilloscope using its built-in digital triggers, pretrigger/posttrigger modes, and programmable AC/DC coupling.
Price: NB-A2000, $2995; LabDriver software, $295; coaxial adapter board, $225; 1-meter coaxial adapter cable, $175.
Contact: National Instruments Corp., 12109 Technology Blvd., Austin, TX 78727, (800) 433-3488 or (512) 794-0100.
Inquiry 1136.

A Disparate Pair of AT Motherboards

While many computer users need or want the speed or power of a state-of-the-art computer system, not everyone wants (or can afford) to start from scratch. For these folks, a motherboard upgrade is a logical choice. Here are two recently introduced cases in point:

DTK has a new 16-MHz 80286-based motherboard with several unique features.

The PTM-1660C puts all major system functions on the motherboard. Besides the usual contingent of AT-clone features, DTK has built a monochrome graphics controller, a floppy disk drive controller, and a 16-bit AT bus header into the motherboard. Also on the board are a PS/2-like mouse port, two serial ports, and a parallel port.

Using Chips & Technologies' NEAT chip set, the PTM-1660C also has on-board support for EMS 4.0. The board supports page-interleave memory and has space for 5 megabytes of on-board RAM (100-ns RAM is required for 16-MHz operation).

The board directly replaces all standard and reduced-size AT motherboards. DTK says the PTM-1660C will be available as a complete computer by the third quarter of this year.
Price: $725 (without memory).
Contact: DTK Computer, Inc., 15711 East Valley Blvd., City of Industry, CA 91744, (818) 333-7533.
Inquiry 1137.

At the other end of the spectrum, the Hauppauge 386 Motherboard/33 will make even the most processor-intensive applications fly.

As its name implies, the 386 Motherboard/33 is built around an 80386 processor running at 33 MHz. But applications don't live on fast processors alone, so the folks at Hauppauge have added a 64K-byte static RAM cache and a full 4 megabytes of 32-bit main memory.

The Hauppauge 386 Motherboard/33 is a direct replacement for any standard AT board. The company claims the board gives you 7-MIPS performance.
Price: $4495.
Contact: Hauppauge Computer Works, Inc., 175 Commerce Dr., Hauppauge, NY 11788, (516) 434-1600.
Inquiry 1138.

continued

Board Upgrades PC to 80386SX

Sota Technology has what it claims is the first available add-in board that upgrades IBM PCs and compatibles to 80386SX-processor power. The company says the Sota 386si board is optimized for use with all 8088- and 8086-based systems, including the IBM PC XT, IBM PS/2 Models 25 and 30, the AT&T PC 6300, and the Compaq Portable and Deskpro.

The board comes standard with an 80386SX running at 16 MHz. There's also 16K bytes of zero-wait-state cache RAM and a socket for an optional 80387SX math coprocessor. It's a half-length add-in card that fits in any standard 8-bit slot.

The 386si also has a standard 16-bit local bus connector to which you can attach Sota's Memory/16i, an optional memory card that supports both extended memory and the EMS 4.0 specification. You'll need this board if you want to run OS/2. There's also a connector on the 386si for the Floppy I/O Plus, a controller that supports up to four floppy disk drives in capacities up to 1.44 megabytes. The Floppy I/O Plus also has both serial and parallel ports.

Sota claims that when you install the 386si in a PS/2 Model 30, the system will run 18.7 times faster than an IBM PC and 2.5 times faster than an AT.
Price: 386si, $645; Memory/16i (with 0K), $295; Floppy I/O Plus, $149.
Contact: Sota Technology, Inc., 559 Weddell Dr., Sunnyvale, CA 94089, (408) 745-1111.
Inquiry 1139.

Programmer's Paradise offers an

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Smalltalk/V 286	200	169
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NEW RELEASES

HALO WINDOW TOOLKIT

New from Media Cybernetics, a windowing system for building sophisticated user interfaces for graphics-based programs. Designed for use with Microsoft C Compiler. Supports extensive list of graphics display devices.

List: $495 Ours: $359

VITAMIN C 3.2

Popular C library for developers seeking an easy way to integrate windows, data entry, menus, and text editing. The new version offers support for EGA and VGA modes, an improved User's Guide and enhancements for context-sensitive help development.

List: $225 Ours: $162

MS OS/2 PRESENTATION MANAGER TOOLKIT

Development Toolkit that includes a collection of graphical tools for Presentation Manager, extensive documentation, more than 3 megabytes of sample code, complete hypertext MS OS/2 Programmer's Reference Library on-line, and two hours of Microsoft OnLine electronic support.

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Norton Guides	100	75
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Bas_Pas (Commercial)	280	242
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MS QuickBASIC 4.5	99	69
MS QuickC 2.0	99	69
MS QuickPASCAL	99	69
MS Sort	195	139
MS Windows	99	69
MS Windows/386	195	130
MS Windows Development Kit	500	319
MS Word 5.0	450	285
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Zortech C Debugger	90	79
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"VM/386 should be considered mandatory software as important as MS-DOS." ... Computer Language 10/88

VM/386, PC Magazine Technical Excellence Award Winner, lets you create "virtual machines," each running its own MS-DOS application so you save valuable time while maximizing the performance of your 386 PC. Time consuming tasks like compiling code and running bulletin boards no longer tie up your PC, because they run simultaneously. VM/386 offers the highest level of data integrity and software compatibility available in a multi-tasking operating environment. Order your copy today!

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Special Price: $199

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NEW VERSION 2.0

F77L-EM/32 is a fast and powerful 32-bit FORTRAN compiler that lets users write and port programs up to 4 Gigabytes on 80386s. EM/32 was the winner of PC Magazine's 1988 Technical Excellence Award for Compilers/Languages. New 2.0 features: Weitek support for faster processing, easier mainframe porting with DO WHILE & END DO statements, and built-in graphics. Other features include: Full 77 Standard, VAX and IBM VS mainframe extensions, fast compilation, excellent diagnostics, and a powerful debugger. Another outstanding product from the FORTRAN experts. (Requires Lahey/AI OS/386.)

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PRO-C

PRO-C is the database applications generator that produces professional quality C source code in a fraction of the time it would take to write the same code by hand. PRO-C features an integrated screen generator, report generator, menu generator, data definition tool, update program generator, and an extensive context-sensitive help utility. Unlike 4GL applications, PRO-C generated applications run at 3GL speed and do not require additional run-time modules. Use PRO-C Workbench to completely customize your applications.

VESTRONIX

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LATTICE C 6.0

Lattice C is back on top and the benchmarks show it!! Due to a new optimizer and many performance improvements in the library, Lattice C 6.0 for DOS and OS/2 is again outperforming its competitors. And Lattice C now includes a full-screen symbolic debugger, CodePRobe, that will enable you to easily debug family mode programs, Presentation Manager applications, and OS/2 multi-thread applications. And it can be used with a mouse.

The already comprehensive library has been expanded to include the curses screen manager, graphics, and communications libraries.

Best of all, Lattice support comes free with Lattice C. Lattice's bulletin board and telephone support are the best in the business.

Lattice C 6.0's new list price is $250.

Lattice

Special Price: $199

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Circle 226 on Reader Service Card

Is It a Mouse or a Trackball?

Kensington Microware, whose Turbo Mouse ADB trackball substitute for the Macintosh rodent has saved many a cramped desktop, now has a version for IBM PS/2s. Even though it's called the Expert Mouse, the relationship is in name only. It's a true trackball that sits quietly next to your PS/2. The Expert Mouse has the same two-button configuration as the IBM and Microsoft mice, and it has what Kensington calls an "ergonomic design" that's arranged for both right-handed and left-handed users.

The Expert Mouse plugs directly into your PS/2's mouse port and uses optical technology that the company claims has virtually eliminated moving parts—except for the trackball itself. Kensington says its rodent is 100 percent compatible with all PC applications designed with a mouse in mind. And for non-mouseable applications, Expert Mouse comes with programmable pop-up menus that let you use the trackball with many popular PC applications.
Price: $169.95.
Contact: Kensington Microware, Ltd., 251 Park Ave. S, New York, NY 10010, (212) 475-5200.
Inquiry 1142.

Portable Power for Laptops

The portability of your laptop doesn't do you much good if your computer's battery is dead or dying and you're nowhere near an AC socket. But if you use your laptop in your car (not when you're driving, of course), PowerTrip might help.

It's a 4¼- by 2¼- by 1¼-inch box that turns your car's 12-VDC power into 115 VAC.

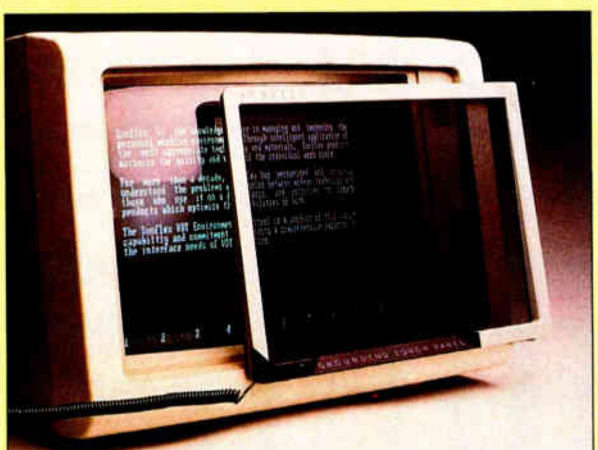
You can plug in your laptop's charger or any other electrical equipment that draws less than 100 W. Zirco claims that PowerTrip's circuitry protects your equipment from the comparatively "dirty" power (low-battery, overloading, and overheating) of automobile electrical systems.
Price: $179.95.
Contact: Zirco, Inc., 10900 West 44th Ave., Wheat Ridge, CO 80033, (303) 421-2013.
Inquiry 1145.

VDT Filter Does It All

The scare stories about the potential adverse health effects of your harmless-looking CRT are enough to make you think more than twice about sitting down in front of that tube. Whether or not you believe the stories about harmful CRT radiation, you have other hassles to deal with: glare, reflection, eyestrain, and overall fatigue.

In an effort to solve many of these problems in one fell swoop, Sunflex offers its VDT Environmental Control (VEC) filter. For glare and reflection control, the VEC filter is constructed from a pattern of matte black microfibers. Sunflex says it minimizes diffused glare and mirror-like reflections while effectively sharpening the CRT's focus, increasing contrast, and eliminating dust buildup on the glass.

Chief among radiation concerns is VLF (very low frequency) emissions, which are blamed for a number of potentially dangerous side effects. Sunflex claims that because the VEC's microfibers are conductive and connected to a common ground point, the VEC filter eliminates up to 99 percent of VLF emissions before they hit your face.



Then there's that pesky buildup of static electricity in dry weather or dry air-conditioned internal climates. While seldom dangerous, it's annoying, and a large-enough static charge can damage computer components. The VEC has a grounding touch panel that discharges static charges to ground. There's even an indicator that lights as your personal static charge gets grounded.

Sunflex says the VEC filter is available in models for most computer monitors.
Price: $69.95.
Contact: Sunflex, 73 Digital Dr., Novato, CA 94949, (800) 321-1659 or (415) 883-1221; in California, (800) 458-3539.
Inquiry 1144.

Gray-Scale VGA for Desktop Publishing

If you want the advantages of a matched gray-scale monitor/graphics card for desktop publishing and the capability to use color-based applications, Relisys has a solution. Its bundled VGA monitor/board system is optimized for serious desktop publishing users.

Dubbed the RA1541X Graphics Subsystem, it includes a half-length add-in card for IBM PCs and compatibles that uses Gemini Technology's application-specific ICs, along with special software drivers for popular desktop publishing packages (like Ventura Publisher and PageMaker). These push the system resolution up to 1280 by 1024 by 4 shades of gray.

Although the board can be used with any analog multifrequency or fixed-frequency monitor, it's optimized for the Relisys 1541 15-inch multiscan, a full-fledged color monitor. But it also features a gray scale for high-resolution monochrome applications.

You can use the Relisys Graphics Subsystem with any IBM PC or compatible that has a free half-length slot. Software drivers are included.
Price: $995.
Contact: Relisys Corp., 320 South Milpitas Blvd., Milpitas, CA 95035, (408) 945-9000.
Inquiry 1143.

continued

Use Epson Printers with Your Mac

Epson America's LQ printer software is a package of two floppy disks and a cable that lets you connect your Macintosh to Epson 24-pin LQ-series printers. The package works with the Mac Plus, SE, II, and IIx, and it connects with the LQ-500, LQ-800, LQ-850, LQ-950, LQ-1000, LQ-1050, LQ-2500, and LQ-2550. (The LQ-500 requires a serial interface board.)

With the software, you can access up to eight resident fonts and up to four bit-mapped fonts, depending on the LQ model you're using. Graphics resolution is up to 360 by 180 dpi. Epson says the printer software is compatible with most Mac applications, including WordPerfect, Microsoft Excel, Aldus PageMaker, and HyperCard.

The printer software will work with minimally equipped Macs, but for maximum system performance, Epson recommends a minimum of 2 megabytes of RAM, a hard disk drive, and an 800K-byte floppy disk drive. If you have an LQ-850, LQ-950, LQ-1050, or LQ-2550, the printer software will let you use those printers' built-in SmartPark paper handling, as well as their landscape and envelope printing capabilities.

Besides a custom cable for mating your Mac and LQ, the LQ printer software includes a chooser, installer, fine-tuned bit-mapped fonts, and a spool adjustment disk. The whole package takes about 1.6 megabytes of disk space.
Price: $69; serial interface board for LQ-500, $59.
Contact: Epson America, Inc., 23530 Hawthorne Blvd., Torrance, CA 90505, (213) 539-9140.
Inquiry 1147.

With Epson's LQ printer software, your Mac can print to your Epson 24-pin LQ series printer.

Co/Session Gets an Upgrade

Version 4.0 of Co/Session, Triton Technologies' remote-access software package, has several major enhancements, according to the company. They're designed to make it easier and more efficient to take control of remote personal computers over the telephone lines.

Co/Session now has several user-interface options. The new menu system lets you use function keys, arrow keys, or even single letters to call up program features. There's also a command-line-only version for experienced users. The result, according to Triton, is that you need fewer keystrokes to control the program.

Another improvement in Co/Session is that the installation process has been enhanced, with no changes needed to your AUTOEXEC.BAT or CONFIG.SYS files. You can also enter additional user information on serial ports, modem types and speeds, and phone information for remote systems.

Co/Session 4.0 now supports EGA and VGA graphics (in addition to text and CGA). It has what Triton claims are the fastest screen updates in the remote-access software category. The program uses a "global" approach that updates only screen areas that have changed.

Also new is a proprietary sliding-window error-correcting file transfer protocol. Triton says it's a full-duplex protocol that's similar to SDLC and X.25.

Co/Session 4.0 is made up of two programs: Support and Application. Support is installed on the remote computer and requires 125K bytes of RAM. Application is installed on the local computer that's used to access the remote system. It requires 51K bytes of RAM. Both programs run on the IBM PC, PS/2s, and compatibles and require DOS 2.0 or higher.
Price: Support, $175; Application, $125; bundled, $249; upgrade for registered owners, $50.
Contact: Triton Technologies, Inc., 200 Middlesex Essex Turnpike, Iselin, NJ 08830, (201) 855-9440.
Inquiry 1151.

continued

Hyper Comm Package Covers DOS and OS/2

Hilgraeve has introduced the HyperACCESS/5 communications program. Designed for Presentation Manager under OS/2, it also ships in a character-based configuration for the MS-DOS world.

According to the company, HyperACCESS/5 is the first full-featured communications program that takes full advantage of OS/2's multitasking capabilities. Running in protected mode under PM, the program supports multiple concurrent communication sessions, true background operation, child processes (to the HyperACCESS/5 parent process), and detached operation.

It's compatible with four different manufacturers' digital telephones for support of the multiple, simultaneous sessions afforded by ISDN telecommunications. Hilgraeve says HyperACCESS/5 was designed for ISDN in particular and allows your computers serial access to digital telecommunications (versus access to analog telecommunications through modems) with these telephones.

While supporting all standard file transfer protocols, HyperACCESS/5 also has its own proprietary method. HyperProtocol uses on-the-fly adaptive compression that Hilgraeve claims gives effective throughput that's up to five times the line speed.

The package has its own script language and uses a unique user interface with sliding windows that let you "point and fire" to make your selections.

HyperACCESS/5 runs on any IBM PC, PS/2, or compatible and uses 350K bytes of RAM. You'll also need either OS/2 1.0 or higher or DOS 2.0 or higher. Both 5¼- and 3½-inch floppy disks are included.
Price: $199.
Contact: Hilgraeve, Genesis Centre, 111 Conant Ave., Suite A, Monroe, MI 48161, (800) 826-2760 or (313) 243-0576.
Inquiry 1149.

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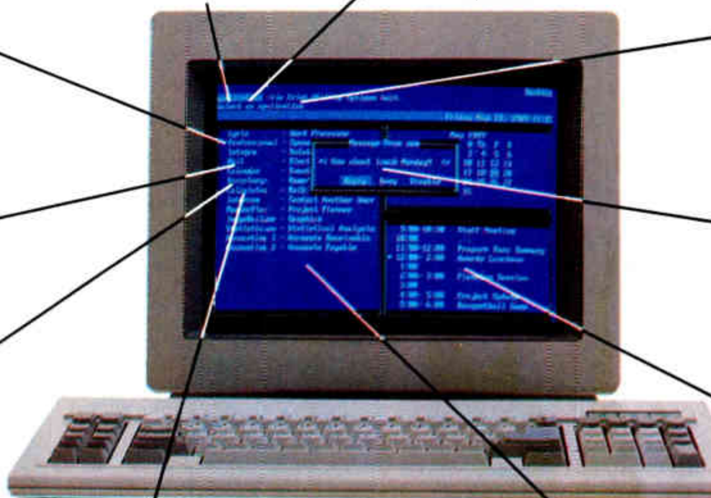

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Circle 250 on Reader Service Card

LANstation Brings You (Desk) Space

For reasons of security, management control, and price, diskless workstations are increasingly popular in many LAN installations. Some are also popular for their small footprint.

Having redesigned the case and removed the bulky CRT, Emerald Computers says its diskless AT-compatible LANstation I is now as small as, or smaller than, the rest.

The LANstation I uses an electroluminescent flat-screen display that is 95 percent smaller than a CRT. The EL display is EGA-compatible, displaying monochrome graphics in resolutions of up to 640 by 350 pixels. It also doesn't generate heat or emit radiation like a CRT.

With the elimination of a fan and the space needed for disk drives, the entire LANstation I measures just 14½ by 5¾ by 9¾ inches. It weighs 9 pounds. Each unit comes with 2 megabytes of RAM, a single full-length 16-bit expansion slot, plus two serial ports and a parallel port. There's also a front-panel slot for a ROM card option that lets you add special functions or custom programs to your LANstation.

In keeping with the compact design of the LANstation, its keyboard is also reduced in size. With 85 full-size keys, it measures 14½ inches wide. The LANstation I comes with 80286 clock speeds of 8, 10, 12, or 16 MHz.
Price: $2195 to $2495.
Contact: Emerald Computers, Inc., 7324 Southwest Durham Rd., Portland, OR 97224, (800) 321-5711 or (503) 620-6094.
Inquiry 1152.

Save desk space with the LANstation I, a diskless networking system.

A Security Man for Your UPS

Uninterruptible power supplies can be lifesavers for critical computer systems, especially LANs. Para Systems' Network Manager software works with its Minuteman UPSes.

When power fails, Network Manager works with the UPS to perform an orderly shutdown of the system. Para Systems says Network Manager distinguishes between brief interruptions and hard power failures. If power is restored within 10 seconds, the power shutdown sequence doesn't start.

Network Manager works with the IBM PC or compatibles running SCO Xenix 2.2.3 or Novell 2.1 or higher. In Novell networks, you set the Interrupt Filter delay during installation. In SCO Xenix, you can set the delay at any time.
Price: Network Manager, $199; Minuteman 1000 UPS, $2249.
Contact: Para Systems, Inc., 1455 LeMay Dr., Carrollton, TX 75007, (800) 238-7272.
Inquiry 1148.

Low-Cost Board Adds Micro Channel Serial Quartet

Adding extra serial ports to Micro Channel–equipped versions of the IBM PS/2s can be an expensive proposition. But NeoTech has come to the rescue of those without bottomless wallets with the low-cost CM/4 multichannel serial board.

The IBM-registered card adds four standard RS-232C serial slots to your PS/2 and takes up just a single slot in your computer. Since all serial connections are via standard 25-pin connectors (cabled from the rear of the card), there's no need to fool with 9-pin adapters.

All serial ports on the card have the full complement of handshaking lines on every channel to support all standard serial devices. NeoTech says you can use the CM/4 with Xenix, Unix, and OS/2.
Price: $395.
Contact: NeoTech, Inc., 30295 Solon Industrial Pkwy., Solon, OH 44139, (800) 552-1552 or (216) 248-4114.
Inquiry 1154.

continued

LAN Uses Expanded Memory

Although Invisible Software's newest LAN product is called the Invisible Network, it's a very visible line of three different LAN boards for the IBM PC and the Micro Channel bus. Using dual twisted-pair wiring, the system transfers data at up to 3 Mbps.

Invisible Software claims that the Invisible Network is the only LAN that supports expanded memory. On systems equipped with EMS 4.0, your DOS memory overhead can be as little as 3K bytes for a workstation and 13K bytes for a server. This can leave you up to 630K bytes of free DOS memory while you're running the network. (Without expanded memory, the overhead is 60K bytes for a workstation and 80K bytes for the server.)

The Invisible Network comes with the company's NET/30 Network Operating System. It includes facilities for file sharing, print spooling, E-mail, security, and an on-line help system. The Invisible Network is also compatible with NetBIOS, the IBM PC LAN, and Novell NetWare.

Three boards are available: The Model 200 is a low-cost board that transfers data at 1.8 Mbps; the Model 300 increases that speed to 3.0 Mbps; and the Model 200/A is a 1.8-Mbps Micro Channel board.
Price: Model 200, $215; Model 300, $315; Model 200/A, $399.
Contact: Invisible Software, Inc., 1165 Chess Dr., Suite D, Foster City, CA 94404, (415) 570-5967.
Inquiry 1153.

IN ALL FAIRNESS, YOU SHOULD READ WHAT ASHTON-TATE® IS SAYING BEFORE YOU PURCHASE ORACLE.

Ashton-Tate Fights SQL Bugs

Same Query Run Twice Can Result in Different Replies

Ashton-Tate last week acknowledged that the Structured Query Language (SQL) portion of dBASE IV can produce inconsistencies and inaccurate results.

The crux of the SQL problems lies with three anomalies that occur when data is structured in a specific way, according to Knox Richardson, a spokesman for the Torrance, Calif., firm. As a result, the same query run two different times can result in two different replies, for example, or a query can retrieve incomplete information from the database. (See Chart, Page 8.)

Ashton-Tate does not plan to issue a diskette to fix the problem; it is, however, offering work-around solutions to users through its support lines and bulletin board, and on CompuServe, Richardson said.

Though Ashton-Tate is characterizing dBASE IV's SQL problems as "minor" and confined to specific circumstances, database experts claim their impact is more serious.

"The SQL in dBASE IV is unstable, unreliable and unpredictable," said Richard Finkelstein, president of Performance Computing Inc., a database consulting firm in Chicago.

"I don't see how anyone can use it," he added. "They'd have to know the answer to the SQL query ahead of time."

Surprisingly, the majority of dBASE users were unfazed by dBASE IV's SQL glitches.

"The drawbacks in SQL are an

See DBASE Page 8

PC Week, January 9, 1989

Oracle developed the first commercial SQL database over 10 years ago.

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AppMaker Eases Mac Interface Programming

AppMaker, an application generator for the Macintosh, lets programmers and nonprogrammers shorten development time by generating source code for creating or changing menus, windows, dialog boxes, and alerts in the application interface.

With AppMaker, you point and click or type to arrange the user-interface elements on-screen; the program then generates source code in Pascal or C.

With AppMaker, you can concentrate on your application's unique features instead of programming the standard user-interface elements. Nonprogrammers can also use the program to create a prototype of the application and then turn the rest of the application over to a programmer. Bowers Development also reports that programmers unfamiliar with the Macintosh environment can use AppMaker as a study tool.

To compile and link the C or Pascal source code that AppMaker generates, you need MPW or Think. AppMaker works on all Macs with System 5.0 or higher (6.02 on the Mac II), Bowers reports. It uses 400K bytes of memory and is MultiFinder-compatible.
Price: $295.
Contact: Bowers Development Corp., P.O. Box 9, Lincoln Center, MA 01773, (617) 259-8428.
Inquiry 1107.

Expert-System Tree

A non-rules-based expert-system tool that uses multipath decision trees capable of handling 100,000 rules per application was announced by CAM software. LogicTree was designed for classification, decision making, logic and software documentation, and diagnostics applications.

During development, you enter your logic to a decision tree without having to enter code as you would in a standard AI language.

LogicTree runs on IBM PCs with 640K bytes of RAM, a hard disk drive, and DOS 2.0 or higher.
Price: $495.
Contact: CAM Software, Inc., Westpark Building, Suite 208, 750 North 200 West, Provo, UT 84601, (801) 373-4080.
Inquiry 1108.

The Programmable Editor

Infinitor lets you emulate any other editor and actually change the way the editor works to suit your needs, according to Agranat Systems. The program is an ASCII file editor and text-processing utility.

Included with the program is TPL (for Text Processing Language). You can run or compile TPL programs while editing a file without leaving Infinitor. TPL programs can retrieve text from a file, manipulate it, and add new text. They can also generate code, act as code utilities, and serve as on-line references. The program comes with 17 TPL programs.

Infinitor also includes a windowing system called Nimble Windows, which lets you edit 10 files at once, each with its own window.

To run Infinitor, you need an IBM PC with 384K bytes of RAM and DOS 2.0 or higher.
Price: $150.
Contact: Agranat Systems, P.O. Box 4415, Brockton, MA 02401, (800) 526-5368.
Inquiry 1110.

Generating C for PM

Winpro/PM 2.1 is a Presentation Manager application prototyping tool for use with the Microsoft OS/2 Software Development Kit 1.06.

The program enables you to create C source code from a standard PM resource definition file. The C code supports menu bar items, pull-down menus, dialog boxes, and accelerator keys. You can also compile the code with Microsoft's C 5.1 to create an executable PM application prototype.

Winpro/PM 2.1 runs on any IBM PC or compatible running Microsoft OS/2 Software Development Kit 1.06.
Price: $350.
Contact: Xian Corp., 625 North Monroe St., Ridgewood, NJ 07450, (201) 447-3270.
Inquiry 1109.

dBASE Compiler for Interactive 386/IX Unix

WordTech Systems' Quicksilver for Unix lets you compile your dBASE III Plus applications as stand-alone .EXE files to run under Interactive's 386/IX. Quicksilver for Unix is compatible with dBASE III Plus and WordTech's dBASE III Plus interpreter, dBXL. The compiler supports automatic record and file locking and will allow any multiuser dBASE application written for DOS LANs to execute on Unix, WordTech reports.

The compiler requires version 1.0.6 of 386/IX or higher. Each stand-alone application running in Unix will require 512K bytes of memory plus 256K bytes per person, the company reports.
Price: $1399.
Contact: WordTech Systems, Inc., P.O. Box 1747, Orinda, CA 94563, (415) 254-0900.
Inquiry 1106.

Dis.Doc Upgraded

The Dis.Doc interactive disassembler and patcher from RJ Swantek is now available in version 3.0.

The program cuts programming time by immediately making and displaying changes you make to a disassembled listing.

With version 3.0, you can load files through the command line. Other enhancements include the ability to edit segments and data types, an improved outline format, and uppercase and lowercase features.

Dis.Doc 3.0 runs on the IBM PC with DOS 2.0 or higher and at least 384K bytes of RAM.
Price: $125.
Contact: RJ Swantek, P.O. Box 1032, Hartford, CT 06111 (203) 953-0236.
Inquiry 950.

continued

QNX vs. OS/2 UNIX

QNX®: Bend it, shape it, any way you want it.

ARCHITECTURE If the micro world were not so varied, QNX would not be so successful. After all, it is the operating system which enhances or limits the potential capabilities of applications. QNX owes its success (over 75,000 systems sold since 1982) to the tremendous power and flexibility provided by its modular architecture.

Based on message-passing, QNX is radically more innovative than UNIX or OS/2. Written by a small team of dedicated designers, it provides a fully integrated multi-user, multi-tasking, networked operating system in a lean 148K. By comparison, both OS/2 and UNIX, written by many hands, are huge and cumbersome. Both are examples of a monolithic operating system design fashionable over 20 years ago.

MULTI-USER OS/2 is multi-tasking but NOT multi-user. For OS/2, this inherent deficiency is a serious handicap for terminal and remote access. QNX is both multi-tasking AND multi-user, allowing up to 32 terminals and modems to connect to any computer.

INTEGRATED NETWORKING Neither UNIX nor OS/2 can provide integrated networking. With truly distributed processing and resource sharing, QNX makes all resources (processors, disks, printers and modems anywhere on the network) available to any user. Systems may be single computers, or, by simply adding micros without changes to user software, they can grow to large transparent multiprocessor environments. QNX is the mainframe you build micro by micro.

PC's, AT's and PS/2's OS/2 and UNIX severely restrict hardware that can be used: you must replace all your PC's with AT's. In contrast, QNX runs superbly on PC's and literally soars on AT's and PS/2's. You can run your unmodified QNX applications on any mix of machines, either standalone or in a QNX local area network, in real mode on PC's or in protected mode on AT's. Only QNX lets you run multi-user/multitasking with networking on all classes of machines.

REAL TIME QNX real-time performance leaves both OS/2 and UNIX wallowing at the gate. In fact, QNX is in use at thousands of real-time sites, right now.

DOS SUPPORT QNX allows you to run one PC-DOS application at each computer on a QNX network. With OS/2, 128K of the DOS memory is consumed to enable this facility. Within QNX protected mode, a full 640K can be used for PC-DOS.

ANY WAY YOU WANT IT QNX has the power and flexibility you need. Call for details and a demo disk.

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Multi-Tasking	64 (150) tasks per PC (AT).	**Flexibility**	Single PC, networked PC's, single PC with terminals, networked PC's with terminals. No central servers. Full sharing of disks, devices and CPU's.
Networking	2.5 Megabit token passing. 255 PC's and/or AT's per network. 10,000 tasks per network. Thousands of users per network.		
Real Time	4,250 task switches/sec (AT).	**PC-DOS**	PC-DOS runs as a QNX task.
Message Passing	Fast intertask communication between tasks on any machine.	**Cost**	From US $450. Runtime pricing available.

QNX

For further information or a free demonstration diskette, please telephone (613) 591-0931.

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BIX CALENDAR JULY

Display this month's BIX activities

J U L Y

SUNDAY, 7/2, 9 PM EST. "Computer Babel: Which language is best for your project?"
Which programming language should you use for which project? Why shouldn't you use one language for all projects? The BIX Language Group conference moderators are joined by some of BIX's best programming experts as they try to define language needs. (join the CBix topic of the Other.lang conference)

THURSDAY, 7/6, 8:30–9:30 PM EST. "Just what is Ada, anyway?"
Randy Brukardt and Dan Stock of R.R. Software discuss the Ada language, why it isn't "just another programming language," and the difficulties of using it in distributed processing. (join the CBix topic of the Janus.ada conference)

WEDNESDAY, 7/12, 9–11 PM EST. "Emerging trends in the microcomputer industry"
Join BYTE Editor in Chief Fred Langa and BYTE columnist Wayne Rash, Jr. in a discussion of the future of this industry. (join main CBix area, Band A, Channel 1)

All-Month Conference

"Getting Ready for the Boston MacWorld Expo: What to look for in upcoming products" is the theme of the month in the Macintosh Exchange. In addition, Macsbug 6.1 will be this month's focus utility. It has been changed dramatically since version 6.0, so there's a lot to talk about—including user-extensible-D commands that can let the debugger carry out preset commands or code.

Uploads/Downloads

One of the major features of BIX is its Listings areas—the place to find and share program code for your computer. Here's a small sampling of some of the newest files.

Amiga Listings Area

colorlab.arc—A program for studying the Amiga's color capabilities. You can look at all the colors of the Amiga computer by clicking into gadgets or by sliding the R,G,B proportional gadgets.

jrcomm93.zoo—A terminal program that supports ANSI graphics, and XMODEM, YMODEM, and ZMODEM protocols. Other features include macros, scripts, an intelligent dialer and telephone book manager, and a review buffer.

mandvrm.arc—A Mandelbrot generator kit.

IBM AT Listings Area

diskflag.zip—A utility that checks your disk for free space.

egaedit.arc—An EGA font editor that lets you create custom EGA character fonts, such as special or multilingual character sets. Features include pixel-by-pixel editing of all 256 characters in the EGA character set and such editing features as invert, flip backwards, and flip upside-down. Fonts can be loaded and saved.

rom2ram.zip—A utility that moves your EGA's ROM BIOS into extended memory, which increases speed.

IBM PC Listings Area

alias421.com—Alias is a resident program that provides command aliasing, parameter recall, and command completion.

inflat.exe—An inflation calculator that helps you watch your money's value erode.

MS-DOS Listings Area

tsarc.exe—The TimeStar time-management system includes schedules for recurring activities, archives completed tasks, shows your week at a glance, pops up calendars and alarms, and includes a text and graphics database manager with an auto-dialer. Shareware; requires Microsoft Windows.

Macintosh Listings Area

address17.sit—Address Book 1.7, an address and phone book application. Described by the uploader as "the best I have seen." Features include a modem dialer, a Desk Accessory and Application form of the program with complete documentation, and a merge program to combine two files.

separate.sit—Adds a separation line to your menu between Desk Accessories.

Telecomm Listings Area

atexcodes.txt—Description of ATEX typesetting system's file structure and a code set based on research done by the author on an ATEX system. The program's author uses this information to submit files to ATEX.

elink20.arc—EAZilink is a shareware terminal package that includes support of external protocols for error-free downloads and a number of interesting emulations, including ViewData and ANSI-BBS. It also supports a mini-BBS mode.

Ti Listings Area

c99mdos.ark—Clint Pulley's C99 C Compiler for the Ti.

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Finite-Element Modeling on the Mac

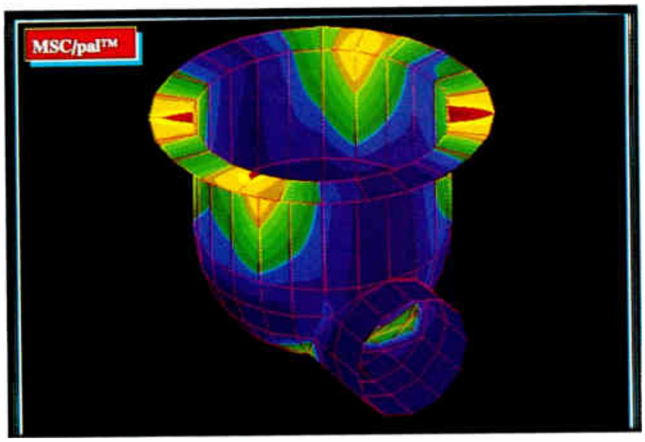
LapCAD3 is a Macintosh finite-element preprocessor that creates models for MacNeal-Schwendler's MSC/pal and MSC/Nastran.

The MacNeal-Schwendler programs perform stress, vibration, and heat transfer analysis of structures and mechanical components. MSC/pal runs on the Mac, and MSC/Nastran runs on workstations and mainframes.

LapCAD3 is a graphics preprocessor that creates the geometry, element mesh, element and material properties, and loads and constraints. You can also create models for MSC/Nastran on the Mac and upload them to a mainframe.

The program can import geometry from VersaCAD and AutoCAD. And the latest version of LapCAD3 can create models of up to 2500 nodes.

LapCAD3 runs on the Mac Plus, SE, II, IIx, or IIcx.
Price: $395.
Contact: LapCAD Engineering, 885 Lees Ave., Long Beach, CA 90815, (213) 594-5878.
Inquiry 1112.



LapCAD3 simplifies finite-element modeling for MSC/pal and MSC/Nastran.

Numerical Computing

Matfor, an interactive system for numerical computations, lets you perform matrix arithmetic, matrix manipulation, various matrix decompositions, fast Fourier transforms, linear programming, and more.

The program supports two- and three-dimensional plots and produces graphics files in PostScript format.

You can also use Matfor as a programming language by making use of functions with multiple output and optional input arguments, lists, user-defined data types, and overloading of operators and functions.

Matfor runs on the IBM PC AT with 640K bytes of RAM, on the Mac II, and on Sun and other workstations.
Price: $75.
Contact: Computational Engineering Associates, 4252 Cordobes Cove, San Diego, CA 92130, (619) 259-8863.
Inquiry 1115.

Studying Chaos

You've heard a lot about chaos, or nonlinear dynamics, but you might not know all you want to about the topic. Chaos in the Classroom is a teaching program that offers an introduction to nonlinear systems and chaos.

The first module of the program, Maps and Bifurcations, is currently available. It lets you explore the behavior of eight systems of equations, including logistic and seasonal logistic growth equations. Features include bifurcation diagram construction, visualization of time series and phase portraits, and sequential magnification.

A second module on fractals and Julia sets is planned for midsummer, according to Dynamical Systems.

The program runs on the IBM PC with 512K bytes of RAM and a CGA or EGA card.
Price: $49.95.
Contact: Dynamical Systems, Inc., P.O. Box 35241, Tucson, AZ 85740, (602) 825-1331.
Inquiry 1113.

Mainframe Math Program Now on 80386-Based PCs

MACSYMA, a symbolic and numerical math program jointly developed by MIT and Symbolics for mainframes, is now available for 80386-based DOS machines. Besides automating numerical problem solving, the program can automate symbolic operations, including differential equation solving, Laplace and Fourier transform computations, and vector and tensor calculus. The program includes a library of methods for computing perturbation and series solutions for problems with unknown exact symbolic solutions.

Written in Lisp, the program runs in CLOE, a Lisp application delivery package for 80386 PCs. CLOE provides two advanced memory management features, virtual memory and garbage collection.

The PC version of the program will feature two- and three-dimensional graphing capabilities, a debugger and compiler, and code generators for C, FORTRAN, and TEX.

PC MACSYMA requires an 80386-based PC running DOS 3.1 or higher with 4 megabytes of main memory and a 40-megabyte hard disk drive.
Price: $2900.
Contact: Symbolics, Inc., 8 New England Executive Park E, Burlington, MA 01803, (800) 622-7962 or (617) 221-1251.
Inquiry 1111.

Parameter Manager Plus Upgrade

GW Instruments recently upgraded its Parameter Manager Plus data acquisition software that runs on the Macintosh. Version 3.0 offers more powerful data-smoothing features, larger graph sizes (up to 400 by 400 inches), and the ability to handle up to 32,767 graphs from a single data set.

The new version is also faster and lets you move and sort graphs of data as individual slides. Slides can also be up to 400 by 400 inches, with a maximum of 32,767 per document.

Version 3.0 includes the MacADIOS TurboDrivers and SCSI hardware I/O drivers, enabling you to run the program with MacADIOS II and SCSI-compatible data acquisition hardware.

The program runs on the Mac Plus, SE, and II.
Price: $990.
Contact: GW Instruments, Inc., 35 Medford St., Somerville, MA 02143, (617) 625-4096.
Inquiry 1114.

continued

How to match the best front end with the best back end.

You've invested in the best hardware, operating system and database products. You have a staff of programmers ready to go. But to build great looking applications with the sophisticated features today's users demand, you need a powerful front end development tool—JAM.™

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JAM is hardware independent, so it isn't limited to one computer, database or operating system. In fact, JAM runs on everything from PC's to super-minis, works under 7 operating systems and provides access to a host of database products. Using JAM you can create a consistent user interface across multiple systems and hardware platforms.

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- MS-DOS®
- XENIX®
- VOS™
- AOS/VS™

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JAM is fast, as well as flexible. Development time is reduced significantly thanks to JAM's powerful screen drawing utilities and comprehensive library of subroutines. You can easily create and link together screens, windows, and menus to develop an application shell. Then simply attach the processing routines, and your application is complete.

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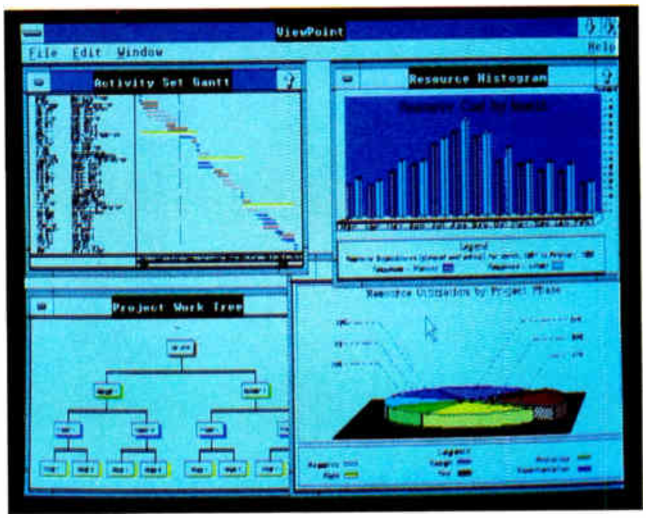


A logic diagram of work flow done with ViewPoint OverView.

Management Software Links Multiple Projects

ViewPoint OverView, a LAN-based multiuser program, lets you manage scheduling, resource, and budget requirements among several departments working on more than one project. It determines how an event affects its own and other projects, present and future.

OverView's security system, based on password access, determines which projects are available to line managers and program managers, and which projects can be saved after revisions.

Computer Aided Management, the program's publisher, also released graphics modules that support Windows under DOS and Presentation Manager under OS/2. You can use the modules to make Gantt charts, logic diagrams, bar charts, histograms, and the like. The new modules let you attach notes and scanned logos to a chart. (Both programs are scheduled to ship this summer.)

ViewPoint OverView works on the IBM PC XT with 512K bytes of RAM, a mouse, and a CGA, EGA, or VGA card.

Price: $2000 per user; graphics module, $995.
Contact: Computer Aided Management, 1318 Redwood Way, Suite 210, Petaluma, CA 94952, (800) 635-5621 or (707) 795-4100.
Inquiry 854.

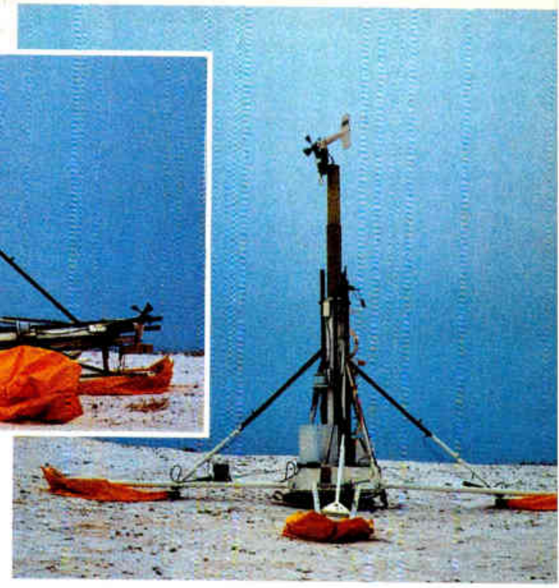
Add-in Reduces Spreadsheet Chaos

Sorting through a spreadsheet's screens or printouts full of numbers can be difficult. Symantec's solution to this problem, an add-in for Lotus 1-2-3 called Budget Express, is a two-dimensional "outline processor" that can hide numeric detail and bring it back when you touch a key.

Budget Express lets you shrink spreadsheets to a format where you see the labels, subtotals, and cell formulas only. You can manually specify the area to be collapsed into outline form, or the program can do it for you automatically by detecting indented ranges, labels, and cell formulas. The program adds a plus sign to rows in the spreadsheet that summarize hidden detail. When you move the cursor to a summary row and press a key, you can expand or reduce the spreadsheet.

Budget Express can also generate automatic quarterly

continued



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The "creature" shown above doesn't depict a futuristic lunar landing. Rather, it represents a *polar* landing of a sophisticated weather monitoring device. A new parachute-deployed device that instantly transmits vital environmental data to waiting scientists. And whose Antarctic installation and erection now happen automatically, in a matter of minutes, allowing critical data collection in remote areas that were impossible to reach before.

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Try the AVSIM demo yourself for 30 days. If you're not satisfied for any reason, return the unopened program disk for a full refund — less $35 for the demo disk and manual, which are yours to keep.

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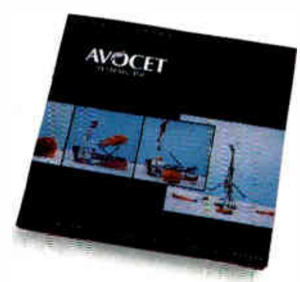

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and annual reports. The Goal Tracking function lets you keep a running scoreboard of current and target values. The program's virtual memory scheme lets you store closed or shrunken portions of the spreadsheet on disk, and you can also use it to consolidate dissimilar spreadsheets.

Budget Express works with Lotus 1-2-3 versions 2.0, 2.01, and 2.2, uses 64K bytes of RAM, and can be removed from memory while you're in Lotus 1-2-3.
Price: $149.
Contact: Symantec, 10201 Torre Ave., Cupertino, CA 95014, (800) 635-6887 or (408) 253-9600.
Inquiry 1116.

Expert Software Creates Employee Handbook

KnowledgePoint's Personnel Policy Expert covers more than 50 policy subjects to help you create a legally appropriate policy for your business. The program gives you an overview of the critical issues that must be addressed when developing a policy on smoking, pay, termination, drugs, or nondiscrimination. It then leads you through a question-and-answer process and, based on the answers you provide, creates the policy.

The program is available in single-user and consultant versions. The consultant version allows you to create a questionnaire from the knowledge base that an employer completes, helping you write a manual for that company.

Personnel Policy Expert includes a built-in word processor that allows you control over the final wording of the document.

Personnel Policy Expert runs on the IBM PC with DOS 2.11 or higher and 512K bytes of RAM.
Price: $495; consultant version, $1495.
Contact: KnowledgePoint, 1311 Clegg St., Petaluma, CA 94952, (707) 762-0333.
Inquiry 1117.

Accounting Database for the Mac

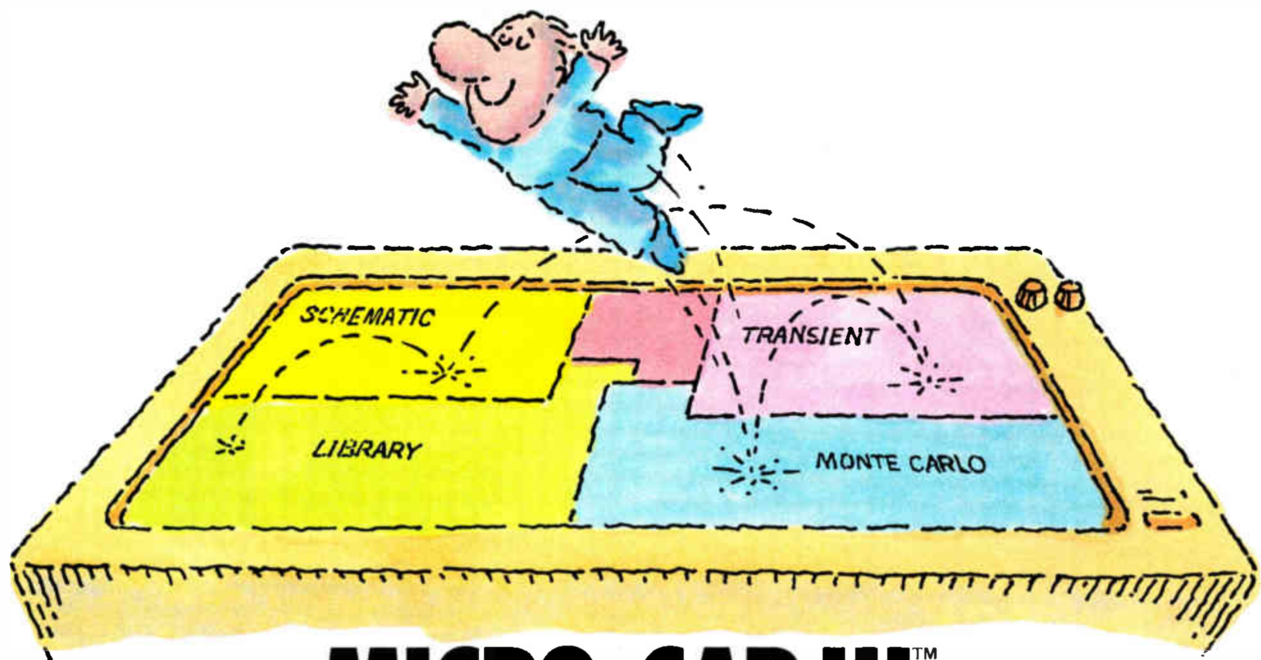
Written in 4th Dimension, a⁴ is an integrated accounting, communications, and sales tracking database for companies with sales in the $1 million to $10 million range.

Accounting functions of the program include accounts receivable and payable, general ledger, order entry/invoicing, and inventory. Accounts payable or receivable invoices can be aged by calendar month, or you can define your own aging period. Partial payment can be applied to both client and server invoices.

The program's communications functions include a memo pad, calendar, specialized menus that you can create for departmental passwords, and quick report, letter, and mailing label capability.

Softek recommends that you use the program with a 68020- or 68030-based system such as a Mac II, IIx, or SE/30, or a Mac SE with an accelerator card. The program requires 2 megabytes of RAM, a hard disk drive, and 4th Dimension or 4D Runtime. Softek reports that the program works on any Macintosh-compatible network except TOPS. For 10 or more users, the company recommends a Macintosh-compatible Ethernet solution.
Price: $1000; a⁴ Open (includes source code), $2000.
Contact: Softek Design, 882 Calgary Way, Golden, CO 80401, (303) 526-0606.
Inquiry 1118.

continued



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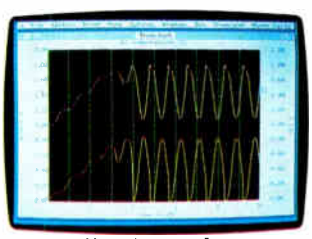

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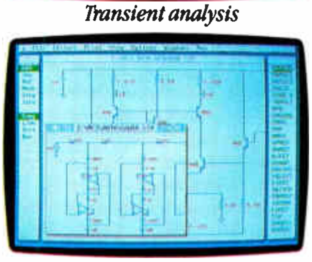

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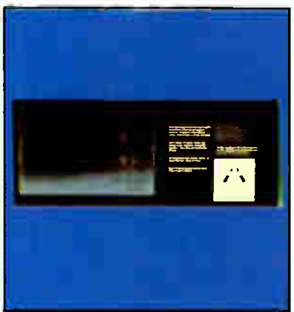

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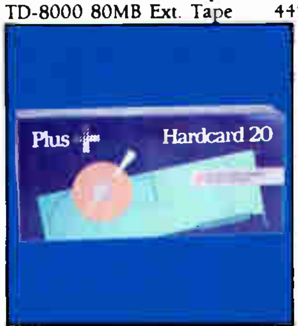

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A107

SOFTWARE • OTHER

ReadStar Ex-Press optical-character-reader software has page-analysis capability.

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Inovatic's ReadStar Ex-Press is an optical-character-recognition (OCR) program that analyzes character shapes and assigns them to mathematical models instead of using matrix-matching or feature-extraction recognition methods. The program is entirely software-based and works with standard IBM PCs and desktop scanners, Inovatic reports.

ReadStar Ex-Press can differentiate among text, graphics, headlines, and multiple columns in one pass and suppresses images and logos automatically. The software's semiautomatic mode allows the system to recognize characters about which the automatic expert system is unsure.

The program can also recognize typewritten and typeset text as small as 4 points. The program includes an editor with lexicon for correcting OCR text files. ReadStar Ex-Press runs on the IBM PC AT and PS/2s with 640K bytes of RAM.

Price: $995.

Contact: Inovatic, 1911 North Fort Myer Dr., Suite 708, Arlington, VA 22209, (703) 522-3053.

Inquiry 1125.

Reference Adds Utility to Grammatik

The Utilities Pak from Reference Software is an add-on set of programs for the company's Grammatik III grammar checker. It's a standard feature of the latest release of Grammatik; current Grammatik users can purchase it separately.

The Utilities Pak adds four new tools to Grammatik. You used to have to exit from your application to use Grammatik, but one utility now gives you the option of making Grammatik RAM-resident. You can call up grammar checking with the touch of a hot key and then use your word processor to make the suggested corrections. Grammatik's RAM-resident option takes up a whopping 200K bytes of RAM, but Reference says a version that uses expanded memory will be available soon.

Also new is a Grammar Rules Editor that lets you tap Grammatik's parsing information and customize the

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Circle 164 on Reader Service Card (DEALERS: 165)

A Word Publisher for OS/2

Lennane Advanced Products announced DeScribe Word Publishing (DWP), a program that combines word processing and desktop publishing features.

Lennane claims that the program is a "start from scratch" Presentation Manager application that makes full use of OS/2's graphical user interface to allow you to create graphical pages without having to use a full-fledged desktop-publishing application. The program also has WYSIWYG capabilities and makes extensive use of point-and-shoot mouse commands, multiple windows, and pull-down menus.

DWP lets you control columns, windows, and typography (including leading, kerning, and letter spacing). It also has a variable undo feature that uses a sliding window to let you choose how much to undo, all the way back to when you first opened the document.

The program includes several standard stylesheets and gives you the option of customizing your own. It also imports and exports documents and graphics from and to a variety of standard applications. It outputs pages on any PM-supported printer and includes a driver for PostScript printers.

Lennane includes Proximity's dictionary and thesaurus with DWP. There's also a built-in customizable hyphenation dictionary.

Price: $595.

Contact: Lennane Advanced Products, 4047 North Freeway Blvd., Sacramento, CA 95834, (916) 646-1111.

Inquiry 1121.

program's rules to reflect your personal or company-specific rules. There's also a Grammar Help Editor that lets you customize Grammatik's pull-down grammar help screens. Using this feature, you could include a corporate style guide in Grammatik.

Last but not least, Grammatik's Utility Pak adds a customizable compare function that lets you include up to three custom documents that Grammatik will compare to any other document. This gives writers a graphical comparison of their documents with the standard.

The Grammatik III Power Pak includes both Grammatik and the Utilities Pak. If you're already a Grammatik user, you can buy the Utilities Pak by itself.

Price: Utilities Pak, $59; Power Pak, $149.

Contact: Reference Software, 330 Townsend St., Suite 123, San Francisco, CA 94107, (800) 872-9933 or (415) 541-0222.

Inquiry 1122.

Take the Cache and Run

Intelligent Devices has introduced Power Cache and Power Cache Plus, two new disk-caching products. Power Cache is designed for those who want a program that uses very little conventional memory (less than 5K bytes).

You can install Power Cache Plus in conventional, expanded, or extended memory. It includes an assist utility that lets you change the size and configuration of the cache on the fly without having to reboot your machine.

Both versions run on the IBM PC and PS/2s with DOS 2.0 or higher and at least 512K bytes of RAM.

Price: Power Cache, $69.96; Power Cache Plus, $99; both packages, $139.95.

Contact: Intelligent Devices Corp., 245 East Foothill Blvd., Suite 297, Upland, CA 91786, (714) 946-4959.

Inquiry 1123.

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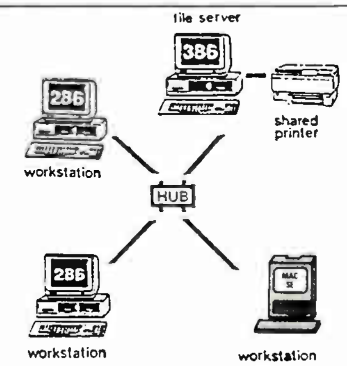

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Circle 491 on Reader Service Card (DEALERS: 492)

SIGGRAPH '89

SIGGRAPH '89, the sixteenth annual conference for graphics and audio/video applications, will feature 16 panels and a computer graphics theater. Planned panels include high-vision computer graphics, high-definition television, future directions in desktop video, distributed graphics, scientific data visualization, and virtual environments.

The conference will include a graphics art show, hardware and software exhibits, and paper presentations. The Association for Computing Machinery and the IEEE's technical committee on computer graphics are cosponsoring the show, which will be held at the Hynes Convention Center in Boston July 31 to August 4.
Price: Exhibits and art show only, $15; two days of courses, $435 (nonmembers, $500; students, $215).
Contact: SIGGRAPH '89 Conference Management, 111 East Wacker Dr., Suite 600, Chicago, IL 60601, (312) 644-6610.
Inquiry 1030.

BIX Helps Users Groups with Newsletters, BBSes

The BYTE Information Exchange, or BIX, an online service for computer professionals, is offering two services for users groups to help them with newsletters and BBSes: the User Group Exchange and the Bulletin Board Exchange. Both services provide publishing rights to news stories from Microbytes, Short Takes (capsule reviews of new products), features, and the Best of BIX.

If your users group publishes one line of information about BIX in each newsletter and at your BBS's sign-on display, the group will receive two free subscriptions to BIX and a 25 percent discount off the regular BIX price for its members. BIX also asks that you include a BIX brochure in a mailing to the group.

The free subscriptions don't include the use of Tymnet: If you call using long distance or PC Pursuit, there's no additional cost; if you use Tymnet, you can choose from off-peak ($2 per hour), peak ($8 per hour), or unlimited off-peak use ($15 a month).
Contact: The BYTE Information Exchange, One Phoenix Mill Lane, Peterborough, NH 03458, (800) 227-2983 or (603) 924-7681.

Unix Training Event

Unix at Work is the theme of UniForum/Boston, the second annual conference sponsored by /usr/group, the international network of Unix system users. Twenty tutorials are planned, including the features of Unix System V release 4, CASE and Unix, making sense out of POSIX and related standards, Unix system security,

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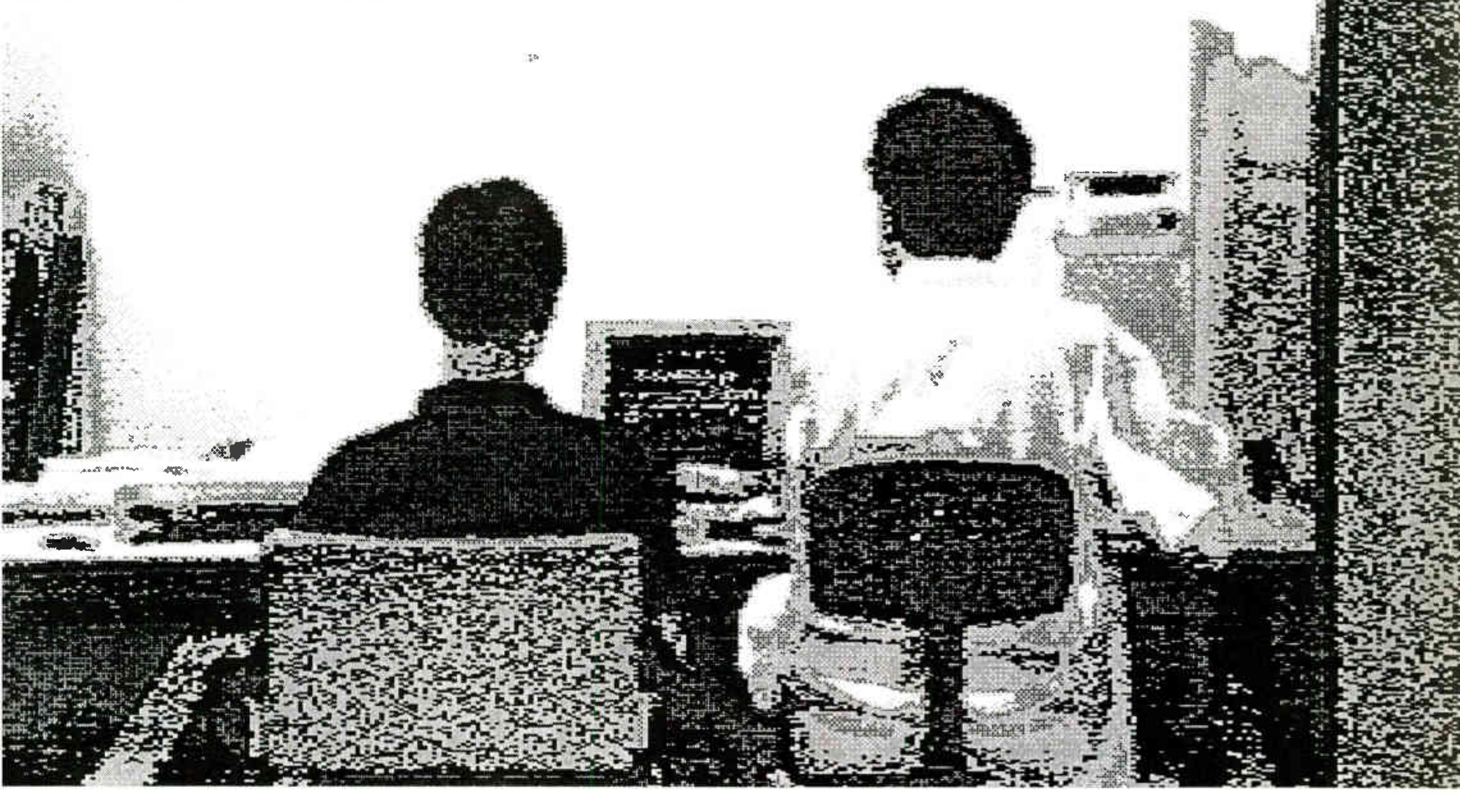

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managing application portability, an introduction to programming the X Window System version 2, Unix development tools, and Unix networking.

UniForum/Boston will be held at the Hynes Convention Center on August 22–24.
Price: Three days, $395; two days, $350; one day, $175.
Contact: UniForum/Boston, 2400 East Devon, Suite 205, Des Plaines, IL 60018, (800) 323-5155 or (312) 299-3131.
Inquiry 1041.

Technology in the Classroom

Lesley College in Cambridge, Massachusetts, will be the site this summer for several institutes dedicated to helping elementary school teachers integrate technology in the classroom to better teach mathematics and science.

The courses will be one-week sessions, and each can be taken for one or two graduate credits or on a noncredit basis. The courses include Using Numbers: Statistics Activities for the Elementary Grades, Teaching Critical Thinking in the Mathematics Classroom, Reasoning Under Uncertainty: Activities for Teaching Statistics in the Middle Grades, and Student as Scientist: Exploring with Technology.
Price: One or no credits, $254; two credits, $498.
Contact: Amy Navin, Lesley College, 29 Everett St., Cambridge, MA 02138, (617) 868-9600, ext. 294.
Inquiry 1045.

High-Speed Semiconductor Conference

The twelfth biennial conference on Advanced Concepts in High-Speed Semiconductor Devices and Circuits will be held at Cornell University in Ithaca, New York, on August 7–9. The conference will cover the physics and performance of high-speed devices and circuits. Topics will include superconducting devices, speculative transistor concepts, ballistic and hot electron transistors, and more.
Price: IEEE members and government employees, $140; nonmembers, $175; students, $25.
Contact: IEEE/Cornell Conference 1989, School of Electrical Engineering, 424 Phillips Hall, Cornell University, Ithaca, NY 14853, (607) 255-3409.
Inquiry 1042.

OS/2 Users Group

The OS/2 Users Group, which is affiliated with the New York Personal Computer Users Group (NYPC), meets the fourth Thursday of the month in Manhattan.

The group now meets at 61 Broadway, but this may change as more people join. Membership in NYPC is encouraged.
Contact: Bill Zack, OS/2 Users Group Chairman, 61 Broadway, New York, NY 10006, (212) 785-1818.
Inquiry 1043.

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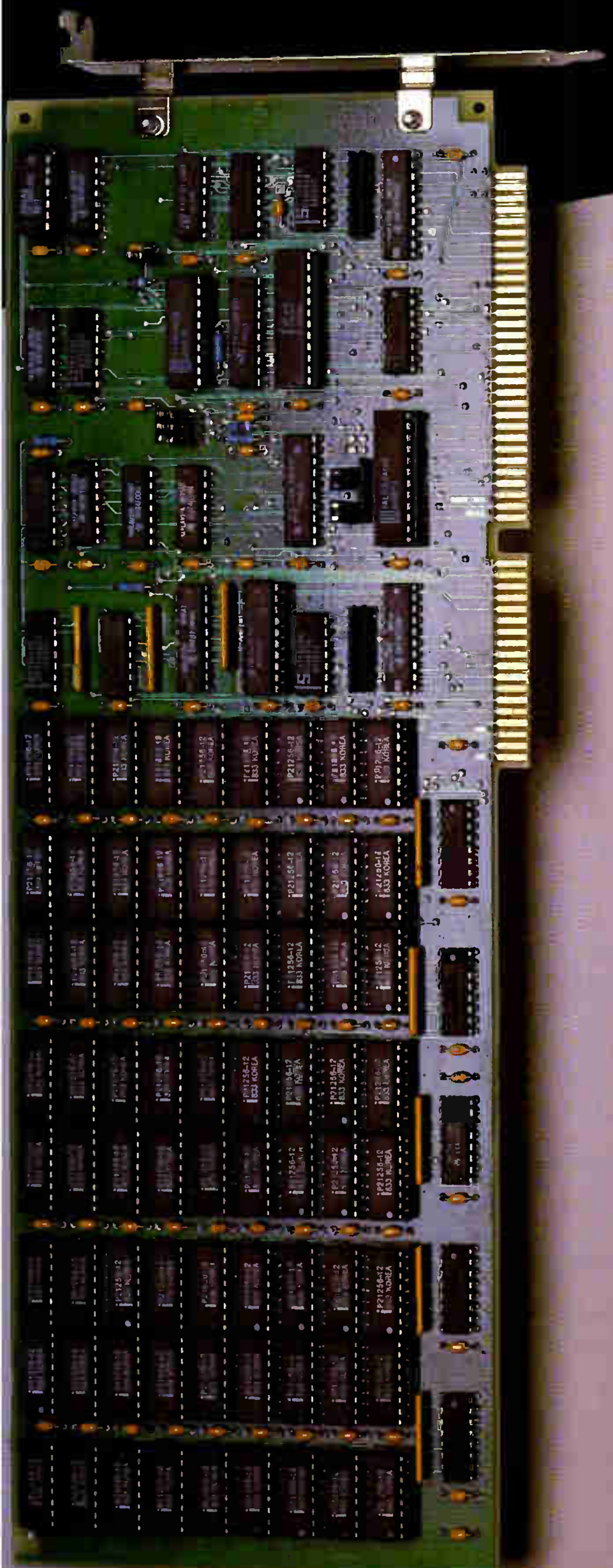

Break the 640K DOS barrier and utilize the Advanced Features of the LIM 4.0 standard while using only one motherboard slot!

DESIGN PHILOSOPHY

• The Teletek X-Bandit was specifically designed to utilize the advanced features of the Lotus/Intel/Microsoft EMS 4.0 Specification. Further, the X-Bandit's Segmented Memory Mapping capability allows the user to extend DOS size beyond the 640K barrier. It is available in both 8 and 16 bit versions for use in the IBM XT, AT, and compatibles.

MEMORY

• Segmented Memory Mapping allows the user to fill out unused memory segments between 640K and 1024K. By "claiming" unused portions of memory in 16K increments, the user effectively increases TPA size. LAN or custom software modules, for example, can be loaded into these high memory areas thus relieving the lower 640K of TPA for other application programs.

• Split Memory Addressing allows the user to fill out conventional memory to 640K.

• Extended Memory Addressing is available for the PC/AT version.

• 2 MB capacity in a single slot. Up to 8 MB per system.

• Parity checking.

SOFTWARE

• Easy menu-driven auto configuration software.

• Device driver includes print spooler and RAM drive.

• Supports multitasking with the appropriate shell-resident software package.

SPEED

• 6/8/10 MHz speed with 0 wait states. 12 MHz speed with 1 wait state.

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• One year parts and labor.

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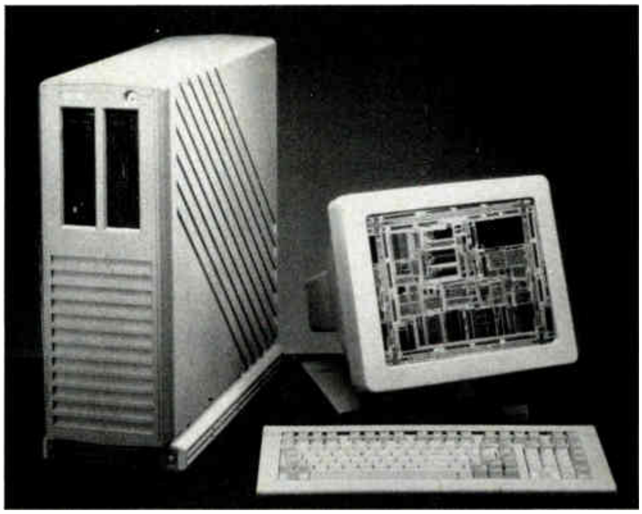
Altos Ships 33-MHz Multiuser System

The Spring Comdex didn't lack new product announcements featuring Intel's 33-MHz 80386 chip, but Altos says that its Altos 386 Series 1000 Model 33, which runs on Unix, is the industry's first multiuser system based on the 33-MHz chip.

Along with the new Intel processor, the Model 33 features a 16-MHz controller clock rate, up from the previous unit's 9.8 MHz. The system is shipped with 4 megabytes of RAM, expandable to 24 megabytes. Other basic configuration features include eight serial I/O ports, zero-wait-state operation, a fully streaming 125-/150-megabyte SCSI cartridge tape drive, and a 1.2-megabyte floppy disk drive.

The system comes in two versions, the 1414T-33 (with a 145-megabyte full-height SCSI hard disk drive) and the 1430T-33 (with a 300-megabyte SCSI hard disk drive).
Price: Between $20,000 and $25,000.
Contact: Altos Computer Systems, 2641 Orchard Pkwy., San Jose, CA 95134, (408) 432-6200.
Inquiry 1070.



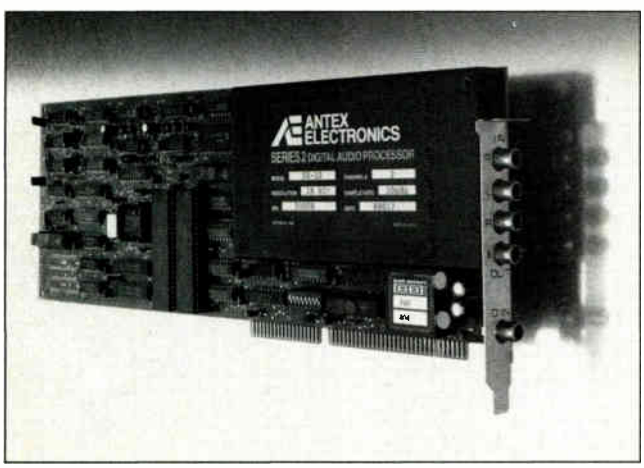
Model 33 runs on Altos's Unix 5.3-compatible System V/386.

Chromatography Research on CD-ROM

CD-CHROM is a CD-ROM database of over 70,000 gas- and liquid-chromatography abstracts from the last 30 years. You can search the abstracts by compounds separated or by the complete text.

The database's Search-LITE software supports Boolean operators and subset references, and it maintains a directory of queries, permitting easy recall of subsets. Because the database includes references to instrument-specific parameters, instrument manufacturers can use CD-CHROM to cite applications using their equipment. Chromatographers can eliminate trial-and-error duplications by referencing tried-and-tested analytical methods. Abstracts are provided from journals in the U.S., Europe, Asia, and Australia.

CD-CHROM contains about 120 megabytes and works on the IBM PC with a hard disk drive, 640K bytes of RAM, DOS 3.1 or higher, and a High-Sierra-format CD-ROM player. Updates will be available, starting with the first quarter of 1990, on a trade-in basis.
Price: $1295; updates, $400.
Contact: Preston Publications, 7800 Merrimac Ave., P.O. Box 48312, Niles, IL 60648, (312) 965-0566.
Inquiry 1069.



The SX-10 can handle basic audio mixing.

High-Performance Digital Audio Functions

The SX-10 is an add-in card that can simultaneously record or play back two separate audio channels at sample rates of up to 50 kHz and with full 16-bit resolution. You can use the board to add high-performance digital audio functions to an application program, including digital audio mastering and recording and audio communications systems.

The full-length board's programmable sample rates range from 6.25 to 50 kHz, in 100-Hz increments. You can simultaneously play and record, for overdubbing, and the board includes a digital input interface for CD, DAT, and other digital players. The board has a Texas Instruments TMS320C10 DSP chip running at 25 MHz.

The board requires an IBM PC AT or higher with a 1-to-1 hard disk drive controller, a hard disk drive with no greater than a 28-ms average access time, and DOS 2.0 or higher for the driver.
Price: $1995; driver, $750.
Contact: Antex Electronics Corp., 16100 South Figueroa St., Gardena, CA 90248, (213) 532-3092.
Inquiry 993.

Create Special Effects with Display Text

TypeStyler, a typography styling tool, lets you bend, twist, squeeze, stretch, and rotate display type. TypeStyler is compatible with fonts from Bitstream, The Font Company, and other third-party font developers.

The program lets you add perspective, shadows, shades, patterns, and colors to display type. Ten AGFA Compugraphic typefaces are included with the package.

The program imports and exports PICT, EPS, and paint files. Broderbund recommends that you use the program on a Mac Plus or higher.
Price: $199.95.
Contact: Broderbund Software, Inc., 17 Paul Dr., San Rafael, CA 94903, (415) 492-3200.
Inquiry 983.

continued

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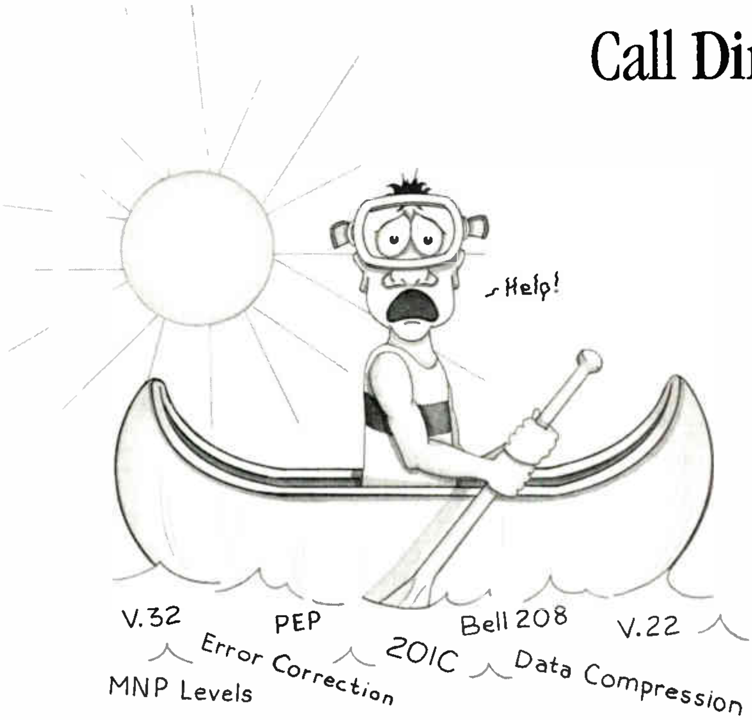

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Duping Your Disks Automatically

With the Autoloading Diskette Duplicators, you can load, format, copy, and verify up to 960 disks per hour, according to Datapath Technologies.

You can expand both models (the AL-525D for 5¼-inch formats, and the AL-350D for 3½-inch formats) from single- to eight-drive systems, and you can mix and match formats and drive types.

To use the Autoloading Diskette Duplicators, you need Datapath's Copy Manager software. The software is menu-driven and features status summaries on-screen. It also beeps at you if any problems occur.

Other capabilities of the duplicators include batch-job operation, storage of duplication masters in image files, and flexible disk serialization.

The duplicators work with the IBM PC with at least 256K bytes of RAM.

Price: AL-525D, $2495; AL-350D, $2545; software, $395.

Contact: Datapath Technologies, Inc., 46710 Fremont Blvd., Fremont, CA 94538, (415) 651-5580.

Inquiry 994.

Datapath's duplicators can handle the 1.44-megabyte formats.

Low-Cost Desktop Publishing on the Mac

Publish It! is a desktop publishing program with page layout, word processing, draw and paint features, and graphics editing for the Mac. It can import graphics created with draw and paint programs. You can also use it to create your own graphics (including object-oriented graphics), do spot color separations, and create special effects with type.

The program's word processor can automatically wrap text around circular or irregularly shaped objects and flow text through successive or staggered pages. It includes a 100,000-word spelling checker and a 240,000-synonym thesaurus. Text size can range from 4 to 127 points, and you can lead and kern in 0.0005-inch increments.

You can create 72- and 300-dpi bit-map graphics, or you can import them from Adobe Illustrator, MacPaint, FreeHand, SuperPaint, FullPaint, and Draw It Again, Sam. Graphics can be rotated, cropped, sized, colored, shaded, and stretched within Publish It!. Text importing from major Mac word processors is done with underlining, bold, and other formatting intact.

Other features include an Undo command, automatic page numbering, multiple document windows, and a reverse print command (for printing large documents in reverse order).

Publish It! uses 512K bytes of RAM with a Mac Plus or higher.

Price: $395.

Contact: Timeworks, 444 Lake Cook Rd., Deerfield, IL 60015, (312) 948-9200.

Inquiry 992.

DSI Takes Aim at Paper-Stuffed Filing Cabinets

Deerfield Systems' DisplayArchive is an optical scanning and database program that lets you store any document for future retrieval or reproduction. The customizable program is for people who need to store millions of documents (e.g., medical and insurance records, business documents, and inventory) for systematic retrieval.

Documents scanned into a system using DisplayArchive are stored in an image database, and images are stored as individual files in file folders. Each file has a profile of information that you can use for referencing.

A voice-annotation option lets you record and review a message for each document, which you can play over a connected speaker. A transparent master control file manages database locations and image indexes, and the program includes a set of utilities.

DisplayArchive works on the IBM PC with 640K bytes of RAM, a graphics scanner and printer, and a magnetic or optical storage device with a SCSI bus. An optional software module provides fax capability.

Price: $495; DisplayFax, $100.

Contact: Deerfield Systems, Inc., 221 Elizabeth St., Utica, NY 13501, (313) 797-1805.

Inquiry 982.

Communications Program with Script Learning

Boyan 4.0, a communications package for the IBM PC, features script files that can run communications sessions unattended. A Script Learn feature can build an automatic script file for you after a session.

Boyan 4.0 supports the major file transfer error-checking protocols, including XMODEM and YMODEM. It includes an extensive macro language with more than 200 commands, and you can define its command keys to customize the keyboard layout. Action Modules allow Boyan to emulate VT-100, VT-52, and ANSI terminals.

Boyan 4.0 also provides a host mode, with two levels of password protection, which lets you dial into your computer from a remote system. With the program's Directory File Manager, you can scan disk directories, copying and viewing files by pressing a key. Other features include a redialing queue, a usage log, a scroll-back buffer, and a backspace buffer.

Boyan 4.0 works on the IBM PC with DOS 2.0 or higher and 512K bytes of RAM. It can run with limited scroll-back and script-learning capabilities with 256K bytes of RAM.

Price: $40.

Contact: Boyan Communications, 9458 Two Hills Court, Columbia, MD 21045, (919) 682-4225 (data line).

Inquiry 981.

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102-key Keyboard, 200W power supply;
2 Serial Ports & 1 Parallel Port;
Monitor & controller card are optional.
Cache memory size=32K (64K optional).

CONFIGURATION	16MHz	20MHz	25MHz	33MHz
80386 Basic System (M:1MB,F:1.2M,H:40M)	$2095	$2295	$2745	$3245
80386 Basic System (M:4MB,F:1.2M,H:40M)	$2595	$2845	$3295	$3795
80386 Cache System (M:1MB,F:1.2M,H:40M)	N/A	$2545	$3045	$3545
80386 Cache System (M:4MB,F:1.2M,H:40M)	N/A	$3095	$3595	$4145

CONFIGURATION	8MHz	10MHz	12MHz	16MHz	20MHz
80286 Basic System (M:1MB,F:1.2M,H:20M)	$945	$1195	$1345	$1545	$1695
80286 Basic System (M:2MB,F:1.2M,H:20M)	$1125	$1345	$1495	$1745	$1895

CONFIGURATION	4.77MHz	8MHz	10MHz
8088 Basic System (M:640KB,F:360K,H:None)	$445	$495	$525

8088 BASED MULTI-USER TERMINAL
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SHORT TAKES

BYTE editors' hands-on views of new products

The DeskJet Gets Hotter

It's not hard to see why Hewlett-Packard's DeskJet has been a hot seller since its introduction last year. The printer uses "drop-on-demand" thermal ink-jet printing on plain paper, and its output is virtually indistinguishable from that of a laser printer (and it sells for about half the price).

How do you beat a winner? You do something better. The **DeskJet Plus**, which has the same quirky appearance as its predecessor, adds a raft of new features and still sells for $995. (The original DeskJet is still available, with its price reduced to $795.)

The design and documentation of Hewlett-Packard products remain some of the best in the business. About 10 minutes after I expectantly ripped open the box, I had the DeskJet Plus up and running. It was actually easier than setting up most dot-matrix printers, and it has both parallel and serial interfaces.

Because it uses a new motor and new drive electronics that move the paper through the printer at twice the speed of the original, the DeskJet Plus prints a page of text in half the time. But by laser-printer standards, it's still slow, taking about 45 seconds to print a full page (55 lines) of single-spaced text. So if you plan to use a DeskJet Plus to print some copies of your 1000-page Great American Novel, you might be better off considering an alternate possibility.

For graphics, the DeskJet Plus is impressive indeed. It prints them up to five times faster, at the same 300- by 300-dot-per-inch resolution. After I added graphics to my standard page of text, the DeskJet Plus took about 45 seconds to finish the job. This is considerably faster than the original DeskJet, which took almost 3 minutes.

In keeping with Hewlett-Packard's reputation for well-built hardware, the DeskJet Plus is actually rated for a very respectable 12,000 pages per year. But I'd hate to be the person sitting next to the printer waiting for those pages to finish printing.

Another new feature that I found useful is a standard landscape mode. I printed out spreadsheets without having to resort to the special (and expensive) cartridge that the original DeskJet needed.

The DeskJet Plus comes with 10 built-in fonts: six portrait and four landscape. If you want to do funky desktop publishing, you'll still need font cartridges. Hewlett-Packard has 10 available, with fonts up to 30 points. One improvement that I found pleasing is that the company has fine-tuned the spacing tables on proportional fonts, making them look much more natural than the originals.

Although the DeskJet Plus comes with an impressive list of features, it still has some limitations. With only 128K bytes of RAM, I couldn't use soft (downloadable) fonts without plugging in an additional RAM cartridge. But this is another area where Hewlett-Packard has added some versatility to the DeskJet's new incarnation. You could expand the original DeskJet's RAM to only 256K bytes (not exactly a useful amount). However, in the DeskJet Plus, I added both a 128K-byte and a 256K-byte RAM cartridge, to bring the total internal memory up to half a megabyte.

But that adds a whopping $350 to the price tag. And although prices of font cartridges have been reduced by an average of 30 percent, they'll still set you back $75 to $95 each.

You'll also need special printer drivers for your applications in order to take advantage of the DeskJet Plus's features. Drivers for WordPerfect, Lotus 1-2-3, WordStar, Microsoft Word, Harvard Graphics, and MultiMate were the only ones available when I wrote this. But more should be quickly on the way.

Still, even a fully loaded DeskJet Plus costs considerably less than a comparably equipped laser printer, and I needed a magnifying glass to tell the difference in the output. It's not designed for a stressed-out production environment, but I found the DeskJet Plus a logical step up from my elderly dot-matrix printer. And I never want to go back.

—Stan Miastkowski

THE FACTS

DeskJet Plus
$995

Options:
Font cartridges, $75 to $95; 128K-byte RAM cartridge, $150; 256K-byte RAM cartridge, $200; Epson FX-80 emulation cartridge, $40; HPGL plotter software, $129; dustcover, $35; additional print cartridges, $18.95.

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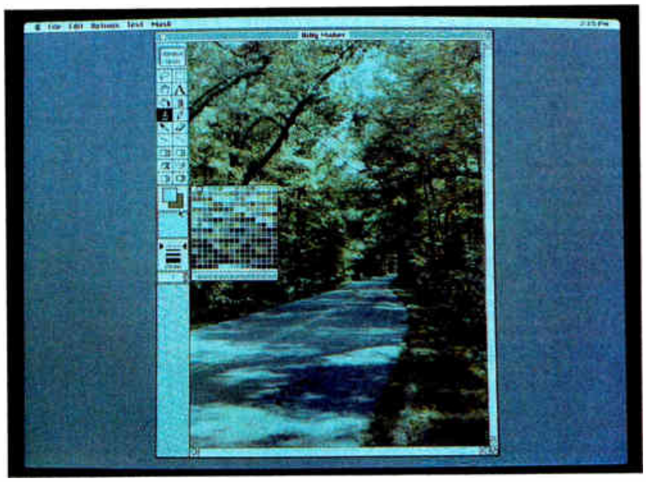
continued

Painting on the Mac Takes a Step Forward

PixelPaint, a color graphics application distributed by SuperMac Technology, first demonstrated that the Macintosh II's color capabilities could be put to use by the professional artist. It did this with a set of intuitive MacPaint-style painting tools and easy-to-use but powerful color special effects. Early this year, **PixelPaint 2.0** arrived with significant enhancements to existing features, improved color-output-device support, and a scanning module that lets you import images from a scanner.



PixelPaint 2.0 has improved color dithering techniques that eliminate most of the *banding* or *fringing* effects that usually occur when working with a limited set of 256 colors. This new version of PixelPaint imports and exports TIFF images. Unfortunately, you're limited to working and saving only gray-scale information for TIFF files.

The special-effects capabilities of the painting tools have been beefed up. For example, the Brush tool has a Paint with Clipboard feature that lets you use the image captured in the Clipboard as the Brush shape and color. This feature, which is identical to the one in Photon Paint, lets you select a portion of a forest, or a Martian crater, to paint with.

Mask is a new addition to the Menu bar. This lets you select an arbitrary region on a picture to be rendered unalterable; that is, if you use the SprayCan tool on the image, everything inside the Mask region is not affected by the spraying operation, and everything outside the Mask is altered. This is similar to the frisket that airbrush artists use to protect parts of a picture as they apply another layer of paint to it.

However, what looks good on the screen isn't worth much if you can't get it onto paper. PixelPaint 2.0 addresses this problem with its support of Pantone 747XR colors. It does this with a custom spot color picker, and a Pantone color formula guide comes in the package. PixelPaint 2.0 can output an image as PostScript, color PostScript, or CYMK (cyan-magenta-yellow-black) process color separations.

Additional dialog boxes let you set undercolor removal, ink buildup, and density range for process colors. You can also set line resolution for output on high-resolution devices (e.g., a Linotronic printer). You can print directly to color PostScript devices like the QMS Color Script 100. Color printers like the Tektronix Model 4693D, Hewlett-Packard's PaintJet, and the Mirus FilmPrinter are also supported by special drivers.

I tried PixelPaint 2.0 on a Mac IIcx running System 6.0.3 and alpha versions of Apple's 32-Bit QuickDraw and the LaserWriter 6.0 driver. The system had 4 megabytes of RAM, an 80-megabyte hard disk drive, and a full-chunky SuperMac Spectrum/24 video board driving a 19-inch color monitor. For the scanning of images, I used the Howtek Scanmaster color scanner.

PixelScan 2.0, the scanning module, is a big improvement over the version I reviewed in the April BYTE, with a much-needed preview mode. PixelPaint 2.0's results are still eye-catching. Performance is improved in some areas. However, it's degraded in other areas. PixelPaint 2.0 seems particularly sluggish catching keyboard commands: You have to really hold down, say, the Command-Q keys to get the application to quit. PixelPaint 2.0 printed a color image as a gray-scale print on the BYTE Lab's LaserWriter IINT without difficulty, even though it was using Apple's preliminary driver.

Overall, PixelPaint 2.0 is a worthy heir to its predecessor. The big improvements are the masking for detailed artwork and the ability to drive sophisticated color output devices. This latter feature alone is reason enough to upgrade.

—Tom Thompson

THE FACTS

PixelPaint 2.0
$395

Requirements:
Mac II family or Mac SE/30 with at least 2 megabytes of RAM, an 8-bit video board, a color or gray-scale monitor, and a hard disk drive.

SuperMac Technology
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Desktop Manager with Hypertext Power

Are you one of those IBM PC-compatible users who mills around the Apple booth at trade shows, gazing wistfully at the Macintoshes running HyperCard? Or perhaps you're looking for a colorful mouse-and-windows DOS shell that doesn't require gobs of memory. **HyperPAD** delivers an easy-to-use character-based hypertext environment on DOS PCs.

HyperPAD is a sophisticated package that emulates most of HyperCard's features and provides a user-configurable "push-button" DOS shell for desktop management and program launching. Although it uses different terminology than HyperCard—stacks are called PADs (short for personal application designs) and cards are called pages—it uses the same logical hierarchy as its Apple ancestor and offers similar objects, tools, and menus.

As a desktop manager, it competes with other new offerings like Magellan and ViewLink. But HyperPAD is not just a file manager with a friendly face: It's an object-

continued

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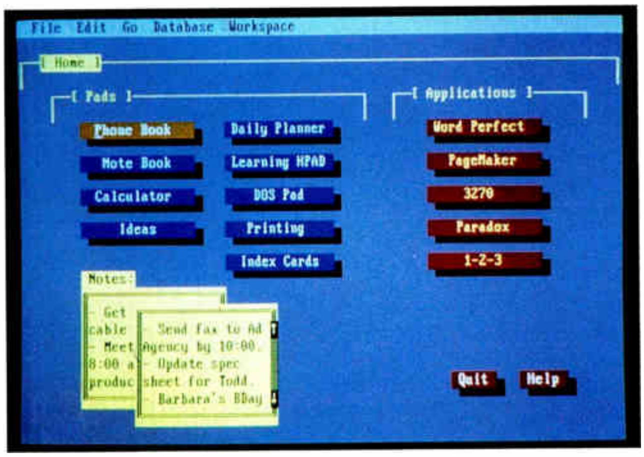
oriented, free-form database with drawing, painting, and form-generating capabilities. At its heart are authoring tools and a scripting language called HyperScript, which is strikingly similar to Apple's HyperTalk. Yet it is character-based, not bit-mapped, which means it will run on any PC, and it will run faster and with less memory consumption than HyperCard.

HyperPAD will be shipped with 25 preconfigured PADs, including a "home" screen, assorted desktop functions (e.g., an appointment calendar, notepad, and Rolodex), and a DOS PAD that allows push-button disk formatting, directory management, file copying, and other tasks.

You can easily reconfigure the canned PADs, or you can lock them with passwords. When installed, HyperPAD uses 384K bytes of RAM; after your applications are launched, a 2K-byte stub is left behind that reloads HyperPAD upon your exit from an application.

HyperPAD struck me as an elegant implementation of hypertext for a PC. It includes a windowing system that looks and behaves remarkably like Microsoft Windows, with pull-down and pop-up menus, dialog boxes, and scroll bars. It's fast—the slowest part was waiting to load new PADs from the hard disk. Designing



THE FACTS	
HyperPAD $99.95 *Requirements:* IBM PC with 512K bytes of RAM, at least 720K bytes of mass storage, and DOS 2.1 or higher. A color monitor and a mouse are strongly recommended.	Brightbill-Roberts & Co., Ltd. 120 East Washington St., Suite 421 Syracuse, NY 13202 (315) 474-3400 **Inquiry 1027.**

new buttons and pages is a snap, and the menus of options offer considerable aesthetic flexibility. The package includes snazzy graphics features like tear-away and fade-out screen segues, a character paintbrush, and three-dimensional shading. And the underlying HyperScript language is very impressive, although most people won't need to use it.

Not everything about HyperPAD was gratifying, however. Bearing in mind that I ran an early, buggy version of the product that included only seven working PADs, I found its power and flexibility to be marred by some questionable design decisions. For example, it's easy to create buttons and fields with literally dozens of combinations of border colors and text, yet to change the background color for a page requires an oddly unintuitive process. Some of the menus were strangely arranged, and I occasionally got lost or had difficulty navigating between levels, especially the foreground and background of a page.

I tried HyperPAD on both a color-monitor system with a mouse and a monochrome system with only cursor arrow keys. The mouse was helpful, but I could have survived without it because keyboard movement was fast and logical. On the other hand, HyperPAD in monochrome was almost unusable. I couldn't tell where I was, and the normally communicative screens became disorienting and muddled. I strongly advise color capability as a precondition for using HyperPAD. Incidentally, I also had to unload all my TSR programs before it would run.

In short, HyperPAD is an exciting, richly detailed program with great potential, assuming the bugs get fixed and a few conceptual lapses are cleaned up. Whether you just need an easy-to-use PC desktop manager or you want to develop products using a hypertext platform, you should consider buying HyperPAD.

—Andrew Reinhardt

Smarter Than Your Average Mouse

You *can* get there from here. Quite easily, in fact, if "there" is some area on a computer screen and you have a mouse. But on a very large screen, it may take some time. You may have to move the mouse, pick it up, and repeat the process a few times. To make the trip a little easier, Mitsubishi has designed a mouse that it claims can almost jump to the other side of the screen. But can it?

The new **Mitsubishi Smart Mouse** reportedly has special hardware that lets it vary its resolution from 200 dots per inch to 800 dpi. According to the company, the actual resolution depends on how fast you move the mouse. Note that this increased resolution is not for fine graphics work, but to let you quickly traverse large sections of the screen.

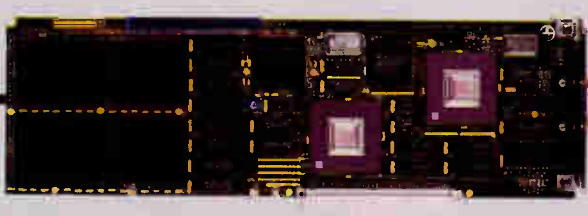
THE FACTS	
Mitsubishi Smart Mouse $194.50; with EGA Paint, $239.50; with Drafix CAD, $264.50 *Requirements:* IBM PC with a serial port.	Mitsubishi International Corp. 520 Madison Ave. New York, NY 10022 (212) 605-2000 **Inquiry 1028.**

In appearance, this mouse looks much like most other two-button mice. It seems well made and has a nice feel. Its two buttons are large and easy to access. The mouse is about a quarter of an inch wider than the sleek Microsoft Mouse. Personally, I would prefer the Mitsubishi device to be a little narrower.

Installation is easy. You can plug it into any 9- or 25-pin

continued

SONY



serial port on an IBM PC. Since the Smart Mouse is software-compatible with the Microsoft Mouse, programs like Microsoft Windows are all ready for it. It also includes TSR programs that let it work with applications that do not directly support mice, like XyWrite III Plus and Lotus 1-2-3.

To get a feel for the varying resolution of the new mouse, I did some simple tests using Microsoft Windows. At a very slow speed (about 1 inch per second), it took about 3.2 inches of mouse movement to traverse the screen. Moving the mouse as fast as I could, it took only about 1.2 inches, or about 38 percent as much space as before. This is impressive, but not quite the ratio you would expect going from 200 to 800 dpi.

Out of curiosity, I tried the same test using the Microsoft Mouse. With slow movement, the mouse needed about 3.1 inches to traverse the screen. When I moved it quickly, it needed only about 1.6 inches, or only 52 percent as much space. This is almost as impressive as the results for the Smart Mouse. Evidently, Windows has its own mechanism for speeding up cursor movement.

The Smart Mouse worked quite well with Windows and fairly well with other non-mouse-oriented applications. In the nonmouse applications, the mouse movements substitute for cursor key presses, and a menu of keyboard macros can be called up.

The mouse worked pretty well with Lotus 1-2-3, XyWrite III Plus, and SideKick. But I noticed a curious phenomenon: The speed change seemed to go in reverse. Fast mouse movement caused slower cursor movement, while slower mouse movement caused faster cursor movement. This seemed a bit strange, but this mouse is not intended for these types of applications.

Although the Mitsubishi Smart Mouse performed quite well, it was not as impressive as I'd expected. The lower-priced Microsoft Mouse offered a perceived resolution increase that was almost as good as that of the Smart Mouse.

I'd use the Smart Mouse only as a second mouse for certain specialized applications. If you are using PageMaker on a portrait-style monitor, or AutoCAD on a 19-inch screen, the Smart Mouse will save some wear and tear on your mouse pad. But for most other applications on normal-size screens, an ordinary garden-variety rodent should work just fine.

—Rich Malloy

Counterpart Mirrors Your Drives

Counterpart is an add-in-card security device for the IBM PC and compatibles. It acts as a mirroring controller that continuously and transparently backs up data from a primary hard disk drive to a second drive.

In keeping with today's concern for security, Counterpart also gives you the option of adding several levels of access control to your system. You can add multiple user passwords, as well as control access to drives and directories. And if you're really paranoid about the company secrets, you can also add automatic password-controlled encryption and decryption of all data on your disks. Counterpart lets you use either the industry-standard Data Encryption Standard or a proprietary standard.

Counterpart doesn't replace your existing hard disk drive controller. Instead, it works with it. Since my controller, like most, handles two drives, all I had to do was install the second drive and the

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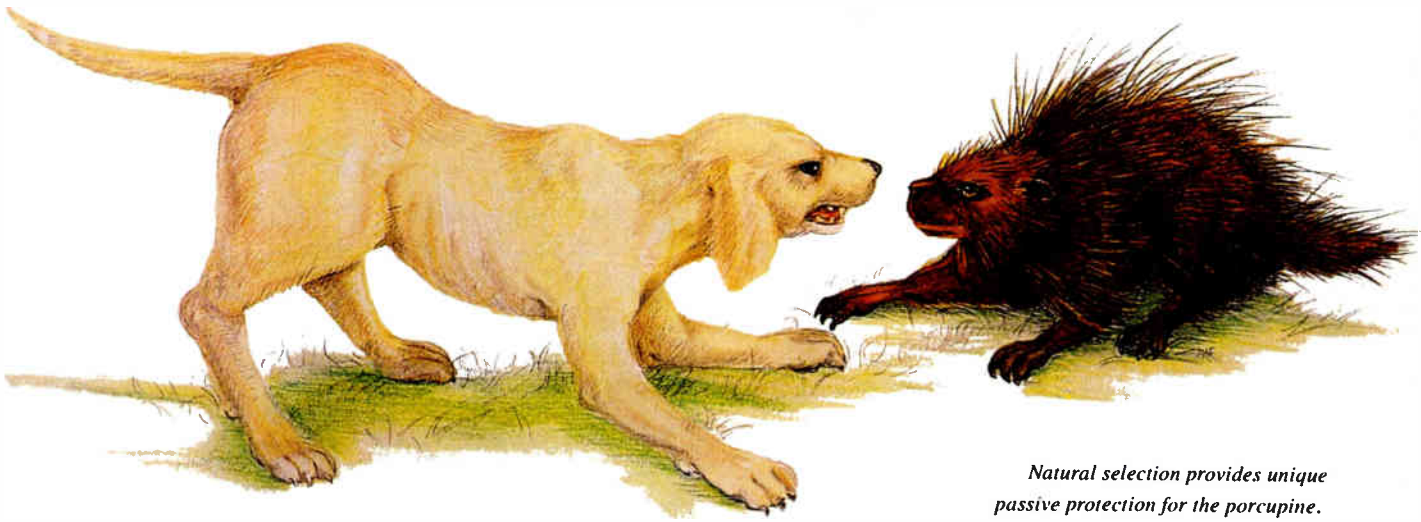

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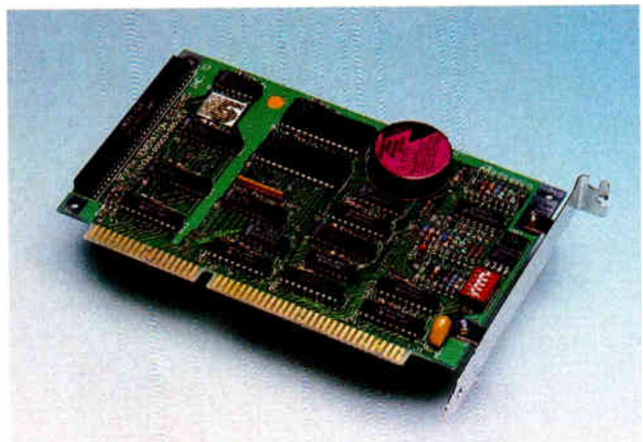

THE FACTS	
Counterpart $495 *Requirements:* IBM PC with two hard disk drives and DOS 2.1 or higher (DOS 3.3 or higher for multiple logical drives).	Fifth Generation Systems, Inc. 11200 Industriplex Blvd. Baton Rouge, LA 70809 (504) 291-7221 **Inquiry 1029.**

Counterpart card. And thankfully, the second drive doesn't have to be identical to the primary drive, as long as it has at least the same capacity.

I found installing the second drive the most difficult part of the process. I had to track down a cable that would handle two drives and then puzzle over setting the disk-select jumpers on the drive. But once that chore was finished and the new drive was formatted and partitioned, I ran a preinstallation program that checked the interrupts in my system and told me how to set the jumpers on the Counterpart card. Then I plugged in the card (there's nothing to connect to it).

Fifth Generation Systems' automatic installation utility made the final steps a breeze. I set up password protection for my system but chose not to encrypt all data on the drive. After rebooting the system, Counterpart went quietly to work, backing up all the data on my primary drive to the new drive. Then I performed the ultimate test, pulling the power connector on my primary drive while it was doing a database sort. The system didn't miss a beat, automatically switching to the second drive. The card also started beeping, telling me that there was a problem with my primary drive.

Disk mirroring has been used in large computer systems for many years, especially for critical applications like on-line banking, where system downtime or data loss can be an unmitigated disaster. Counterpart brings this level of security down to the world of PCs. Best of all, it's easy to install.

Counterpart isn't for everyone. I think that its $495 price is a bit high. And when you add the cost of the required second drive, the total cost of adding disk mirroring and security to your system can easily top $1000. And I still back up my data to tape. But if you use your system for critical applications, Counterpart will surely give you that hard-to-find peace of mind.

—Stan Miastkowski ■

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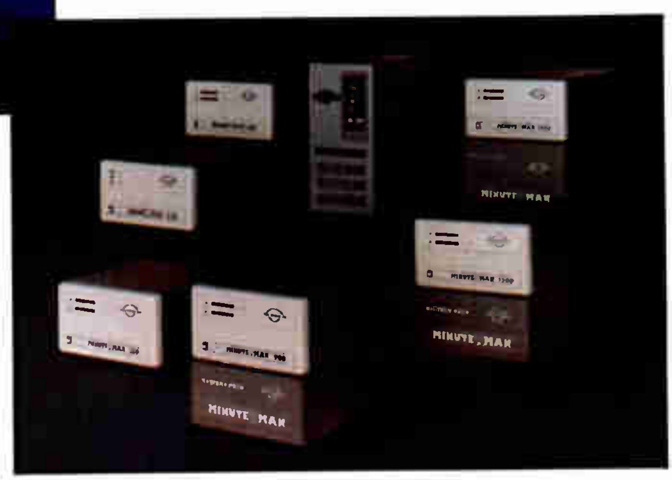

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Apple's 32-Bit QuickDraw Covers the Spectrum

An update to the Mac's System software advances color imaging for microcomputers

Editor's note: *What follows is a hands-on appraisal of 32-Bit QuickDraw. Tom Thompson has written a follow-up article that will appear in a subsequent issue. It provides technical background and describes in greater detail how 32-Bit QuickDraw works.*

With the introduction of 32-Bit QuickDraw, Macintosh II and SE/30 users are now able to produce photo-quality images with a virtually unlimited choice of colors. Several graphics board vendors already have products available that take advantage of 32-Bit QuickDraw's capabilities. Unfortunately, there is a downside to this newfound power: It's expensive to fully exploit.

When Apple upgraded Color QuickDraw, the Mac II family's core graphics primitives, the company needed to extend the capabilities of existing routines while retaining compatibility with existing Mac applications. Many of these new extensions had to handle 32-bit addresses or data values—hence the name 32-Bit QuickDraw.

The most important of these extensions is that 32-Bit QuickDraw routines can now operate with pixels larger than 8 bits: Color pixels can now be 16 bits (with 15 bits of color information) or 32 bits (with 24 bits of color information). This means that the Mac is no longer limited to 256 on-screen colors; it can display thousands of colors (32,768 for 15 bits) or its entire color palette (16,777,216 colors for 24 bits) on-screen with the appropriate video hardware. With this range of colors, a Mac can generate photo-quality images. The data for these images could come from a scanner or from the output of a complex simulation, such as the exhaust flow in a rocket nozzle.

However, displaying high-quality images by itself is not enough. These new features must fit into the day-to-day graphics operations that many a Mac user relies on. Other 32-Bit QuickDraw extensions let you cut and paste these images into other application windows or documents, and a revision to the color picture definition format allows you to save these images to a disk file. A new LaserWriter 6.0 driver now supports color PostScript devices, such as the QMS ColorScript 100 and the Tektronix Phaser CPS printers. The new driver also allows color images to be printed as halftones on monochrome PostScript printers. Finally, even the typical user benefits: Performance in the 2-, 4-, and 8-bit screen modes has been improved.

The Components of Color

The new QuickDraw runs on any 68020- or 68030-based Mac running System 6.0.3. To install it, you simply copy the files in the 32-Bit QuickDraw package to the System Folder and restart the computer. The package consists of a disk with seven files. You can obtain this disk from your Apple dealer, or the files will be included with products that require 32-Bit QuickDraw.

The 32-Bit QuickDraw file contains the QuickDraw extensions. It is not an

continued

Photo 1: *32-Bit QuickDraw in action. The image has 24 bits of color information that was captured using a Howtek Scanmaster scanner.*

Table 1: *The BYTE Small-C video benchmark test results. All times are in seconds. All tests were conducted on a system where there were no INITs or special cdevs, MultiFinder was not in use, and AppleTalk was disabled; (32) indicates that 32-Bit QuickDraw was in use. The CPU's code cache and, where applicable, data cache, were disabled. See the text for a discussion of the results.*

Mac II

Mode	Text		Graphics	
	TextEdit	DrawString	Slow Graphics	QuickDraw
32-bit	42.94	33.06	33.33	0.72
8-bit (32)	15.73	9.42	34.81	0.57
8-bit	14.45	8.4	134.02	0.61
4-bit (32)	11.17	5.52	35.0	0.55
4-bit	10.45	4.95	99.3	0.57
2-bit (32)	9.13	3.77	35.31	0.53
2-bit	8.5	3.23	82.29	0.58
1-bit (32)	9.8	4.28	31.27	0.48
1-bit	7.32	2.26	58.89	0.5

Mac IIcx

Mode	Text		Graphics	
	TextEdit	DrawString	Slow Graphics	QuickDraw
32-bit	38.80	30.07	30.42	0.62
8-bit (32)	13.99	8.57	31.63	0.48
8-bit	12.87	7.67	116.48	0.51
4-bit (32)	9.79	4.96	31.86	0.47
4-bit	9.17	4.51	76.94	0.49
2-bit (32)	7.92	3.35	32.12	0.47
2-bit	7.37	2.87	70.67	0.49
1-bit (32)	8.44	3.63	28.65	0.42
1-bit	6.27	2.01	50.59	0.43

INIT: Instead, it contains several "ptch" resources you use to patch System resources and the Mac Toolbox, and a "PACK" resource with a new version of the Color Picker designed to handle the wider range of colors. These patches replace parts of Color QuickDraw and the Slot Manager and take up about 120K bytes of RAM on the system heap. The Mac must be running System 6.0.3, which detects the presence of the 32-Bit QuickDraw file and installs the patches. If this process succeeds, the file's black-and-white icon turns into a colored one.

The Monitors cdev file now supports video boards that handle the new large-pixel formats. If your system has a 32-bit-deep video board in it, you use this cdev with the Control Panel to select a screen depth ranging from 1 bit deep (dull aesthetically since the screen is black-and-white, but blazingly fast on screen redraw) to 32 bits deep (magnificent colors, but with slower screen redraw). Or you can select screen depths between these two extremes (2, 4, 8, and 16 bits, depending on the video board) to achieve a reasonable compromise in color fidelity and display speed. While this might seem like a simple enhancement, it wasn't, because the method of displaying large pixels differs from that of 8-bit or smaller pixels.

The changes to the General cdev file are internal and not accessible to the user. Specifically, a bug has been fixed, and this cdev now interacts with the Mac color environment in a way that doesn't disturb the current palette of colors.

The modifications to the laser printer files let you print deep images on monochrome or color PostScript devices. The LaserWriter 6.0 file has a new pop-up menu in its Page Setup dialog box that lets you select custom page sizes. This is handy for those color PostScript printers that have a page-image area different from that of Apple's printers.

The LaserWriter dialog box has two new radio buttons: Color/Grayscale and Black & White. The first button indicates that the output device supports color or gray-scale PostScript printing. If the second button is selected, the driver resembles the older LaserWriter 5.2 driver. You would use this selection to maintain compatibility with those applications that assume a black-and-white graphics port (`grafPort`) during printing operations, or to speed the printing process for those situations that would benefit by it (line drawings or text-only documents).

You don't need a 16- or 32-bit video board to make use of 32-Bit QuickDraw. As mentioned earlier, the display speed at the "shallower" (2-, 4-, and 8-bit) modes has been improved. You can also view "deep" or "true color" (16- or 32-bit) images with just an 8-bit board: 32-Bit QuickDraw renders these images at the current screen depth, using either best-match or dithering algorithms.

However, if you plan to use a graphics package that manipulates true colors, you'll want a video board that can display the full range of colors. Apple currently does not offer such a board, but several third-party vendors do: Radius, SuperMac Technology, and RasterOps. The cost of viewing true color is not cheap: Prices for this type of video board start at about $3500 and can go over $5000.

All these new features use memory. The patches consume space on the system heap. And the larger pixels themselves use more memory: double the RAM over an 8-bit image for 16-bit pixels and four times the RAM for a 32-bit-deep image. Apple recommends that a Mac running 32-Bit QuickDraw have a minimum of 2 megabytes of RAM. If you work with deep images on a large display, plan on needing more.

Seeing Colors

Apple provided an alpha version of 32-Bit QuickDraw. SuperMac Technology loaned us a full-chunky Spectrum/24 board that displays 32-bit, but not 16-bit, pixels. This board drove one of its 19-inch color monitors. To evaluate the software, I used a Mac II with 2 megabytes of RAM and a Mac IIcx with 4 megabytes of RAM, both running System 6.0.3. At times, I also connected an Apple Portrait Display monitor using its 16-color video board to see how well the software handled depth conversions of images as they were moved across screens.

Connectix's virtual memory INIT broke right away, and I had to disable it to get the system to boot. This was expected, since Connectix had informed me that its product was not 32-bit clean and that the company plans a fix.

The rest of the INITs worked just fine.

I was pleasantly surprised to find that most screen-saver INITs, such as Blackout and Moire, functioned. Most applications worked with no problems, although there were a few exceptions.

SuperPaint 2.0 crashed if I shuttled a window between screens unless I set it to only the Preferences to use QuickDraw operations. Some graphics applications write directly to the screen to boost performance, but for the sake of compatibility, they ought to use QuickDraw functions when required. It's a nice option for an application to have, and I'm glad to see it in SuperPaint. MacDraw 1.1 could use it: In the 32-bit mode, it draws the windows and the controls properly, but the window's content region is a blizzard of parti-colored snow.

Drawing activities on the screen were noticeably slower, but not sluggish. The drawing operations are certainly faster than those on a 24-bit chunky/planar board I've worked with. The drawing speed is influenced by the size of the area to repaint: Menus snapped down smartly enough, but large images took several seconds to draw. Remember that I was working with a large screen with a large area to paint, however.

To generate 32-bit-deep color images, I used a Howtek Scanmaster color scanner and SuperMac Software's PixelScan 2.0 application. You simply clap a photo to the scanner's bed, tell the PixelScan application to scan, and in several minutes a breathtaking image as detailed as the photo itself appears on the screen. Images seem to jump off the screen at you with their realism (see photo).

PixelScan lets you save these images to PICT files, and they're about three times the size of PICT files storing the same image as 8-bit indexed pixels. (32-Bit QuickDraw has a packing scheme that clips that fourth alpha channel byte from the pixels when the image is saved to disk.) But even with this type of packing, a small 32-bit-deep image takes about half a megabyte or more of disk space, and I easily made files that were several megabytes in size. Nevertheless, this combination of scanner hardware and the Mac definitely makes for plug-and-play imaging technology.

I had no problems using the Mac IIcx with 4 megabytes of RAM. But on the Mac II with 2 megabytes of RAM, certain applications wouldn't load because there wasn't enough memory. If you want to use 32-Bit QuickDraw with graphics applications, plan on having 4 or more megabytes of RAM in the system.

To accurately gauge the performance of the deep display, I ran version 1.2 of BYTE's low-level graphics and text benchmarks (see table 1). In the shallow screen modes, the graphics tests indicate a performance boost at every screen depth with 32-Bit QuickDraw installed. The Slow Graphics benchmark indicates that pixel manipulation is certainly faster. The small spread in the times using 32-Bit QuickDraw for this benchmark indicates that the application has become CPU-bound: It's the code execution and not graphic I/O that takes most of the execution time. The QuickDraw test shows that 32-Bit QuickDraw operations are faster in the shallow modes. This benchmark also shows that these operations take longer in the 32-bit mode, but not by a large margin.

Both text benchmarks indicate that the speed of drawing text has slowed in 32-Bit QuickDraw. This won't be a problem for typical word processing tasks, since you'd normally perform such work using a shallow screen setting anyway. But it might be a problem for color prepress applications that typically display a page with a combination of deep color images and text. However, at this stage of 32-Bit QuickDraw's development, I can understand that the software engineers would want to optimize QuickDraw's graphics speed first and concentrate on text performance later.

There are some caveats to these numbers. First, the software and the board's firmware were both undergoing changes. I got several software updates and one configuration ROM during the course of this article. Second, the code cache (and data cache on the 68030) were disabled, so these numbers can be considered worst-case figures.

My overall impression is that 32-Bit QuickDraw is slower in the deeper screen modes, but not prohibitively so, even with a large screen. While you might not do real-time animation in the 32-bit mode, its response time makes it quite usable for graphics design or painting applications. It's an impressive piece of software when you consider the amount of data the Mac works with just to draw the deep screen.

Over the Rainbow

With 32-Bit QuickDraw, the Mac II family and the Mac SE/30 can serve as serious image-processing engines. They can now tackle complex graphics simulations performed routinely on high-end workstations or mainframes, such as processing medical or satellite imagery or electronically retouching and adjusting the color of photos for darkroom work or

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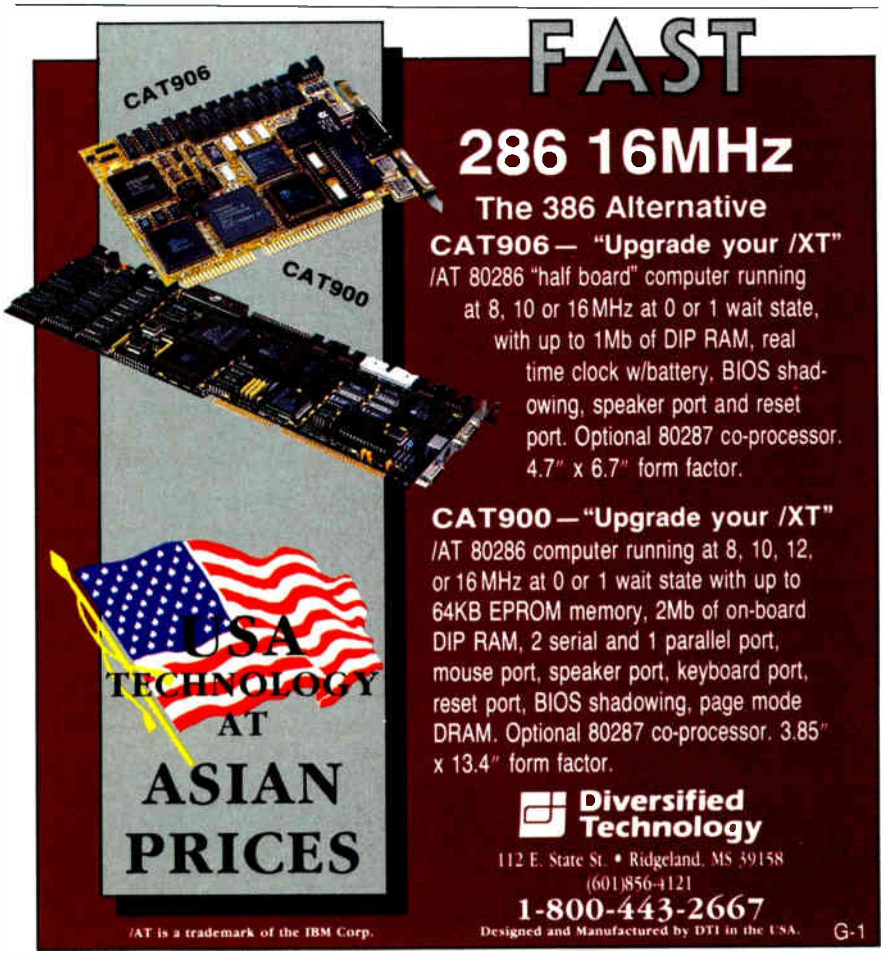

color prepress applications.

However, the cost of this capability is quite steep. SuperMac's Spectrum/24 video board alone costs $3999. This is on top of the cost of the Mac, a color monitor, and the additional RAM and disk space you'll need. If this cost seems prohibitive, remember that Apple has put a lot of effort into making 32-Bit QuickDraw serve up respectable imagery on an 8-bit-deep screen. Even if you're a typical Mac user, you might use 32-Bit QuickDraw to get a performance boost at the shallower screen modes.

Do you really need thousands or millions of colors? After all, if you lit every pixel with a different color on a 19-inch 1024- by 768-pixel display, you could display only 786,432 colors at once. To display all 16.8 million colors at 72 dots per inch, you'd need a screen that's nearly 4¾ feet to a side. But that's missing the point: What it means is that a 19-inch monitor can show thousands of colors, not just 256. It makes a big difference in how images look on-screen.

This capability becomes crucial when you consider printing the image. While Mac monitors have a resolution of 72 dpi, PostScript printers start at 300 dpi and go up to 2540 dpi. With these output densities, even a standard 8½- by 11-inch page at 300 dpi comes close to holding the range of colors possible using 16-bit pixels, and, at 2540 dpi, the color range possible requires the use of 32-bit pixels. Color printing certainly needs the capabilities of 32-Bit QuickDraw, and it's no surprise that Apple introduced a printer driver to support it.

Apple's 32-Bit QuickDraw extends imaging technology for microcomputers. It takes the manipulation of photo-quality images out of the darkroom and puts it onto the desktop. The new LaserWriter driver ensures that these images reach a printer when necessary and makes it useful for color prepress or other color printing technologies. It does so, however, by making large demands on the Mac's resources in terms of RAM, storage, and display. But for those people whose work needs the full spectrum of colors, 32-Bit QuickDraw now lets them accomplish it on a

ACKNOWLEDGMENT

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Tom Thompson is a BYTE senior technical editor at large. He can be reached on BIX as "tom_thompson."


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Clash of the Object-Oriented Pascals

Quick Pascal and Turbo Pascal 5.5—fast, friendly Pascal compilers with object-oriented extensions

Microsoft's and Borland's new Pascal products took me completely by surprise. Both start where Turbo Pascal left off to create a true object-oriented language.

Quick Pascal from Microsoft ($100), scheduled to ship last May, closely follows Apple's Object Pascal. Turbo Pascal 5.5 from Borland ($150), also scheduled to ship in May, likewise draws on Object Pascal, but it adds some ideas from C++ and some original features.

Why my surprise? Well, I thought that the language giants' first OOP (object-oriented programming) products would test the C++ waters into which other vendors, such as Zortech, have ventured. C++ projects are probably on the drawing boards at Microsoft and Borland, but in the meantime the new Pascals are nice environments in which to explore OOP. It seems appropriate that Pascal, the language that taught one generation of programmers about structured programming, may in a new guise teach another generation about OOP.

A true object-oriented language must support both encapsulation and inheritance. Encapsulation means that the language provides a way to combine data and the code that operates on that data into reusable structures. But that's not enough. Although Ada's packages and Modula-2's modules support encapsulation, these are not object-oriented languages in the modern sense. Inheritance, which is the ability to derive a specialized structure from a more general one, is the crucial ingredient.

Like Object Pascal, Quick Pascal and Turbo Pascal 5.5 implement inheritance by means of a new Pascal type called *object*. Like a Pascal record, an object can hold data of varying types. But an object can also contain *methods*—Pascal procedures or functions—that operate on the object's data. Moreover, an object can inherit data and methods from another object, add new data and methods, and (if necessary) override the inherited methods.

Although subtle differences exist between the object-oriented dialects that the two products implement, they are comparable in scope and power. They don't offer the generality and conceptual wholeness of a pure object-oriented language like Smalltalk, in which everything is either an object or a message. But these are in no sense toy languages. The benefits of the object-oriented extensions will be immediate and tangible.

Consider a family of objects that define files of various types and operations on files. A root object, File, might define data (`Position`, `Length`, `CreateDate`) and methods (`GetByte`, `PutByte`, `SetCreateDate`) that are common to all files. Derived objects `MagDiskFile` and `NetworkFile` might then inherit File's data but redefine its methods in a manner appropriate to the medium at hand.

Suppose now that all these objects are compiled (using Quick Pascal or Turbo Pascal 5.5) and distributed as a standard unit called Files. Suppose further that you purchase the Files unit and want to add support for a new kind of file, an `OpticalDiskFile`. You can, without access to the Files unit's source code, acquire its data and methods, define the object `OpticalDiskFile`, and implement the new object with a minimum of effort by overriding only the methods concerned with specific characteristics of an optical drive.

A system like this has two remarkable properties. First, you don't need to write any code to implement `SetCreateDate`. Since `SetCreateDate` concerns itself with an abstract property of File, it's not necessary to change File's `SetCreateDate` method. `OpticalDiskFile` can simply inherit it. Second, although you'd have to write a new implementation of `GetByte` and `PutByte`, because these methods talk to a physical device, you wouldn't have to change any programs that use the interface to the File unit. Programs that call `GetByte` and `PutByte` can continue to do so, blissfully unaware that they might now be talking to an optical drive rather than to a magnetic disk or network pipe.

Quick Pascal: Turbo Pascal with Objects

If you're familiar with Turbo Pascal, you'll experience a sense of déjà vu when you fire up Quick Pascal's integrated environment. The two products look and feel strikingly similar. A text editor dominates the environment; from it you access the compiler and debugger. When you're editing Pascal source code, help is context-sensitive. If the cursor is on the word `Crt`—the name of a library of utility routines—the help key brings up a list of the routines in that library.

When you activate the compiler and it encounters an error, Quick Pascal puts the cursor at the right spot to fix it. If the current file refers to other units (the Turbo Pascal equivalent of packages or modules), you can transitively compile the whole network of units. Once a program compiles cleanly, you can either run it or debug it. With the debugger you can step line by line through the source code and see the values of selected variables in a watch window.

Like Turbo Pascal, Quick Pascal provides an escape from the sometimes overwhelming embrace of its integrated environment in the form of a command-line version of the compiler. That's fortunate for me because I'm much more productive with my own text editor and a stand-alone compiler than with any of the integrated environments I've seen. The command-line versions of Turbo Pascal 5.5 and Quick Pascal offer a virtually identical set of switches for controlling stack checking, debugging information, and floating-point arithmetic. However, Quick Pascal doesn't provide a stand-alone debugger (as Turbo Pascal does), so if you want to debug a program, you have to use the integrated environment.

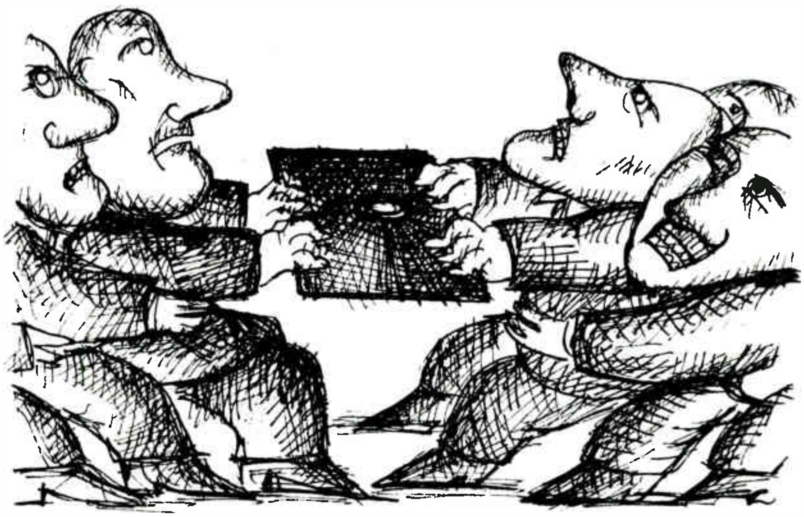
Quick Pascal supports the keywords `unit`, `interface`, `implementation`, and `uses`. This syntax, which Borland introduced with Turbo Pascal 4.0, encourages the construction and use of libraries (units) that export the definitions of useful routines (the `interface`) to any program that acquires (`uses`) these libraries, while hiding the details of the code (the `implementation`). Quick Pascal offers most of the standard units that Turbo Pascal does: `Crt` (screen and keyboard routines), `Dos`, `Printer`, and `Graph`.

Although there's also an `MSGraph` unit that provides an alternate interface to the graphics routines, Quick Pascal's `Graph` unit is, essentially, the BGI (Borland Graphic Interface). And sure enough, Quick Pascal compiled and ran Borland's graphics demo, BGIDEMO.PAS, almost flawlessly. Microsoft has clearly launched a frontal assault on Borland's flagship product.

Quick Pascal's Windows-like behavior relieves the sense of sameness. Unlike Turbo Pascal, Quick Pascal—although character-based—sports windows with mouse-sensitive drag bars, scroll bars, grow boxes, and close boxes. At a resolution of 80 columns by 25 rows, the visual effect is less than spectacular, but the mechanism nonetheless can be useful. If you don't have a mouse, you can, of course, do everything by way of the keyboard; the program supports the normal Microsoft Windows conventions.

Turbo Pascal 5.5: The New Generation

Although I've owned a copy of Turbo Pascal 2.0 since 1985, it's been years since I took it out of mothballs. For this review I dusted it off and compared it to Borland's latest offering; the changes are impressive. Over the years, Turbo Pascal has acquired a number of important features—separately compiled units, a graphics toolkit, a multiwindow interface, and an extremely powerful debugger. Borland has now added object-oriented extensions that are quite similar to the ones offered by Microsoft but in several respects more useful.



Borland's OOP implementation encompasses Microsoft's and adds static methods, more flexible dynamic allocation of objects, and implicit access to objects' data and methods. Each of these features takes a bit of explaining.

Methods like the Files unit's `GetByte` and `PutByte` exemplify what's called late binding. When the unit compiles, the addresses of these routines can't be known because, as I explained in the case of `OpticalDiskFile`, the code may not yet exist. In Turbo Pascal 5.5, you declare such methods with the special keyword `virtual`; a call to a virtual method binds late—that is, at run time. You've seen the flexibility this technique confers. There are costs as well. Objects must store pointers to their methods, and the run-time system has to use those pointers to locate and execute methods. Moreover, all virtual methods that share the same name (e.g., `File.GetByte`, `Network.GetByte`, and `OpticalDiskFile.GetByte`) must declare the same number and types of arguments.

In Quick Pascal, all methods are `virtual`; there's no other alternative. In Turbo Pascal 5.5, methods are static, or early-bound, unless you specifically request otherwise. Because they're embedded in objects, static methods should be a little slower than normal Pascal procedures and functions, but because their addresses are known at compile time, they should be a little faster than virtual methods. In fact, that's just what I found when I timed 1 million Turbo Pascal 5.5 procedure calls (4.1 seconds), static method calls (5.7 seconds), and virtual method calls (6.1 seconds). Equivalent times for Quick Pascal were as follows: procedures, 4.1 seconds; static methods, not applicable; virtual methods, 6.7 seconds.

Although Turbo Pascal 5.5's static methods are more efficient than virtual methods, they are not overwhelmingly so, and speed isn't a compelling reason to use them. Convenience is. Suppose the File object has an `Initialize` method. The objects you derive from File may require different quantities and types of data in order to initialize themselves. For example, in one case you might want to call

```
MagDiskFile.Initialize(name,
   bufsize)
```

and in another case,

```
OpticalDiskFile.Initialize(name,
  buf1size, buf1address,
  buf2size, buf2address)
```

Turbo Pascal 5.5's static methods permit that.

Subtle Differences

In Quick Pascal, objects behave like dynamic variables. To get hold of an instance of `MagDiskFile`, you first declare a variable of that type, then call `new` to allocate storage for it:

```
var
  MyFile : MagDiskFile;
begin
  new(MyFile);
```

In Turbo Pascal 5.5, objects behave like static variables. To create an instance of `MagDiskFile`, you only need to do this:

continued

ILLUSTRATION: MACIEK ALBRECHT © 1989

```
var
  MyFile : MagDiskFile;
```

You can also choose to allocate an instance dynamically, using Pascal's normal pointer syntax:

```
var
  MyFilePtr : ^MagDiskFile;
begin
  new(MyFilePtr);
```

Moreover, Borland has extended the syntax of new so that it works with another keyword, constructor. Constructors (and their counterparts, destructors) come from C++. In that language, you can write code that will automatically execute at the beginning and the end of an object's lifespan. An object typically requires dynamic memory to fulfill its mission; constructors and destructors are convenient places in which to localize the allocation and release of that memory.

Turbo Pascal 5.5's extensions to new are threefold: You can pass new a pointer type rather than a pointer variable; you can pass an optional second argument that is a constructor; and you can return the pointer value that new creates:

```
type MagDiskFilePtr =
    ^MagDiskFile;
var MyFilePtr : MagDiskFilePtr;
begin
  MyFilePtr := new
    (MagDiskFilePtr,Initialize
    ("myfile", 1024));
```

The equivalent operations in Quick Pascal are as follows:

```
var MyFile : MagDiskFile;
begin
   new (MyFile);
   MyFile.Initialize("myfile",
     1024);
```

So what's the big advantage? In this case, there is none. But consider what happens when you want to manipulate more than one object of type MagDiskFile. In Turbo Pascal 5.5, MyFilePtr refers to an object only indirectly. The object that it points to is anonymous. Therefore, you can dynamically allocate and initialize a list of object instances like this:

```
for i := 1 to FileCount do
  FileList.Add (New
    (MyFilePtr,Initialize
    (FileName[i],1024)));
```

where FileList is an object that takes a pointer to an object of type File (or to any of File's descendants) and adds it to a list of such pointers.

In Quick Pascal, though, MyFile refers directly to an object. To create and initialize three instances, you'd have to do this:

```
var MyFile1, MyFile2, MyFile3 :
    MagDiskFile;
begin
  New(MyFile1);
  New(MyFile2);
  New(MyFile3);
  MyFile1.Initialize("myfile1",
    1024);
  MyFile2.Initialize("myfile2",
    1024);
  MyFile3.Initialize("myfile3",
    1024);
```

Turbo Pascal 5.5 also provides a parallel extension to dispose. You can pass dispose a destructor, so in a single call you can activate an object's shutdown method and then free its memory.

Another convenience that Turbo Pascal 5.5 provides has to do with how an object accesses its own data. Here's what Initialize would look like in Quick Pascal:

```
procedure Initialize (InitName :
     string; InitBufsize :
     integer);
begin
  Self.Name := InitName;
  Self.Bufsize := InitBufsize;
  Self.SetCreateDate;
end;
```

Initialize assigns values to the object's Name and Bufsize slots and calls its SetCreateDate method. But in order to gain access, Initialize, even though it already belongs to the object, must qualify everything with Self—which simply affirms, "yes, go ahead and operate on *this* object." Turbo Pascal 5.5 makes Self implicit, so the equivalent method is just:

```
procedure Initialize (InitName :
     string; InitBufsize :
     integer);
begin
  Name := InitName;
  Bufsize := InitBufsize;
  SetCreateDate;
end;
```

It's a small thing, but once you've spent some time with Turbo Pascal 5.5, it's annoying to move to Quick Pascal and have to type "Self" constantly.

Choose Your OOP

The release of these two excellent products will do much to advance the cause of OOP. I'd recommend either of them over C++ for a gentle introduction to what is in many ways a bewildering subject. But which one? For me, it's no contest: I'd pick Borland's Turbo Pascal 5.5.

Points in Quick Pascal's favor include excellent speed, graphics, a Windows-like environment, an integrated debugger, on-line help, and the object-oriented extensions. Of these, the only feature unique to Quick Pascal is the Windows-like environment. That doesn't weigh heavily with me, though; since I don't depend on a mouse for my daily work, I find Turbo Pascal's keyboard-driven windowing environment just as useful.

Turbo Pascal 5.5 matches or betters Quick Pascal in all other respects. It's faster—though you'll need a very big program before either of these products will make you wait long. Its on-line help is better organized. Where Quick Pascal just displays the interface part of, for example, the Crt unit, Turbo Pascal 5.5 gives you a list of names of routines in that unit. When you select a name, you get another screen with the procedure header and descriptive documentation.

Although the two integrated debuggers match one another on a feature-by-feature basis, Turbo Pascal 5.5 also comes with Borland's justly renowned stand-alone debugger. Unlike either of the integrated debuggers, the Turbo Debugger can trace a mixture of source and assembly code and can inspect complex variables (e.g., unpack nested records and follow chains of pointers). Borland has now added a new OOP-related feature—an object hierarchy inspector. This tool displays and traverses a family of objects. It can inspect data belonging to an object and identify the object's methods. It's very impressive and gives Turbo Pascal 5.5 the feel of a Smalltalk system.

Finally, although the two OOP dialects are roughly equivalent, Borland's encompasses Microsoft's and adds several quite useful conveniences. The battle isn't over. Object-oriented technology is on the march and will doubtless soon appear in other forms. There's little hope of mastering the complexities of modern graphical environments without the leverage that OOP provides. But while there's no telling what surprises the two companies may have in store, this round goes to Borland. ■

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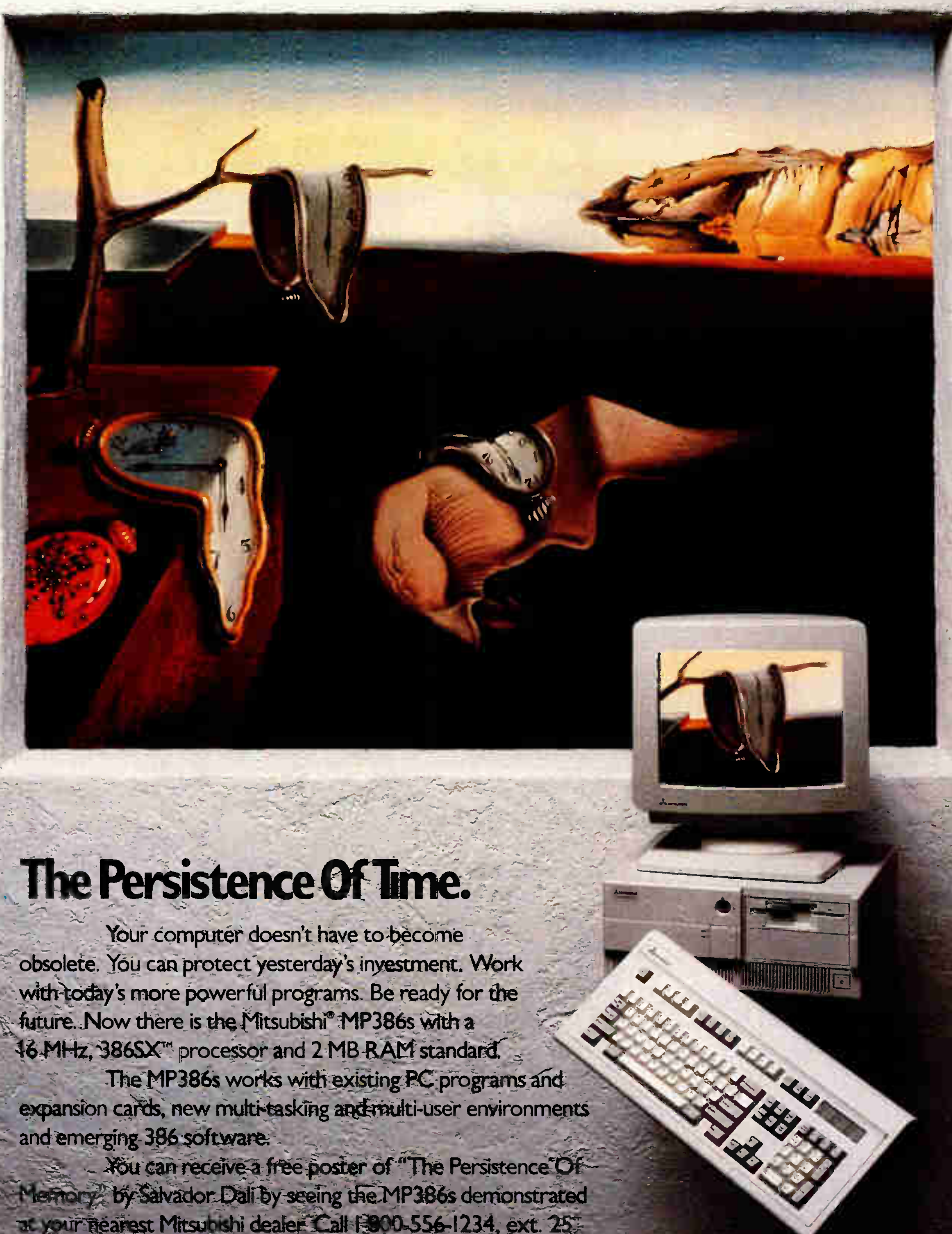

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COMPUTERS VS. TAXES

Jerry wages his annual battle with taxes and breaks in a new Northgate computer

Well, I survived doing my income tax. It wasn't easy. Because of trips and deadlines and a touch of Chicago flu, I found myself *starting* on Friday, April 14, with not all my income, cash, and credit card expenditures *entered* into my accounting system, much less posted off into their proper ledger pages. Worse, just about everything I did have entered was on 8-inch disks—and I didn't have an 8-inch drive.

Of course, it was all my fault. For years I have kept my accounts on the Golem, a big CompuPro Z80/8086/80286 machine running Concurrent CP/M. The Golem has an integral 8-inch floppy disk drive as well as a 360K-byte 5¼-inch DOS drive; you can easily see which one I got into the habit of making backup files on.

As it happens, the Golem was shipped up north to CompuPro for a complete upgrade. He's getting an 80386 CPU card, a new hard disk drive, and a number of other features, and will be, in the words of some of the kids who hang out around here, "just awesome." I carefully copied all the important files onto 8-inch disks and sent the machine away. It took longer to get him back than I'd figured, so there I was.

Transferring the files wasn't much of a problem. Barry Workman offers that service, and he's only half an hour away. Then I had to recompile all my accounting programs.

For some of them, those written in CBASIC2 for CP/M, it was trivial. Just compile (type CB86 FILENAME) and link (LINK86 FILENAME), and you're done. There are various compiler toggles I don't remember—one suppresses sending the listing file to the screen—but none of that mattered. The programs recompiled and ran flawlessly.

Others weren't so simple, since I had, for unaccountable reasons, written them in Microsoft BASCOM for CP/M, and Microsoft QuickBASIC isn't quite compatible with that. In particular, you'll want to pay a lot of attention to any IF...THEN statements with multiple consequences. There were also a bunch of odd errors: programs would compile, but they had errors when run. I'd eventually trace those down, but the error often didn't relate at all to the error message. In one case, I was trying to read in a file as "D:Filename" while logged onto a subdirectory in D. I should have got a "Bad File Name" error, but instead I got "String Space Corrupt." There were others of that kind.

A warning to QuickBASIC 4.5 users: if you get what you think are impossible error messages, they probably are. Look for something else entirely. It will probably be silly.

I also noticed something else. CBASIC2 executable files are much smaller than those produced by QuickBASIC 4.5. As an example, the CBASIC2 source file for JOURNAL is 31K bytes; it's certainly the most complicated program in the entire accounting suite. The .EXE file produced by CBASIC2 is only 36K bytes long. ALLOC, a much simpler program that uses a small subset of the same code as JOURNAL (it reads in a big composite journal file and allocates the entries to smaller files sorted by date), is 8.5K bytes in source code, but QuickBASIC 4.5 makes an .EXE file 65K bytes long!

QuickBASIC 4.5 has records (although I don't use them in the accounting programs) and a few other such features, but if I were going to write many more programs in BASIC, I'd seriously consider ignoring both QuickBASIC 4.5 and Turbo Basic and working in CBASIC2; it's still a real contender, especially if it's augmented by CBC Tools from Minnow Bear Computers.

On the other hand, I did get all my files converted, except for some whose source code I had foolishly never saved off the Golem's hard disk. Actually, I do have the code, but it's in one or another box of 8-inch disks that are stored away; it wasn't saved onto the disk that I thought it was on.

The upshot was that I did not have the code for my depreciation programs; all I had was a memory of what they did. Starting from scratch, I was able to recreate those programs in QuickBASIC 4.5 in about 2½ hours. Of course, I had samples of the input and output to them from my past years' tax returns; I wasn't designing the program. Even so, it's an impressive testimonial to the power of the QuickBASIC 4.5 environment. I know I couldn't have done it anywhere near that quickly with CBASIC2, especially late at night with fatigue poisons slowing me down.

MacInTax and TaxView

By working through the night, I was able to get nearly all the accounting part of my tax reports done. I still had a few hours of work entering stuff, but since April 15 fell on a Saturday this year, I had until midnight April 17 to get the things done. (I know about extensions. All I can say is that I'm compulsive.)

I figured the hard part was over.

True, Monday morning's paper was full of stories about people going mad over the new tax code, but I wasn't worried. I had a secret weapon: an unopened box from SoftView. I've used SoftView's MacInTax for several years now, enough so that I have enormous confidence that no matter how complex your tax returns—and mine are *very* complex, what with limited partnerships that make small profits but require an amazing

continued

amount of paperwork, and stuff like that—MacInTax will take care of it. I've said often enough that it's worth getting a Mac if all you do with it is run MacInTax; and I have a Mac complete with the LaserWriter IINTX. MacInTax not only figures your tax returns, it also prints the forms for you.

I didn't even hurry. Consequently, it wasn't until after dinner that I opened the box—and discovered to my horror that what I had wasn't MacInTax for the Mac but TaxView for the IBM PC.

OK. My fault, of course. SoftView has no obligation to send me their products year after year. I know they work, and I jolly well could just go *buy* a copy of MacInTax, and indeed I would have if I hadn't had a big box prominently marked "Jerry's 1988 Tax Programs" put off in the "Don't anyone *ever* touch this" area. The point was, though, I hadn't, Egghead and Priority One were closed, and the deadlines were coming.

There was nothing for it but to try TaxView.

TaxView is SoftView's Windows implementation of MacInTax. To get it running, you must first install the run-time portion of Microsoft Windows. Therein lies the first rub: Windows isn't easy to install.

First, you must prepare. If you use DESQview, dump it. Get rid of every TSR program you have. Later, you may want to add them, but when you're first installing Windows—even the run-time package—the last thing you need is complications. Make your system as vanilla as possible.

Be warned. The instructions look as if they're clear. They look as if they were written for rank beginners. Alas, they aren't really. For example, at one crucial point, the system tells you what it thinks it's looking at. In particular, it says it thinks you have a Microsoft Mouse. Well, I don't have a Microsoft Mouse in Big Cheetah. I have a Logitech Mouse, with a Microsoft Mouse emulator. I read the screen report as saying that Windows had tested the system and decided my mouse was acceptable, and I told Windows to proceed.

It did proceed, for quite a long time, and eventually locked the system so thoroughly that I had to use the hardware reset button. Next time, I told it I had a Logitech Mouse. It accepted that and trundled along. I forget what went wrong that time.

I went through several more iterations. In between I was, I fear, rather impolite to SoftView's answering service. Eventually, I got put through to a SoftView technician. (I shamelessly pulled rank; look, I was desperate.) After that, things went swimmingly. In 7 minutes, I was talked through the installation complexities—all of them due to Windows, not TaxView—and was looking at a screen nearly indistinguishable from the MacInTax I know and love.

There are a few other anomalies. A few things don't work the same way in TaxView as in MacInTax; once again, it's entirely due to Windows. More important, they *do work*. In about 2 hours, I had the silly tax forms filled out and told TaxView to print them on my (quite vanilla) LaserJet Plus. There were no problems at all. It does take quite a while before printing begins—TaxView thinks to itself for several minutes before sending even the first byte to the printer—but eventually out they came, page after page of tax forms and schedules.

So, as I said, I survived my taxes. I'd

continued

still rather use MacInTax than TaxView, but that's mostly due to the problem of getting the Windows run-time package installed. The real bottom line is that TaxView gets the job done on time, even if you started far later than you should have.

Highly recommended, for the fourth straight year. And I do apologize to the receptionist at the answering service.

SIMNON

Last month I talked about Extend, the simulation program for the Mac. Even as I wrote about it, I vaguely remembered I'd been sent a program of the same sort for the PC, but I couldn't recall what it was. I was also in a hurry.

Yesterday, we were trying to clear off the table in the Great Hall, and I ran across SIMNON, an MS-DOS simulation program developed at the Department of Automatic Control, University of Lund, Sweden, and distributed in the U.S. by Engineering Software Concepts. I hate cleaning up, and I like simulation programs, so . . .

Like Extend, SIMNON consists of a box of tools for setting up, solving, and graphing solutions to differential and difference equations. You can build models of a variety of situations, both orderly and chaotic.

SIMNON's cover features the now-familiar butterfly graph of a Lorenz "strange attractor." You needn't feel bad if that term means nothing to you; it's part of chaos theory. In the past dozen years, the study of chaos has moved from academically disreputable to intellectually respectable. No one is quite sure what discipline it belongs to. It isn't mathematics: mathematicians thrive on rigorous proofs, the notion being that you can count on the previous work to be absolutely sound, and chaos theory consists in large part of computer programs. It's too theoretical to be engineering or computer science.

No matter. The study of chaos seems to throw light on a number of academic disciplines, from hydraulics to population biology. In essence, it's the mapping and modeling of systems in which tiny changes in the initial conditions can produce wildly different and unpredictable results. If you want to know more, a good place to start is *Chaos: Making a New Science* by James Gleick (Viking, 1987).

After you've read that book, get SIMNON if you have a PC, or Extend if you have a Mac, and you'll be ready to play your own chaos simulation games.

Even without chaos theory, SIMNON

continued

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isn't for the fainthearted. The manual assumes you know what differential and difference equations are; it also assumes a general familiarity with programming. There are even syntax diagrams in the back of the book.

However, there are examples, and the manual, while terse, is at least clear; it has been a long time since I did any serious mathematical work, and while I can't say I understand everything in the manual, I was able to get started playing around with a wide variety of simulations. I'm now working on a difference-equation model to predict the number of grendels you might find on the mainland. If you haven't read *Legacy of Heorot*, that won't make sense, but it's a situation you might find in extraterrestrial biology.

For more on the fun—and the importance—of simulation tools, see the "Models of Doom" section in my June column. I won't say SIMNON on the PC is as easy to use as Extend on the Mac, but it will do the job if you'll take the trouble to learn it. Recommended.

Last-minute reflection: SIMNON will teach you a lot about nonlinear simulations, but I think $695 is severe overpricing; for that, you ought to get a whole course on simulation.

More Chaos

Another program for studying chaotic behavior is Chaos in the Classroom from Dynamical Systems. CITC runs in color and generates bifurcation diagrams. Bifurcation diagrams are explained in Gleick's book; they're fundamental to the study of chaos. CITC has a lot of neat demonstration programs. It's pretty slow, but that's to be expected given the nature of what it's modeling. The manual is meant for those dedicated to using the program, but it does explain a bit of what's going on. If you're seriously interested in chaos, this is another program that's worth having.

The CITC package probably came with a letter that has been lost. On that score: Please, always make sure that your name, address, and phone number (if you've sent something you want reviewed) are on everything you send me. I have probably a hundred letters I can't answer because the address was only on the envelope. Envelopes get lost here. So, alas, do cover letters.

Northgate 80386

I think I first heard of Northgate at the 1987 Comdex in Las Vegas. They were in a booth over in Caesar's Palace, and while they probably had clones, the interesting thing on display was the keyboard, which had a decent (but not superb) layout and an excellent feel. I recall making some suggestions about key layout.

A few months later, I was startled to find they'd listened to my advice and revised the keyboard. It still had a few bugs, but then they fixed those. They've been improving ever since, and as I reported last month, the Northgate Omni Key/102 has become the standard keyboard at Chaos Manor; my only problem is that I don't have enough of them. What with the Backspace key in the right place and that great keyboard feel, I just hate having to use anything else.

Anyway, I was talking with Northgate president Art Lazere about keyboards, and he pointed out that they sell computers, too; in particular, they sell a vanilla 80386. "I think it's a shame that people get touted onto fast 80286s," Lazere said. "The 80386 doesn't cost that much more, and you get a lot more machine."

Since that squares 100 percent with my view, we got on famously. He suggested that I take one of his standard 80386 systems and give it a workout. I thought of protesting that I have more than enough machinery around here and darned little time; but it really was a reasonable proposition.

I do most of my work on fairly advanced equipment. I don't really need all that speed and power, but I appreciate it. Every now and then, I get a letter suggesting I ought to work with equipment readers can afford. My general reply is that I'm trying to stay *ahead* of the industry, and what's exotic today is vanilla next year. Still, it's an argument I'm sensitive to. Then too, I keep vanilla XT and AT clones as test-beds. I certainly ought to have a standard 80386. "OK," I said.

There followed an odd comedy of errors: the next thing I knew, I had a call from BYTE in Peterborough. They said that a chap in Orange County had received several boxes of computers with my name on them shipped to his address. He had no idea why, but could he have an address or phone number? They'd come Air Express, and he was worried that I needed them for a deadline, which was in fact true.

It took a while to get that sorted out. What happened was that while I was on the phone to Lazere, I mentioned a program called System Sleuth (see my May column). Lazere jotted down the company's name and address. Then he sent a memo to his people instructing them to ship me a standard 80386 from stock. Guess what address was attached to the memo?

Eventually, the Northgate 80386 arrived, just as Roberta and I were leaving on one or another trip. When we got back, the poor machine was buried under *more* mail. Sigh. Finally I got it cleared off and invited my son Alex over to play with it.

There's this about Alex: he carries a Murphy field wherever he goes. If a computer can be crashed, he can crash it. Sometimes, he only has to be in the same room. Exhibitors at trade shows hate to see him coming.

First thing was to unpack the system. Northgate packs these machines very well, indeed. Everything was in good shape, despite the brief diversion to Orange County.

The keyboard was Northgate's newest model, advanced enough that I grabbed it off for my own workstation; I'm using it to write this now. I put my old Northgate keyboard on the new machine, and we fired it up.

So far, so good. The Northgate 80386 comes with MS-DOS 4.01. I'm not familiar with it, but I figured it hardly mattered—DOS is DOS.

When we get in new machines, we have standard procedures. First thing is to install some essential programs: the Norton Editor (for big editing jobs, I prefer BRIEF or Logitech's Point, but for an all-around general utility, you just can't beat the Norton Editor), Norton Utilities, Mace Utilities Gold, Coretest, Norton Commander, and Golden Bow's Vopt.

The next thing is to set up the machine environment the way I like it. We use the Norton Editor to set the prompt (I use 'PROMPT $P THHH$G '—note the space—which displays the directory path and the time in hours, minutes, and seconds, but without the hundredths of seconds), add DEVICE=ANSI.SYS into the CONFIG.SYS file, and generally make the display a bit more informative and attractive. All that worked as expected, which was a relief; the last time I'd tried MS-DOS 4.01, the Norton Utilities wouldn't work with it. Norton has since revised the Utilities, and they work fine.

Now it was Alex's turn.

I'm an admitted DESQview user; indeed, one reason I like 80386 machines so much is the way DESQview works with them compared to 80286 machines. The trick is to use QEMM-386 properly so that a number of essential TSR programs get loaded up above the 640K-byte DOS barrier; with care, you can get DESQview windows greater than 550K

continued

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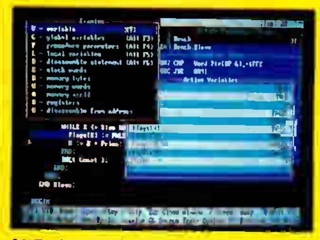

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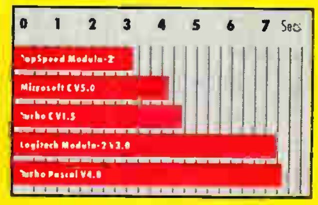

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bytes and still have lots of files and buffers, a mouse driver, and either a WORM (write once, read many times) drive or CD-ROM. Alex has got this down to an art. It's an art I don't quite understand, since much of it is based on undocumented features of QEMM-386 that he's ferreted out somehow; but it's sure effective on Big Cheetah.

There was only one problem: it didn't work. QEMM-386 would not load properly. Now what, I wondered. My suspicion was that MS-DOS 4.01 was at fault, but I couldn't be sure. Alex went over to Quarterdeck, while I sent E-mail to Lazere.

That worked wonders: Lazere called Quarterdeck while Alex was there, so I got the whole story. It seems that Northgate's BIOS chips come from American Megatrends. In assembling the Northgate BIOS, they left in some identifiers that make the system believe it's a Compaq Deskpro 386. QEMM-386, meanwhile, looks into the BIOS to see if it's dealing with a Compaq. If it is, it knows that certain memory areas are available; only those areas are *not* available on the Northgate 80386.

"There's a simple remedy," Alex told me. "Use DEBUG on QEMM.SYS to find the ASCII message 'COMPAQ.' Change that to 'COMPAL' or 'COMPAT' or anything else with exactly six letters. Then everything will work."

It didn't sound all that simple to me. Sure, I could dig out the DEBUG manuals and do the job, but then I'd have two versions of QEMM-386 floating around, and sure as anything they'd get mixed up and confused. Of course, an 80386 without DESQview is a crippled 80386, and I did want to be fair. . . .

Fortunately, there was another trip coming up, so I didn't have to do anything at all. When I got back, there was a package from Northgate: new ROMs, which were now standard for future Northgate 80386s. American Megatrends had fixed the problem. All I had to do was install these two chips in the machine. I needed to look inside the machine anyway, so that didn't figure to be a problem.

The Northgate 80386 opens up like most other AT machines. I noted that the case is sturdy, and the motherboard construction is clean and neat. The boards are thick; I've seen some clones with boards so thin they wave in the breeze. There are no extraneous jumper wires. It's assembled inside and out with good-quality screws so that the heads don't get munged up by my power screwdriver. Everything is mounted properly, and the drive cages are all sturdy. There are two serial ports and one parallel port on the motherboard. The solder joints look clean, no telltale discolorations. The power supply is 220 watts, more than enough for an 80386. The fan is strong and quiet. Definitely a solidly made machine, quality materials throughout.

The BIOS ROMs were in the middle of the motherboard, just underneath the disk drive controller board. They were labeled "high" and "low," while the new ones were labeled "odd" and "even."

It happens there was a note enclosed with them explaining that "even = low," but it had got mixed in with other papers before I saw it. I wasn't worried. Provided you get the chips installed properly in their sockets, you can't hurt them by swapping two ROMs. The machine wouldn't work with them in the wrong sockets, but nothing would be harmed.

I got out the chip extractor. Mine is labeled "Burndy," and I probably got it at Radio Shack. It sure beats using a screwdriver. There was only one problem. One of the chips came out smoothly and easily, but the other is mounted extremely close to one of the bus sockets. It's so close that the chip extractor can't get a proper grip, and for that matter, you can't even get a screwdriver under the end of the chip closest to the bus. Eventually, I pulled the chip out, but in doing it I broke off a pin.

Nothing for it now: either the new BIOS chips worked, or this machine was dead. I got out another chip tool, bent the pins to the proper angle—all chips apparently come with the pins spread out too far for insertion—and stuck them in. On with the power switch.

The machine came right up. QEMM-386 loaded properly. All of Alex's strange little tricks to pack high memory worked fine. We were in business.

Video

The Northgate 80386 comes with a 16-bit VGA board and a Princeton Graphic Systems' Ultra-14 monitor. The video is *fast*, considerably faster than what I'm at present getting from either Big Cheetah or the Zenith Z-386. The colors are bright. I somewhat prefer the Zenith ZCM-1490 Flat Technology Monitor—which works quite well with the Northgate 80386's VGA board—but there's really very little difference. It's hard to complain about the video output of the Northgate 80386.

I don't really have a way to measure it, but compared to the Z-386 with an 8-bit Video Seven VGA board or Big Cheetah with a vanilla VGA, the Northgate 80386 is noticeably faster on graphics images. Empire, which is all graphics, is almost twice as fast on the Northgate 80386 as on my other machines. So is Windows, once you get that working.

TrackerMouse

One of the things I saw at Comdex in Chicago was TrackerMouse from Penny and Giles Computer Products. This isn't really a mouse; it's a small trackball device set onto a stand that includes, of all things, a small solar-powered calculator. Why a calculator in your mouse? Why not? It costs little more to add it, and it's often very convenient to have a calculator handy.

However, the real feature of TrackerMouse is that it's small: the trackball is more the size of an extra-large marble than the orange-size things you generally see. The case, calculator and all, is low profile, standing not much higher off the table than your keyboard.

The end of the TrackerMouse cable is a 9-pin plug suitable for AT serial ports, but just in case you've got a machine with DB-25 connectors, the company supplies an adapter. All quite elegant.

Installing TrackerMouse is simple: just plug it into a serial port and transfer the software to your hard disk. The driver goes in CONFIG.SYS. TrackerMouse is supposed to emulate a Microsoft Mouse, and in general it does, but see below.

Using TrackerMouse is an odd experience. The buttons—two of them—are on each side of this calculator-size box. Thus, you tend to use your thumb for the left button, middle finger for the right button, and forefinger for manipulating

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Inquiry 1040.

the "thumbball." I think I'd find it simpler to put both buttons on one side of the TrackerMouse box, so that the thumb would be used for guidance; but I'm not sure.

I experimented with TrackerMouse for about an hour, testing it with various programs; eventually, I fired up Empire, since it's completely mouse-driven. You *can* play Empire without a mouse, but it's sure not easy. Anyway, because it's mouse-intensive, it's as good a way to practice using a mouse as any.

I didn't have any problems; indeed, it was simple enough to use that I'm seriously thinking of stowing TrackerMouse in the kit with my Zenith SupersPort 286 portable; I don't often need a mouse on the road, but then I haven't really thought about it much. TrackerMouse should work just fine, once I transfer the driver to a 3½-inch disk.

I don't think I'm tempted to change to TrackerMouse for everyday use. It does get easier to use with practice, though, and it takes less room than a normal rodent. If you're a mouse hater in a world that's increasingly moving to mice, you might want to investigate trackballs, and this is a pretty good one.

Compatibility

Back in the early days, you tested system compatibility with Flight Simulator; if that ran, almost anything would. Nowadays, the acid test is Windows.

I didn't want to install full Microsoft Windows on the Northgate 80386 because I'm not sure I have the latest version; but I had something nearly as good: TaxView with the Windows run-time package.

Installing Windows, whether the real thing or just the run-time package, is tedious. There are five 1.2-megabyte disks; you insert the first one, log onto the floppy disk drive, and type INSTALL. After that, the program guides you through screen after screen and disk after disk. The whole process seems to take forever.

I went through it the first time, letting Windows think TrackerMouse was a Microsoft Mouse. There didn't seem to be any glitches until the installation was over; then the program informed me that it was improperly installed and died. There were no other error messages, and my only remedy was to start over.

I did. This time, I told the Windows INSTALL program that I had a strange mouse. The program asked for the disk containing the MOUSE.SYS driver. I put that in. Windows trundled awhile, then asked for its own disks back and continued with no problems. Ten minutes later it was done, and it wouldn't work. No error messages, just "It don't work, Turkey!" (Actually, it says "Windows Improperly Installed!," forces you to click on "OK," and dies, but the effect is the same.)

I now had a genuine quandary: was it the mouse, the Northgate 80386, or MS-DOS 4.01 that was causing the problem? It was simpler to change mice than operating systems. Since I'd recently received an update of Microsoft's MOUSE.SYS (many previous versions do *not* work with Windows), it seemed reasonable to install a Microsoft Mouse and have done with it. Then I started the installation process all over again.

Ten minutes later I was done, and this time it worked. There was TaxView in all its glory, and with the Northgate's 16-bit VGA video driver, it was *fast*—blindingly fast compared to Big Cheetah with his 8-bit VGA.

I make no doubt that the Logitech Mouse would have worked as well (since that's what I have on Big Cheetah); but the Penny and Giles MOUSE.SYS needs some revision before it will work with Windows.

First Report

Next thing was to test the Northgate 80386 for speed. I'm not a big fan of benchmarks, which I think are misleading; but people do like numbers. The Northgate 80386 has a Norton SI of 17, meaning that it's supposed to be 17 times as fast as a standard IBM PC XT. For the hard disk drive, the Coretest throughput index is 6.5, which compares favorably with any machine I have except Big Cheetah with his Distributed Processing

continued

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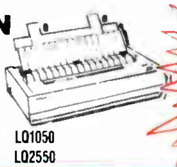

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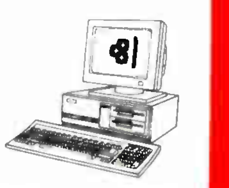

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I tend to use criteria like "slow," "good enough," and "wow!" rather than numbers anyway; and I rate the Northgate 80386 as better than good enough on CPU and disk speed and wow! on video speed.

When Northgate first started shipping machines, I had reports of some problems with quality control; but I haven't seen any of those for months. I have good reason to believe the early problems were caused by the rapid growth of the company. Meanwhile, let me repeat that I am impressed with this machine's construction. Of course, I expect any machine sent to me will work—although some haven't—but I also have reports from other people who have Northgate computers, and they're happy.

I still recommend that utter novices will be better off going through a reliable dealer rather than ordering by mail, but I have to add that reliable dealers aren't all that easy to find; and there sure wasn't any installation required for this system. I just turned it on, and it came up in MS-DOS 4.01.

I'll hang onto the Northgate 80386 for a while and let you know how it wears; but my preliminary report is that I like this machine a lot. The configuration I have is the 80386 computer running at 16 MHz with 4 megabytes of RAM, two serial ports, and one parallel port; a 70-megabyte hard disk drive with MS-DOS 4.01 installed to segment the drive into 5-megabyte and 65-megabyte logical drives; two floppy disk drives, one 1.2-megabyte 5¼-inch and one 720K-byte 3½-inch; a 16-bit VGA card; the Ultra-14 monitor; tons of documentation; and the wonderful Northgate Omni Key/102 keyboard. This is a very good configuration.

If you ever run out of hard disk drive space, there's room for a second drive inside the case. The workmanship is superior. Changing BIOS ROMs is close work because of the way the sockets are situated, but clearly I was able to do it all right.

All in all, the Northgate 80386 looks like one of the best deals in town. It would certainly do as the only machine I had if I were in another line of business. More as we use it more.

Objects!!!

The most exciting thing this month just came in: a beta copy of Borland International's Turbo Pascal 5.5. It has *objects*, and Borland swears that by the time you read this it will be shipping.

Objects, for those who have been hiding out in the North Woods for the past year, are all the rage as programming tools. The notion is that you build a complex structure—say, a window with colors, graphics, text, and dialog boxes—and define it as an object, after which you can manipulate it as you would any other data structure in your program.

In the Turbo Pascal 5.5 implementation, objects are similar to records, but they can contain procedures. The new compiler has syntax for object construction and destruction (thus releasing all their memory) and various ways to manipulate the objects. I've had almost no time to run this, but I like it enough already that I am seriously contemplating converting Mrs. Pournelle's Reading Program to Turbo Pascal 5.5; it certainly would be easier to modify and maintain.

continued

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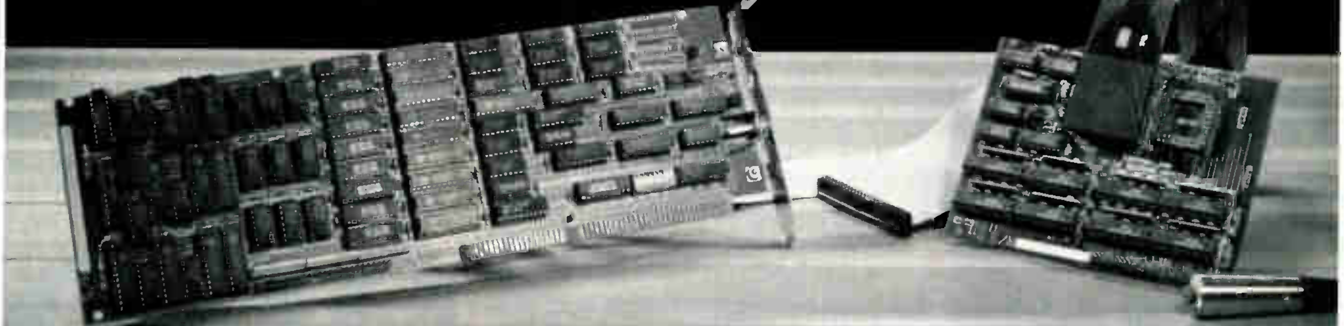

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Ross Greenberg
"Best of 1988" (Development Tools)
PC Magazine, January 17, 1989

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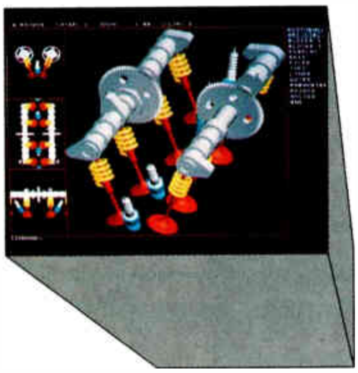
DesignCAD 3-D version 2.0 is as powerful as most CAD systems costing $5000-$10,000! Features like: Complex Extrusions-linear, scaler, and circular, Blending of Surfaces, Shading, Cross Sectioning, Complex Sweeps and Translations, and Boolean operations make DesignCAD 3-D one of the most powerful 3-D CAD systems available... at any price! Engineers, Architects and Consultants constantly tell us that they use CAD systems costing thousands of dollars which are not as powerful as DesignCAD 3-D.



VERY EASY TO USE

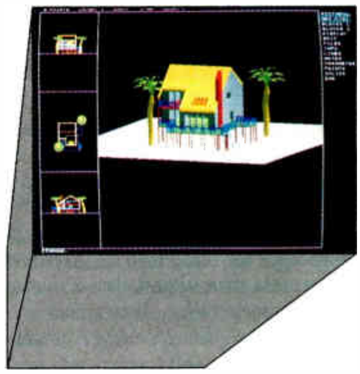
Just because DesignCAD 3-D is powerful doesn't mean it is difficult to use. Single keystroke commands and side-bar menus which give short directions on how to proceed make DesignCAD 3-D a snap to use! While not required, DesignCAD 3-D supports all popular digitizers and mice.

Many of the older, more cumbersome CAD systems require weeks of training before a user can be productive. DesignCAD 3-D users find they can be producing useful drawings in a matter of minutes! In a recent CAD contest only one contestant was able to match our drawing time. The package sold for $3000.00. The other CAD packages took up to twice as long to perform the same drawing and cost up to $5000.00!

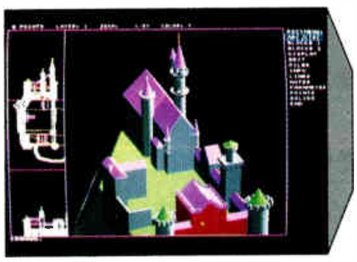
Still don't believe us? The goblet pictured below required only 16 keystrokes and 3 commands to create! The top, front, side, and isometric views were created simultaneously... in less than one minute!

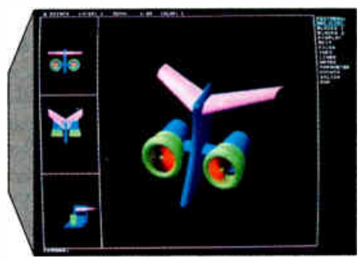
VERY LOW PRICED

The first question asked by many people is, "Why is DesignCAD 3-D priced so low?" The answer? After developing DesignCAD 3-D version 2.0, we were unable to decide how the product should be priced. We consulted experts. We used the finest spreadsheets on the market. We took employee polls. Finally, in the great American Tradition, we said, *"Aw... What the Heck! Let's see the other guys beat this price!"* DesignCAD 3-D version 2.0 sells for $399.



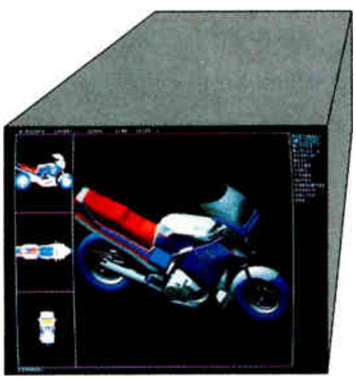
DesignCAD 3-D only $399!

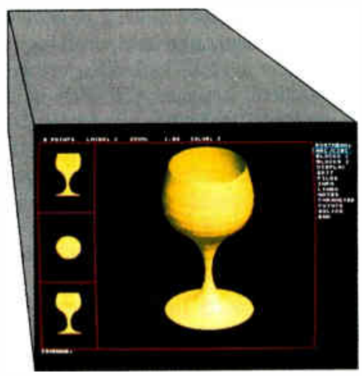




WHY BUY THIS ONE?

There is a very important reason to buy DesignCAD 3-D. PERFORMANCE. No other CAD system can match our price/performance ratio. Many people make the serious mistake of thinking that it is necessary to spend thousands of dollars to obtain "a good 3-D CAD system." This is not true! We talk to people everyday that are sadly disappointed with their "expensive" CAD systems. Don't be one of them! Call us and we will send you a complete set of literature and a free slide show demo disk. Once you compare DesignCAD 3-D version 2.0 with other CAD systems we know you will choose DesignCAD 3-D.





DON'T TAKE OUR WORD FOR IT

Here is what other people have to say about DesignCAD 3-D:

"After you've worked with DesignCAD, the single keystroke commands are simple to remember and it becomes easy to "flick one key" to execute a command. An extremely ergonomically designed program."

HENRY LEVET, Levet & Daigle Architects · New Orleans, LA
Designed a 65,000 sq. ft. nursing home using DesignCAD

"Recently I worked with a firm that builds decks. They purchased your product on my recommendation. I sat down with them and in two hours they were very proficient in DesignCAD. Now they are more effective; and we can communicate... it's wonderful to be able to do a block repeat 42 times and there are 42 2x4's to make the deck!"

J. TURNER, Architect, TAO Ltd. · The Woodlands, Texas

"Allows scientists and engineers to expend minimum time learning and using CAD software so that their time can be expended on the project at hand. It also allows scientists and engineers to quickly present to management all views of a subject (3-D)."

DR. STEVENS, NASA Space Scientist/Engineer

HOW DO I GET ONE?

DesignCAD 3-D version 2.0 is available from most retail computer stores, or you may order directly from us. DesignCAD 3-D is available in a number of foreign languages from distributors throughout the world. All you need to run DesignCAD 3-D is an IBM PC Compatible and 640K RAM. DesignCAD 3-D supports most graphics cards, printers, plotters and digitizers. Free information and a demo diskette are available by contacting us at:

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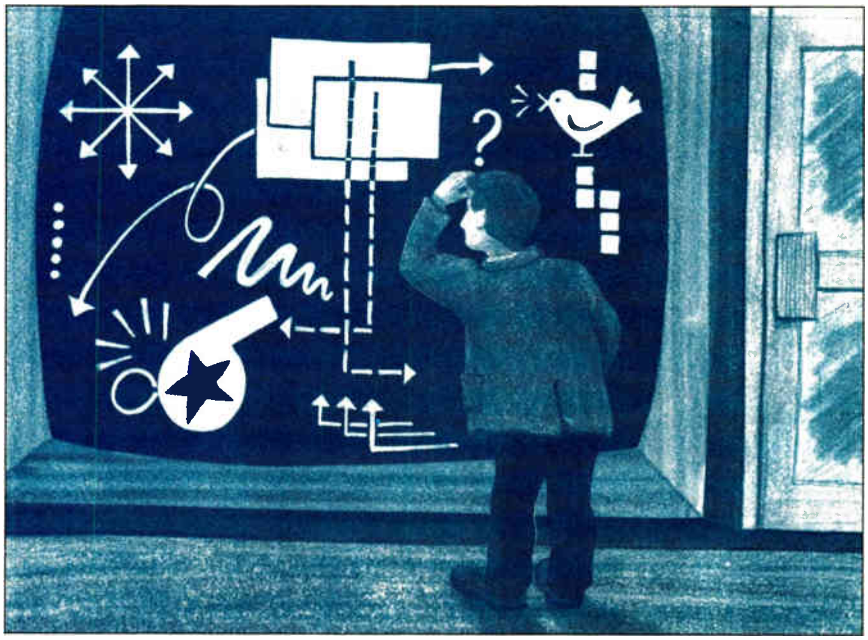
918/825-4844
FAX: 01-918-825-6359
TELEX: 9102400302

IS BIGGER BETTER?

Recent upgrades raise the question: When do bells and whistles overwhelm a product and its users?



I have been railing against the computer industry's penchant for constant upgrades for many months; we're caught in a spiral of bigger and bigger products designed to solve smaller and smaller problems. Spreadsheets, word processors, database managers, and such were tremendous boosts to productivity and creativity when they first appeared on microcomputers; any of the later enhancements to the basic concepts are trivial by comparison.

Generating an automatic table of contents or deriving an internal rate of return with one command is all very fine, but these niceties don't change our lives the way our first personal computers did. Yet each minor improvement, no matter how inconsequential, is hailed as a major revolution, and we rush like check-writing lemmings to jump on the bandwagon.

Simple programs have grown to include the equivalent of indoor plumbing and electric appliances, which we may or may not need; few, if any, of us will ever use all the bells and whistles of every product we own. But as each of us requires different features, it all works out for the best in the end. Or does it?

Here's a fact: Manufacturers abandon old products when new versions come out. No way can you buy a copy of SuperCalc2, a nice introductory spreadsheet, or WordStar 3.x, or any of the forerunners of today's megaprograms. If you want a limited but comfortable set of features, you're forced to look into odder and odder corners of the market. Laptop owners trying to avoid the weight penalty of hard disk drives are at peril, as are users with meager needs and/or little interest in becoming power users.

I'm really dismayed by what all this means for those people new to computing. Those of us who have been around for a while accept the welter of new functions with an occasional sigh, but we can handle it. We're capable of ignoring unnecessary kitchen-sink features or deciding when an upgrade makes sense and when to pass. However, the feature wars have created programs that can be pretty daunting to the neophyte. Yes, software is easier to learn today than ever before, but there's a lot more to learn.

So what are the repercussions? Is the computer industry inadvertently setting up barriers that block its own growth? Is too much attention being paid to sophisticated doodads and not enough to simplicity and elegance? It's been so long since I was a novice that I'm not sure anymore. But I do notice that whenever an absolute beginner asks me what programs to buy, I keep wishing that some of the products of a few years ago were still available.

Some companies (distressingly few) solve this dilemma by providing downscaled variants of their powerhouse products or by developing junior-level programs. These are good moves. I'd also like to see some older products remain on the shelves, even after they've been superseded by newer, hotter, and bigger versions. We need more tiers of software functionality, particularly at the simple, user-friendly level. Without the software equivalent of a welcome mat, the industry will risk turning away those making their first tentative steps into computing.

Some Examples

More II for the Macintosh and WordStar Professional 5.0 in the MS-DOS world bring this phenomenon into sharp focus. More II is a brilliant package, combining outlining with presentation graphics and word processing. I stand in awe of the

continued

programming skills of the Winer brothers, Dave and Peter, who took the basic idea of an outlining tool and refined it into this amazing product.

But it has become so powerful, so flexible, and so enormous that you can spend weeks trying to figure out everything it can do. More II is the slickest tool I've ever seen for creating and organizing a slide show with graphics, whether you output it as 35mm slides or project it as computer screens. There are built-in tree and bullet charts with draw-style graphics, editing capabilities, installable style libraries, dissolves and wipes, and a timed execution facility for unattended presentations. On the text-handling side, More II has added style sheets, a spelling checker, true headers and footers, page breaks, and a print-preview feature.

Also, More II no longer restricts outline headlines to one line of text, effectively freeing you from the constraints of the indented outline format. And, of course, the program retains its predecessors' outline-manipulation features: cloning, mark and gather, time stamping, calculation, and so on. As I said, it's wondrous stuff.

However, using More II to cobble up a little outline, perhaps to organize your thoughts before sitting down to write a report, is like using low-yield nuclear weapons to rid your house of termites. The screen is awash with new teeny cryptic symbols. Endless menus lead to endless submenus. Understanding the More II library format and how to use it is an afternoon in itself. The scope of this program has vastly outstripped the scale of the job it was originally intended to do.

I wrote about WordStar Professional 5.0 in January, so I'll skip some of the gory details. Suffice it to say that my old standby now has the best print-preview screens in MS-DOS, a variety of interfaces (including pull-down menus), automatic reformatting, direct import of spreadsheet and database files, windows, macros, a selection of new commands for font control on laser printers, and much more. Although it is still identifiable as a word processor, it's a far cry from the familiar product I first began using many years ago.

Both More II and WordStar Professional 5.0 are excellent programs, highly recommended. Yet after a few months with each of them, I went back to the previous versions, More 1.1c and WordStar 4.0. I found I had little use for most of the new stuff, and it got in the way more than it helped. Further, both programs had lost the indefinable feel that had characterized their ancestors.

ITEMS DISCUSSED

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(505) 897-4024
Inquiry 1021.

More II............................$395
Symantec Corp.
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Cupertino, CA 95014
(408) 253-9600
Inquiry 1022.

Plain Paper Ink Cartridge...................... $11.95
Diconix, Inc.
343 State St.
Rochester, NY 14650
(800) 848-9977
Inquiry 1023.

WordStar Professional 5.0....$495
MicroPro International Corp.
33 San Pablo Ave.
San Rafael, CA 94903
(415) 499-1200
Inquiry 1024.

Now, the good folks at Symmetry will point out that Acta Advantage has everything I need in a Macintosh outliner, and they're probably right. If it's command-set compatibility with old versions of WordStar that I want, I have only to look to Sprint, PC-Write, SideKick's Notepad, or half a dozen other MS-DOS word processing programs that can be configured to emulate the old classic.

But I don't merely want similar functionality to, or close emulation of, the original programs, and there's more than nostalgia to my complaint. The originals had a cohesiveness—integration, if you will—lacking in the new versions. It's that sense of "rightness" that causes me to favor one program over another. And the new ones, no matter how spectacular, don't have it.

On the Jet Stream

OK, I admit it, I feel a little dumb. It's taken me over a year to discover a wonderful product, and I wish I'd known about it when it began shipping in April 1988. It's one of those seemingly trivial items that attract little attention but can completely change the way you work. What's this magic bullet that's got me so excited? It's the Diconix Plain Paper Ink Cartridge for portable ink-jet printers, that's what.

The rap on low-cost ink-jet technology has always been that you can't get good print quality without special paper. As ink-jet ink is still technically a liquid when it hits the paper, it has been recommended that you use stock with high absorption characteristics. Until the introduction of the Diconix cartridge, you had only two choices: clay-coated paper, which absorbs ink without much spreading at the edges of the dots, or ultra-cheap, highly absorbent paper that allows so much spreading that printouts look like the lines on the eye chart below the last one that you can read. Ordinary paper was out of the question; unabsorbed ink remaining on the surface would smudge the instant you touched it.

I fell in love with Hewlett-Packard's ThinkJet printer before it was officially unveiled (and Hewlett-Packard insiders were still calling it "Vesuvius"). It was small and quiet. Also, it didn't shake the table like a subway train passing under the building at full throttle. But the paper question kept me from adding a ThinkJet to my printer collection.

When the Diconix 150, a yet smaller portable printer based on the same disposable-cartridge technology, was introduced, I continued to raise a skeptical eyebrow. Clay-coated printer paper is not exactly a common household item.

Last month, however, I decided to take the plunge, seduced by advertisements calling the Diconix unit a "plain paper printer." It arrived with one ink cartridge and an ominous sample pack of clay-coated paper. I used a few sheets, and the output looked marvelous. When I used plain paper, however, it was Smudge City. Irritated, I began a long series of phone calls.

What I eventually learned was that Diconix has a cartridge filled with a quick-drying ink formulation that the company calls "plain paper ink." This item is, of course, not mentioned anywhere in the materials provided with the printer. I ordered a sample, and, wonder of wonders, it worked.

It worked on every type of paper I could find in my office. It even worked on my personal letterhead, which is bright white and slick, a rough test for any printer. No smudging, period. So far, I've encountered only one type of stock that can't handle the ink: those clear plastic labels designed for photocopiers. As of yesterday, the machine-gun daisy-wheel printer and the chain-saw dot-matrix printer have been banished to their original cartons in the back of the garage. I'm in printer heaven.

continued

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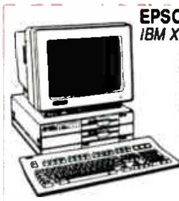

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These Diconix cartridges cost $11.95 a pop, produce about 500 pages in draft-quality mode, and work in the ThinkJet, the Diconix 150 and 300, and the General Computer WriteMove printer for Macintosh users. Reproduction is not quite as glorious as you'll obtain with clay-coated paper or with a 24-pin near-letter-quality dot-matrix printer, but for routine work, this arrangement can't be beat.

For the Birds

The odd product of the month—possibly of the year—is BirdSongs! from Corrales Software. It's a Macintosh package, and the name says it all. For $45, you get a resource file of digitized birdcalls and two programs with which to play them—a stand-alone application and a desk-accessory version. BirdSongs! is designed to let you play sounds in the background, either with MultiFinder or without it. When you adjust sliders to set maximum and minimum intervals for playback and choose an assortment of songs from the menu, you can have a bunch of birds merrily twittering while you work.

Author Loren Cobb explains that the sound-generation capabilities of the Mac are ideally suited for reproducing high-frequency noises. A quick check with an impartial panel of experts (my cats) certifies the validity of this claim; these judges responded to BirdSongs! with noticeable interest and ear-twitching. The songs are quite attractive to human ears as well. I heard none of the unpleasant clicks and hissing that characterize many other collections of digitized sounds; the overall effect is delightful.

BirdSongs! contains the sounds of 17 North American birds, mostly thrushes, wrens, and catbirds. If you're so minded, you can build your own resource files for the program using any digitized sounds; simple instructions are included in the short manual. Or for $15 each, Corrales Software will sell you other sound files, including Southwestern birds and animals, birds and monkeys of Madagascar, and (my favorite) arctic wolves. Just the thing to perk up a dull day at the office.

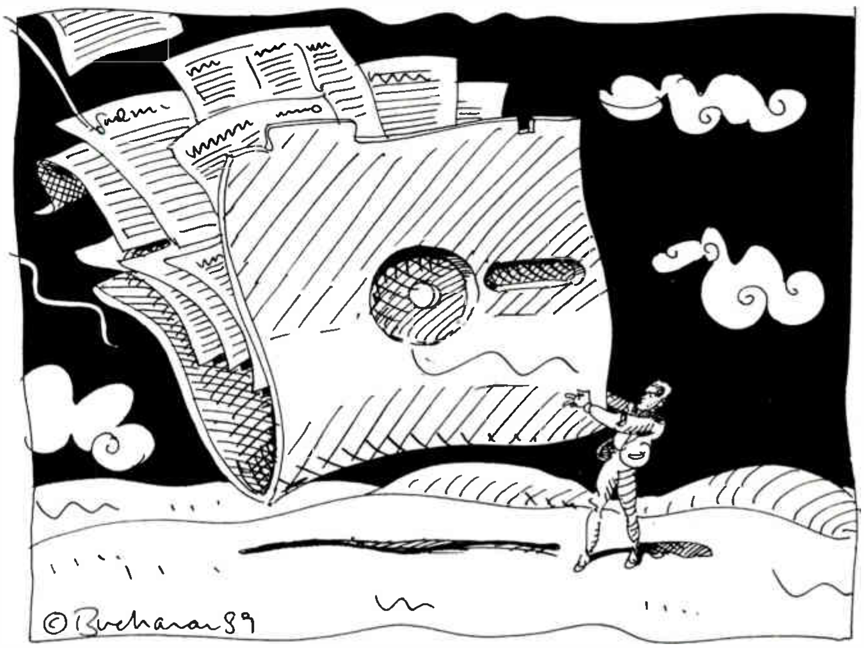
Recommended if you fancy this sort of thing. ■

Ezra Shapiro is a consulting editor for BYTE. You can contact him on BIX as "ezra." Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

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

FIGURING OUT CONFIG.SYS

The file that configures your OS/2 system has grown up since its DOS days



You're witnessing computer journalism history. Up until now, I did much of my work under OS/2 but wrote my columns with a DOS-based text editor. This month's column was produced entirely under OS/2.

I'm writing it with the SideKick Notepad. This isn't my editor of choice, but I'm sure the Borland people would be the first to say that it's not intended for writing a 1500-word document. The speed is not great, but Notepad seems to keep up with my typing unless virtual memory is activated—then it can take seconds for what I've keyed to show on the screen.

This is just another example of something I've said before: Avoid the virtual memory feature of OS/2, if you can. Here's how to tell if you've activated virtual memory: An action that should not affect the disk drive causes the drive light to go on. Consider the drive light your "buy some more memory now" light.

Another oddity about Notepad is that it uses a large monospace Courier font. Courier is easy to read, but the 55 columns remind me of the 1981 IBM programs that were all written to run on the lowest common denominator of the time —a 40-column screen.

This month, I'll finish the discussion of building and setting up a Presentation Manager-ready system.

In previous columns, I've discussed how to assemble the hardware that you'll need to run IBM's PM. Then I discussed how to install OS/2 and what files are on your disk once the installation has been completed. In this column, I'll show you how to set up CONFIG.SYS.

Listing 1 shows a typical CONFIG.SYS file under OS/2. Many of these commands will look familiar to the knowledgeable DOS user. PROTSHELL tells the system where to find the user shell program (COMMAND.COM under DOS, PM under OS/2 1.1).

SHELL does the same thing that it did under DOS. In fact, it affects only the DOS mode session (what used to be called the compatibility box). As under DOS, you may have to modify SHELL if you face "out of environment space" errors. Just add the /e:*nnn* option, where *nnn* is the size in bytes of space to allocate for environment strings, which are short pieces of information put in an area called the environment. The environment is accessible from a program.

SET PATH and SET DPATH show that, under OS/2, you can put your environment strings in CONFIG.SYS. For example, to tell Microsoft Word that you have a VGA display, you could put the following line in your AUTOEXEC.BAT file under DOS:

SET VGA=YES

The SET command places values in the environment string space. In this case, of course, the VGA=YES doesn't mean anything to any other program but Word (and, perhaps, some other Microsoft programs).

Finding the Path

PATH and DPATH refer, as in DOS, to the sequence of subdirectories searched to find programs and data, respectively. PROMPT is essentially the same as in DOS. The fourth SET command, COMSPEC, will also be familiar to the DOS technician. COMSPEC gives the path of the command-line interpreter. Under DOS, the command-line interpreter is COMMAND.COM. Under OS/2, it's called CMD.EXE.

continued

LIBPATH, an important new command, tells OS/2 where to find its dynamic link libraries. In the case of my CONFIG.SYS, I have the usual OS/2 DLLs, which, you will recall from last month, are placed in the \OS2\DLL subdirectory by the IBM installation program. The \OS2\DLL subdirectory comes first on my LIBPATH. SideKick requires DLLs, so LIBPATH must point to the C:\SIDEKICK subdirectory.

Finally, I have some utilities—I've mentioned ALIAS, a command-line editor, for example—that require DLLs. Those DLLs all go in my \XOS2 (extra OS/2) subdirectory. There is no environment string for LIBPATH, because Microsoft doesn't want you confusing the operating system by changing LIBPATHs in midsession. Just imagine the confusion if you inadvertently took, say, the DLLs for the video driver off the LIBPATH.

BUFFERS is the same as in DOS. DISKCACHE creates and sizes a hard disk drive cache, a function similar to BUFFERS.

Allocating Memory to Resources

MAXWAIT and THREADS control the multitasking environment. I discussed MAXWAIT in my November 1988 column. THREADS just sets the maximum number of simultaneous threads of execution. The IBM installation procedure sets them at 128, but 64 will work just fine. Strangely enough, even the minimum value, 32, seems to work, despite claims from several sources that 48 is the practical minimum. Lowering the number of threads frees up 2K bytes per thread. Dropping THREADS to 64 will recover 128K bytes of RAM.

PROTECTONLY tells OS/2 whether or not to create a DOS mode session. PROTECTONLY=YES means *don't* run real-mode (DOS) programs (i.e., don't create a DOS mode session). Confused? Me, too. Just remember that PROTECTONLY=YES means *no* DOS mode session, and PROTECTONLY= NO means go ahead and set one up. The default is NO.

RMSIZE tells OS/2 how much memory to allocate to the DOS mode session. The default is 640K bytes.

MEMMAN and SWAPPATH control the memory manager under OS/2. MEMMAN's first parameter is either SWAP or NOSWAP, which controls virtual memory. As you'd expect, NOSWAP says, "Don't do virtual memory." SWAP, the default, allows virtual memory to be activated when real memory overflows.

The second parameter is either MOVE or NOMOVE. It does for your RAM what a product like Disk Optimizer or Norton SpeedDisk does for your hard disk drive: eliminates fragmentation. Because OS/2 is a multitasking operating system, it must allocate and deallocate areas of memory to specific tasks as they are created and destroyed. MEMMAN= MOVE or NOMOVE is used to tell OS/2

continued

Listing 1: *A typical CONFIG.SYS file under OS/2.*

```
SET PATH=C:\OS2;C:\OS2\SYSTEM;C:\;c:\xos2
SET DPATH=C:\OS2;C:\OS2\SYSTEM;C:\;
SET PROMPT=$i[$p]
SET COMSPEC=C:\OS2\CMD.EXE
PROTSHELL=C:\OS2\PMSHELL.EXE C:\OS2\OS2.INI C:\OS2\CMD.EXE
SHELL=C:\OS2\COMMAND.COM /P
LIBPATH=C:\OS2\DLL;C:\;C:\SIDEKICK;c:\xos2
BUFFERS=30
DISKCACHE=128
MAXWAIT=1
THREADS=64
PROTECTONLY=NO
RMSIZE=640
MEMMAN=SWAP,MOVE
SWAPPATH=C:\OS2\SYSTEM 10000
BREAK=OFF
FCBS=16,8
COUNTRY=001,C:\OS2\SYSTEM\COUNTRY.SYS
DEVINFO=SCR,EGA,C:\OS2\VIOTBL.DCP
DEVICE=C:\OS2\EGA.SYS
DEVICE=C:\OS2\POINTDD.SYS
DEVICE=C:\OS2\MOUSEA04.SYS
DEVICE=C:\OS2\PMDD.SYS
DEVICE=C:\OS2\COM01.SYS
```

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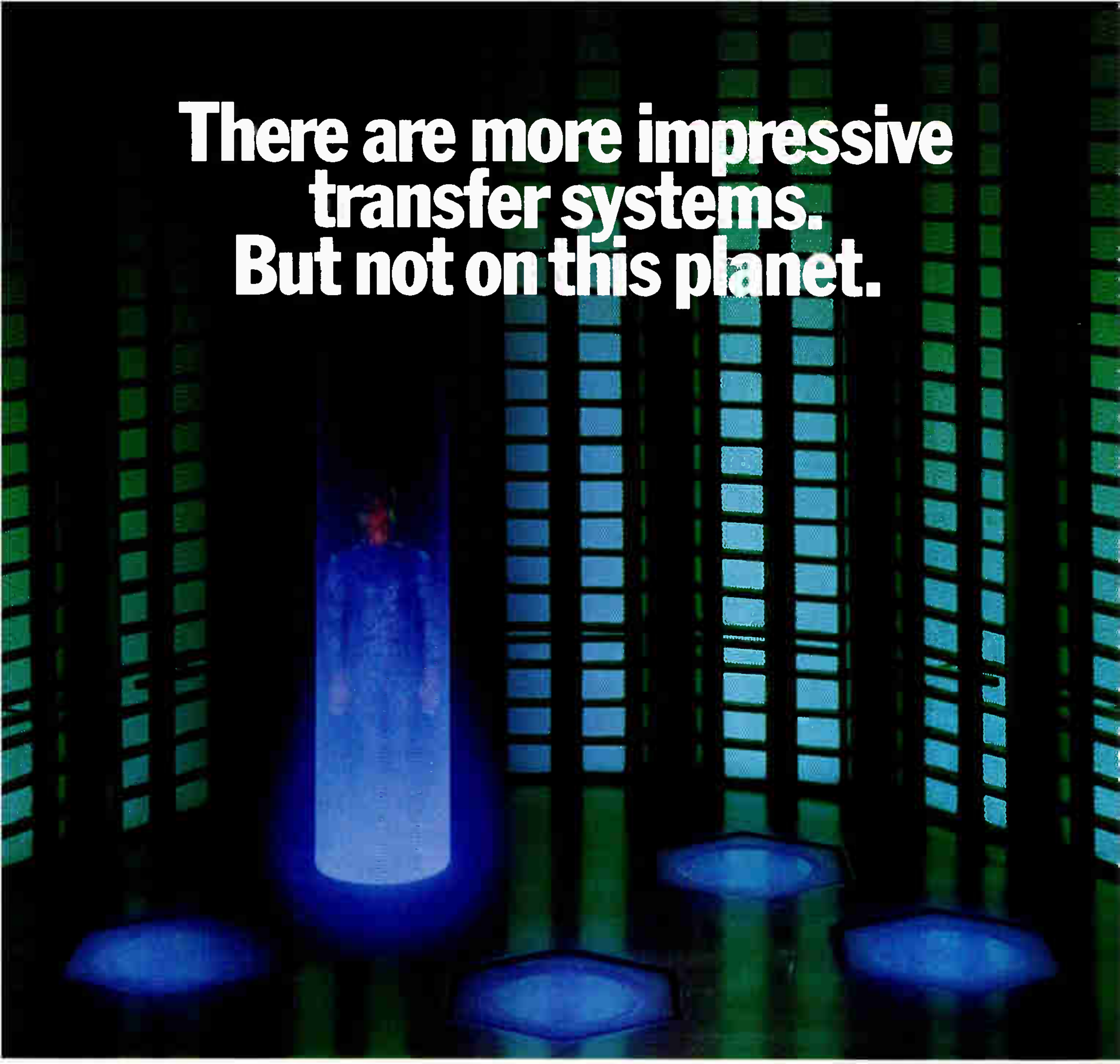

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whether it's kosher to move memory blocks in order to keep all the allocated regions together and all the deallocated regions together.

Imagine what a problem this must be for the operating-system designer: You've got to move memory blocks while the programs are running without damaging these programs. That's like trying to tune a car while it's traveling down the highway. Most of us will use MEMMAN=MOVE, although if you've got lots of memory to burn and don't start and stop many applications, you might squeeze some extra performance from your machine with NOMOVE.

SWAPPATH does two jobs. First, it tells the swapper where to put the temporary virtual memory storage files. SWAPPATH=C:\OS2\SYSTEM just names the subdirectory in which to put the swap files. Under OS/2 1.1 only, it also restricts the growth of the swap files. Now you can tell the swapper to leave some room free with the second parameter of the SWAPPATH command. SWAPPATH=C:\OS2\SYSTEM 10000 tells OS/2 that it can use the disk for virtual storage, but that it must leave 10,000K bytes free at all times. If you don't do that, the swapper's temporary files can grow to fill the disk, as I've discussed in previous columns.

Finishing Up

The remaining commands are fairly straightforward. BREAK and FCBS behave exactly as under DOS. COUNTRY is the same as under the later versions of DOS—an international device-support command. It tells OS/2 things like what character is used to prefix currency amounts, what format currency is reported in (e.g., in the U.S., it's floating point with two decimal places), and collation sequence.

It also covers date format. For example, in the U.S., we report month/day/year. Set the country for the United Kingdom, and you get the more logical day/month/year. Unlike other .SYS files, COUNTRY.SYS needn't be in the root directory. If you live in the U.S. or English-speaking Canada, you needn't even include the statement.

DEVINFO is another international support command. It supports foreign-language character sets for the screen, keyboard, or printer. The example here is a support command for the screen.

Finally, there are the device drivers. The first one, EGA.SYS, matters only for the DOS mode session. The next three—POINTDD.SYS, MOUSEA04.SYS, and PMDD.SYS—supply mouse support. The last one, COM01.SYS, drives the serial ports. And remember not to put the COM01.SYS driver before the mouse drivers if you have a serial mouse. If OS/2 sees the serial driver first, it allocates all the serial ports to COM-port status. By the time OS/2 sees the serial mouse driver, the serial ports are all taken, and it can't recognize the mouse.

Believe it or not, that's a basic OS/2 CONFIG.SYS file. That will get you started; you can dig into the IBM manuals for more. ■

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

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DAWN OF THE DEAD DISK

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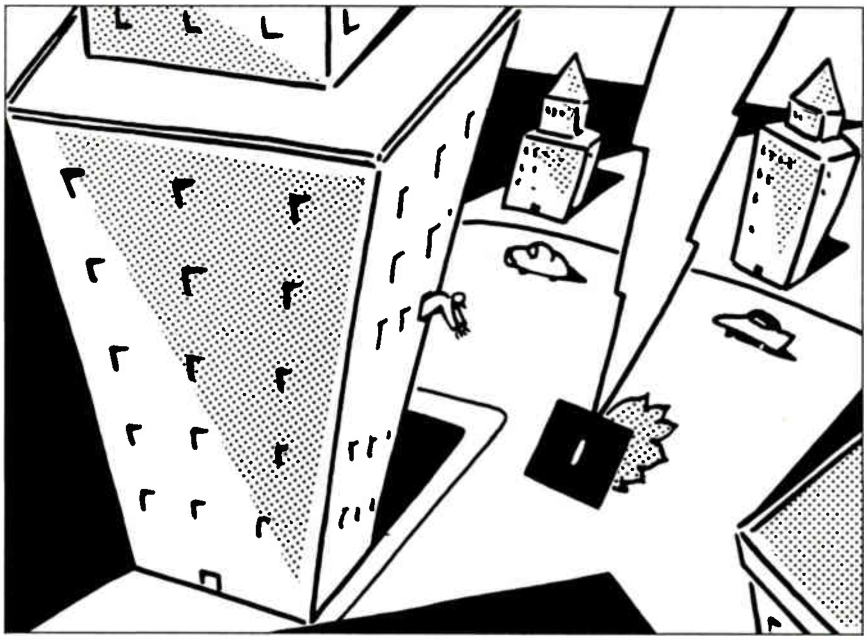

If I asked you to name the element of your computer system that is worth the greatest amount of money to your business, what would you say? Most people would pick an expensive CPU or perhaps a network file server. And they'd be wrong. In any business that depends on a computer, the most valuable component is the information contained in the computer's storage, not the hardware itself. If you have your business and accounting records on the computer, the operation of your business depends on your having access to the information. This is compounded if your product also exists on the computer, as it well might if you have a consulting company or programming shop.

Whether your company depends on a mainframe or on a personal computer doesn't matter. What does matter is that mainframe users usually have a full-time staff assigned to keep the information safe and available. Businesses that depend on personal computers usually don't have such a staff. As a result, data backups don't always happen, and when they do happen, they may be defective or stored improperly.

Without timely, complete backups, your business may well depend on the mechanical health of a $200 hard disk. One day you may find that a thunderstorm the night before fried the electronics in your disk. Or you may find something less dramatic, such as drive C suddenly not being available any more.

Coping with the message "Invalid drive specification" when you try to use your hard disk is no fun. It's no fun even if you have complete backups, but it's a lot less fun if you haven't been as faithful as you should have been. Fortunately, help is available.

Depending on the nature of the problem, you can send your hard disk to a company that specializes in data recovery, or you can buy software and try to do it yourself. Some problems, such as a hard disk that's been fried by lightning or dropped, or that seems to have suffered some mechanical or electronic failure, will require you to send the drive out. Others, including scrambled directories and file structures, can be done by you or sent out. The choice there depends on your skill and confidence.

Major Surgery

When something really awful happens—your computer catches fire or falls from a window or something—you have little hope of recovering the data yourself. In times like these, you will need to call a professional data recovery service that can actually rebuild a hard disk to the extent necessary to remove the information that's on it. One of the clear leaders in this field is Ontrack Data Recovery.

Ontrack has been known to extract data from disks that have been in fires, have had their electronics fried, or have simply suffered from mistakes on the part of their operators. Because it has a clean room, Ontrack Data Recovery can take your hard drive apart to repair it, if necessary. Ontrack can even move the hard disk platters from one drive to another to get the data off.

Of course, most failures are not quite so catastrophic, and most of Ontrack's business comes from problems with head alignment and from failure in the electronics. Ontrack says that it will turn a data recovery job around in as few as three days.

Workman & Associates, long a respected supplier of software for personal computers, has recently expanded its services to include data recovery. It takes

continued

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DOSutils $99.95
NetUtils $99.95
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(612) 937-1107
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Mace Gold $149
Paul Mace Software, Inc.
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Inquiry 1105.

Norton Utilities Advanced Edition 4.5 .... $150
Peter Norton Computing, Inc.
2210 Wilshire Blvd., Suite 186
Santa Monica, CA 90403
(213) 319-2000
Inquiry 1104.

Ontrack Data Recovery, Inc.
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hard disk $200
floppy disk $100
Recovery .... $300–$800
(See Ontrack Computer Systems, Inc.)
Inquiry 1102.

Workman & Associates
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Rush .... $65/hr.
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Pasadena, CA 91104
(818) 791-7979
Inquiry 1103.

disks that are not physically damaged but have lost their data through electronic or operator problems.

Both Ontrack and Workman & Associates use a variety of commercial and proprietary software tools to recover the information from a disk. For competitive reasons, neither company will reveal what those tools are, but they do agree on one item: Patience is the most important part of the process.

While I couldn't find out exactly what Ontrack and Workman & Associates do to recover scrambled or lost data from disks, I could at least get some ideas about Ontrack. Ontrack Computer Systems, the parent company of Ontrack Data Recovery, sells a set of data recovery and disk management tools called DOSutils, which combines data recovery with hard disk diagnosis, formatting, and optimization.

Unfortunately, DOSutils was thrown off by the hard disk and controller combination I had in the Cheetah 386. This is an ESDI controller with 4 megabytes of cache from Distributed Processing Tech-

nology. It works well with the Cheetah and its Priam drive, but DOSutils was convinced that the drive had an average seek time of less than 1 millisecond. Meanwhile, the Disk Look utility refused to look at all.

Ontrack also makes a utility called NetUtils for managers of Novell LANs. While I didn't have the chance to wring this package out, it offers many of the utilities found in the DOS version. One potential problem is that NetUtils is designed for standard IBM PC AT controllers, while the Novell-branded file server normally uses a SCSI disk interface. Still, this is about the only set of disk utilities available for use with NetWare, so if you're a system administrator, you should check it out.

Norton Expands

One of the original sets of packaged utilities for disk management was the Norton Utilities. Over the years, this set of programs has been improved and expanded. Once, its most popular feature was its ability to restore a file that had been erased. It still does that, but now it will restore a hard disk that has been formatted, let you edit the file allocation table or the directory, and do direct editing on any other portion of the hard disk, including the boot record.

> *Clearly, there are many ways to recover your data if you need to.*

The new version of Norton Advanced Utilities is a powerful set of programs indeed. Fortunately, it is accompanied by a complete set of three manuals. It also includes an excellent book on troubleshooting and a slim volume that tells how a hard disk works with MS-DOS. If anything is missing, it is explicit coverage for types of DOS beyond those supplied by IBM and Compaq. Fortunately, there are very few differences among the types of DOS, but there are some.

Unlike the software from Ontrack, the Norton Utilities were not thrown off by the Cheetah 386 and its Priam disk and ESDI controller. For some reason, though, the package did seem temporarily confused by the existence of a second hard disk in my Zenith Z-248, although I was able to overcome the problem.

The Norton Utilities are designed to allow easy access to any spot on your hard disk. This is good in that you can correct anything, but you do have to know what you're doing. It's easy to make a mistake, but that's the price you pay for the power you need to recover your data. The Norton Utilities also have a solid selection of disk management software that will reduce file fragmentation, check for sectors that are going bad, and the like.

Of course, these capabilities are also in Mace Utilities, which have been around nearly as long as Norton. Paul Mace was the first to market a program that would restore a hard disk that had been formatted. This used to be a common problem until the format programs were changed to make it harder to do. The Mace Utilities also include a data

continued

recovery program for dBASE files, and a program that saves the contents of memory to disk periodically, so that you can even recover from a power outage.

The Mace Utilities disk management software helps ensure against hard disk failure by allowing sectors that are going bad to be locked out before they actually destroy data. In addition, there's a text-file data recovery program that works with disks that DOS may not recognize.

Eliminating the Problem

Clearly, there are many ways to recover your data if you need to. Unfortunately, even the best of recovery services or recovery software can't recover data that's destroyed. "When it really heads for the weeds," Motorola's Bill Lucas told me, "a little software isn't going to stand in the way of total destruction." He's right, and there are still several ways for total destruction to happen. A software development project gone amok is fairly common, but so is the physical destruction of the magnetic surface of the disk. When these things happen, you're out of luck.

The real solution, then, is the one that the mainframe staffs already use. It's called backup. If the information on your computer is important to the operation of your business, it should be backed up daily, unless you can afford to lose a day's work. The backup data should not be stored in the office with the computer. A backup is of little value if it burns in the same fire that gets the computer. Many companies simply send the daily backup home with a trusted employee.

With the advent of networks and large hard disks on microcomputers, floppy disks have become less attractive as a backup medium. A logical alternative is a tape drive, which can be found inexpensively. I'll be looking at tape backup units soon. Meanwhile, you may have recourse if your hard disk suddenly disappears from view. The range of services available makes it likely that someone will find a way. Unfortunately, it won't be cheap. But replacing your company's information wouldn't be cheap, either. ■

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

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LEARN ON ME

The Mac provides new ways to handle engineering and scientific courseware

Courseware (or computer software that helps you learn) used to be called computer-aided instruction (CAI) or computer-enhanced instruction (CEI). That's because courseware used to mean mostly drill and practice—learning by rote. Pretty simple stuff, really. Even well-developed CAI software, like the mainframe-based Plato system from the University of Illinois, relied heavily on drill and practice to drive home its lessons.

However, in the last couple of years, what defines courseware has broadened considerably, as techniques borrowed from AI, multimedia, and learning research have been increasingly applied to this field. The Macintosh has helped accelerate these changes, especially in science and engineering courseware, where software that takes an exploratory approach to teaching has emerged from colleges and universities.

Almost from the beginning, the Macintosh has been a natural platform for the development and use of computer courseware. The Mac has always had the basic capabilities that courseware demands: a high-resolution screen and excellent graphics primitives that permit a user interface with icons, windows, and scroll bars; a mouse; and decent sound facilities. With the emergence of the modular Mac II family, Apple has further improved its courseware platform. The Macs in this family provide color, as well as bigger screens, more memory, faster processors and FPUs, and better sound than their compact cousins. These new features, plus NuBus slots that let you plug in peripheral cards suitable for data acquisition and real-time control, make them suitable for science and engineering courseware.

The Medium Is the Message

Most Mac science and engineering courseware is written strictly for the Mac. In other words, the Mac forms a single-medium learning platform for the courseware student. Over the next few years, however, you'll see a greater use of multimedia-based science and engineering courseware. Such software will incorporate visual and acoustic information from nontraditional sources like videodisk (laser disk), videotape, interactive video (CD-I), compact disk video (CD-V), CD-ROM, and 35mm slides.

One of the strongest boosters of multimedia-based courseware has been Apple. Almost from the start, Bill Atkinson and others at Apple envisioned HyperCard as having many uses in courseware authoring and development. Because HyperCard and HyperTalk are reasonably easy to learn and are bundled with every Mac, there has been a considerable incentive among potential science and engineering courseware authors to take advantage of them. With HyperCard 1.2's CD-ROM control facilities, science and engineering courseware developed using HyperCard now has a suitable medium for the storage of large files often needed by simulations and analysis programs.

CD-ROM may also prove to be an excellent medium for the distribution of ambitious and large-scale courseware in medicine, electrical engineering, and biological sciences. Some courseware has already been developed for these disciplines, but one problem has always been including enough descriptive data to teach a detailed technical discipline.

CD-ROM could also solve the data- and software-dissemination problem for interdisciplinary science and engineering courseware, where techniques from these fields are applied to the analysis

continued

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and understanding of subject matter from the humanities and social sciences. Often, the knowledge base for good interdisciplinary software are lexicons or concordances of millions of words or the original texts themselves. Before CD-ROM, the solution was to build such courseware around very small textual or visual samples. Since a CD-ROM disk has a capacity of over 650 megabytes, science and engineering interdisciplinary courseware authors can create applications based on the real data, not on some sketchy samples or tiny extracts.

While the Mac is being used in junior high schools and high schools, most of the science and engineering courseware already developed for the Mac is pitched at the college student. Courseware under development at most universities also starts with the college student in mind.

Courseware Developers

Although some science and engineering courseware is developed and sold by commercial software vendors, most of the courseware used in higher education comes from within the schools. The reasons that both the developers and the consumers of this type of courseware come from the same institutions are simple. First, only the universities truly know their pedagogical needs, especially in the technical disciplines. Second, homegrown software can be developed under the auspices of federal grants (especially from the National Science Foundation) and local university grants, which pay for the development costs. Once the software has been developed for a local university market, it's easy to sell to other universities through mechanisms provided by the Apple University Consortium (AUC) and Kinko's Academic Courseware Exchange.

Most courseware is developed by the universities that use it.

The AUC now consists of 30 institutions. Among its other functions, it shares information and development efforts on courseware development and the use of multimedia within courseware units as an instructional aid. Information about current AUC science and engineering courseware developments can be found in the quarterly journal *Wheels for the Mind*, which is available to anyone interested in educational computing. *Wheels* does a good job of chronicling the individual courseware development efforts at AUC schools, while also focusing on special courseware-related topics. The Fall 1988 issue, for example, incorporated articles on multimedia in education, hypertext in teaching, medical instruction on the Mac, and software engineering courseware.

Authoring Systems

As I mentioned earlier, much of the early CAI software belonged in the drill-and-practice category before the introduction of the Macintosh. Part of the reason was that the programmers who created CAI software were often not subject-matter or pedagogy specialists. They got the job by virtue of their programming expertise. This scenario started to change a year or so after the introduction of the IBM PC (1981), when several software vendors introduced computer courseware authoring packages that did not require specialized programming knowledge for their effective use. One of the most popular of these early courseware authoring programs was McGraw-Hill's Course Authoring System, running under DOS.

On the Mac, the availability of authoring systems like Telerobotic's Course Builder has helped push the development of science and engineering courseware. Course Builder uses a flowchart metaphor to allow scientists and engineers, who may not be familiar with CAI teaching techniques or know much about courseware creation, to create standalone courseware in their fields.

Course Builder is really a visual language (not unlike Mainstay's V.I.P. language) that is incorporated into a full-blown system encompassing a graphics editor, animation capabilities, sound-presentation tools, real-time calculation abilities, and a true Mac interface for all courseware created. Automatic branching facilities make it easy for authors to keep their lessons interesting without getting sidetracked into CAI model testing. Course Builder also generates a record for each student who uses a created application, so you can track students' progress.

A companion product to Course Builder, called Video Builder, allows the courseware author to control full-motion video or 35mm slide sources for display on appropriate Mac II color screens, separate video monitors, or slide projection screens. Video Builder can control videotape player/recorders, laser disk players, or slide projectors to introduce additional visual or sound elements into a course created with Course Builder. Video Builder is especially useful for providing ancillary visual material to support the main points of any courseware lesson.

A good example of this might be a courseware program that teaches students about the basic techniques for VLSI design. While it's necessary for students to master the symbols, electronic methods, and logical basis for VLSI design (which your courseware would presumably facilitate), you can add tremendously to the learning experience by including video selections of the actual fabrication of VLSI chips or a discussion by professional VLSI engineers about the practical problems of the field.

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Hardware and Software Requirements

The minimum hardware and software requirements for courseware authoring systems like Course Builder and Video Builder aren't too demanding, and typically a Mac Plus and a hard disk drive will suffice. However, the actual learning station requirements (i.e., the computer system where students use the science and engineering courseware) are typically much greater.

Because you'll want to give students the best sound and visual presentation possible (especially critical in conveying the complex symbolic content of many science and engineering topics), a Mac II, IIx, or IIcx with a large hard disk drive and large-format color monitor is a requirement. And, naturally, to really develop courseware effectively for this platform, courseware authors need the same hardware.

If you decide to add full-motion video to your courseware, you'll need a compatible videodisk or tape player (costing upwards of $1000) for each student and developer, plus a color monitor to view the video (or a special National Television Systems Committee NuBus board that allows NTSC video to appear on a Mac II color monitor). For ambitious science and engineering courseware, these kinds of hardware requirements can be a severe burden to already-tight laboratory budgets. That's one reason why courseware that takes this kind of multimedia approach has been slower to develop and get disseminated than courseware that needs only a Mac.

The state of science and engineering courseware art can be summarized by two words: solid and growing. The Mac has solidified the development of this software with all the user-interface innovations for which Apple should be regularly applauded (even as I've groused at the company for its failings in some other areas).

The buzzwords for the next round of science and engineering courseware development will probably be hypermedia and multimedia. With more and more developers using HyperCard, CD-ROM, and laser disks, and the price of video peripherals dropping, the garden-variety science and engineering courseware that will be popular in the 1990s will have a very different look from the courseware of today. ■

ITEMS DISCUSSED

Course Builder $395
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Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He can be reached on BIX as "decrabb."

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NETWORKS ■ Mark L. Van Name and Bill Catchings

THE LAN ROAD TO OSI

Here's how three LANs stack up against the Open Systems Interconnection model

The world of LANs is rife with inconsistent terminology. Most LAN vendors, however, pay at least lip service to the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) reference model, the framework within which international communications standards are developed. Conformance to the OSI structure, and to the standards within its layers, ensures connectivity between heterogeneous computing environments. We'll examine that framework and see how some important LANs stack up against it.

The OSI reference model consists of seven layers, each of which communicates only with the layers directly above and below it. The model describes only each layer's basic capabilities, not the exact interface between those layers.

At the bottom is the physical layer, layer 1. It defines how the data bits get onto the physical medium. It includes the connector to that medium and the electrical signaling convention.

Above the physical layer is the data link layer, which assures reliable data transmissions. If it receives a packet that contains an error, it requests another transmission. While the data link layer doesn't guarantee that a transmission succeeds, it passes only correct packets to the next higher level.

A set of data link layer protocols, the IEEE 802 LAN standards comprise two functions: Media Access Control (MAC) and Logical Link Control (LLC). Each 802 LAN protocol—such as 802.3 (Ethernet), 802.4 (Token Bus), and 802.5 (Token Ring)—has its own MAC component, which determines whether the LAN uses tokens or CSMA/CD logic to manage packets. Above the MAC, IEEE 802.2 defines the LLC, which is the same for all the 802 MAC protocols. LLC handles error control, acknowledgment, and flow control.

OSI's layer 3, the network layer, establishes, maintains, and terminates connections and routes packets through the network. Since all nodes can communicate directly with all other nodes in a LAN, no routing through intermediate nodes is necessary. In a wide-area network, on the other hand, a packet may be routed through many intermediate nodes before it reaches its destination.

So far, the OSI model guarantees the delivery of accurate packets but doesn't ensure each packet's arrival. That's the function of the transport layer, layer 4, which also ensures that all data packets are delivered in the right order. Because LANs transmit one packet at a time, data packets on a LAN can't get out of order and are rarely lost, so a LAN's transport layer has little to worry about.

OSI layer 5, the session layer, sets up communication sessions between two computers. Its functions include such common network verbs as open, close, read, and write. The next two layers give the user the final network application. The presentation layer, layer 6, provides the services that a particular application needs, such as the file command OPEN FILE. Layer 7, the application layer, is the application that the user sees, such as a file server's remote file commands.

The OSI model, like many abstractions, is reasonably elegant, but the real world of LAN protocols is altogether different. The figure shows how the protocols supported by three major microcomputer LANs—AppleTalk, NetWare, and LAN Manager—map to the OSI model.

AppleTalk

Apple's AppleTalk architecture is the only one of these LAN environments that has separate protocols that correspond to all seven layers of the OSI model.

Apple currently provides two options at the physical layer, LocalTalk and EtherTalk (Apple's implementation of Ethernet). At the data link layer, AppleTalk has a Link Access Protocol (LAP) for each option. LocalTalk is built into the Mac.

Apple's equivalent to the OSI network layer is its Datagram Delivery Protocol. DDP manages "socket-to-socket" delivery. (A socket address is the unique identifier of a particular service on a given node.) DDP sends and receives datagrams.

AppleTalk actually has several different components at the transport layer; we have omitted some of them from the figure for clarity. The Name Binding Protocol (NBP, not shown) converts names to socket addresses. Several different higher-level protocols—including the Printer Access Protocol (PAP), AppleTalk Session Protocol (ASP), and the AppleTalk Data Stream Protocol (ADSP)—can call NBP.

Another transport layer protocol, the Routing Table Maintenance Protocol (not shown), uses a table to route packets over bridges between separate AppleTalk networks. Both it and the Echo Protocol (also not shown) are accessible only from another system. DDP uses the Echo Protocol, which echoes packets to see if a node is accessible.

The AppleTalk transport protocol that best fits the OSI model is the AppleTalk Transaction Protocol. ATP guarantees end-to-end packet delivery.

At the session layer, Apple is promoting ADSP for writing network applications. It replaces the older ASP and ATP. ADSP actually covers both the session and transport layers.

ASP is a typical session protocol, with the usual open, close, send, and receive operations. AppleTalk now uses it only for older applications and as the Session

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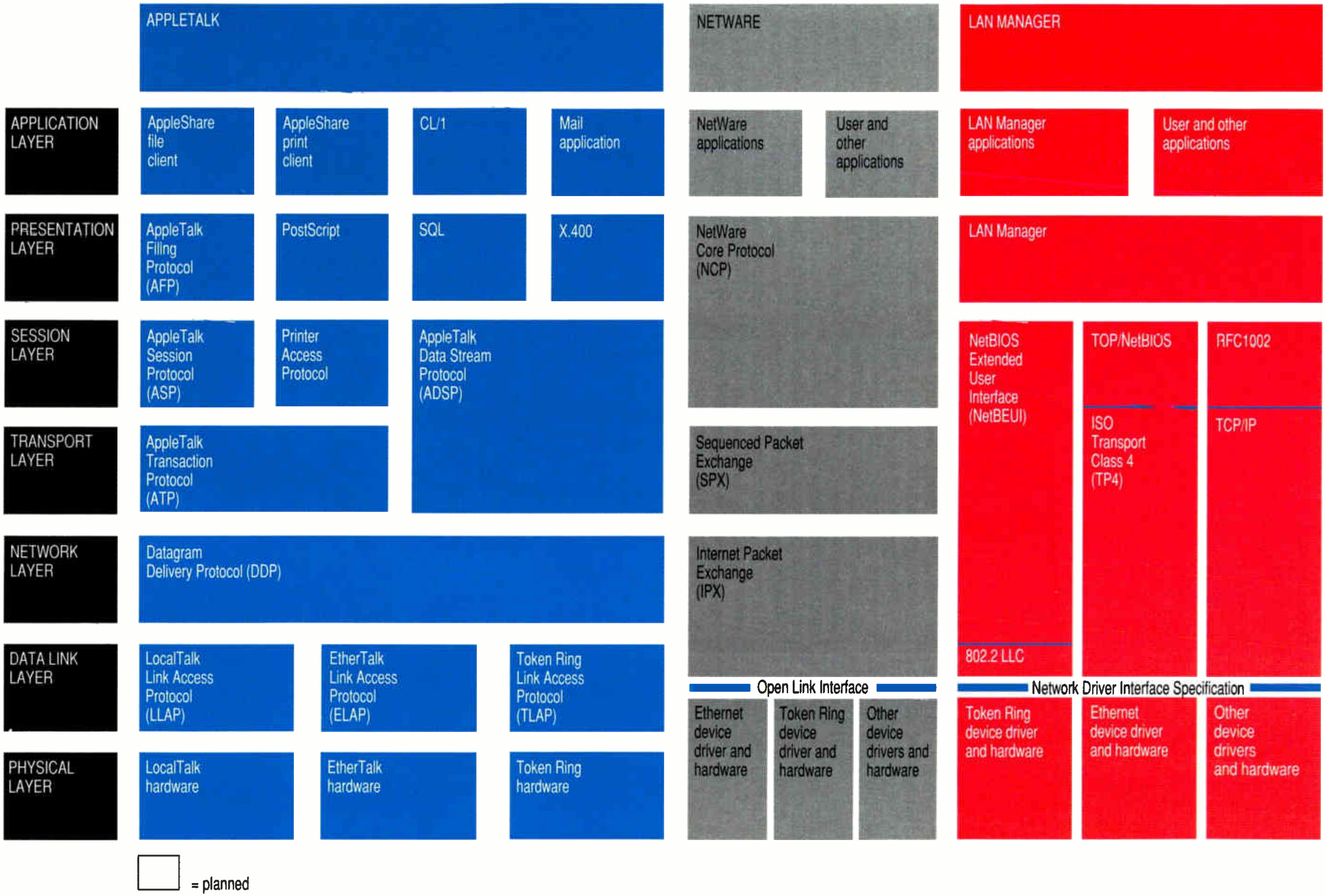

The protocol stacks of Apple's AppleTalk, Novell's NetWare, and Microsoft's LAN Manager mapped to the Open Systems Interconnection reference model. LAN Manager and NetWare run on additional hardware platforms.

Protocol for the AppleTalk Filing Protocol (AFP).

The other two transport protocols, Zone Information Protocol (not shown) and PAP, are specialized. ZIP helps track the users in a particular subset, or zone, of an AppleTalk LAN. PAP lets AppleTalk interact with a LaserWriter.

AppleTalk's presentation- and application-level protocols work together to provide a few basic network applications. One network application, the AppleShare Print Client, lets you print on a LaserWriter. While the LaserWriter understands the PostScript language, APC is the actual printing application.

Another Presentation Layer protocol, the AppleTalk Filing Protocol, provides the primitives necessary for remote file services. On a Macintosh, AFP serves only the AppleShare File Client at the application layer. However, AFP can also talk to several other servers, including the AppleShare File Server and Novell's new NetWare for Macintosh.

Apple also is planning two new network applications that will use ADSP: an E-mail package and its CL/1 distributed database language.

NetWare

In the MS-DOS world, the major LAN packages don't map so nicely to the OSI model. Consider, for example, NetWare, Novell's network operating system, which currently leads the DOS LAN pack.

The lowest layer of NetWare's architecture contains the hardware and device drivers for many different physical networks, including Ethernet, Token Ring, and ARCnet. The device driver and hardware lie in the bottom of the data link layer and extend into the physical layer. The top half of the data link layer contains part of IPX (Internet Packet Exchange), which is also NetWare's network layer protocol.

These two parts of the data link layer need to communicate, and a fairly new NetWare interface, the Open Link Interface, tells how device drivers should communicate with higher-level protocol stacks (i.e., any group of protocols that spans multiple OSI layers). By obeying OLI, a single device driver can work with multiple protocol stacks; conversely, a single protocol stack can work with many device drivers.

By offering OLI, Novell hopes to get other firms to develop for NetWare both device driver and higher-level industry-standard protocol stacks like TCP/IP or ISO's TP4 (Transport Class 4).

While part of IPX is in the data link layer, its biggest role is at the network layer. IPX handles internetwork packet routing. Like other network layers, it guarantees that the packets it hands upward are correct.

Sequenced Packet Exchange (SPX), NetWare's transport layer protocol, ensures that packets arrive and are in order. SPX and IPX compose Novell's proprietary protocol stack. Protocol stacks that obey the OLI could substitute for this combination.

Above this combination is another NetWare interface (not shown in the figure) that defines the interactions between the transport layer and NetWare's higher layers. NCP, the NetWare Core Protocol that provides client/server services, obeys that interface. NCP spans the session and presentation layers.

Finally, NetWare applications sit on top of the whole stack. They include the

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basic file services that many users see as an integral part of NetWare.

LAN Manager

The hottest newcomer in the PC LAN world is Microsoft's OS/2 LAN Manager, an OEM software product that provides the core functionality of 3Com's 3+Open, IBM's LAN Server, and many other network operating-system products. LAN Manager supports several protocol stacks.

The LAN Manager network operating system sits at the presentation layer. It supports an application layer that contains both LAN Manager built-in applications and applications that others develop. The SQL Server may be the most important new application.

Underneath LAN Manager can sit any of several different protocol stacks. While Microsoft offers only one today, it will support two others. In addition, LAN Manager licensees offer their own protocol stacks for LAN Manager.

Both NetWare and LAN Manager are moving toward a modular, OSI-compliant model that provides clean interfaces between layers so that they can plug in popular protocol stacks, such as TCP/IP.

All the underlying LAN Manager protocol stacks must provide a NetBIOS interface between their session layer components and the LAN Manager software. The one currently available protocol stack uses IBM's NetBIOS Extended User Interface (NetBEUI). 3Com and Madge Networks Limited jointly developed this protocol stack, which also includes an IEEE 802.2 LLC-compatible portion of the data link layer.

Other underlying protocol stacks are under development. 3Com, using code from Retix, is building one that will support ISO's TP4, with a TOP/NetBIOS session-layer protocol as its NetBIOS interface to the presentation level. Excelan is developing a TCP/IP stack that will speak to the presentation layer via the ARPA RFC1002 session-layer protocol, which maps NetBIOS to TCP/IP.

Just as all these protocol stacks present a NetBIOS interface at the top, they obey another interface at the bottom. This interface, Microsoft and 3Com's Network Driver Interface Specification, defines the way device drivers communicate with the higher-level protocol stacks. NDIS essentially splits the data link layer between the IEEE MAC and LLC layers.

The hardware on which LAN Manager runs—which may be Token Ring, Ethernet, or a variety of other configurations—fills the data link layer's MAC portion and the physical layer.

Clear Direction

The greatest benefit of the OSI model is not the levels it defines, but that it argues strongly for well-defined levels.

All three of these LAN architectures are developing clean interfaces between their levels. The reward is the ability to plug in different protocol stacks while retaining the controlling LAN operating system and its features. As more people need to link heterogeneous networks, this ability will prove crucial to the success of LAN vendors and users alike. ■

Mark L. Van Name and Bill Catchings are independent computer consultants based in Raleigh, North Carolina. You can reach them on BIX c/o "editors" and as "wbc3," respectively.

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

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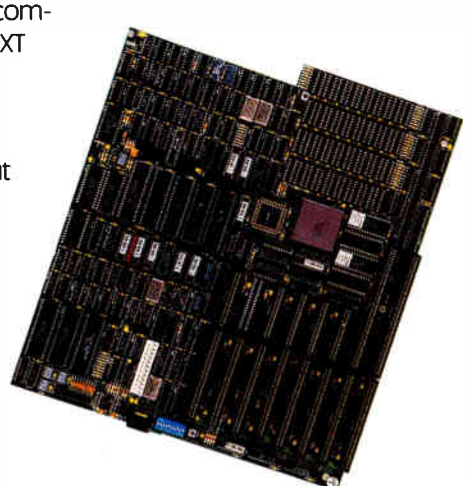
DTK means value in PC-compatible motherboards, add-on and networking cards, and bare bone systems, including FCC Class B-certified 10 and 12 MHz '286 computers. Which is why the two high-speed XT clones named "Best Buys" in *PC World*'s August, 1988 issue, both use DTK motherboards.



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If NetWare can't detect a full transaction, it "rolls back" the data to its former state.

Given NetWare's size and complexity, installation is fairly painless. The documentation clearly addresses planning issues up front, and then it steps you through menu selections and configuration options according to your requirements. NetWare requires a dedicated

NetWare is a proprietary network operating system that requires a dedicated server and a special server disk format.

server and uses its own proprietary format on the server disk. You can still run DOS, but NetWare acts as the host operating system. A dedicated network operating system offers additional security, since users can't boot directly from the server disk; they must pass through the network to access server files. There is a downside to this, though: If anything goes wrong, you can't call on familiar DOS utilities such as FDISK.

Novell strictly enforces the server-client model for network operations. A centralized server retains network resources, while each of the client sites accesses the server through the NetWare shell. The shell intercepts all DOS calls processed by interrupt 21H. It turns local operations over to DOS and translates network calls to the NetWare Core Protocol (NCP) for the server to process.

The NetWare shell is surprisingly compact, requiring only 45K to 60K bytes of precious workstation RAM. This is less than any of the other products we reviewed—in fact, NetWare's is the only shell to leave enough room in DOS memory for RAM-hungry applications like dBASE IV.

A series of menus and a set of command-line utilities form the NetWare User Interface. The SYSCON menu drives the most common operations. From this menu, the supervisor can add new users, delete old ones, join users to a group, modify file permissions, set log-in restrictions and other security features, maintain the error log, track group/user status, and even establish charge rates for network services. The entire user interface is logical and consistent. For instance, from the screen display that lists network users, you press the Insert or Delete key to add or delete users, respectively. NetWare retains this basic interface structure throughout each configuration screen and menu option.

As a supervisor, or as a trustee with parental rights in a directory, you can assign different file permissions (e.g., read, write, create, delete, open, modify, search, or parental) to each user. You can also assign attributes to individual files (e.g., read/write, read only, and shareable/nonshareable) that then apply to all users, despite the permissions they have within the directory. A trustee can change file permissions within a directory, allowing the supervisor to delegate administrative responsibilities to other users. The supervisor can still retain security control by modifying the "Maximum Rights Mask." The mask specifies which permissions the trustee can assign. If the supervisor removes delete permission from the Maximum Rights Mask, the trustee can't let any other user delete files, although he or she still retains that permission.

Special log-in features highlight NetWare's security arsenal. You can systematically purge inactive accounts by setting an account expiration date. You can also set password expiration dates to force users to make periodic password changes. Concurrent access restrictions limit the number of stations a user can log onto while still logged on somewhere else. Station restrictions let the user log onto only one specific station address. You can also designate time blocks, limiting user access to certain time intervals. Other utilities—console monitoring, error logs, and usage statistics—help track user activity. You can temporarily disable suspicious accounts and set an account to automatically disable itself after a preset number of failed password attempts. A NetWare utility will evaluate your security system, pointing out any deficiencies that it finds (such as an account without a password assigned to it).

Special utilities help the supervisor face the arduous task of adding large numbers of new users. This can be especially trying when the administrator first establishes the network. The MAKEUSER utility accepts a listing of names and adds them to the network. The file can also specify permissions and restrictions, or you can set up one user with a generic set of permissions and assign equivalent security status to any other user or group of users.

Administrators will quickly appreciate NetWare's accounting functions. You can apply charges for time logged onto the network or for server disk storage. Rates can fluctuate according to the time of day. Even if your organization doesn't charge for network usage, the accounting module creates an audit trail for tracking user log-ons, session durations, and resource use.

3Com's 3+Open LAN Manager 1.0

3Com has played the compatibility game patiently. While Novell impressed users with a fast, dedicated network operating system, 3Com stuck with DOS and the limited services of MS-NET, opting for the standard despite its limitations. Now, with the introduction of 3+Open LAN Manager, 3Com's time may have come. All the pieces of 3+Open have yet to come together, although the overall structure is in place.

Novell has stuck with its proprietary IPX protocols, which have made it one of the fastest LANs on the market. But Novell doesn't directly support other protocols, such as industry-standard TCP/IP, within its architecture. 3Com has introduced a protocol-switching shell to support various combinations of protocols. This shell, which should be available by press time, will let the company build and dynamically install an assortment of compatible transport stacks.

3+Open initially loads the NetBIOS Protocol (NBP), a slimmed-down (25K-byte) version of the Xerox Network Standard (100K bytes) with limited file and print services. It loads XNS for other services like E-mail. However, when an application requires a different protocol, such as TCP/IP or ISO TP/4, the resident protocol manager swaps it in automatically. Since 3+Open will directly support multiple alternate transport stacks, it won't require gateways or creative kludges for internetwork communications. Although 3Com is now shipping the protocol-switching shell and NBP, we didn't receive them in time for inclusion in this review. We performed our tests using XNS.

As 3Com implements TCP/IP and other alternative transport stacks and as OS/2 catches on, 3+Open should prosper.

continued

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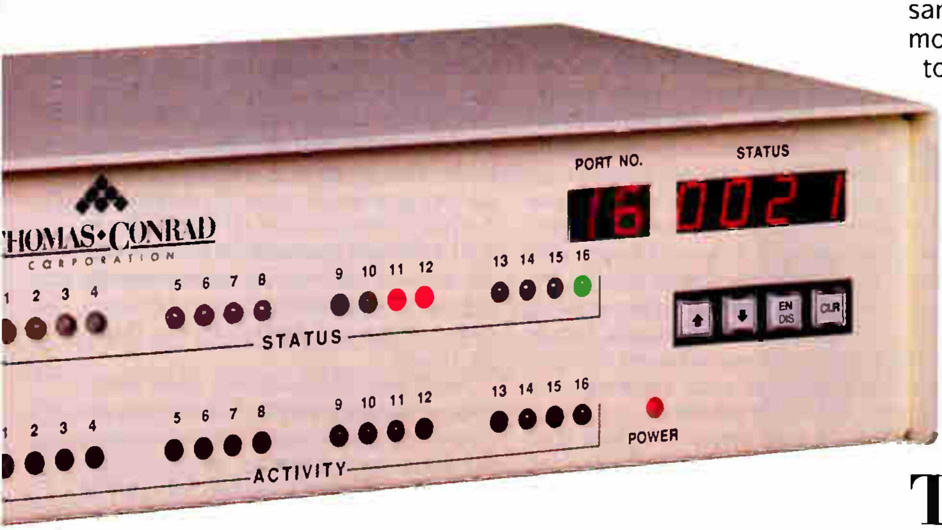

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demand that it respond to requests for data without noticeable delay. If every user is to have the illusion that his or her area on the server is simply another local drive, then the network needs to provide data at local-disk speed.

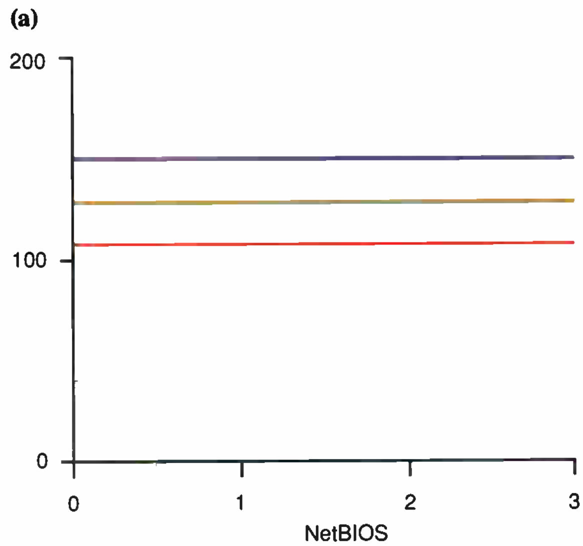
We used a comparison with single-user drive performance as our throughput yardstick. The shaded area in each figure (except figure 1a) represents performance below that of our PS/2 server when taken off the network and run as a stand-alone machine. Figure 1a, NetBIOS test results, doesn't have a single-user equivalent.

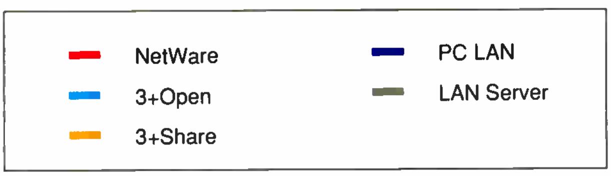
The flat load response of our NetBIOS test, which doesn't access the server drive, led us to conclude that most of the load delays shown by the other tests represent a server bottleneck. Traffic on the physical layer and the effectiveness of the protocol stack had little to do with overall throughput. Most of our tests measured how well a given operating system handled server disk access and the quality of the software's network adapter driver. In practice, these are the factors most likely to degrade performance on any server-based system. Some tests, like file I/O, also seemed sensitive to workstation caching.

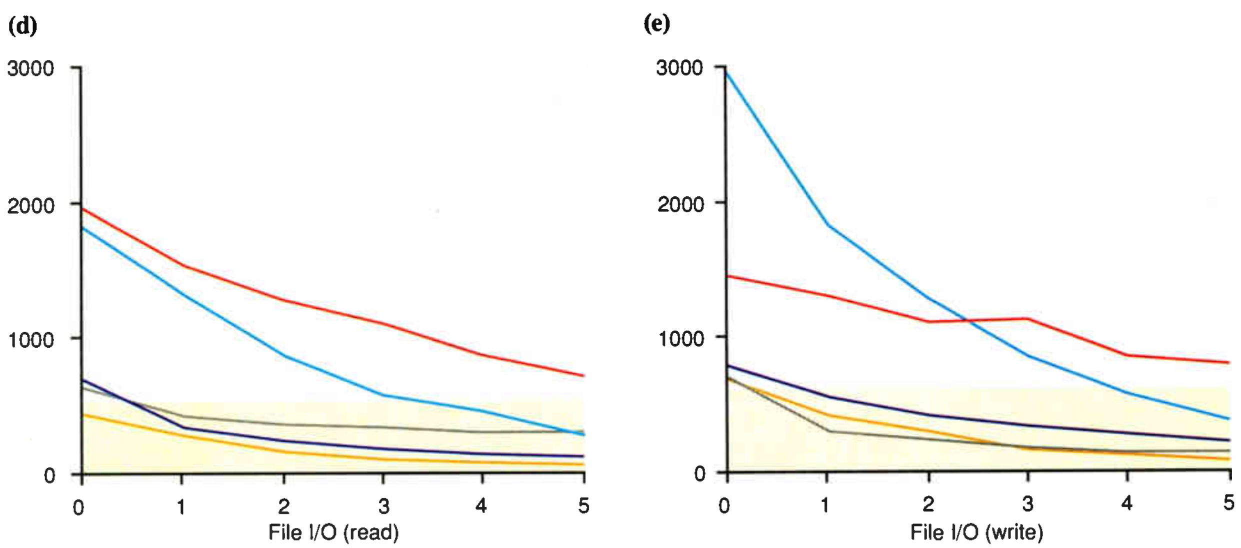
Novell's NetWare had a spectacular showing. Novell's disk optimizations include a server cache made up of 4K-byte buffers, limited in number only by available memory. Directories are also cached, making for rapid disk searches. NetWare's disk format features larger logical blocks than the 512-byte sectors of DOS and OS/2, which enhances performance on large file transfers. The one weak spot was NetWare's NetBIOS test result, which was the lowest of the tested packages. NetBIOS is the native session protocol for the other systems, while IPX is Novell's native session protocol. Its NetBIOS is an emulation layered on top of IPX, so it suffers when compared to native NetBIOSes.

Only 3Com's 3+Open came close to NetWare's performance. We tested 3+Open running under Microsoft's server adaptation of OS/2, a special version normally bundled with the 3+Open package. The main performance difference between this version and standard-edition Microsoft OS/2 is the inclusion of a sophisticated caching utility. Unlike the standard OS/2 cache, the server adaptation cache is write-behind, can be configured for sizes of up to 14 megabytes, and employs scatter-gather algorithms to enhance performance. The sys-

Figure 1: *Results of the BYTE benchmark suite for five LAN operating systems. All graphs represent network throughput; higher numbers mean better performance. Part* **(a)** *shows the NetBIOS test results. The yellow-shaded areas in parts* **(b)** *through* **(g)** *represent the levels of performance you could expect from a single-user system operating on the same file server. Points in the shaded areas mean response delays you wouldn't see in a dedicated system, and points above the areas indicate better operation than a single-user machine. All values are in kilobits per second except for the database benchmark, which is in write transactions per second.*







tem used a 384K-byte cache on our server. 3+Open also buffers the server disk with three 64K-byte buffers. All of 3+Open's parameters can be adjusted to further fine-tune performance.

Although 3+Open turned in good benchmark results, it outdid NetWare only on our file I/O write test. 3Com says that its new NBP protocol will substantially improve performance, and the company claims especially good performance for 3+Open over linked networks. Its transport protocol, unlike Novell's IPX, can send multiple packets before requiring receiver acknowledgment.

3+Open proved to be a much more responsive system than its older sibling, 3+Share. OS/2's multitasking capability and very high memory ceiling make it much more effective than DOS at handling the strain put on a network server.

3+Open, like NetWare, handles multiple client requests as multiple processes. Because it can handle requests concurrently, 3+Open is able to intelligently buffer up requests that refer to adjacent areas on the disk. This enables it to satisfy the largest number of requests with the fewest disk accesses.

3+Share caches the server disk, directories, and FAT. While performance with the system set up in its default configuration was disappointing, 3+Share is completely configurable and devotes an entire manual to network tuning.

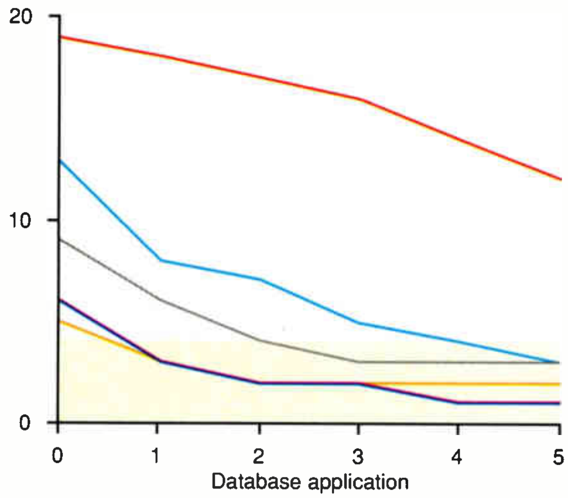
IBM's two entries, both running in a Token Ring environment, showed surprisingly similar performance. While the throughput levels are about where we'd expect for PC LAN, LAN Server's numbers are surprisingly weak.

Since it's sold as a stand-alone package, we ran LAN Server under IBM OS/2 Extended Edition 1.1, not the server-optimized version packaged with 3+Open. As a result, OS/2's server caching was limited to the 64K-byte cache to which OS/2 defaults as part of the installation. Though it wasn't part of the formal benchmarks, we did tweak the cache up to 384K bytes to see whether it was the only factor limiting LAN Server's performance. The server responded with slightly better throughput, but the numbers were still significantly worse than those for 3+Open. The rest of LAN Server's disk buffer parameters default to the same values as 3+Open's.

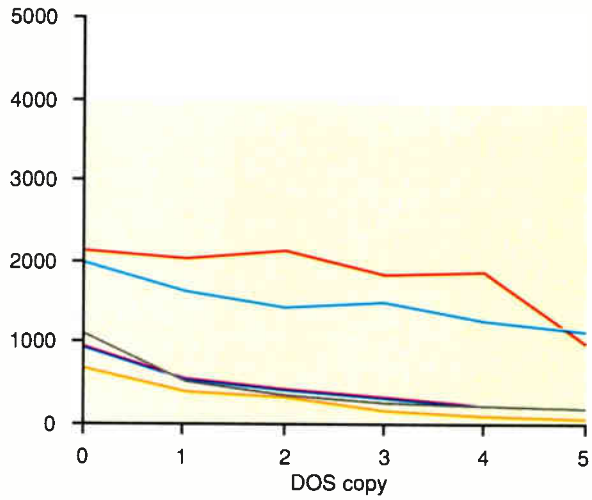
You should keep in mind that we tested LAN Server with DOS workstations that were running the PC LAN redirector software. Any workstation contributions

continued

(b)



(c)



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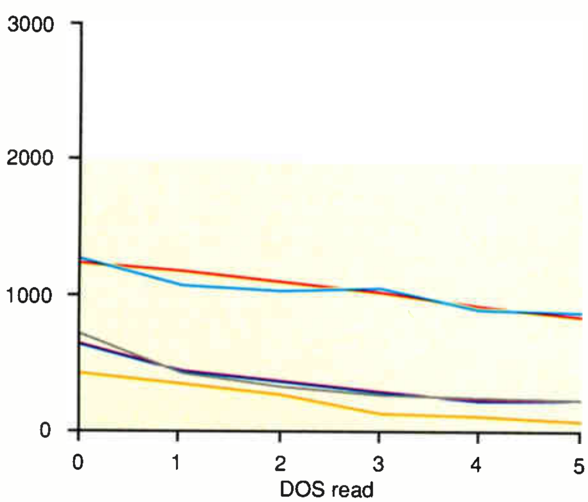
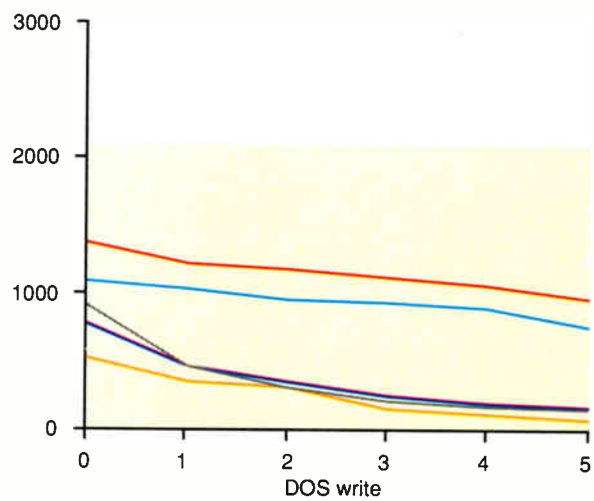


(g)



COMPANY INFORMATION

IBM Corp.
Armonk, NY 10504
Contact local representative.
Inquiry 1071.

Novell, Inc.
122 East 1700 South
P.O. Box 5900
Provo, UT 84601
(801) 379-5900
Inquiry 1072.

3Com Corp.
3165 Kifer Rd.
Santa Clara, CA 95052
(408) 562-6400
Inquiry 1073.

to performance were identical for PC LAN and LAN Server. This is not like the relationship between 3+Open and 3+Share, because 3+Open DOS workstations aren't compatible with 3+Share.

In testing the OS/2 networks, LAN Server and 3+Open, we ran into a few performance oddities: We were able to run tests repeatedly and get results varying by as much as 40 percent from run to run. Often the test results would fall within a narrow window from a long series of tests and then suddenly degrade with no apparent changes to the configuration. Microsoft representatives speculate that the performance quirks may be due to using up all the clear blocks in the server cache.

Final Decision

Even with Extended Services, PC LAN is fairly basic. It appears to have no fault-tolerant provisions and no auditing capabilities. If most of the systems in your workplace are IBM PC XTs, then PC LAN is worth a look. But most users in this situation would probably find 3+Share more full-featured.

LAN Server has many of the features that PC LAN lacks. Since LAN Server is built on top of OS/2, it carries with it advantages beyond performance: a common set of application programmer interfaces and an open, modular communications architecture mean excellent compatibility. If you've already got PC LAN installed in your office, the easy upgrade path to LAN Server (provided you've got machines that can run OS/2) bears scouting.

Clearly, the heavyweights here are NetWare and 3+Open. With Novell still solidly entrenched at the top, 3Com has now embarked on a new offensive. No longer locked in the limited confines of DOS, 3+Open should evolve into an impressive product. Ultimately, for large networks with numerous internetwork bridges and gateways to other environments, 3+Open, with its planned support for multiple transport stacks and efficient naming conventions, will hold the edge. But while we're impressed by the promise of 3+Open, NetWare still offers the strongest product overall. It handles network chores with ease, and its management, accounting, and security features are well ahead of the pack. ■

Steve Apiki and Stanford Diehl are testing editors for the BYTE Lab. They can be reached on BIX as "apiki" and "sdiehl." Rick Grehan is the director of the BYTE Lab. He can be reached on BIX as "rick_g."

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Jerry Pournelle
BYTE, June 1989, page 119

CAMBRIDGE
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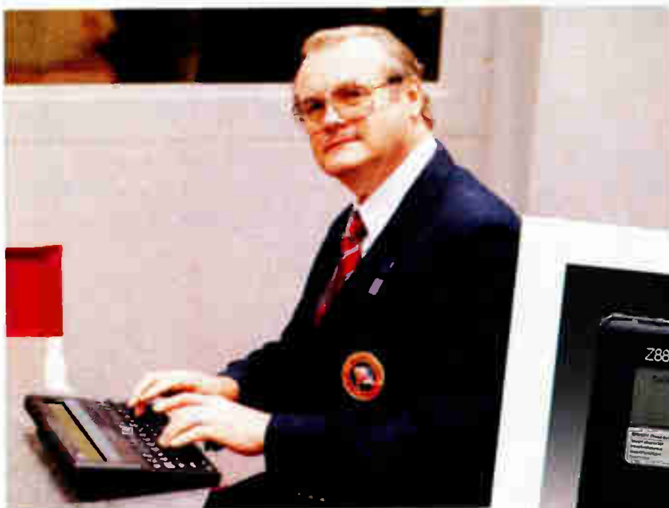

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IBM's New Speed King

The Model 70-A21 is the fastest PS/2, but it's slower than its competition

Caroline Halliday

You'd think they're selling computers by the pound these days. Almost all the recent crop of 25-MHz 80386-based personal computers are large desktop or floor-standing units with a lot of expansion slots and room for storage devices. IBM's PS/2 Model 70-A21 is also a 25-MHz 80386-based personal computer, but it is packaged into a small form factor with only three expansion bus slots. At first glance, the Model 70 may seem to be an ideal machine if you don't need all those expansion slots—but its comparative performance is not stellar.

Essential Features

The Model 70-A21's system board memory architecture includes an 82385 memory cache controller with 64K bytes of static RAM (SRAM). The system board comes with 2 megabytes of 80-nanosecond RAM, expandable to 8 megabytes. One 1.44-megabyte 3½-inch floppy disk drive is standard, and there's room for a second. The 120-megabyte ESDI hard disk drive is similar to the hard disk drive in the 20-MHz Model 70-121. A basic Model 70-A21 costs $11,295.

The 101-key IBM Enhanced keyboard comes with the system unit, but you must purchase the display separately. As with its siblings, this computer's VGA adapter subsystem, serial port, parallel port, and mouse port are integral parts of the system board. The Micro Channel architecture (MCA) expansion bus includes two 32-bit slots and a 16-bit slot for PS/2 expansion boards. The system I reviewed had 8 megabytes of system board RAM ($1495 for each 2 megabytes beyond the standard), the 25-MHz 80387 math coprocessor ($2395), and the 8513 color monitor ($750), for a total price of $18,925. [Editor's note: *After this review was written, IBM announced that it had temporarily stopped production of the 70-A21 to correct an undisclosed problem on the motherboard. Units made since March have the revised motherboards.*]

PS/2 Lineage

The Model 70-A21's styling is similar to that of the other Model 70s and the Model 50s. (I reviewed the previous Model 70s in "Strengthening the Line-up," January BYTE.) From the front, the desktop unit looks very small, occupying over 35 percent less space than an IBM PC AT, but it is almost as deep.

The power switch and floppy disk drive are on the front of the unit. You can install a second 3½-inch floppy disk drive ($425) in the bay between them. All connectors are on the rear panel, as is the keylock for locking the case. The keyboard locks via the password protection facility supplied with all the PS/2s.

The keyboard and mouse port connectors are 6-pin mini-DIN connectors that are physically similar but (unlike their counterparts on the Model 30) not interchangeable. The display is connected via a miniature DB-15 VGA connector

continued

IBM PS/2 Model 70-A21

Company
IBM Corp.
900 King St.
Rye Brook, NY 10573
(800) 426-2468

Components
Processor: 25-MHz 32-bit 80386; socket for optional 25-MHz 80387 math coprocessor
Memory: 2 megabytes of 80-ns RAM, expandable to 8 megabytes maximum on the system board and 16 megabytes maximum in the system; 82385 memory cache controller with 64K-byte SRAM zero-wait-state memory cache
Mass storage: One 1.44-megabyte 3½-inch floppy disk drive (optional second floppy disk drive); optional 120-megabyte hard disk drive
Display: VGA as integral part of system board; optional 8513 color VGA monitor
Keyboard: 101-key IBM Enhanced
I/O interfaces: One female DB-25 parallel port; one male DB-25 serial port; miniature DB-15 VGA connector; one 6-pin DIN mouse port; two 32-bit MCA expansion slots and one 16-bit MCA slot

Size
5½ × 14⅕ × 16½ inches; 21 pounds

Software
Reference Diskette

Documentation
Quick reference guide

Price
Model 70-A21: $11,295
System as reviewed: $18,925

Inquiry 852.

rather than the CGA's and EGA's DB-9 connector. The extra pins are necessary, in part, to enable the computer to identify the type of monitor attached.

Inside Story

The Model 70-A21's interior is similar to that of the other Model 70s and the Model 50; no cables are used. The power supply runs from front to back on the right side, and the system board lies in the base of the unit. A platform arrangement above the system board supports the disk drives. The hard disk drive is mounted on the platform behind the floppy disk drives. All disks are linked to the system board via a printed circuit board that effects the right angle connection.

The system board occupies the whole bottom of the case to the left of the power supply. The processor, math coprocessor, and cache controller are on a piggyback board under the floppy disk drives. The main system RAM modules are on the main system board. You need to remove the drive support platform to add system memory modules. You can reach the math coprocessor socket through a hole in the platform under the second floppy disk drive (if installed).

Three MCA expansion slots are in the left rear of the system board. The 16-bit slot on the far left includes the video extension portion of the bus, which allows you to use video boards, such as IBM's 8514/A, in place of the VGA. The two 32-bit slots do not include this extension.

Banning DIP Switches

On the PC and AT, DIP switches and jumpers set the interrupt levels and starting addresses for the expansion board. The PS/2s attempt to rectify this annoyance with an automatic configuration system, standard across the machines and achieved through software rather than just hardware. IBM thereby discourages third-party vendors from adding any jumpers or switches to boards. (But it breaks its own rule on the 8514/A video board memory-expansion module.)

This configuration standard is called Programmable Option Select. Each PS/2 expansion board has a unique ID, set in software-writable latches, that POS uses. When any option is added, taken out, or even moved around in a PS/2, the supplied Reference Diskette is used to reset the configuration.

For most situations, the automatic configuration utility on the Reference Diskette is adequate. The utility determines the type of adapter in a particular slot, the adapter's desired interrupt level, and the adapter's starting address. For many adapters, alternate interrupts and starting addresses are also specified. The configuration utility sets the interrupt levels and starting addresses so as to avoid conflicts, selecting alternates if possible, or disabling an adapter board if conflicts cannot be resolved. The current configuration information is stored in the battery-backed CMOS RAM, where the operating system can access it.

In addition to the software-writable latches on an adapter board, a board manufacturer can supply a floppy disk that includes adapter description files, diagnostic tests, and power-on self test error messages. These are added to the Reference Diskette prior to configuration. The Reference Diskette includes other configuration utilities that you use for more specialized applications when you don't want to use the settings from the automatic configuration.

Also on the Reference Diskette is the password protection utility, which offers two levels of password protection: power-on and keyboard. You must type the correct password, which can be up to seven characters long, before you can use the computer. The keyboard password program lets you lock the keyboard from the DOS prompt until the password is typed. You set the passwords initially via a utility on the Reference Diskette.

Reading Reference

The Model 70-A21 comes with a quick reference manual and disk cache instructions. The reference manual gives a basic introduction to the Model 70, information on installing options into the computer, and some troubleshooting tips.

The instructions are clear and concise, with adequate graphics. For example, the instructions for installing the math coprocessor start with checking the type of coprocessor and turning off the computer and continue through orienting the chip and reconfiguring the computer.

Measuring Up

As expected from the company that set the standard, IBM's Model 70 is fully software-compatible. I did not have any problems with application software.

The BYTE benchmarks, with no disk-caching software installed, rated the 25-MHz Model 70-A21 lower than the 20-MHz Compaq Deskpro 386/20, the Dell System 310, and Advanced Logic Research's FlexCache 20386. This is due to the Model 70's slower hard disk drive.

With a disk cache added, the various machines perform more evenly. A good disk-cache program operates out of RAM most of the time, only accessing the disk when a cache miss occurs. Arguably, the supplied disk cache compensates for a lower-performance disk drive. If you are using DOS and typical application programs, the hard disk with disk-caching software installed won't present a performance problem. But for applications that access data randomly from the disk, there is a performance penalty.

At the CPU level, the Model 70-A21 is faster than the Compaq Deskpro 386/25, even though both machines use the Intel 82385 as the memory cache controller (not to be confused with the disk-caching software). IBM's implementation is a 64K-byte, two-way associative cache; Compaq's is a 32K-byte cache.

When a cache miss occurs on the Model 70, 8 bytes, rather than 4, are

continued

IBM PS/2 Model 70-A21

APPLICATION-LEVEL PERFORMANCE

IBM PS/2 Model 70-A21 **16.4***

WORD PROCESSING

XyWrite III+ 3.52	**Medium/Large**
Load (large)	:13
Word count	:02/:13
Search/replace	:03/:17
End of document	:01/:11
Block move	:08/:08
Spelling check	:06/:38
Microsoft Word 4.0	
Forward delete	:18
Aldus PageMaker 1.0a	
Load document	:09
Change/bold	:19
Align right	:14
Cut 10 pages	:13
Place graphic	:03
Print to file	1:54
Index:	**3.20**

SPREADSHEET

Lotus 1-2-3 2.01	
Block copy	:02
Recalc	:01
Load Monte Carlo	:15
Recalc Monte Carlo	:03
Load rlarge3	:04
Recalc rlarge3	:01
Recalc Goal-seek	:02
Microsoft Excel 2.0	
Fill right	:03
Undo fill	1:09
Recalc	:01
Load rlarge3	:17
Recalc rlarge3	:01
Index:	**3.75**

DATABASE

dBASE III+ 1.1	
Copy	:51
Index	:19
List	1:26
Append	1:50
Delete	:02
Pack	1:46
Count	:17
Sort	1:18
Index:	**1.52**

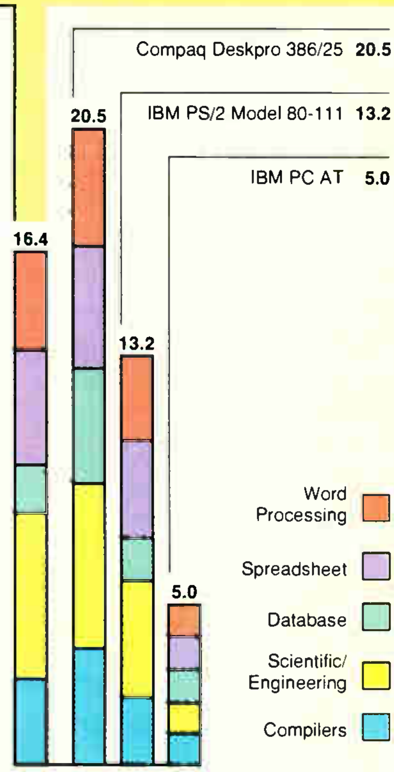
SCIENTIFIC/ENGINEERING

AutoCAD 2.52	
Load SoftWest	:32
Regen SoftWest	:22
Load StPauls	:08
Regen StPauls	:04
Hide/redraw	7:09
STATA 1.5	
Graphics	:23
ANOVA	:10
MathCAD 2.0	
IFS 800 pts.	:09
FFT/IFFT 1024 pts.	:09
Index:	**5.33**

COMPILERS

Microsoft C 5.0	
XLisp compile	3:07
Turbo Pascal 4.0	
Pascal S compile	:05
Index:	**2.62**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT=1.



*Cumulative application index. Graphs are based on indexes at left and show relative performance.

LOW-LEVEL PERFORMANCE[1]

IBM PS/2 Model 70-A21

CPU

Matrix	2.69
String Move	
Byte-wide	18.95
Word-wide:	
Odd-bnd.	23.73
Even-bnd.	9.50
Doubleword-wide:	
Odd-bnd.	16.49
Even-bnd.	4.76
Sieve	14.22
Sort	10.64
Index:	**4.71**

FLOATING POINT

Math	5.06
Error[2]	
Sine(x)	1.59
Error	
e^x	1.86
Error	
Index:	**10.23**

DISK I/O

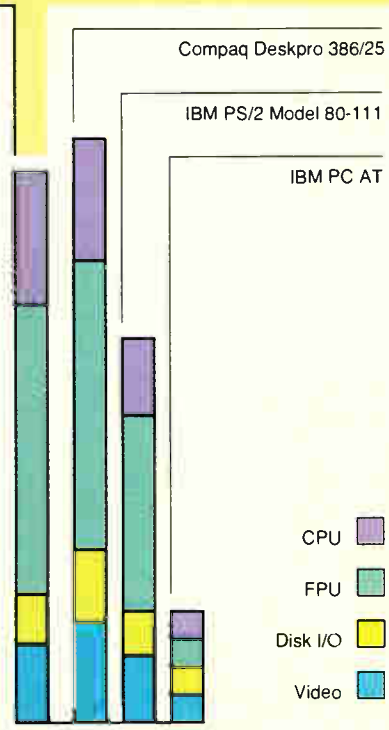
Hard Seek[3]	
Outer track	5.00
Inner track	5.00
Half platter	7.14
Full platter	8.60
Average	6.43
DOS Seek	
1-sector	12.67
32-sector	26.88
File I/O[4]	
Seek	0.09
Read	1.06
Write	1.14
1-megabyte	
Write	5.25
Read	4.96
Index:	**1.64**

VIDEO

Text	
Mode 0	3.13
Mode 1	3.13
Mode 2	3.41
Mode 3	3.41
Mode 7	N/A
Graphics	
CGA:	
Mode 4	1.26
Mode 5	1.21
Mode 6	1.38
EGA:	
Mode 13	2.47
Mode 14	2.96
Mode 15	N/A
Mode 16	2.93
VGA:	
Mode 18	3.06
Mode 19	1.26
Hercules	N/A
Index:	**2.96**

CONVENTIONAL BENCHMARKS

LINPACK	142.05
Livermore Loops[5] (MFLOPS)	0.20
Dhrystone (MS C 5.0) (Dhry/sec)	7974



N/A=Not applicable.

1 All times are in seconds. Figures were generated using the 8088/8086 and 80386 versions (1.1) of Small-C.

2 The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

3 Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

4 Read and write times for File I/O are in seconds per 64K bytes.

5 For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

fetched from memory. When cache misses occur one after another in groups, this method improves the machine's performance. Typically, applications access memory sequentially, which makes using a cache worthwhile; however, once a cache miss occurs, several more cache misses are likely, making IBM's method efficient. The ALR 25-MHz 25386 outperformed the Model 70 on all the CPU tests because its proprietary cache controller has superior performance.

The Model 70's video performance, while completely compatible with IBM's own standard, is not as good as that of the Compaq machine because of its 8-bit architecture. Compaq's 16-bit VGA architecture gives it the edge here.

As expected, the disk I/O tests show the weakness of the Model 70's hard disk drive. The results are similar to those of the IBM PS/2 Model 80-111; however, the index of 1.64 indicates a performance only 1.64 times faster than the hard disk drive in the 8-MHz AT. Pitted against competitors, IBM's hard disk drives do not fare well. For example, the 25-MHz Compaq has a hard disk index of 2.55.

The application-level benchmarks show the effect of the hard disk drive and graphics in typical applications. As expected, the database results are the most affected by the hard disk drive. The Model 70 takes 50 percent longer to perform the database tests than the Deskpro 386/25. In the scientific and engineering tests, the superior memory architecture shows when calculations are significant, but its effect is tempered by the 8-bit VGA when graphics are important.

Wrap-Up

The 25-MHz Model 70 offers full software compatibility with the AT class of machines and a fast speed. It is hardware-compatible with the PS/2 family, incorporating 32-bit MCA expansion slots. The MCA expansion bus and the 3½-inch floppy disk standard may be a barrier to some purchasers, but the IBM label may be important to others.

Machines comparable to the Model 70-A21, such as Compaq's Deskpro 386/25 ($11,447) and ALR's FlexCache 25386 ($9499), are larger, but they incorporate other features (e.g., faster hard disk drives and VGA boards) that enable them to perform substantially faster. In fact, some 20-MHz machines perform the BYTE benchmarks faster than the Model 70-A21. This shortcoming is mostly attributable to a slower hard disk drive and an 8-bit VGA system. However, the hard disk performance can be improved to acceptable standards with the supplied disk-caching software.

With the disk caching, the Model 70-A21 is a reasonably fast machine, and you can have up to 8 megabytes of memory on the system board before needing one of its three expansion slots. If you need more than three expansion slots along with the speed, opt for a Compaq Deskpro 386 or an ALR 80386 computer. Otherwise, this, or one of the slower, lower-priced versions of the Model 70 (the Models 70-E61 and -121), may fit your needs cost-effectively. ■

Caroline Halliday is an electrical engineer and freelance writer living in the Chicago area. Her recent books are: IBM PS/2 Technical Guide *with James A. Shields (Howard W. Sams and Co., 1988) and* Using OS/2 *with Mark Minasi and David P. Gobel (Que Corp., 1989). She can be reached on BIX c/o "editors."*

Color by Numbers

Tektronix takes the cost of PostScript-compatible color output to a new low

Kent Quirk

If you're working with color images on your PC and need to get color hard copy, you have few options. Plotters are generally limited to drawings. Dot-matrix printers offer limited colors and mediocre resolution. Film recorders support many colors and are flexible, but they require additional processing to get a full-size image and usually require special driver software. A more attractive alternative may be color thermal-transfer printers. The Tektronix Phaser CP is the newest and lowest-cost entry in this field.

The Phaser CP takes the impact of full-size, high-resolution, color hard copy and adds to it the power of a PostScript-compatible page description language. The result is a color thermal-wax-transfer printer that generates brilliant color hard copy from a wide variety of applications (see figure 1). And at $12,995, it's several thousand dollars cheaper than its nearest competitor, the QMS Color Script 100 Model 20.

An AppleTalk-compatible version of the Phaser for the Macintosh should be available by the time you read this. The $15,995 Phaser CPS supports Color PostScript only. It includes a separate controller box with a 40-megabyte hard disk drive and ports to support the LaserWriter and Phaser CP driver cards.

The Tektronix Phaser CP's print engine is a hefty 95-pound unit that resembles an old-style Xerox copier. Opening the front panel reveals lots of green handles and levers; the paper path is unusually complicated, compared to current single-color laser printers.

The printer mechanism is based on a Kyocera thermal print head, which doesn't move. The head prints a complete horizontal line at once, and the paper moves past it at a constant vertical speed. The printer boasts 300-dot-per-inch resolution along both axes.

Between the print head and the paper is a film ribbon that's composed of alternating bands of yellow, magenta, and cyan wax on a transparent plastic substrate. The print head melts the wax, transferring it from the plastic ribbon to a special coated paper. Each band of color on the ribbon is the width of a page; the ribbon and the paper move together past the print head, once for each color printed. Tektronix also sells four-color or all-black ribbons.

Because printing a single color image requires three or four passes past the print head (depending on the thermal-transfer ribbon used), the printer clamps the paper tightly to ensure accurate positioning. Unfortunately, the clamping process takes up space on both ends of the page, leaving a usable area of just 8¹⁄₁₀ by 8³⁄₅ inches on an 8½- by 11-inch page. Thus, you must use legal-size paper to print a full page of text.

Phaser Driver

The Phaser CP actually comprises two components: the CP printer ($6000) and the Phaser Card ($6995). The add-in card contains a 12-MHz 68020 processor with 8 megabytes of RAM, and it has connectors to drive Tektronix color and monochrome laser printers, when they become available. Tektronix says that future printers will be able to use this card without modifications. It supports a wide variety of interfaces. You can set up the system to emulate (in hardware) any COM or parallel port.

The first 3 megabytes of RAM is located on the main card; another 5 megabytes is on a full-length daughtercard. You can add another 3 megabytes of RAM to the daughtercard, for a total of 11 megabytes. Tektronix says this additional memory improves printing time

continued

Tektronix Phaser CP

Company
Tektronix, Inc.
Graphics Printing and Imaging Division
P.O. Box 1000
Wilsonville, OR 97070
(800) 835-6100

Features
Compatible with PostScript and HPGL; supports 35 standard PostScript fonts; prints letter- or legal-size documents (English and metric sizes) on transparencies or thermal paper

Size
12¾ by 22 by 21⅕ inches; 95 pounds (paper cassette adds 13 inches to width)

Hardware Needed
IBM PC or AT with an 8-bit slot, a floppy disk drive, and a hard disk drive

Documentation
Printer manual; Phaser Card manual; Symbol and Dingbats font reference cards; Phaser Interpreter reference manual available

Price
Phaser Card: $6995
Phaser CP printer: $6000
Complete package: $12,995

Inquiry 851.

and increases bit-map space for images.

Tektronix went out of its way to acquire rights to all the same type families that Adobe uses. The fonts are adjusted to look good at all point sizes. Although the character widths are identical to Adobe's, there are tiny but noticeable differences in character outlines, particularly in the shape of serifs. This may be the result of the difference in printing technology. The Phaser CP also supports PostScript downloadable (Type 3) fonts.

The Phaser CP comes with plenty of documentation, including user's guides for the printer and the Phaser Card. A reference manual is available for $45.

Most PostScript printers include information about statusdict, the dictionary of printer-specific operators for the language, and the limitations imposed by the implementation. That's even more critical in this case, because this is not name-brand PostScript—although the language implementation is fully compatible with Adobe PostScript version 49, including the color extensions.

Tektronix has implemented several extensions to the PostScript language without affecting the base operators. Most of the implementation limits are the same as those on the Apple LaserWriter, with a few extensions (like total number of path segments) that Tektronix thought were too limiting. I did not discover any PostScript compatibility problems in testing with output from various PostScript application drivers, nor when I wrote PostScript code. Since the PostScript interpreter resides on the host system disk, any compatibility problems that might occur could be fixed with a software release.

The software for the Phaser Card is enormous. It comes on 15 360K-byte 5¼-inch disks or eight 720K-byte 3½-inch disks. The setup software is courteous enough not to modify your AUTOEXEC.BAT file unless you give it permission. Once you've downloaded the software to the Phaser Card, it doesn't use any system RAM, although it does take up nearly 3 megabytes of disk space.

On my 20-MHz AST Premium/386 running DOS 3.3, the Phaser Card consistently refused to load properly at initial power-on. It emitted an error message and aborted. Tektronix was unable to explain this behavior. However, the card loaded properly when the system was rebooted, taking approximately 28 seconds to download 2.3 megabytes of software. You can also set up the software to emulate the Hewlett-Packard Graphics Language (HPGL).

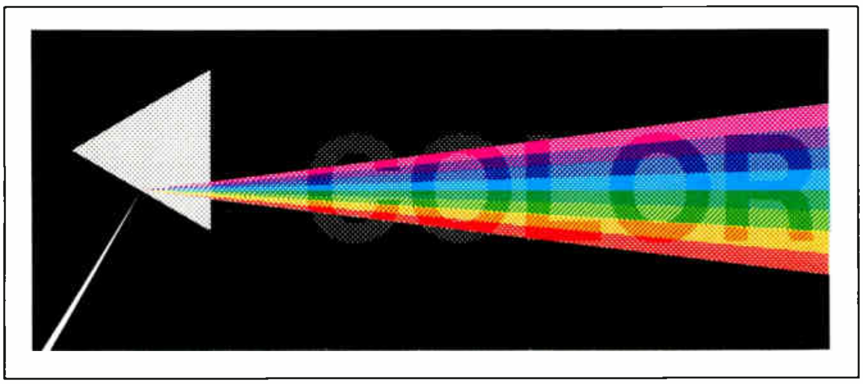


Figure 1: *This sample output from the Phaser CP shows the printer's color quality and resolution. To ensure accurate reproduction, I created this sample image using PostScript and then used a PostScript program to break down the image into its cyan, magenta, yellow, and black components and to print each separation. The resulting image, printed here without additional processing, appears at the same resolution as the original and maintains color consistency with it.*

Performance

With a three-color ribbon installed, the print engine can generate about one legal-size page every 50 seconds. It prints each color layer individually and then backs up and reprints on the next color for the same page. According to Tektronix, a four-color ribbon should print a legal page in about 70 seconds, and a black ribbon should print the page in about 30 seconds.

Despite the 68020 processor, the PostScript interpreter is fairly slow compared to some of the newer laser printers. Even ignoring the speed of the actual print engine (which is also very slow, compared to laser engines), image generation takes a long time. A Mandelbrot set routine (which is calculation-intensive) ran for 1 hour on a QMS PS-810 Plus laser printer and would have run for over 16 hours on the Phaser CP if I had let it finish. On the other hand, bit-map generation continues in the Phaser Card while the print engine is printing, so the effective throughput on multipage jobs is fairly good.

The Phaser Card has an application-specific IC designed to implement color halftoning at high speed in hardware. Images where this is used seemed to print quickly, although I didn't use any objective color benchmarks to test this.

I did run the benchmark tests that Steve Apiki and Stan Diehl used in "PostScript Printers Come of Age" (September 1988 BYTE). When compared to the QMS Color Script 100 Model 30, the large text file took significantly less time on the Phaser CP; the time for the other files was roughly comparable (see table 1).

True Resolution

The Phaser CP advertises 300-dpi "positional resolution," but the size of those dots can vary with the medium used and the density of the print. As a test of printer resolution, I printed 1-pixel vertical lines over a range of different colors and spacings using the standard three-color ribbon.

At 300 lines per inch, the dots merged (as they should). At 100 lpi, they were clearly separated. At 150 lpi, however, they were separated for the first quarter inch of vertical distance and then blurred together as the print head heated up. The black area was particularly bad, because the yellow wax seems to melt at a lower temperature than the others. It therefore bleeds more, and the 150-lpi area ends up as a rather sick-looking shade of brown. When printed on a transparency, the dots spread even more, but this improved the appearance nearly everywhere.

Although the resolution is the same as that of a laser printer, the difference in printing technology is noticeable. Jaggies are obvious on diagonal lines, lending a low-resolution appearance, particularly at smaller point sizes.

Table 1: *PostScript printer benchmark tests. In the large-text-file benchmark, the Phaser CP was significantly faster than the more-expensive Color Script 100 Model 30. Times are in seconds.*

Benchmark	Phaser CP	QMS Color Script 100 Model 30
Large text file	640	1582
Small text file	380	362
PostScript graphics file	285	297

Not for Everyone

The Phaser CP should prove popular in the presentation departments of large companies, in the graphic arts industry, or as an output device for three-dimensional mechanical renderings. Other users will find that both the Phaser CP's purchase price and its cost per page are too high for most applications. Printing costs range from 38 cents per page using a three-color ribbon on thermal paper to $1.50 per page for color transparencies using a four-color ribbon. Compare this to an average cost of just 8 cents per page for a monochrome laser printer.

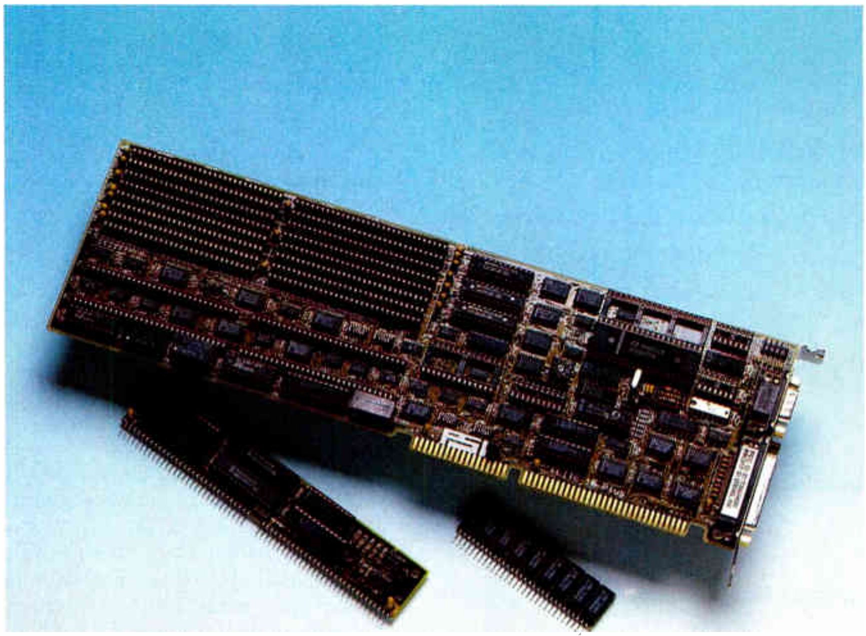
Although the images are stunningly bright, the resolution isn't good enough to use them as color originals for four-color work, nor should you count on the Phaser CP to generate accurate colors for printing proofs. However, those who need a color printer for presentation graphics should strongly consider this one, particularly in a workgroup situation. The image quality is terrific, the PostScript compatibility is high, and as this review went to press, its price made it an excellent buy. But competition in this market is heating up. If you can afford to wait, prices should continue to tumble as QMS and other vendors introduce competitive products. ■

Kent Quirk is president of Totel Systems, a software development company in Westford, Massachusetts. You can reach him on BIX as "kquirk."

EMS with a Cache

The Elite 16 Plus HyperCache boosts EMS 4.0 performance

Jeff Holtzman



The Elite 16 Plus HyperCache is an EMS 4.0 board with a twist. It provides capabilities similar to those of other boards, such as the Intel Above Board Plus and AST Research's RAMpage Plus/286, but it distinguishes itself with an on-board 16K- or 32K-byte memory cache that gives it a performance edge. It's also a cost-effective way to bring modern memory design techniques to older 8-MHz 80286-based systems. And in systems with faster bus speeds, the board's memory cache lets you use slower, less-expensive DRAMs.

You can configure the HyperCache with up to 16 megabytes of memory on the card; it includes one parallel and one serial port and a 16K-byte RAM cache. The board boasts switchless installation, full EMS 4.0 compatibility, and an extremely versatile memory-allocation scheme. Options include an extra 16K-byte RAM cache ($189) and a second serial port ($50). A Micro Channel architecture version of the board should be available by the time you read this.

As with other EMS boards, you can allocate memory on the HyperCache among conventional, extended, and expanded memory. You can allocate extended memory 16K bytes at a time, which is more efficient than the 512K- and 128K-byte increments that the Intel Above Board Plus and AST RAMpage Plus/286 use, respectively. The HyperCache can also backfill conventional memory and swap that memory in 16K-byte pages according to the EMS 4.0 specification.

The HyperCache has only a single EMS alternate-mapping register set, an optional feature of EMS 4.0 that lets you swap entire memory-mapped contexts with a few I/O instructions. Like paged conventional memory, alternate-mapping registers also let operating environments such as Windows and OmniView operate more efficiently. By contrast, the RAMpage has 32 alternate mapping registers; the Above Board Plus has none.

To set up the Intel Above Board Plus and AST RAMpage Plus/286, you must run a utility that programs an on-board EEPROM. To set up the HyperCache, your machine just loads the AUTORAM.SYS driver during boot-up (a $158 EEPROM-based setup is available for running OS/2 and Unix environments).

Arguments to AUTORAM.SYS let you specify operating parameters, including memory allocation and ranges of memory to include and exclude for EMS page mapping. In addition, several parameters let you specify operational aspects of the board, including DRAM speed, number of wait states, bus timing, and whether you want 8- or 16-bit access to EMS memory above A0000.

Installation Decisions

Before installing the HyperCache, you must decide what you want to do with motherboard memory. The HyperCache can backfill from as low as the 128K-byte boundary (20000h). It's best to disable as much motherboard memory as possible, since the HyperCache won't cache it. You also can't swap system memory, because the motherboard lacks EMS 4.0 mapping hardware.

continued

Elite 16 Plus HyperCache

Company
Profit Systems, Inc.
30150 Telegraph Rd.
Birmingham, MI 48010
(313) 647-5010

Features
EMS 4.0 board with 16K- or 32K-byte cache; 512K bytes to 16 megabytes of RAM allocatable among conventional, expanded, and extended memory; includes serial and parallel port; switchless setup

Size
Full-length

Hardware Needed
IBM PC AT or compatible with 16-bit expansion slot

Documentation
Instruction guide

Price
With 512K bytes of RAM: $895
With 2 megabytes of RAM: $1895
As reviewed: $2084

Inquiry 853.

Memory modules are available in 256K-byte and 1-megabyte sizes; you install them in pairs (512K bytes or 2 megabytes), which you can intermix. You can install up to seven HyperCache boards in one system; a miniature rotary switch determines the board's ID and I/O port address range. The software handles multiple boards automatically; it also maps out bad blocks, detected at boot time, in 16K-byte increments.

The board should operate in most systems, regardless of bus speed or timing, but you may need to tweak several parameters in the driver software to optimize performance, especially if the machine's bus doesn't adhere strictly to IBM timing standards. The instruction guide is insufficient for doing this; it says to call the company for assistance.

In the default configuration, the board backfills conventional memory to 640K bytes, if necessary, and allocates the rest to expanded memory. If you want extended memory, you must specify the amount to the driver. Even with all memory allocated as extended memory, the version of the software that I tested left the EMS driver, needlessly, in memory.

Another annoyance is that the driver consumes about 20K bytes more of conventional memory than either the AST or the Intel drivers. Also, a bug in the software driver prevented Lotus 1-2-3 from executing properly out of swappable conventional memory; Profit Systems should have this fixed by the time this review reaches print.

Overall, the board is well built. It uses single in-line memory modules (SIMMs) with pin connections rather than edge card connections. The modules extend out from the board into the next expansion slot; however, a half-length card will still fit in the adjacent slot.

Performance

I tested a HyperCache with 2 megabytes of 100-nanosecond DRAM (main memory) and 32K bytes of 45-ns static RAM (cache memory) in an 8-MHz IBM PC AT with a 20-megabyte hard disk drive and a Hercules Graphics Card Plus.

Profit Systems built the HyperCache around the IDT7174 cache-tag RAM chip from Integrated Device Technology. This chip supports a direct-mapped cache in which multiple locations in main memory correspond to a single location in the cache. When the upper bits of the address bus equal the value in the tag RAM, a cache hit occurs, and the CPU can read the desired data with zero wait states. Otherwise, the board runs with one wait state. (For more on cache memory, see "Caching in on Memory Systems" by Brett Glass, March BYTE.)

Profit Systems says that the board can run with zero wait states (during cache hits) in buses running as fast as 12 MHz, and with one wait state in 12- to 20-MHz buses, no matter what the speed of the board's DRAMs. But this means only that the board itself will generate zero or one additional wait state; if you have a system bus that's designed, say, for two-wait-state operation, the bus delay will at least partially negate the gain in performance from the HyperCache.

I ran BYTE's CPU benchmarks and several high-level tests on the AT's motherboard memory by itself, and on the backfill memory provided by an AST RAMpage Plus/286, an Intel Above Board Plus, and an Elite 16 Plus HyperCache with a 32K-byte cache. The results appear in table 1.

To test the memory boards, I disabled the AT's upper 256K bytes of memory so each board could backfill memory. To ensure that the tests ran in expansion memory, I wrote EATMEM.EXE, a program that allocates a specified block of memory and executes the DOS TSR function, and used it to eat up memory to a point just above the 384K-byte boundary; this ensured that the tests ran just

continued

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Table 1: *Benchmark tests using the standard IBM PC AT configuration, the Intel Above Board Plus, the AST RAMpage Plus/286, and the Profit Elite 16 Plus HyperCache. I tested the HyperCache using a 32K-byte cache. All times are in seconds.*

	IBM PC AT	Intel Above Board Plus	AST RAMpage Plus/286	Profit Elite 16 Plus HyperCache
Low-level tests				
Matrix	11.7	11.6	11.7	9.7
Move (byte)	80.4	80.4	80.5	80.6
Move (word odd)	80.4	80.5	80.5	80.6
Move (word even)	40.3	40.3	40.3	36.3
Sieve	73.7	73.4	73.4	56.3
Sort	84.4	84.6	84.6	62.4
High-level tests				
AutoSketch redraw	42.2	42.3	42.2	33.4
VP-Planner recalc	7.7	7.6	7.6	6.4
WordStar scroll	28.1	28.0	28.1	24.3

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

from the expansion-board memory.

As shown in the table, the HyperCache had the fastest times in the low-level benchmarks. (It lost its edge on the byte and odd-aligned string-move tests because of the way the motherboard hardware converts 16-bit memory accesses into 8-bit accesses.)

The high-level tests consisted of redrawing a vector graphics screen in AutoSketch 1.04 Standard Edition, recalculating a 100K-byte spreadsheet under VP-Planner 1.0, and scrolling a 30K-byte file in WordStar 5.0. Here again, the HyperCache performed 15 percent to 20 percent faster than the other boards.

Not shown in the table are the effects of running a 16K-byte cache versus the optional 32K-byte cache. The low-level benchmarks ran about the same because they're small programs; most fit within a 16K-byte cache. However, the application benchmarks ran 6 percent to 12 percent slower with the 16K-byte cache.

Investment Potential

A 2-megabyte HyperCache costs $1895; comparable setups from AST and Intel cost $1940 and $2095, respectively. Not only is the Profit HyperCache cheaper, it provides better performance. But you get the most from the HyperCache on machines with an 8-MHz bus; relative performance increases diminish as the machine's bus speed increases.

For example, I installed the board on an AST Premium/286 and changed the bus speed from 6 to 8 to 10 MHz. Moving from a 6- to an 8-MHz bus, the relative increase in bus speed and board performance was about 30 percent. But moving from an 8- to a 10-MHz bus, the 10 percent increase in board performance doesn't keep up with the 25 percent increase in bus speed. The board must insert more wait states because the bus is faster than its 100-ns memory.

On systems with faster buses, the board's attraction is that it lets you save money by using slower DRAMs. For example, if your machine requires 80-ns DRAMs, the HyperCache's memory cache should let you use 120-ns DRAMs while maintaining nearly the same performance as with the 80-ns chips.

In terms of future upgrades, the HyperCache has a big advantage over the Above Board Plus because it uses more-economical SIMMs. It also holds 16 megabytes of RAM in 1½ slots, while the RAMpage and Above Board require two and four slots, respectively. The RAMpage does have more alternate mapping registers, an advantage where efficient multitasking is important, but the HyperCache has more-flexible memory allocation, which is important if you want to conserve memory while running Windows with HIMEM.SYS.

If you're looking for a memory upgrade or for a way to increase the performance of an older AT-class machine, this board is an excellent buy. ■

Jeff Holtzman owns Publishing Concepts, a firm in Ann Arbor, Michigan, that specializes in evaluation, verification, and documentation of high-technology products. You can reach him on BIX as "jholtzman."

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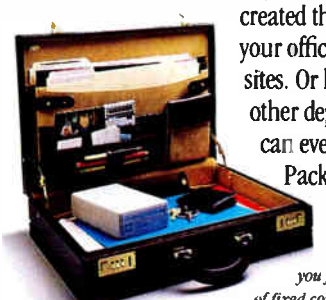

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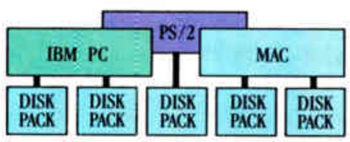

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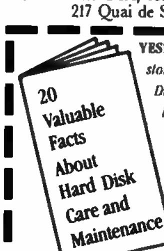

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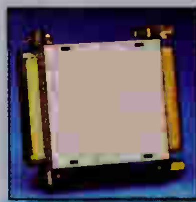

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Breaking the Memory Barrier with 386|VMM

Phar Lap transparently adds virtual memory to extended-DOS programs

Martin Heller

The 386|VMM ads say "Think Big." And indeed, thinking big is what this 80386-based virtual memory manager is for. If you want to build large applications with megabytes of code and megabytes of data, and you don't care that they run only on pricey 80386-based computers, Phar Lap's 386|VMM will help you do the job.

By itself, the developer's version of 386|VMM is a mere $295. But that's the least of your costs. You will also need Phar Lap's 386|ASM/LINK ($495); a Phar Lap-compatible compiler, like MetaWare's 80386 High C ($895) or MicroWay's NDP FORTRAN-386 ($595); and Phar Lap's 386|DEBUG symbolic debugger ($195). All this just lets you develop code. To distribute programs with 386|VMM, you can buy out the royalties for $10,000 or pay $20 to $50 per copy, depending on quantity.

What It Does

Phar Lap's extended-DOS environment puts the 80386 CPU into *flat* memory mode (i.e., it uses the 32-bit capabilities of the 80386 chip to address large amounts of memory). With 386|VMM, the extended-DOS environment also includes demand-paged virtual memory, another 80386 capability that operating systems such as Unix and Xenix exploit.

If your program is running with 386|VMM, then, instead of hitting a wall at 640K bytes of conventional memory (as it would under DOS) or at the end of extended memory (as it would under normal extended DOS), the program just starts swapping 4K-byte chunks of memory (i.e., pages) to and from your hard disk until you run out of disk space or reach the maximum virtual memory size of 4 gigabytes. When your program tries to use a piece of code or data that is paged out to disk, it causes a *page fault*, and 386|VMM restores the necessary page. Of course, another piece of memory has to be written to disk to make room. You can instruct 386|VMM to swap out the least-frequently used page (that's the default) or a page that was not used recently. You control the details of the swapping mechanism by means of command-line switches.

Most of this technical detail is not important. From a user's point of view, a program built with 386|VMM uses up all the memory in the machine and goes to the hard disk if it needs more. It does it efficiently and without much fuss.

A Lengthy Process

You don't test a system like this by timing the Sieve of Eratosthenes. I tested it by experimenting with MicroEMACS, a freely distributed programmer's editor. The DOS incarnation of this program can't read a file that's bigger than available RAM. Under extended DOS with 386|VMM, that limitation goes away, theoretically without changing any code. After about 60 sleep-deprived hours, three telephone calls, and a half-dozen BIX messages, I had MicroEMACS 3.9 running under 386|VMM. And yes, without ever writing any code to handle virtual memory, I got the program to read and edit multimegabyte text files.

What took all the time and effort was getting the program to compile under MetaWare's High C Compiler, link with the MetaWare library, and operate properly in Phar Lap's protected-mode environment. Once I'd ported MicroEMACS to the Phar Lap environment, adding virtual memory took only a few minutes.

To begin with, I spent time reading the manuals: The three binders from Phar Lap along with the MetaWare manual make up a formidable library. Then I had to install six disks from Phar Lap and six disks from MetaWare. And, of course, I configured and validated everything. One somewhat unusual aspect of the installation involved modifying the MetaWare initialization code (INIT.ASM) to recognize the Phar Lap memory management scheme, reassembling it with the Phar Lap assembler, and using the Phar Lap librarian to put the new module back into the MetaWare library. At this point, you'd think that all I had left to do was to compile MicroEMACS with MetaWare's High C Compiler and link with Phar Lap's 386|LINK. Not so.

If you have a program that uses only K&R C and has no machine, system, or compiler dependencies, you might get away with just compiling and linking. But I picked a real-world program that directly accesses video RAM, calls the IBM PC BIOS, and calls DOS. I also tripped on a few good C "gotchas," like the size of an `int`. It was, shall I say, educational.

A Few Snags

MetaWare's High C Compiler has to be the fussiest C compiler I've ever used. The original philosophy of C was that it should be a *loose* language. For fussy examination of your code, you would use a lint utility.

MetaWare doesn't subscribe to this theory. The company has made its C compiler more like a Pascal compiler—it makes few allowances. Even on perfectly good code, the High C Compiler tends to generate pages of warnings.

MicroEMACS is already full of conditional code geared to different compilers and environments. To adapt the editor

continued

386|VMM

Company
Phar Lap Software, Inc.
60 Aberdeen Ave.
Cambridge, MA 02138
(617) 661-1510

Format
One 360K-byte floppy disk

Hardware Needed
80386-based PC

Software Needed
DOS 3.x or higher; 386|ASM/LINK; 386|DEBUG; Phar Lap-compatible compiler (MetaWare 80386 High C, NDP FORTRAN-386, or NDP C-386)

Price
Developer's version: $295
Run-time version: $20 to $50 per copy, depending on volume, or a $10,000 one-time fee for unlimited distribution

Inquiry 881.

for High C and the Phar Lap 386|VMM environment, I started out in the file ESTRUCT.H:

```
#if     MSDOS & HIGHC
   /* M. Heller: for
     BYTE review */
#include <msdos.cf>
   /* DOS calls, interrupts,
     and registers */
#include <system.cf>
   /* c_unlink, etc. */
#include <string.h>
#define movmem(a,b,c)\
     memcpy(b, a, c)
#define int86(a,b,c)\
     callint(a)
#define bdos(a,b,c)\
Registers.AX.LH.H=a;\
Registers.DX.R=b;\
Registers.AX.LH.L=c;\
     calldos()
#define intdos(a,b)\
     calldos()
#define NULLFP\
     (int (*) () )0
#define unlink(a)\
     c_unlink(a)
#endif
```

MS-DOS C mavens will note that High C's definitions for access to the 80x86 registers are different from most. But what appears in ESTRUCT.H is only the good news. The bad news shows up inside C routines as conditional code. For instance, in the file IBMPC.C, which contains the system-dependent code for the IBM PC architecture, you have

```
#if HIGHC
short int _far *scadd;
struct overlay {int off;
      short seg;};
short int _far *scptr[NROW];
short unsigned int sline[NCOL];
#else
long scadd;
  /* address of screen ram    */
int *scptr[NROW];
  /* pointer to screen lines */
unsigned int sline[NCOL];
  /* screen line image        */
#endif
```

Note the keyword `_far` rather than `far` in the definitions of `scadd` and `scptr` for High C. Also note that these are short integers; that's necessary because MetaWare's `int` type is 4 bytes long. You're looking at the result of quite a bit of coal mining in the manuals and help files, with assistance from the folks at Phar Lap. Here's more of the code to directly address the screen:

```
#if HIGHC
   ((struct overlay *)&scadd)->
      seg=0x1c;
   ((struct overlay *)&scadd)->
      off=0;
#endif
```

This code initializes `scadd` to a magic screen-segment selector provided in the Phar Lap environment. It took more spelunking to find out about that selector.

After straightening this out, I still had trouble getting MicroEMACS to write to the screen. Recall that in ESTRUCT.H, I defined `movmem` to use the `memcpy` macro. Unfortunately, MetaWare's library code for `memcpy` uses a REPE MOVDS block-move instruction, which ignores our carefully set `_far` segment selector. Instead of writing to the screen, MicroEMACS wrote over parts of itself. The solution to this problem would have been to write a `_far` version of `memcpy`.

Despite the massive 32-bit address space for which the MetaWare compiler generates code, the memory model has one code segment and one data segment. MetaWare quaintly refers to the memory model as the *small* model, although it's clearly anything but small. Nevertheless, MetaWare provides libraries only for the small model. To get `memcpy` to work across segments, you'd need the equivalent of a large-model version of the routine. I abandoned the idea of doing a memory-to-memory copy; I simply looped through each line, poking characters individually to the screen.

But the overwriting of my program's code took me by surprise. I've grown used to debugging my C code under OS/2 using the large model in protected mode. In the OS/2 protected-mode environment, code segments are read-only, and that's what I expected in the Phar Lap environment. Unfortunately for me, Phar Lap chose not to write-protect the code segments "to be more compatible with DOS." The company did help me find the problem, though—the key was to use the watchpoint command in Phar Lap's 386|DEBUG product.

This debugger is similar to Microsoft's SYMDEB. It's a symbolic debugger that displays assembly code made somewhat more readable by the insertion of variable and function names from your source code. The Phar Lap watchpoint is better than Microsoft's, because it takes advantage of the 80386 hardware debug registers. That means that you can set watchpoints without slowing down the execution of your code. However, 386|DEBUG is definitely not a source-level debugger. If I hadn't been able to read assembly language, I wouldn't have found the problem. I never thought that I'd miss CodeView—but I did.

Finally, I had to convert all the keyboard and screen BIOS calls to conform to MetaWare's unique register structure. Here's one example:

```
ibmmove(row, col)
{
#if HIGHC
        Registers.AX.LH.H=2;
        Registers.DX.LH.L=col;
        Registers.DX.LH.H=row;
        Registers.BX.LH.H=0;
#else
        rg.h.ah = 2;
  /* set cursor position
     function code */
        rg.h.dl = col;
        rg.h.dh = row;
        rg.h.bh = 0;
  /* set screen page number */
#endif
        int86(0x10, &rg, &rg);
}
```

Ugly, isn't it? There's a whole lot more of this, unfortunately. I just wasn't clever enough to come up with a macro that would make this conversion transparent.

The 386|VMM Solution

I expected to add calls to Phar Lap's 386|VMM to activate and control it. I

continued

OS/2 NEWS

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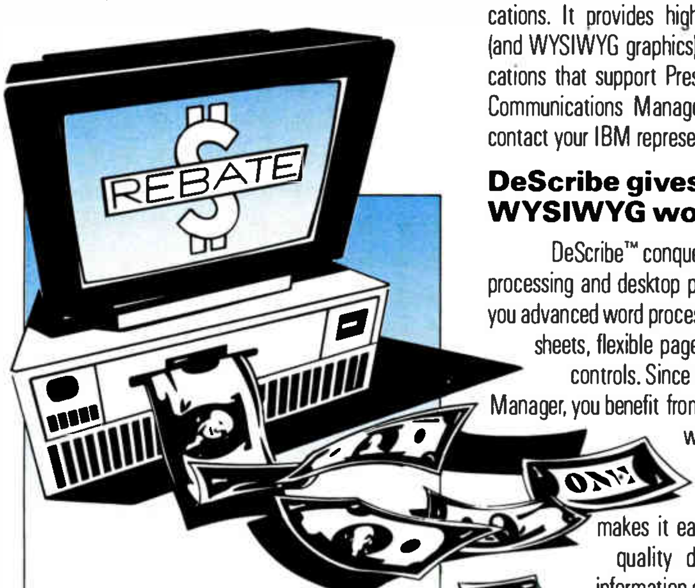

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was pleasantly surprised. All I had to do was load 386|VMM along with the program—everything else was transparent. Here is the one-line batch file I used to run the virtual memory version of MicroEMACS:

```
run386 -vmfile vmmdrv memacs %1 %2
    %3 %4 %5 %6 %7 %8 %9
```

All the magic is in run386 and vmmdrv. The run386 environment puts the 80386 into 32-bit protected mode, launches a 32-bit application, and handles the switching between protected and real modes that's required when the application requests DOS services. In this case, the application is MicroEMACS (i.e., run386 loads and executes a file called MEMACS.EXP). The .EXP extension characterizes protected-mode programs that were built by Phar Lap's 386|LINK and that can run only in the run386 environment.

If you were to type run386 memacs, you would run a protected-mode MicroEMACS without virtual memory. If you then add the command-line argument -vmfile vmmdrv, you activate VMMDRV.EXP, the virtual memory driver. It's that simple—once you've got a protected-mode MicroEMACS to work with.

Phar Lap's 386|VMM works as advertised. You may have some trouble getting your code converted to 80386 protected mode, but once you've done that, adding virtual memory is a snap.

There may be people with a need to solve 20-megabyte financial models.

Who will benefit from 386|VMM? Anyone who has programs bigger than 1 or 2 megabytes destined to run on 80386-based computers under DOS. The first program to ship with 386|VMM was Mathematica 386—certainly a good candidate since it needs at least 2 megabytes of RAM to run and 4 megabytes to run well; with more RAM, it can solve large problems.

I know of many engineering and scientific programs that have been too large for PCs up until recently. Programs specialized for reentry physics, hydrodynamics, solid modeling, and chemical process simulation are a few that spring to mind. Some of these are being ported to Xenix, others to OS/2, and some to DOS extenders like Phar Lap's. These large programs intended for vertical markets are the prime candidates for the VMM treatment.

But who knows what tomorrow will bring? While I can't imagine needing virtual memory to solve a spreadsheet, there may be people out there with a real need to solve 20-megabyte financial models. Anyone care to build a global economic model on a PC? ■

Martin Heller develops software and writes about technical computer applications. He holds a Ph.D. in physics. He can be reached on BIX as "mheller."

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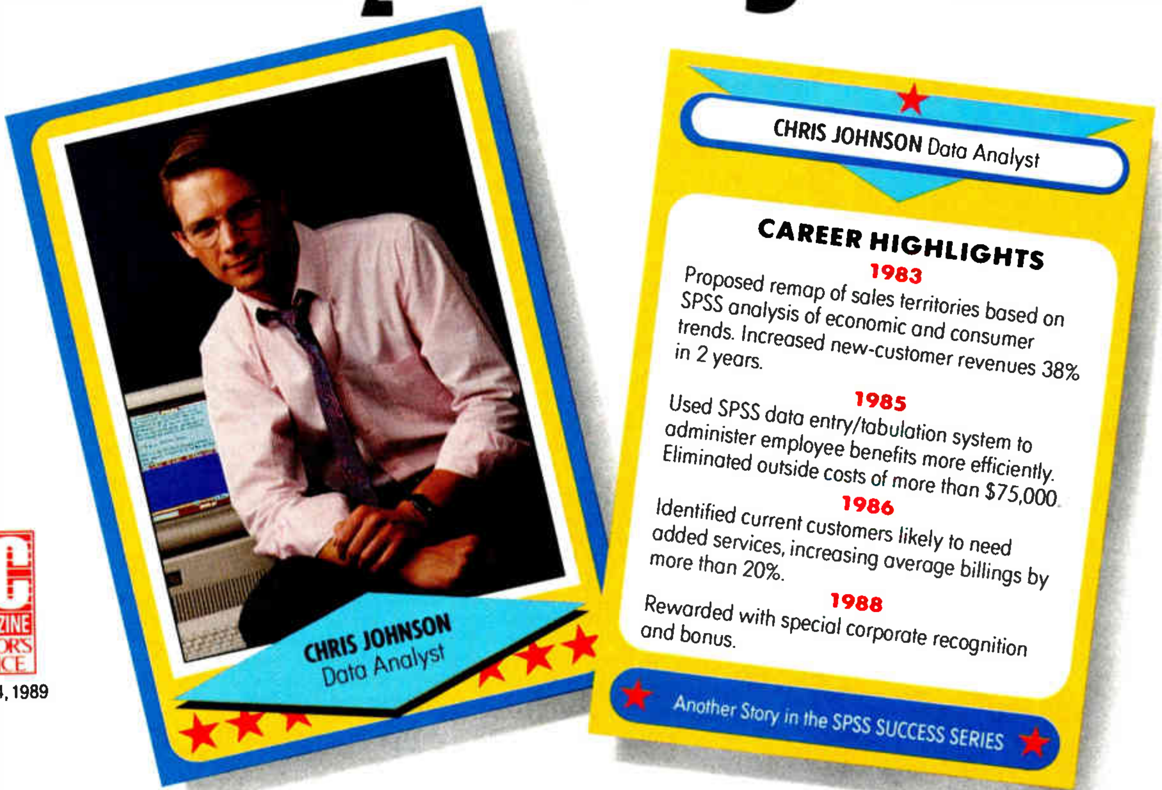

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Bradley Dyck Kliewer

At the heart of every CAD program there's a database of geometric objects, a display manager, and an event manager. That's HOOPS 2.03 in a nutshell. HOOPS (Hierarchical Object-Oriented Picture System) is a library that provides support for three-dimensional imaging to C or FORTRAN programs.

HOOPS can add three-dimensional objects to a database. It can display the contents of the database in one or more viewports, from any point of view, using orthographic or perspective projection, as a wireframe or shaded solid; and it can determine what database object a pointing action (such as a mouse-click) indicates. Because versions of the HOOPS library exist for DOS, Phar Lap's DOS-Extender, the Macintosh operating system, Unix, and VMS, a HOOPS application developed under any of these operating systems will port readily to any other.

Several HOOPS-based three-dimensional CAD programs are in the works. That's not surprising; developers of commercial CAD software desperately need the portability that HOOPS confers. But HOOPS appeals to a larger audience, too. All sorts of applications could profitably use three-dimensional imaging. For example, you might create a graphical front end to an automotive database, using HOOPS routines to manipulate a three-dimensional representation of the parts.

HOOPS requires a powerful system to run properly. Space is tight on a 640K-byte DOS machine. Working on an IBM AT with an Intel Inboard 386 and Microsoft C 5.1, running under DOS, I frequently ran out of memory. When I added a powerful graphics coprocessor—the 3D Engine from Nth Graphics—the situation improved greatly. In that configuration, HOOPS executes on the 3D Engine's transputer, leaving plenty of space for programs. I also tried HOOPS on a Sun386i, with good results.

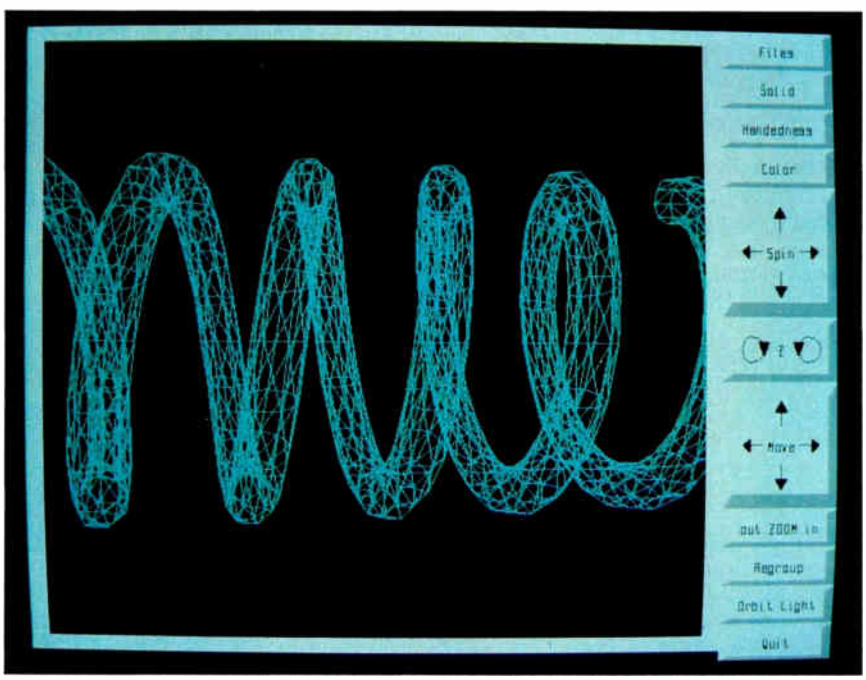
Ithaca Software acknowledges that workstations are the natural domain of HOOPS and intends to support all sufficiently powerful platforms. The 640K-byte DOS machine just barely makes the grade; in fact, the company may not continue to support it. But that same 80286- or 80386-based machine with extended memory, a graphics coprocessor, and DOS-Extender or Unix makes a fine HOOPS platform.

A Tree-Structured Graphical Database

The graphical entities that HOOPS works with are polylines (multisegment lines described by a series of three-coordinate points), polygons (closed, coplanar polylines), pixel arrays, and text strings. The program organizes all graphical data as a hierarchical database. Entities belong to named segments; segments can nest. It's like a hierarchical file system. The root is known as / (as in Unix) and has the alias `?home`. HOOPS maps the display to a special segment called `?picture`. Here's part of a segment tree you might define to represent a car:

```
?picture/car
?picture/car/rf_wheel
?picture/car/rf_wheel/hubcap
?picture/car/lf_wheel
?picture/car/lf_wheel/hubcap
```

continued



HOOPS 2.03

Company
Ithaca Software
902 West Seneca St.
Ithaca, New York 14850
(607) 273-3690

Hardware Needed
IBM PC or compatible with 80286 (640K bytes of RAM) or 80386 (640K bytes of RAM under DOS, 1 megabyte of RAM under DOS-Extender, and 3 megabytes under OS/2), and 80x87 or Weitek coprocessor; Mac II with 2 megabytes of RAM; Sun-3, -4, or 386i; DEC VAXstation; Silicon Graphics 4D Series (including Personal Iris); Sony News; Apollo Domain; and HP 9000

Software Needed
IBM PC and compatible: DOS, OS/2, DOS-Extender, Microsoft C 5.1 or MetaWare High C, Microsoft FORTRAN 4.0
Mac II: Finder 6.0, MPW C 3.0
Sun: SunOS 3.5 (Sun-3) or 4.0 (Sun-4 and 386i), cc
DEC: VMS or Ultrix, VAX C or cc, VAX FORTRAN or f77
Silicon Graphics: Unix, cc, or f77
Sony: Unix, cc, or f77
Apollo: Unix (SR 10), cc, or f77
Hewlett Packard: Unix, cc, or f77

Price
IBM PC compatible (DOS and OS/2) version: $495
IBM PC compatible (DOS-Extender) version: $575
Mac II version: $575
Sun386i version: $1150
For all other systems: $3450

Inquiry 886.

You can navigate a structure like this with the `Open_Segment` and `Close_Segment` routines. While a segment is open, you can modify the geometry contained within it or change the *attributes* that tell HOOPS how to display that geometry. You might build the body and the right front wheel of your hypothetical car as follows:

```
HC_Open_Segment
      ("?picture/car");
  insert_part (body);
  HC_Set_Color("lines=black,
      faces=mulberry");
  HC_Open_Segment ("rf_wheel");
    insert_part (wheel);
    HC_Set_Color("lines=white,
      faces=midnite blue");
    HC_Set_Visibility("off");
  HC_Close_Segment ();
HC_Close_Segment ();
```

The `HC_` names are HOOPS routines; in FORTRAN, they'd begin with `HF_`. The `insert_part` function represents a user-written routine that might read in or fabricate the necessary three-dimensional data, then call HOOPS routines to insert that data into the current segment. When this code fragment executes, HOOPS adds two graphical objects—the body and the wheel—to the database, then displays the database. Because the wheel's visibility attribute is turned off, only the body appears. Note that the second call to `Open_Segment` need only supply a partial name, because `?picture/car` is the current segment (analogous to the current directory in a file system).

Believe it or not, you're looking at a nearly complete HOOPS program. All you need to do to make something happen is to open segments and add geometry. You *don't* have to ask HOOPS to draw this scene; that happens automatically whenever you change the database. All HOOPS attributes have default values, so you'll get the standard colors, line width, camera location, and so on.

Because HOOPS uses descriptive path names and function names, and because the parameters to functions are mainly textual, HOOPS programs are easy to read—though all the lengthy names can be tedious to type. The names of the colors (e.g., mulberry or midnite blue) are a whimsical touch—they're from the Crayola 64 crayon set. You can rename these, or you can create your own color maps using your choice of techniques: HLS (hue, lightness, saturation), HSV (hue, saturation, value), HIC (hue, intensity, chromaticity), or RGB (red, green, blue).

Organizing the Picture

Maintaining the hierarchical database takes effort, but it's worth the trouble. A child segment inherits the attributes of its parent, and those attributes control its color, scale, orientation, and rendering. This scheme gives the HOOPS programmer enormous leverage. You can modify an entire scene by changing attributes in the root segment, or you can change selected parts of a scene by operating on subsidiary segments. For example, you could create an exploded view of the car by translating the coordinates of the wheel segments. The hubcap belonging to each wheel segment would inherit the new coordinates.

What seems very different from a user's perspective—viewports, menus, buttons—look alike to HOOPS. They're just segments with associated windows. Any segment under `?picture` can belong to one or more windows. A menu segment's window might occupy a portion of the display and contain subsidiary segments (representing buttons) with window coordinates relative to the menu's window. So, you could move or even rescale the entire menu by modifying its top segment; the same concept applies to segments containing windows that display database geometry. This uniform handling of different kinds of objects is a great strength of HOOPS.

HOOPS assigns a key (i.e., a long integer) to every segment and to every object within a segment. Routines that insert objects come in two flavors. For example, there's `Insert_Polygon` and also `KInsert_Polygon`. The non-K routines simply insert things; the K routines insert and return a key. Why two versions? You use the former when your application doesn't need to explicitly track objects, and the latter when it does. Of course, if you let HOOPS track things for you, that doesn't mean you can't query the database. You can use HOOPS search routines to traverse the database and return the keys of segments or objects that match a search specification composed of a segment name (which can contain wild cards) and a list of object types.

The wild-card facility makes the search mechanism extremely powerful; for example, the string `"/...*hubcap"` specifies all the hubcap segments. You can then apply a filter so that HOOPS will find only, say, the polygons in those segments. Additional routines use the keys of the found objects to extract their geometric data. When you can't predict an application's pattern of database access, it's probably best to let HOOPS manage the keys, and to ask HOOPS (by way of the search routines) to locate objects when you need them. If you know your application will be using particular segments or objects intensively, you might want to handle the keys explicitly so you always have immediate access.

I've mentioned the special segment `?picture`, which HOOPS associates with the display. Think of it like video RAM on a PC—whatever you write to it appears on the screen. Although you can insert geometry into segments within `?picture`, as I illustrated above, there is a more elegant solution. HOOPS provides two other special segments: `?Include Library` and `?Style Library`. These aren't visible, but you can establish links between them and `?picture` in a manner analogous to Unix file linkage.

Multiple views show this technique to good advantage. You wouldn't want to

continued

replicate segments within ?picture to show front, top, side, and isometric views. Better to manipulate geometry and attributes off-screen in ?Include Library and ?Style Library. You can then reserve ?picture for menus and view windows. The segment that defines each viewport need only refer to geometry in ?Include Library and attributes (e.g., orientation and projection) in ?Style Library.

The HOOPS Repertoire

HOOPS provides more than 150 functions; the manual categorizes them as geometry, attributes, segments, input, and system routines. You've already seen examples drawn from the first three categories (i.e., routines that insert geometry, control its presentation, and navigate the structured database).

The geometry routines insert or retrieve the basic HOOPS entities: lines, polylines, polygons, pixel arrays, and text strings. The HOOPS programmer must build more complex geometry from these primitives. For example, to add a spline or a cylinder to the database, you have to compute the component line segments or polygons and insert them individually. There's no way to add direct database support for new user-defined primitives. Such extensibility, while clearly desirable, would require that users solve the rendering problems associated with those new primitives. By restricting the core set of primitives to those that HOOPS itself can render, users can rest assured that more complex objects they construct from those primitives will render properly.

Although the database is not, strictly speaking, extensible at the lowest level, HOOPS does provide one "back door" function called Set_User_Value, which embeds a single long integer within a segment. You might use that value to store a pointer to your data—or code, for that matter. It's your responsibility to access the data or activate the code; HOOPS just provides a slot into which you can place the hook. The mechanism offers a convenient way to link graphical data managed by HOOPS with nongraphical data specific to an application.

Attribute-related routines control the orientation and presentation of objects. HOOPS can scale a segment, rotate it about its own axis or another axis, or translate it to new coordinates. For special applications, you can add your own transformation matrices to the pipeline of matrices through which HOOPS data passes enroute to the screen.

You can render an image as a wireframe or a solid. In the latter case, you can vary the location and color of one or several distant sources of light. The interplay of colored lights on colored surfaces yields fascinating effects. View control is very flexible. HOOPS provides reasonable defaults for the camera (location of the viewpoint within a scene), target (location at which the camera points), field of view (the camera's lens), and method of projection; you can vary these attributes as required. Depending on the effect you want, the camera can dolly (slide left, right, up, down, in, or out); pan (rotate with respect to a fixed target); orbit (move around a fixed target); or zoom.

To simplify the modification of a segment's attributes, HOOPS provides *quick* versions of several functions; these versions automatically open and close the named segment. Suppose you want to switch from an orthographic to a perspective projection. The long version looks like this:

```
HC_Open_Segment ("?Style
  Library/car_style");
HC_Set_Camera_Projection
  ("perspective");
HC_Close_Segment ();
```

The quick version does the same thing in one line:

```
HC_QSet_Camera_Projection
  ("?Style Library/car_style",
  "perspective");
```

The most basic and useful input function is Get_Selection; it waits for a mouse-click and returns the segment associated with the location of the click. That's all you need to implement a menu system with mouse-sensitive buttons. Show_Selection_Item tells you which piece of geometry within a segment the user indicated. Other functions acquire individual keys or text strings from the keyboard. These high-level input functions are implemented in terms of low-level ones that manage input devices and event queues.

The system-related routines are a mixed bag of extras. There are functions that define error handlers, parse strings, examine environment variables, and inquire about the characteristics and status of devices.

On the Output Side

Output to the screen is the default, of course. But for hard copy, the system provides another special segment called ?hardcopy. To print the display, you open ?hardcopy, force a display update, then close and delete the segment. That takes about eight lines of code. Curiously, the only place to find this information is in the installation manual under the PostScript and Hewlett-Packard Graphics Language (HPGL) driver descriptions. A sample print routine would be a welcome addition to the otherwise excellent tutorial. And although HOOPS's support of PostScript and HPGL gives it a broad base of support, the library could use a driver for the HP LaserJet and perhaps a few other plotters or dot-matrix printers.

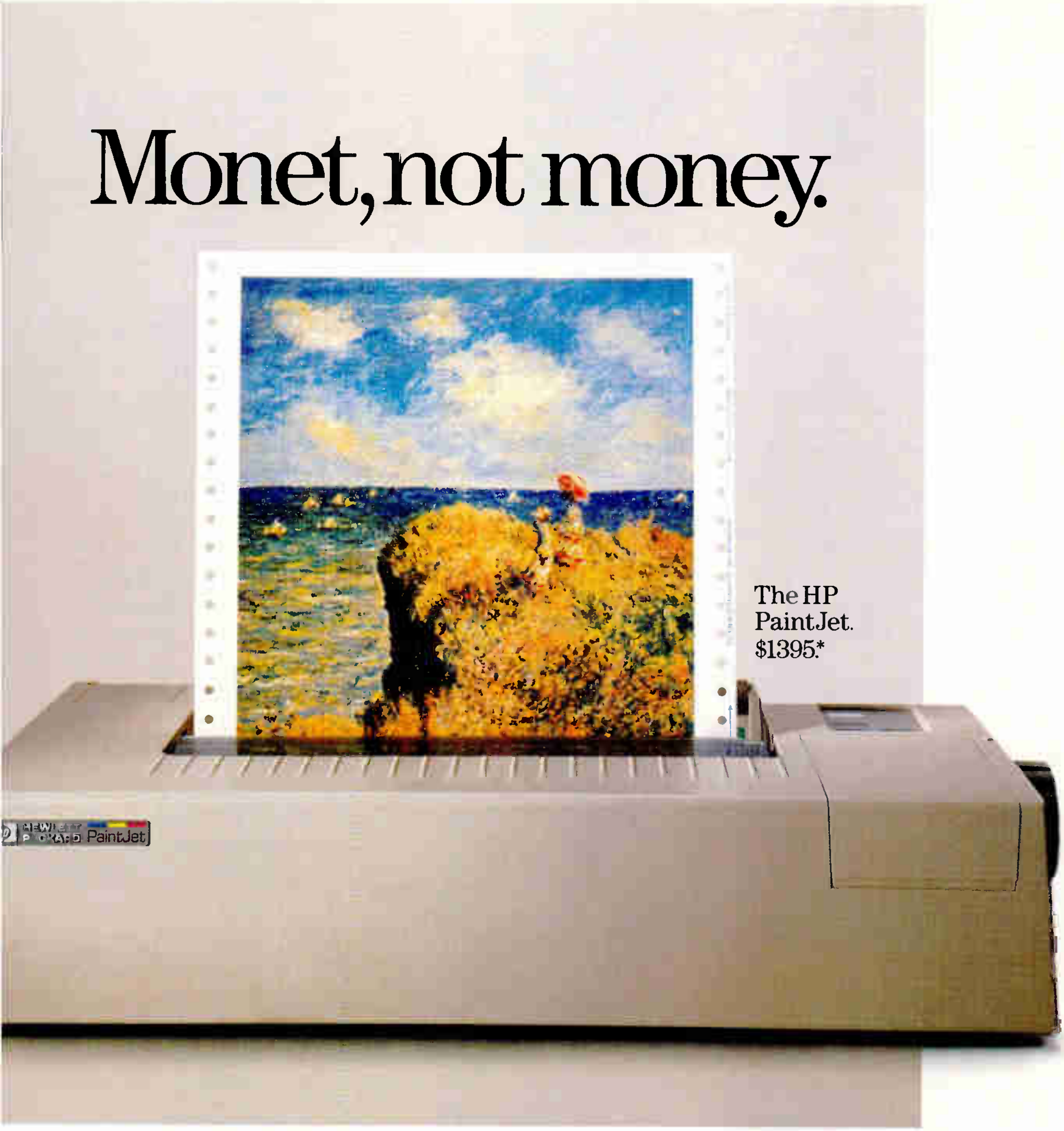
A significant new feature in version 2.03 is Set_Metafile. Metafiles are ASCII dumps of the contents of segments; you can store metafiles to disk and read them back. And since metafiles work with segments, you can save as much or as little data as you need by selecting a segment at the appropriate level in the tree structure. Metafiles have several optional attributes that control the information saved. Normally HOOPS saves just geometry and attribute data, but you can store the entire state of the system if required—including things like color maps and aliases. You can store just the names of included segments or its names and contents, as well.

The ASCII format works nicely for reviewing (or even editing) the database, and of course, it makes metafiles readily portable. It does consume a lot of disk space, though; according to the company, a forthcoming version of HOOPS will support a binary metafile format that will alleviate that problem. HOOPS automatically converts the name of a metafile to something that will work with the host operating system, retaining the original name within the metafile. For example, a Unix-like name, such as test.hps.file.1, might turn into TEST.HPS under DOS.

Learning the Ropes

HOOPS comes with a 50-page tutorial. Using clear and concise examples, the tutorial shows you how to build a simple application that creates a cylinder, displays it in two viewports, and presents a menu that enables the user to rotate and zoom the image. One of the installation disks contains the complete source code for the tutorial application, along with the code for GEOS, a more ambitious program. GEOS can retrieve and display more complex images. These are stored on disk in an ASCII format that GEOS can interpret. They include some of the three-dimensional CAD standards—a

continued



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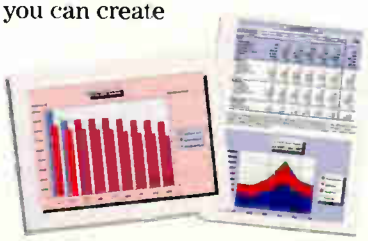

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Volkswagen beetle, a wine glass, and a teapot. GEOS gives a great demonstration of HOOPS's features: You can pan, rotate, or zoom an image; resize the window that contains it; change its color using red, green, and blue sliders; and move the light sources that surround it.

I felt comfortable with HOOPS after a few hours. I did take some wrong turns when first working with the hierarchical database. You need to understand its architecture well, because everything else flows from it. In short order, though, I enhanced the tutorial, adding a new object (a box) and several features (save, load, and print). I discovered how easy it is to make significant structural changes in an object-oriented environment.

I also ported my modified tutorial to a Sun386i. After recompiling the code, it ran without problems. I even loaded metafiles that I had created on my AT. Performance on the Sun386i was roughly comparable to my AT with a 3D Engine aboard. Of course, the $7000 3D Engine from Nth Graphics is an expensive way to cram HOOPS into a 640K-byte DOS environment. If you have or are willing to acquire Phar Lap's DOS-Extender and the MetaWare High C Compiler, the 32-bit DOS version of HOOPS is a good bet for PC compatibles. Since HOOPS supports EGA and VGA output, you won't need a graphics coprocessor. Still, you'll want one (HOOPS supports, among others, the Pixelworks Clipper and VMI Cobra) to see the program at its best. Of course, HOOPS is most comfortable on high-end Sun, Apollo, and Silicon Graphics workstations. Any way you look at it, serious HOOPS development requires serious hardware.

Developers of custom CAD applications for manufacturers, scientists, and engineers will appreciate the power and portability of HOOPS. Such applications often require real-time data analysis. I'd rather add graphics to an existing analytical application, by way of HOOPS, than try to integrate the analysis into a stand-alone graphics or CAD program. HOOPS will help move three-dimensional graphics outside traditional CAD markets. If your application requires or could benefit from three-dimensional imaging and must run on a variety of platforms, take a close look at HOOPS. ■

Bradley Dyck Kliewer is the author of EGA/VGA: A Programmer's Reference Guide *(McGraw-Hill, 1988) and owner of DK Micro Consultants, a microcomputer consulting business in Bloomington, Indiana. He can be reached on BIX as "bkliewer."*

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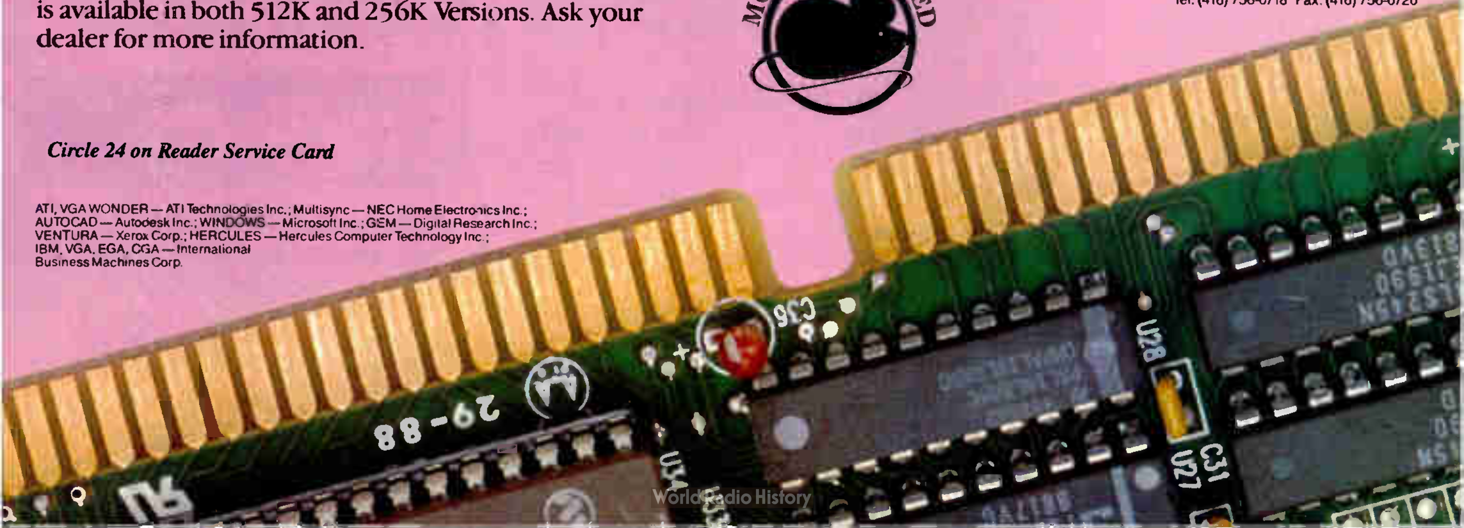

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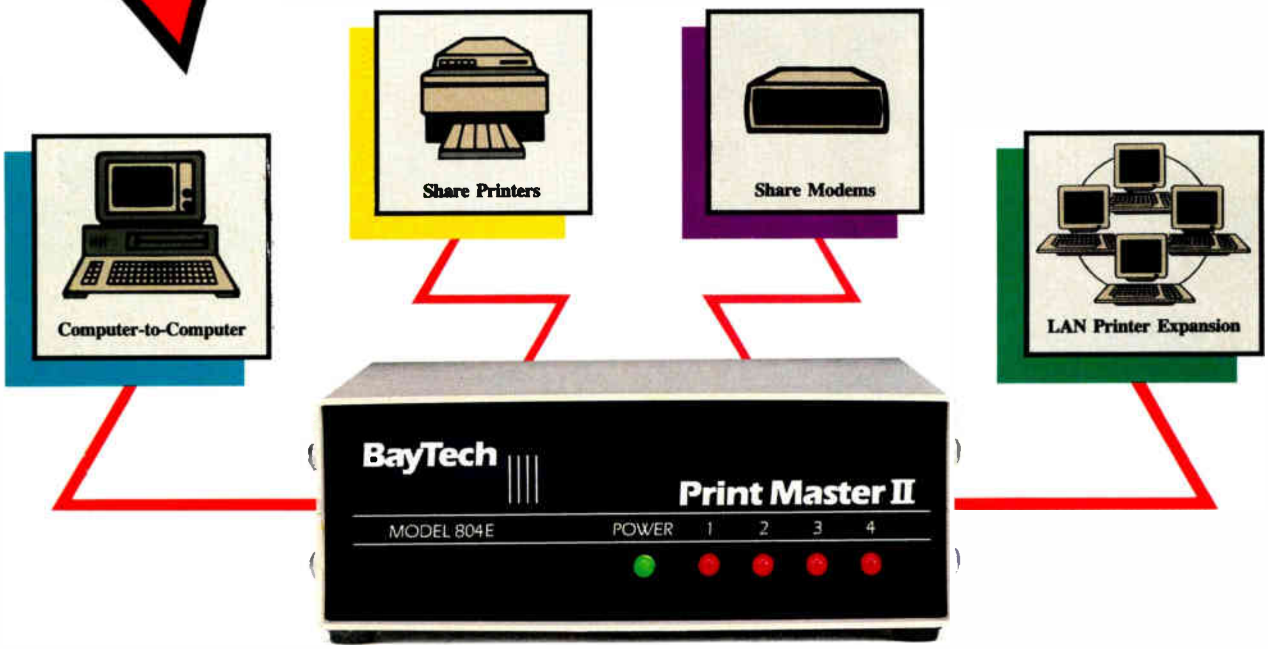

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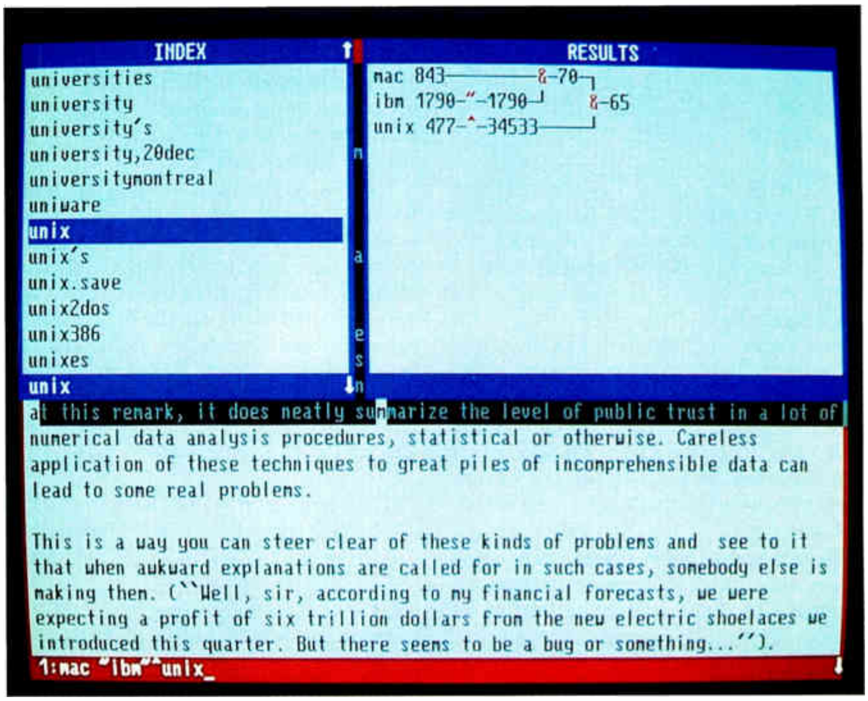
Text Retrieval with a Twist

Folio Views advances text management technology with a new indexing scheme

Dennis Allen



Folio Views helps you find the right search word by displaying its index and highlighting the first match in its list as you type each letter. The program also lets you use wild cards.

In some ways, Folio Views 1.0 is a whole new ball game; in other ways, it's nothing new. It's a synthesis of several applications for DOS machines—text retrieval, hypertext linking, word processing, directory management, and electronic publishing. None of those applications is particularly new, but you've never seen them together before.

Folio Views is more than just a marriage of old ideas. It takes text management technology a step further. Through a proprietary scheme called "underhead," Folio Views indexes every word of your text files and compresses the lot—text and index—into as little as half the space of the original ASCII file. (Its index limit is 10 million unique words, but I can't imagine generating a database that uses that many.)

Folio Views also lets you organize your text in *views*, which you can quickly recall. You can conduct amazingly fast searches and even change the database on the fly without reindexing it.

View Processing

Using logical views to recall text makes sense. If you've ever had to go through several documents, you know what I mean. For example, say you've accumulated a couple megabytes of information—mail, internal memos, proposals, and so forth—and you keep all your mail in one directory (or file), memos in another, and so on. Just finding all the references to, for instance, red-striped widgets in those files is like trying to find a needle without knowing whether to look in the barn or the haystack.

Folio Views lets you keep information physically intact. It also lets you group just the pieces of information about those red-striped widgets. You might have a paragraph from a memo, three paragraphs from a proposal, and the bodies of two letters in the view. By pressing the Enter key, you can see the complete source of any one of the view entries in a separate window, and you can have as many as 10 windows open at once.

Each logical piece of information in a view is called a *folio*. Typically, each paragraph in a document constitutes a folio. However, you can define a folio to be any amount of information, provided you have EMS memory installed in your system (you're limited to up to 10,000 characters without EMS memory).

Markers show where each folio begins, and you can jump from one marker to the next with a single keystroke. You can also jump to the next page (screen) or go directly to any folio you specify. And you can scroll through the text using the cursor keys. Just don't be in a hurry, though. The way Folio Views handles screen updates is atrocious.

Folio Views' slow scrolling is its biggest weakness. Speed is critical when you're dealing with huge amounts of text, and scrolling in the program is just

continued

Folio Views 1.0

Company
Folio Corp.
2155 North Freedom Blvd., Suite 200
Provo, Utah 84604
(801) 375-3700

Hardware Needed
IBM PC or compatible with 512K bytes of RAM and a hard disk drive

Software Needed
MS-DOS 2.0 or higher

Documentation
User's manual; quick reference guide

Price
$495

Inquiry 885.

too slow on my 10-MHz AT clone. The company acknowledges the problem, however, and promises a remedy.

Fast Searches

Folio Views' real strength lies in its text searches. They're fast enough to offset the scrolling problem, and you can do searches from any view—including the full view of the database. Because of its unique index, most searches are instantaneous, even on databases many megabytes in size.

Searches can be as simple as a single word—any word. The program does not use so-called "stop words" to shorten its index. Typically, a text-retrieval program that does indexing will not index words such as *the* and other frequently used articles of speech; it's too costly in both disk space and CPU time.

But Folio Views adds a new—and very efficient—twist to how it indexes text (see the text box "The Trouble with Indexing" on page 204). If you do a search of *the* in a 10-megabyte text file, the program completes the search almost instantly.

I tested that idea on just such a file. I used the text from all BYTE issues in 1988, totaling about 9.6 megabytes in ASCII and about 6 megabytes in Folio Views' compressed format. I typed *the* on the search line; by the time I released the Enter key, the program had completed its search—9824 folios contained the word *the*. Another tap of the Enter key, and 2 seconds later I was looking at a view containing four folios (all that fit on the screen) with *the* highlighted in 32 places.

That was too easy. So for grins, I tried a little Boolean logic. I did a search for all folios that did not contain *the*, and just as quickly I got my answer—8060 folios.

Of course, you can do more complicated searches using full Boolean logic with nesting, wild cards, exact phrases, and proximity matching. About the only kind of search you can't do with Folio Views is one using fuzzy logic. However, if you're not quite sure of a word, the program helps by displaying its word list (the index), highlighting the first match in its list as you type each letter (see photo). You can also use wild cards (* and ?), just as you would in DOS.

The search engine gives highest priority to NOT operations, followed by OR and AND, respectively. You can get around that order, though, by nesting expressions in parentheses, forcing the search engine to evaluate whatever is inside the parentheses first.

Generally, the search engine keeps up with your typing. As you type, it builds a search tree on-screen to verify search criteria and to display the number of finds. I found it difficult to choke the search engine with even the most complicated Boolean searches using nesting several layers deep. What does slow things down, however, is a search using wild cards. Still, the longest wait I had was for the following search:

```
(??86 intel/intel's ibm(pc/pcs)
  compaq/compaq's^(amd/("second
  source"1)
```

That search located every folio with the mention of 80x86 chips that also included the companies Intel, IBM, and Compaq but contained no reference to AMD or the phrase "second source." (The spaces represent logical AND, the slashes represent logical OR, and the caret represents logical NOT.) Because I'm not a fast typist (Folio Views processes the search as you type), my wait was only a couple of seconds. A faster typist might have waited 5 seconds.

One of the best things about doing searches in Folio Views is that you don't have to do them twice. Every search results in a view, and to retain that view, you just name it. The additional views always use text in the existing database, conserving space on your hard disk. You can even confine your searches within specific views.

Links and Dynamic Data

You can create explicit links to views from anywhere in the database and even set up menus to make selecting views easy. You can also use links to create hypertext-like jumps. An attorney, for example, could use a link to directly tie a reference in a brief to the text of the cited court case.

Each link is represented by a token. Viewing the linked view is just a matter of moving the cursor to the link token and pressing Enter. Links are particularly useful for footnotes. You can have up to 200 million links in a database.

Perhaps even more important than Folio Views' links is its ability to be modified. Most other text-retrieval software usually requires you to import all the data just as though you were starting anew once you've appended or changed the original ASCII data file. At the very least, you have to wait for the software to completely reindex the database, which could take hours.

Because of the way Folio Views organizes its index, you can easily add, delete, or edit a database from within it. It even has its own built-in word processor that, while it's no WordPerfect, is adequate for making minor corrections or annotations to the database.

You can also do cut-and-paste imports and exports of the database. You can direct output to your printer or a file in either ASCII format or one that includes the program's folio markers and attribute codes.

If you don't want your database changed, Folio Views lets you lock a database with passwords so that an end user can only view information and not change it.

Electronic Publishing Perils

My trials using Folio Views included creating databases of two years' worth of BYTE text (about 20 megabytes), one month of the *Washington Post* downloaded from The Source (about 6 megabytes), the *King James Bible* (about 4.5 megabytes), about 1.2 megabytes of BIX conference messages, and all my E-mail on file (about 1.9 megabytes).

I learned that electronic publishing is not necessarily easy. Unfortunately, Folio Views does not make a database automatically. First, I had to insert folio markers (Control-E) in appropriate places in the text. For example, I figured I'd just tell my word processor to go through the 20 megabytes of BYTE text and insert a folio marker wherever two hard carriage returns occurred. But it wasn't that easy. Paragraphs in some articles were separated by only one carriage return and an indentation of one or more spaces or tabs. I also had to strip out some of the editing codes that BYTE uses.

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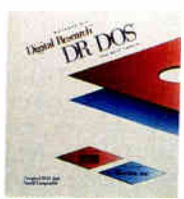

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The Trouble with Indexing

Although Folio Views is not the first program to try to manage large text files, it does it with a new twist in indexing technology. Most developers recognize the *inverted index* as the best and fastest form of indexing. But an inverted index has some serious limitations: namely, that the index is typically 30 percent to 100 percent the size of the original text file, and changing the text file requires the time-consuming chore of reindexing the entire file.

Here's how an inverted index works. Say you wanted to build an inverted index for a 100-word text file. You would extract all the unique words and alphabetize them. Then you would use that list of words, which would be nearly as big as the text file itself, as the basis of the index. Beside each word, you would write the location of each occurrence of the word in the text. That's typically done by counting how many bytes from the top of the file each occurrence sits. What you end up with is a list of words and, beside each word, a string of numbers that represent the locations for every time the word appears in the text.

That seems simple, but what if you change, say, the fiftieth word in the text? You have to update the locations of every word that follows it. That may not be so hard with a 100-word file, but if you have several megabytes, it becomes a difficult chore. That's why some text-retrieval programs reindex the entire file after an update or don't allow updates at all.

Folio Views uses what its developers call "sparse inversion." Rather than storing a list of precise byte offsets to point to word occurrences, it stores a list of the *folios* that contain the word. For example, even if the word "the" appears 20 times in a folio, the program stores a single pointer for that folio. When a search brings up a folio, the program highlights the search words or phrases. To save more space, it uses a proprietary method for compressing the folio pointers.

All the indexing is done during the second of two passes over the text. During the first pass, Folio Views compresses the text, again using a proprietary method. The program's developers say that they steered away from the space-efficient Huffman encoding in favor of a scheme that could decompress more quickly.

Together, the text compression, pointer list compression, and sparse inversion give Folio Views its speed. Those techniques also give it the ability to store a complete database in as little as half the space of the original file.

Now none of this is particularly difficult—I used XyWrite's macro language to automate the process. But when you're dealing with 20 megabytes of text, the process takes a long, long time. My system ran constantly for days while I prepared all the files. I wish Folio Views did some of this work for you. For example, the Create program, which converts the ASCII files to a database, should have an option to insert folio markers on the fly based on parameters that you set.

After I had prepared all the data, I ran the Create program, which does two things: First it compresses the text, and then it indexes it. You can convert a single file into a Folio Views database or set up a parameter file that gives the Create program a list of files and existing Folio Views databases to convert into one big database.

All this works well, provided there are no errors or extraneous characters in your parameter file. I set up a parameter file that listed the BYTE text files (each file contained one issue). The problem I had was that XyWrite embedded an invisible (null) character at the beginning of the file that the Create program interpreted as a delimiter. I didn't know that at first. I just got an error message saying that I needed to specify an output file, which I had in fact done.

Even when I loaded the parameter program into the Folio Views word processor, the extraneous character causing the problem did not appear. Later, when I had removed that character, I had a similar problem with the end-of-file marker placed by XyWrite. This time I got an "Unable to open" message. Surely the error checking can be made more precise.

It would have helped if the program had told me how much disk space I needed to do a conversion. For the BYTE text, which the program compressed into about 13 megabytes (including the index), I thought 17 megabytes of free disk space would be enough. I was wrong. After the Create program ran for about 4 hours, it aborted with an "Insufficient disk space" message. Eventually, I was successful, and my 10-MHz Hyundai 286c took 5½ hours to create the BYTE text database. The process made me want an 80386 system. Creating a smaller database is quicker; I converted my 1.2-megabyte file in less than 9 minutes.

Even if you're not interested in creating your own Folio Views database, you may still come face to face with Folio Views. Several large publishing houses plan to publish text databases in the Folio Views format using a run-time version of the program called Preview. Preview gives you all the search capability, but not the customization, of Folio Views. Preview is also distributed with Novell's NetWare.

If you want to publish electronically, Folio sells Views Publish, which is a developer's kit for putting Folio Views databases together. If you just want to distribute your database internally, you can use Folio Views' Chop and Load programs. Chop breaks a database into floppy disk-size pieces, and Load puts it together again.

Folio Views comes with one database, America, that will probably help you settle some bets in the office. It contains The Constitution, the Declaration of Independence, and several important Supreme Court case rulings.

The Big View

Folio Views has its faults, the biggest of which is the slow text scrolling. I'd like to see the error trapping improved, too. And while I'm making out a wish list, I'd like the Create program to provide an estimate of how much time it will take to make a database and how much disk space it will need. Moreover, it would be nice to have some of the creation process automated.

Yet even with those shortcomings, I've found Folio Views very useful. It's made organizing large amounts of information practical for me. Because of the compression, I didn't have to buy another hard disk drive. Because of the speed, I don't have to take a coffee break when I initiate a search. The good far outweighs the bad.

I see Folio Views as a breakthrough product. Its indexing and compression techniques have pushed that technology to the point of being truly useful. If you've been looking for a way to manage large amounts of text, this is it. ■

Dennis Allen is a BYTE senior technical editor. He can be reached on BIX as "dallen."

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The Flying Spreadsheet

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Don Crabb

Think of WingZ as a *presentation spreadsheet* for the Macintosh. Sure, it does what all the other spreadsheets do, but it also provides flexible, presentation-quality charts based on your worksheets.

WingZ is also fast. It can speed through recalculation so quickly that it's liable to give Microsoft's Excel and Ashton-Tate's Full Impact a serious run for the money.

WingZ runs on the Mac Plus, SE, or SE/30, or members of the Mac II family. The program comes with a getting-started video (VHS format) called "Learn to Fly." The package also includes two manuals: a user's manual, which includes a tutorial (tutorial files are also included on a separate disk), and a reference manual. If you've used a Macintosh spreadsheet program before, you won't have any problem learning to use WingZ.

But WingZ is different from the other major spreadsheet programs. It is really an integrated program that consists of a basic worksheet, a presentation worksheet, and a custom worksheet.

Three Faces of a Worksheet

The basic worksheet includes the kind of powerful number-crunching features that you find in other Macintosh spreadsheet programs, such as Excel, or in spreadsheets for the PC. To help you build financial, budgetary, or analytical models, WingZ includes more than 140 arithmetic, logical, database, algebraic, financial, statistical, trigonometric, and other functions that you can incorporate into any cell formula.

The basic worksheet also includes the usual flat-file database commands that let you use the program as a rudimentary column (representing fields) and row (representing records) database. Besides numbers, WingZ commands can manipulate worksheet text, logical values, dates, and times. Like other spreadsheet programs, it includes automatic recalculation when formulas change, but you can also switch this feature off to make it easier to edit a large worksheet.

WingZ's basic worksheet includes multisheet capability. You can link as many sheets together as you want (within the limits of available memory) to help organize information better or to distribute your analysis into logically separate sheets. Updating one sheet automatically updates those sheets that are linked, so they always maintain their parallel structures.

The presentation worksheet includes a graphics layer that sits on top of the basic open worksheets. It includes two- and three-dimensional color charts, a drawing environment for customizing those charts and creating others from scratch, and presentation aids for creating on-line slide shows, reports, overhead foils, and 35mm slides. You can create an interactive worksheet with WingZ for building demos for novices.

The program includes five drawing tools for annotating existing charts and creating new ones: line, arc, rectangle, oval, and polygon. Besides these tools, it includes many fill patterns, 24-bit color support (for more than 16 million colors), multiple line widths, arrowheads, and borders.

Charts in the presentation layer are linked dynamically to a cell or a range of cells in a corresponding worksheet. When you update the worksheet, you also update the charts. WingZ has 20 different built-in chart types, including bar, line, pie, combination three-dimensional, and scatterplots.

The custom worksheet gives you the ability to customize the program to suit your work. WingZ is built on a scripting language called HyperScript, and the basic scripts that define the preset user interface are included with the package. You can alter these scripts to work like any other spreadsheet on the market or to create a custom application. This customization capability sets WingZ apart from the likes of Excel, Full Impact, Trapeze, and MacCalc.

The program can also record scripts directly, akin to the way that Excel records macros. Once a script is recorded, you can edit it just like any programming language.

The worksheet screen looks a lot like most other Mac spreadsheets, dominated by the ever-present Macintosh menu bar. Below the menu bar, you'll find the title bar for the worksheet that's open, an entry bar that shows the contents of the current cell, a tool box on the left side that holds the drawing and graphics tools, some special quick-scroll navigation arrows, the worksheet grid, and the usual horizontal and vertical scroll bars. For the most part, it's pretty standard stuff.

The graphics layer (when invoked) sits on top of the worksheet grid, as does the editing window for HyperScript. You can also have on-line help windows open while the worksheet remains active.

Programming in HyperScript

HyperScript is a complete worksheet-based programming language. It includes complex data structures, such as matrices and records; functional abstraction, such as user-defined functions; HyperTalk-style ON-handlers, messages, and objects; loops (WHILE

continued

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and FOR constructions); selection structures, such as IF...THEN and CASE; assignment statements; regular expressions; and local and global variables.

To support the HyperScript language, WingZ provides an editing window, the ability to record script commands by *watching* the actions that take place on the screen (like the macro recorder in Excel), and a script compiler that does extensive syntax and error checking.

HyperScript looks something like a cross between Pascal and HyperTalk, although it also has some extensions for handling WingZ objects. But HyperScript is not for the faint-hearted. Even with its handy recording function, building a WingZ application requires previous experience at program design, algorithm construction, and coding. HyperScript's similarity to Pascal and HyperTalk will help experienced programmers get started, but the differences will have to be learned—something that's not easy if you're a regular Pascal and HyperTalk coder.

Nonetheless, HyperScript is powerful, and it provides more computing capability than the macro language of Excel or the Full Talk language of Full Impact. In many ways, HyperScript breaks new programming ground for the Mac by providing the tools to create a self-modifying application.

Snazzy Graphics

There's no doubt you can create snazzy graphics using WingZ. Even someone with zero artistic capability, like me, can pump out basic graphical information, even dazzling charts, of just about every variety. The three-dimensional graphics types will remind you of those available in Wolfram's Mathematica (see "Symbolic Math on the Mac" by Peter Wayner, January BYTE).

Creating charts and linking them to a worksheet is simple—much simpler, in fact, than doing so in Excel. WingZ charts are not separate documents like those in Excel, so the graphics environment is always available as a layer that can be placed on top of any worksheet.

The program is not as handy, however, for producing general-purpose presentations. It's not as powerful as More II, Cricket Presents, Persuasion, or PowerPoint when it comes to making presentations, since it lacks many of their organizational capabilities. For example, while More II is based on the proven More outliner, WingZ lacks such an outliner (although you could conceivably create one using HyperScript). Given that WingZ's presentation capabilities are built into an already first-rate spreadsheet, the compromises made to keep the program small enough to be fast and reasonably priced are good ones. If your presentation needs are basic or primarily consist of charts, WingZ does the job nicely.

Top-Gun Performance

To give WingZ a fair shake, I used it as my everyday spreadsheet, converting my Excel worksheets for use in the program and creating new ones using the program. I kept careful track of the calculations WingZ made, to verify its accuracy. None of the checking I did (using a hand calculator) revealed any calculation errors.

Two things struck me while using WingZ: First, it's easy to use for basic worksheet calculations and for charting, but the HyperScript language is not as easy to master as I thought it would be. Second, the program's Go menu is too condensed—it contains too many submenus. A better strategy would have been to add one more menu-bar listing, perhaps splitting out the important Select command (with its list of 22 subcommands).

Besides general-usage tests, I ran a series of benchmark tests on WingZ to establish its basic performance level. I ran the same tests on a copy of Excel 1.5 for comparative purposes. I used a Mac SE with 1 megabyte of RAM and a 20-megabyte hard disk drive, and a Mac II with 8 megabytes of RAM and a 40-megabyte hard disk drive.

In addition to the standard BYTE spreadsheet benchmark tests, I also timed the recalculation of my departmental budget. That worksheet keeps track of my laboratory operating and capital costs, costs for graduate student stipends, and related instructional costs for my department. The model consists of a sheet that is 24 columns by 250 rows. The worksheet contains mixed calculations, with the bulk consisting of multiplication and addition.

Given all that WingZ can do, I expected sluggish performance, at least on the Mac SE. As the benchmark results indicate (see table 1), nothing could be further from the truth. These tests corroborate what my daily usage tests already told me—that WingZ is substantially faster at everything it does than Excel. Even on mundane tasks, such as horizontal and vertical scrolling, WingZ is much faster than Excel. In fact, WingZ is so much faster than Excel at the

continued

Table 1: *Benchmark test results. WingZ performs notably faster than Microsoft's Excel.*

	Mac SE[1]		Mac II[2]	
	WingZ 1.0	**Excel 1.5**	**WingZ 1.0**	**Excel 1.5**
Savage	3.1	14.1	1.9	6.9
Recalc	3.5	7.1	1.4	3.2
Scroll right	30.5	63.8	15.3	39.2
Load file	3.3	14.8	1.6	6.8
Save file	2.0	18.3	0.9	9.9
Budget recalc	37.3	68.6	18.4	29.9

[1] Standard Mac SE with 1 megabyte of RAM, a 20-megabyte Apple internal hard disk drive, minimal System, Finder (no MultiFinder), minimal fonts, cdevs, and INITs; no RAM cache.
[2] Standard Mac II with 8 megabytes of RAM, a 40-megabyte Apple internal hard disk drive, minimal System, Finder (no MultiFinder), 8 fonts, 7 cdevs, and no INITs.

Note: Each test was repeated 10 times; the results reported are the means. Times are in seconds.

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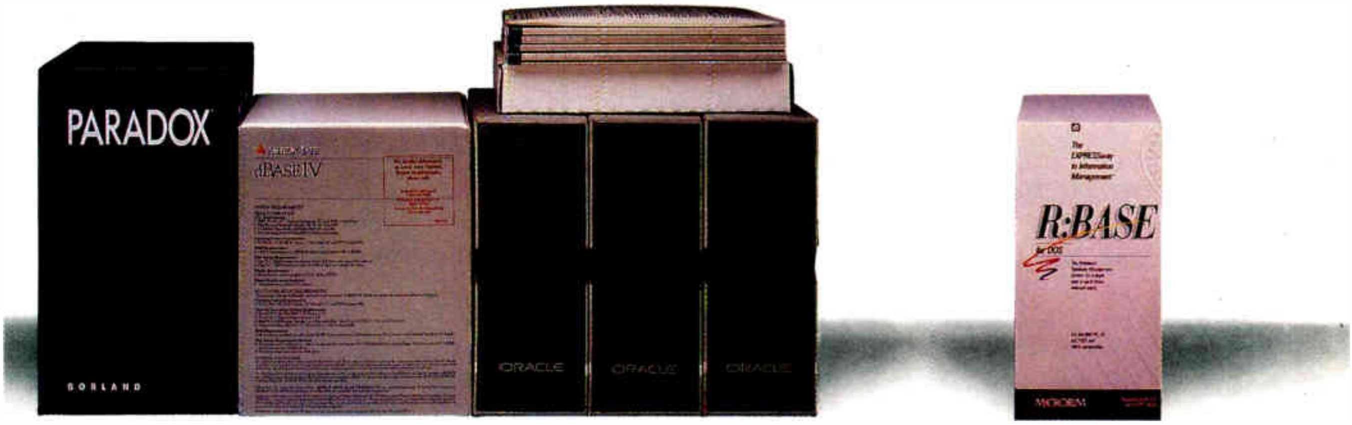

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basics—opening and closing files, saving files, copying and deleting blocks of cells, and scrolling—that it makes Excel seem downright pokey.

WingZ is also faster than Excel at the not-so-mundane stuff, such as sorting, file importing and exporting, updating linked charts, updating the worksheet display when recalculating, and the like. Although I had never thought of Excel as having performance handicaps, WingZ reminded me of just how irritating it is to wait for any software to finish a task. In fact, I found the speed improvement reason enough to convert all my personal Excel worksheets over to WingZ and keep them there.

Adding Up

Is WingZ the best Macintosh spreadsheet? That's hard to say. If all you need is a spreadsheet, without fancy presentation graphics or programming capabilities, then you are better off with a product like MacCalc, which costs under $200. If you need to build complicated display models, you might want to consider Trapeze. But if you are a potential Excel or Full Impact user, then WingZ deserves to be on your short list.

For my money, WingZ is superior to current versions of Full Impact and Excel. It's significantly faster than Excel, and it offers more features than either Excel or Full Impact. It also includes excellent presentation-graphics capabilities that neither of the other programs can touch. Indeed, to get the kind of presentation capabilities that WingZ has, you must export your Excel or Full Impact graphics into a desktop presentation program, which will cost you an additional $200 to $400. WingZ also breaks new ground with its HyperScript programming environment.

At $399, WingZ is only $4 more than the list prices ($395) for Excel and Full Impact. And when you add up all the pluses—speed, lots of worksheet functions, great graphics, fancy programming capabilities, and competitive price—WingZ is a bargain. ■

Editor's note: *At press time, Microsoft announced an upgrade to Excel that it says will have improved speed performance and "presentation-quality output."*

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 consulting editor for BYTE. He can be reached on BIX as "decrabb."

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Distributed Processing

What is distributed processing? Surprisingly, there are many answers to this question. Everything from shared databases to process migration claims a foothold in this field. This popularity indicates that the advantages of the teamwork inherent in distributed processing are significant, but what are they?

Bear with me. Let's assume a friend of ours has a pizza party every Tuesday night. A group of varying size gets together to make and eat pizza and to talk. If four people show up, one person can probably make the pizza without much trouble, but if 10 people come, we'll need several pizzas. If one person makes them all, it takes a while. It works better if several people go to the kitchen and divide up the tasks: rolling the dough, cutting the toppings, grating the cheese. Sometimes the real fun is in the kitchen, so everyone's out there, cutting and chopping and talking.

Believe it or not, this is distributed processing. When there's only a little work to do, one person, or processor, can handle it fairly easily. But when the work multiplies, the more hands, or processors, the merrier. In fact, you may find that some people, and processors, are better at some tasks than others. The benefits add up quickly in terms of cost effectiveness, more efficient use of resources, and quicker response times.

The term "distributed processing" covers client/server systems with distributed transactions; systems that distribute various processes across a network for execution; parallel processing systems, which distribute various processes among their own processors; and distributed applications. Common usage dictates that all these definitions apply.

Our special In Depth coverage of distributed processing begins with "Take Your Pick" by Gilbert Wai. In addition to providing a look at what is—and isn't—distributed processing, he looks in detail at the client/server architecture. In contrast to the loosely coupled LAN environment used for most distributed systems, the text box "The Opposite Tack" by Michael L. Smith and George White delves into a major concern of tightly coupled multiprocessor systems—cache coherency.

Then, in "A Transparent Environment," Bruce J. Walker and Gerald J. Popek detail the concept of transparency in a distributed system. This approach lets you use the resources of other machines on the network without concern for caring where they are. You don't even need to know that you're on a network. How is this done? It's a fascinating subject.

The remote procedure call provides another means of initiating distributed processes on remote machines. In "Remote Control," Carl Manson and Ken Thurber discuss how RPCs work in theory and in practice.

And in "The Paperless Office," Dean Hough looks at a new—to microcomputers—distributed application: document image processing. DIP itself is not new; it has been available on traditional workstations for some time. However, this capability on a PC-based LAN is indeed innovative and is likely to have a strong impact on office automation.

If it sounds like anything goes in distributed processing, I think it does. Any time you have simultaneous, coordinated work or resource sharing, you have distributed the processing you are trying to accomplish. In doing so, you have made your system more effective, more efficient, and probably quicker. Anything goes, indeed. Anchovies, anyone?

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth

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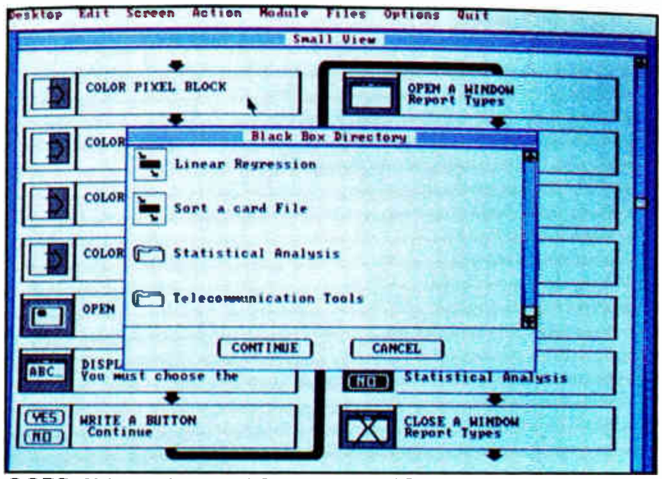

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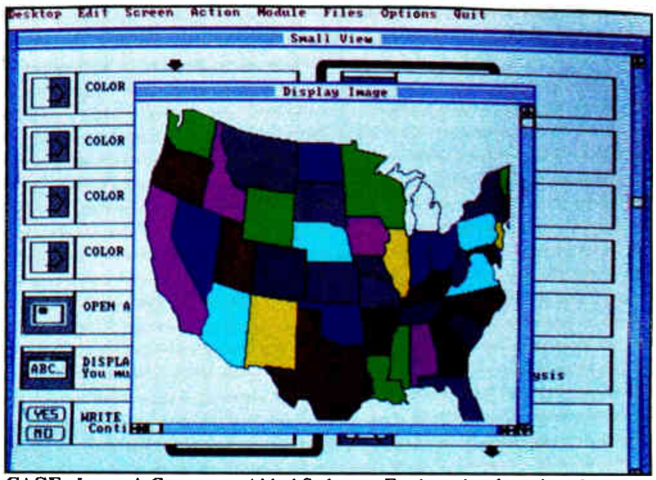

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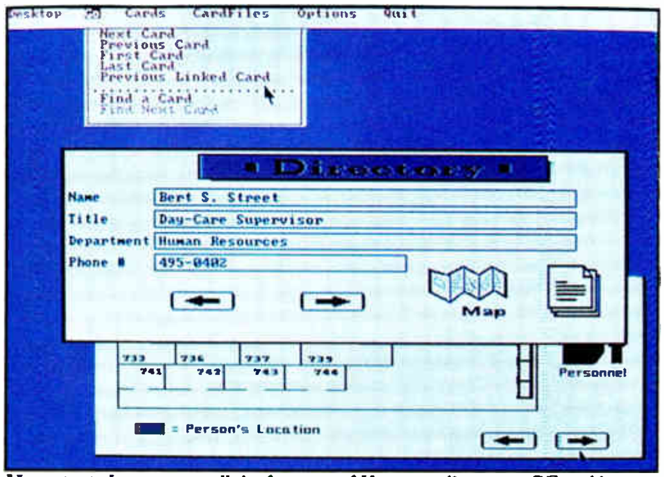

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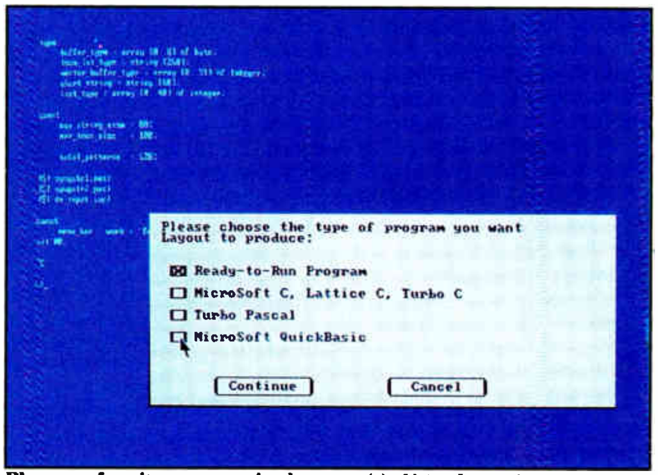

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Take Your Pick

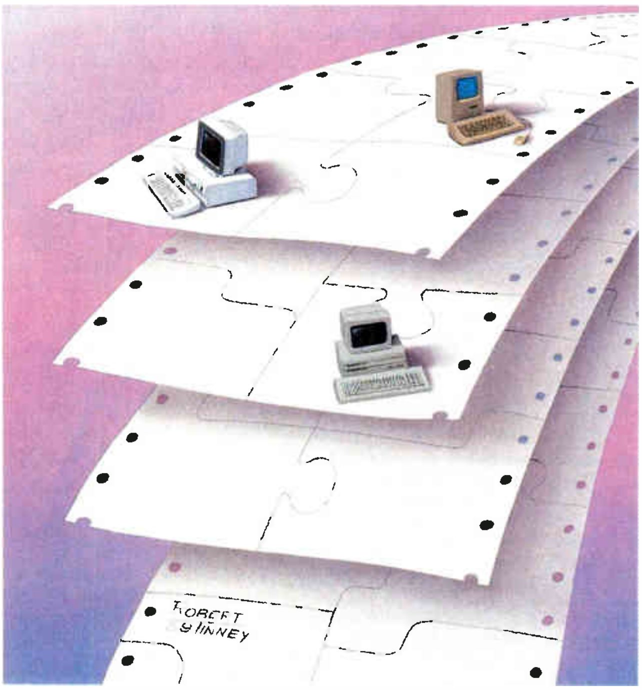
From client/servers to transparency to parallel processing, distributed processing uses a variety of methods to share resources

Gilbert Wai

Not long ago, the choices you had in configuring a computer system were limited. The speeds of the processors, the interconnections possible between different machines, and the capabilities of the software all contributed to a finite range of flexibility.

Now, with the 68030 and 80386 processors operating at 25 MHz and above, LANs available in many locations, and more open and accessible software, you can use almost any combination of software and hardware you want to create an optimum environment. Information that used to exist in one person's word processing, spreadsheet, and database applications can now be shared among an entire workgroup. The value of this information increases with its availability.

Once restricted to the realm of mainframes and minicomputers, distributed processing has now become available in the microcomputer world as well, with midrange systems linked to personal computers and LANs of personal computers. One major source of confusion, however, seems to be exactly what constitutes a distributed processing system.



What Is Distributed Processing?

One school of thought considers the client/server model (which uses Structured Query Language [SQL] and transactions from a variety of users) to be a form of distributed processing. Another insists that distributed processing applies only to those systems that attempt to distribute the various tasks or processes of a program across a network to the systems best suited for them. Still another group considers a parallel-processing system to be distributed, because it distributes various parts of a program among its own different processors. And then there are the distributed applications and databases.

One approach that holds great promise for distributed processing is transparency, the ability to access the resources of other machines without knowing where they are (see "A Transparent Environment" by Bruce J. Walker and Gerald J. Popek on page 225). In a truly transparent environment, you don't even know you're on a network. You can run some parts of an application on one machine while other parts execute on other machines, which might be of different architectures. Besides the user-interface advantages of this approach, it also lets you spread the workload among processors.

A similar approach is achieved with the remote procedure call (see "Remote Control" by Carl Manson and Ken Thurber on page 235). It is a self-defining term: An RPC calls a procedure that resides on a remote machine. It also lets you use a variety of processors that may

continued

The Opposite Tack

Michael L. Smith and George White

In LAN-based distributed processing, you tie processors together to share resources, not to increase speed. However, multiprocessing systems connect processors using a high-speed bus to enhance system performance. But, like LAN systems, multiprocessing systems must overcome obstacles to achieve transparent operation. Some of the obstacles are the same—process scheduling and load leveling, for example. Others are unique to processors that share a common bus and common memory.

For example, the Zenith Z-1000, which is based on an architecture designed by Corollary, connects up to six Intel 80386 processors with a 32-bit high-speed bus called the C-bus. In addition, the bus connects the processors to system memory. The Z-1000 also contains a standard IBM PC AT bus that lets you use standard AT cards for I/O.

Preventing Bus Overload

Each processor on the Z-1000 has a 64K-byte memory cache. With chips rated between 15 and 25 nanoseconds, cache memory is significantly faster than system memory. Thus, each processor can quickly access its most frequently used data. Without the caches, the processors would saturate the bus with memory accesses.

The system's ability to keep the various cache memories in sync is critically important to data integrity. The Z-1000 depends on cache coherency to allow the various caches to work in tandem when collecting and dispensing frequently accessed data from the system memory. Cache coherency provides each processor with an identical view of memory. Since a data value can exist in more than one cache, the system must be able to tell when duplicate data in one cache is modified and to invalidate the stale data in all other caches.

The most common cache-coherency scheme is called *write-through*. Under this scheme, if a data value changes in one cache, the new value is immediately written to main memory (see figure A).

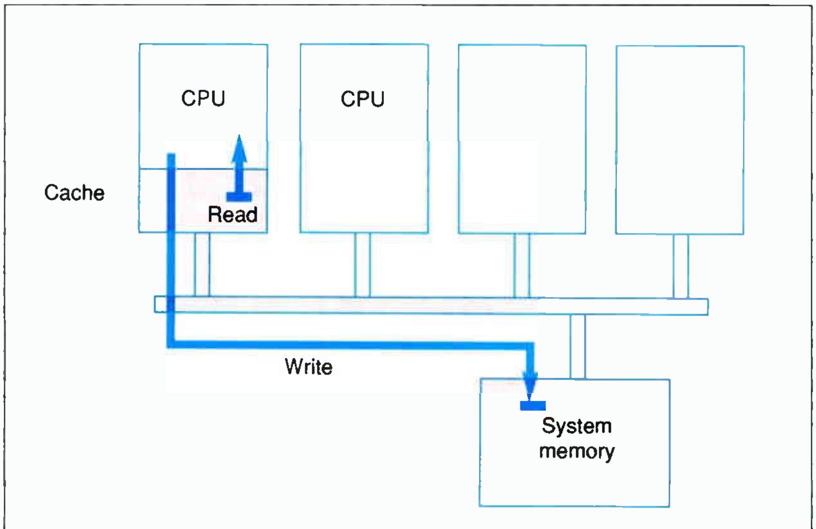


Figure A: *With a typical write-through coherency scheme, data can be read many times from the processor cache, but data can only be written across the bus to the system memory.*

Thus, main memory always has the correct value. If the data also exists in another cache, that cache must access main memory to get the updated value. Write-through maintains coherency, but it requires a bus transfer every time a value changes. This can bog down the entire system.

To keep bus access to a minimum, the Z-1000 uses a different scheme, called *write-back*. With write-back, a processor reads or writes to its own cache as much as possible, accessing the system memory only when necessary. The different cache controllers monitor the system bus to ensure that duplicated data always has the correct value.

To implement the write-back scheme in the Z-1000, each line in a cache has a tag that contains the high-order address for the data location and a set of access bits. The access bits mark the data in the cache as either shared, exclusive, modified, or invalid.

When a processor requests data that is not present in its own cache, it puts a request onto the system bus. If no other processor has a copy of the data, the processor moves it from system memory into its cache and marks it as exclusive. If the processor later writes over the exclusive data, it marks the data as modified. Because the processor is accessing its own cache, it can write the data any number of times without using the system bus (see figure B). Thus, the bus doesn't become saturated as you add more processors.

The individual cache controllers constantly monitor the system bus. When another processor tries to access a data item marked as modified, the owning cache controller intercepts the memory request and places the valid data on the bus (see figure C). The data is then marked as shared.

Processors cannot write to data that is marked as shared. A processor can write only to data marked as exclusive. Consequently, when a processor needs to write to shared data, it first tells all

be geographically separate to perform the various tasks of a single application, often concurrently.

Distributed applications are emerging as well. The higher speed and lower cost of today's microprocessors enable traditional workstation applications to become both PC-based and distributed. For example, document image processing (DIP) was traditionally available only on much larger machines, often dedicated to the application. It is now available in distributed form on PCs attached to a LAN (see "The Paperless Office" by Dean Hough on page 241).

Then there are some people who categorize parallel processing as a form of distributed processing. And who's to say other caches to mark their copies of the data as invalid. After this operation, the data is marked as exclusive, allowing the write to proceed. After the write, the data is marked as modified.

In general, the use of status bits combined with the automatic monitoring of the bus for applicable addresses ensures that duplicated data items are kept in sync without using the system bus excessively.

Processor Scheduling

In addition to keeping data synchronized, a multiprocessing system must be able to divide the workload among the processors. To keep this function transparent to users and applications, it must be done by the operating system.

The Z-1000 uses The Santa Cruz Operations' (SCO) Xenix operating system, which is compatible with AT&T's Unix System V. Corollary modified the kernel to use multiple processors. On the Z-1000, any processor can run the Xenix kernel.

The individual processors schedule themselves from a common run list, which is a modified version of the usual Xenix run list. It contains an added field that indicates which processes must run on the base processor connected to the AT bus and which can run on the other processors.

Load balancing on the Z-1000 is essentially automatic. When a processor finishes a task, it searches the common run list and schedules itself to execute the process with the highest priority. Implementing this scheme involves locking the run list and other common data structures to serialize access to them, but these details are transparent to the processes.

Multiprocessing Transparency

The C-bus cache-coherency system and the modifications to the operating-system kernel that detect and utilize the multiple processors are transparent to both users and applications. The cache system gets around the problem of having multiple processors use the same bus, while the kernel modifications handle scheduling and load balancing. Together, they create on the Z-1000 a transparent, tightly coupled distributed processing environment.

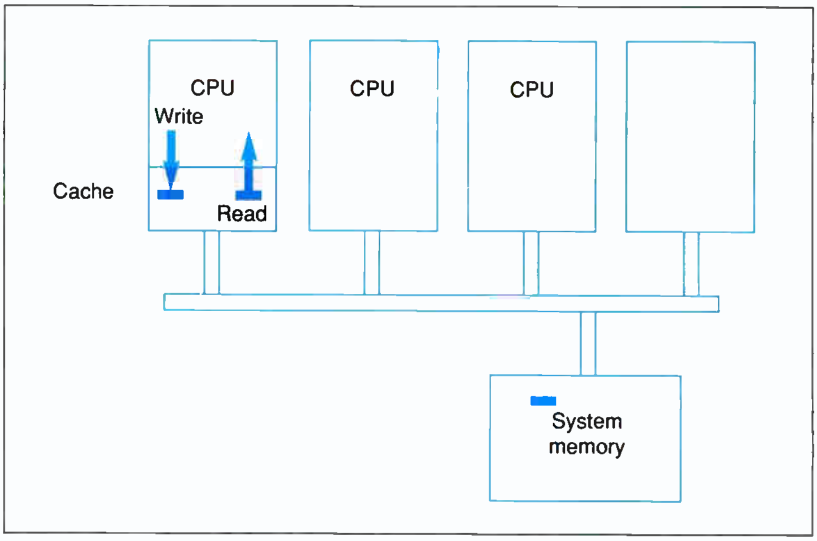


Figure B: *Using a write-back cache, data can be written any number of times so long as no other cache contains a copy of the data. The system bus is never used in this situation.*

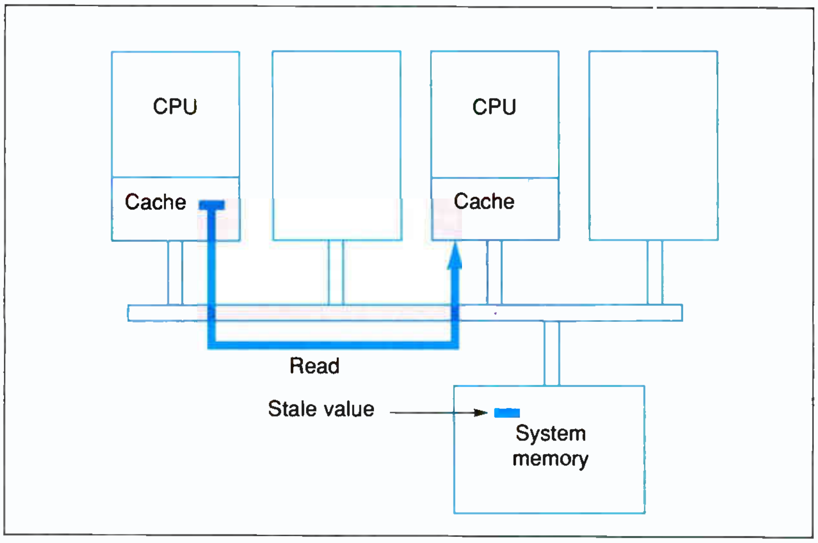


Figure C: *If a processor requests data stored in another cache, the owning cache detects the request and satisfies it by placing the data on the bus.*

Michael L. Smith is director of advanced systems for Zenith Data Systems in Glenview, Illinois. George White is president of Corollary, Inc., in Irvine, California. You can reach them on BIX c/o "editors."

they're wrong? The two bear some marked similarities. Both must distribute tasks among various processors, coordinate any necessary interaction between them, handle errors that didn't occur with a single processor in control, and level loads among the available processors. The difference, of course, is obvious: In a parallel-processing machine, all the processors are in close geographic proximity; over a distributed network, they are much more likely to be remote from each other, physically as well as logically. In other respects, though, parallel processing does resemble distributed processing.

The client/server architecture also

continued

embodies a model for distributed processing, the one I will discuss. The client machines contain the user interface, while the server machine holds the database. Requests for data traverse the network from client to server, and only the appropriate data makes the return trip.

With all these new options, designing an architecture for distributed processing has become a complex and often confusing undertaking. In choosing a distributed processing configuration, you need to keep two major factors in mind: the cost-effectiveness and the responsiveness of the solution. Sharing computer resources can have a huge impact on the cost-effectiveness of a system. It's also important to take full advantage of new technology. For example, using sophisticated workstations simply as dumb terminals is a waste of their capabilities. But as a part of a distributed processing system, their processing power can be more fully utilized.

LANs

The basic element of all but one of these distributed processing designs (the exception being parallel processing) is the network, usually a LAN. LANs are considered loosely coupled systems, since the individual processors are located in separate machines and communicate at relatively low speeds. Parallel processing, on the other hand, is considered tightly coupled because it usually refers to multiple processors in a single machine, communicating over a bus at high speeds. Coordinating multiple processors in a single machine is a different challenge (see the text box "The Opposite Tack" by Michael L. Smith and George White on page 216).

The LAN is the means by which distribution takes place, regardless of what you're distributing. For example, the file-server option provides one LAN approach to distributed processing. PC LANs allow you to store data on a central PC server (see figure 1). You can control and manipulate data locally without the duplication of effort and resources found in replicated systems. You can put files on a disk to be shared, or you can share databases between workstations. And you can access files on remote file servers as easily as you can access information on your own machine.

While the file-server option lets you share information without duplicating data or applications, it can create heavy network traffic. Furthermore, each access to a large file can potentially lock a block of the file, slowing the system down considerably under heavy use and making large amounts of information temporarily unavailable to other users.

Client/Server Model

One common way to employ distributed processing is with a client/server architecture, which splits the application processing into two components: client and server. The relational database, for example, takes advantage of this model. In this case, the user interface resides on the client machines, PCs or workstations, and includes screen display, reports, and data requests. The server machine stores and manipulates the actual data and provides security, locking functions, transaction logging, and recovery capabilities. Data requests in the form of SQL

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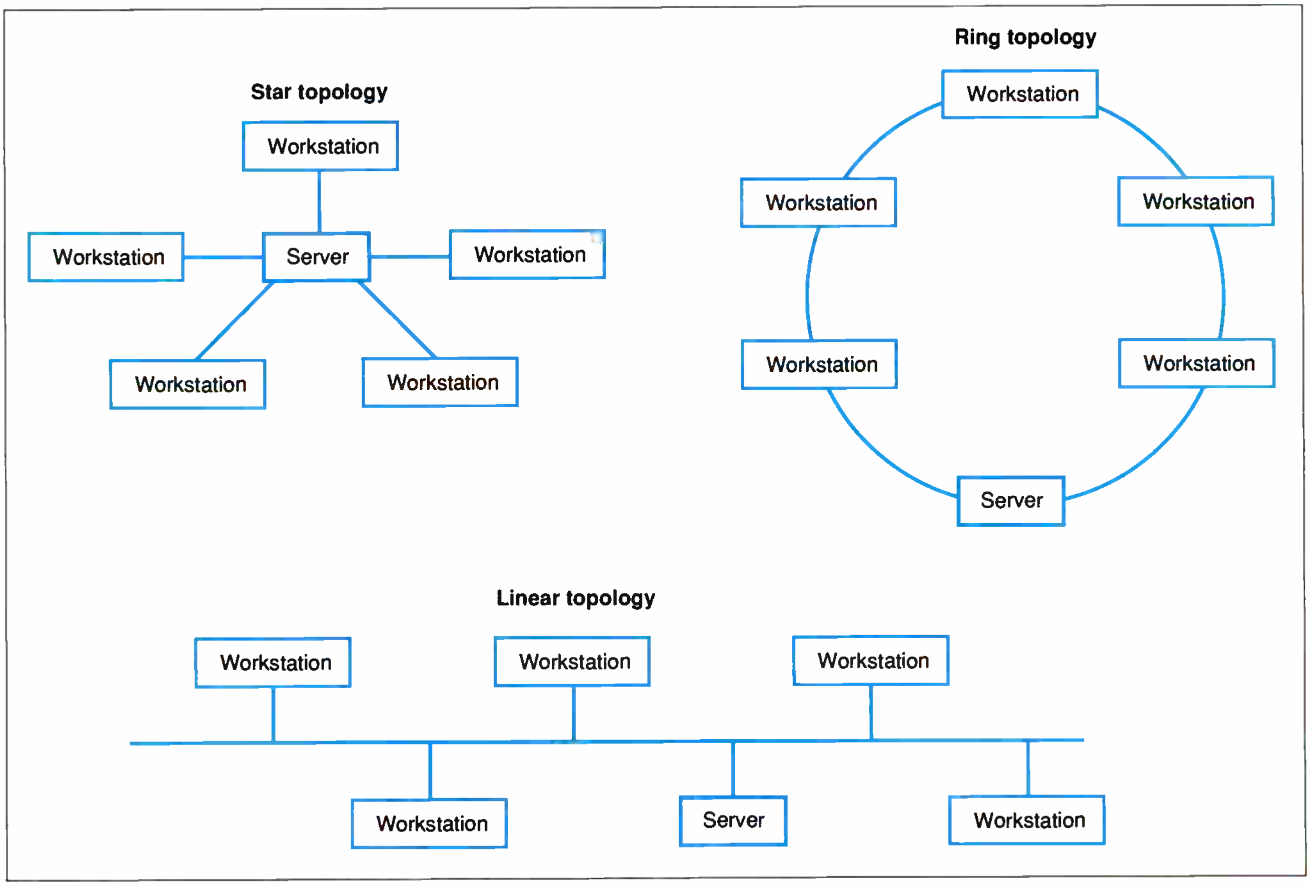

Figure 1: *Three common LAN topologies. The file-server option lets you store data on a central PC server. You can share disk files or whole databases and access remote files as easily as local ones.*

commands travel across the network from the client machine to the server, and only the records matching the request criteria are sent back.

Although the client/server model seems like an updated version of a PC LAN, its advantages are numerous. Each server can support more users with this model, since the client machines manage the user interface. Database information is locked for shorter periods of time. More users can obtain concurrent access to data. More sophisticated locking mechanisms are available. And a number of users can share the data without hampering system performance; this is a definite improvement over file sharing.

In addition, with the increasing connectivity available among so many machines and operating systems, you can choose as client systems the software and hardware environments you are most comfortable with—say an IBM PC. Then you connect these client machines to a more powerful server system, such as a Unix system. No matter where the data is, you can access it without having to learn the server environment.

File Sharing vs. Client/Server

Both the file-sharing and client/server models provide distributed processing capabilities by allowing client machines to share information. In the file-sharing model, PCs can share application software and databases stored on a LAN file server (see figure 2). One DOS computer can handle both the application-tool process and the database-engine process on a LAN operating system. A client computer specifies a file system on the server and can then use its resources as if it were a local file system. Thus, you can access remote files as if they were local.

The client/server model splits the process between the front end, which handles the user interface and interaction, and the back end, which processes your requests. Only SQL queries and commands are sent across the network to the server. The back end on the server processes the request, selects the data that matches the selection criteria, and sends only the appropriate data back over the network to the client machine (see figure 3). SQL lets you manipulate entire sets of data at once instead of one record at a time, speeding up the process.

To see how the client/server and file-sharing methods differ in practice, assume you are using file sharing and you want to find all employees with salaries over $25,000. The employee-records database is stored on another computer on the network. The application process on the client machine requests the file server to send the appropriate database table across the network. The client machine receives the table, checks to see which records meet the selection criteria, and then keeps the appropriate records.

If you were using a client/server architecture, the database server would send across the network only the information that fulfills the request; it wouldn't send the entire file. This form of distributed processing minimizes network traffic and doesn't unnecessarily prevent other users from accessing data.

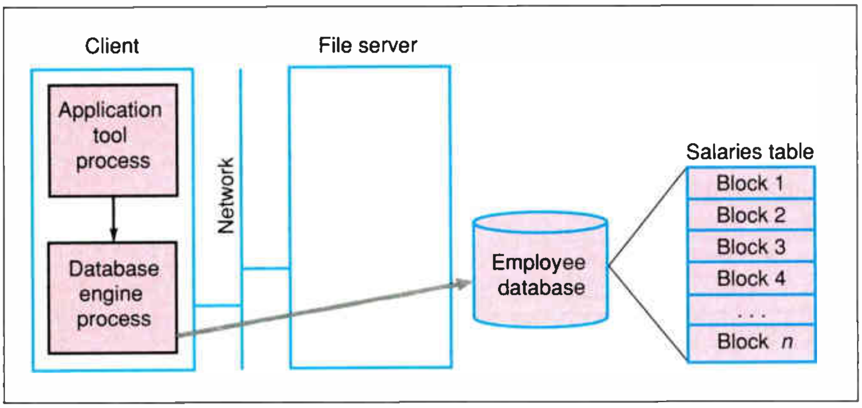

Figure 2: *The file-sharing model. Client machines can share application software and databases stored on the LAN file server as if they were local. The server sends entire files back over the network to the client machine.*

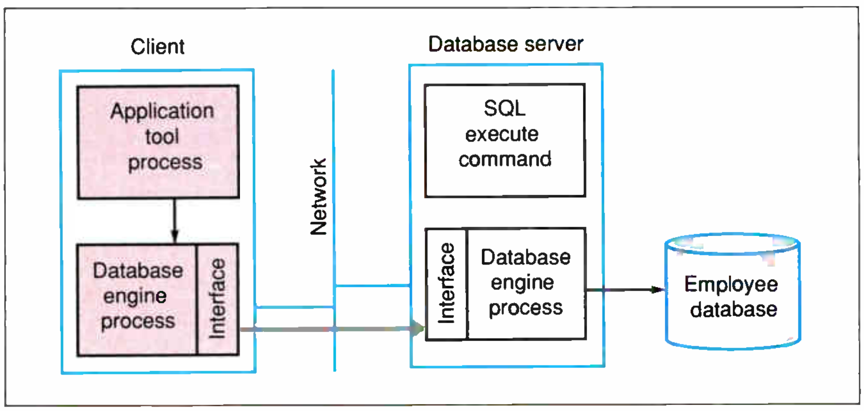

Figure 3: *The client/server model. The front end handles the user interface and interaction, and the back end processes requests. The server sends only the appropriate data back over the network to the client machine.*

Distributed Database Technology

Distributed database technology takes you a step further. With distributed databases, you can access data that is located among a number of physically separate servers (see figure 4). The key advantage of this technology is that it provides you with a global view of the data.

For example, a regional office could view and update its own local records, while the corporate office could access data from all regions to monitor activities. You could make a request like "How many software packages were sold in March?" and the answer might correlate information from the western region, located on a remote machine, with data from the eastern region, located on another remote machine. All you see is the final result; you don't have to know where the information came from. Any updates you add are immediately available throughout the network, so you can't have out-of-date or duplicate data.

Problems with implementing distributed database technology do exist. The technology is still evolving, and all the components of a completely distributed database are not yet in place. A few proprietary systems offer distributed capabilities, but according to a definition put forth by Chris Date, executive vice president of the Codd & Date consulting group, no relational DBMS based on

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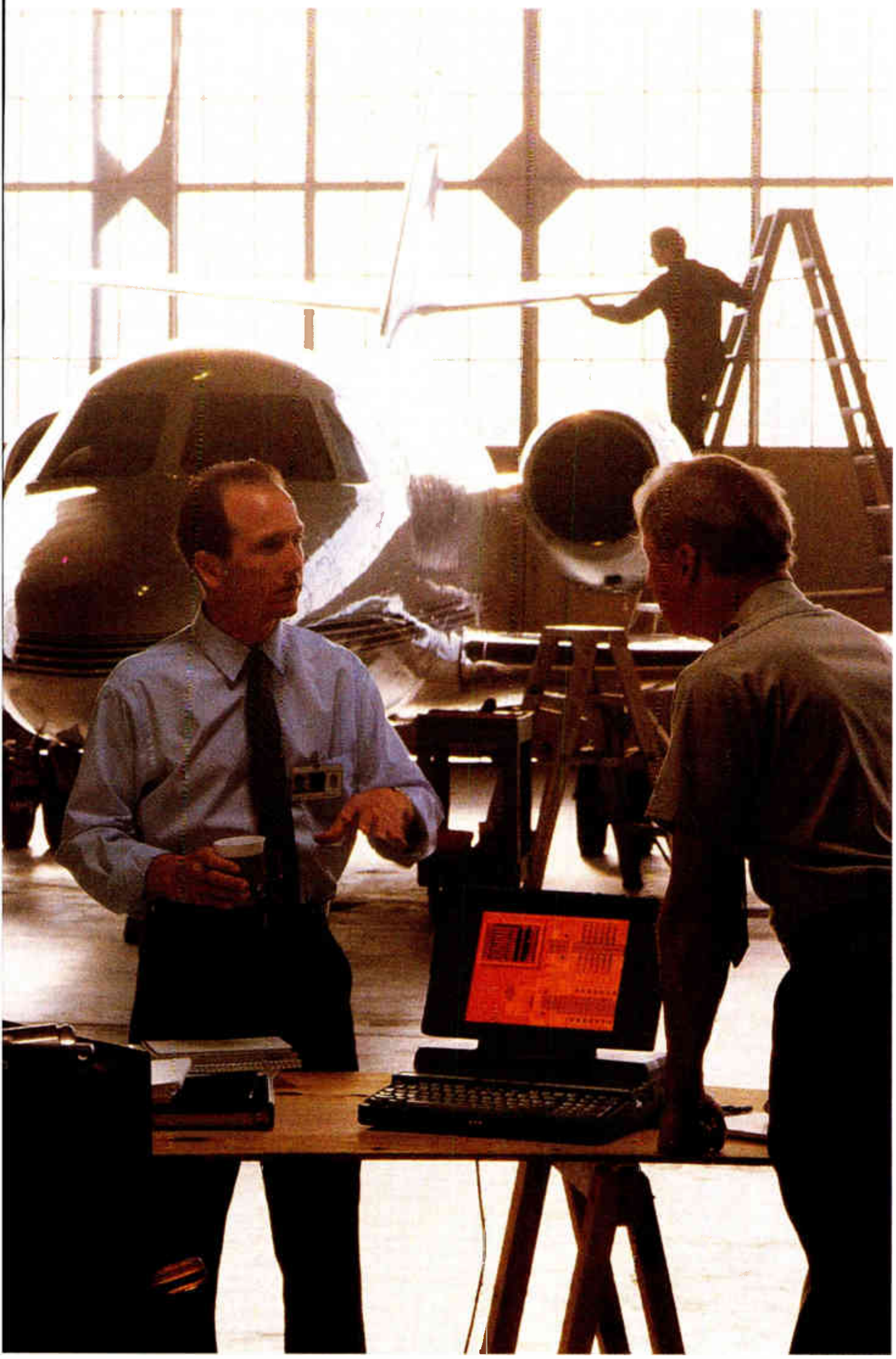
Workstations no longer have to be stationary.



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Developing a distributed database application requires extensive planning to anticipate the many complex possibilities. The potential for a large number of transactions traveling over wide-area networks means that you must consider the capacity of the communications lines and the possible impact on system speed.

Distributed Transaction Systems

Transaction processing involves many on-line users who are simultaneously accessing and updating a common database. The database plays an essential role. Traditionally, transaction processing applications have been centralized using proprietary hardware solutions. The demanding requirements of transaction systems could be handled only by certain proprietary hardware environments. Now, however, such systems have migrated into the minicomputer and microcomputer worlds (see the text box "Under Unix" at left).

Several approaches or models for providing distributed transaction processing exist. The simplest model uses replicated applications. Although these are not truly distributed applications, they provide similar benefits: A single large transaction-processing application is broken down into smaller, independent applications. For example, the benefit of a point-of-sale system with a single computer in each store is that the systems are easily deployable and scaled to local pro-

Under Unix

Distributed transaction processing under Unix has generated a great deal of interest. Unix has wide appeal because of its ability to migrate applications across hardware environments and to utilize development skills across them. Since you can handle a large amount of the processing locally, response time is better, and the bandwidth for a higher-quality user interface is available.

Despite the interest, however, there are three major barriers to distributed transaction systems under Unix: its lack of applications development tools, the constraints of its file system, and current distributed database technology.

The constraints of the Unix file system that impact transaction processing are its limited ability to provide sustained performance with many concurrent users, its inability to guarantee data integrity (i.e., in the event of a system failure, you can lose data), and its limited database capacity (i.e., file sizes are limited by the capacity of individual disk drives).

One of the companies tackling these problems is Informix Software of Menlo Park, California. In the Informix architecture, two procedures handle the processing: A database tool provides the user interface, and a database engine manages the data. They can exist on the same processor, on different processors in the same machine, or in different machines.

One problem to overcome is Unix's lack of applications development tools. Informix-4GL is a fourth-generation language that includes nonprocedural syntax to speed up development and maintenance, procedural syntax for flexibility and control, and a source-level debugger. Fourth-generation languages provide significant improvement in programmer productivity over conventional languages.

The constraints of the Unix file system are dealt with by an on-line transaction processing (OLTP) database engine, Informix-Turbo, which balances system resource allocation among multiple users. Through direct I/O, it provides virtually unlimited database capacity. You can add disk space, and tables can exceed the capacity of an individual disk drive. In the event of a system failure, the database is automatically restored to its last state.

In the near future, Informix plans to release the first phase of its distributed database, which will enable you to perform multisite reads and single-site updates, including remote queries and multitable joins across the network.

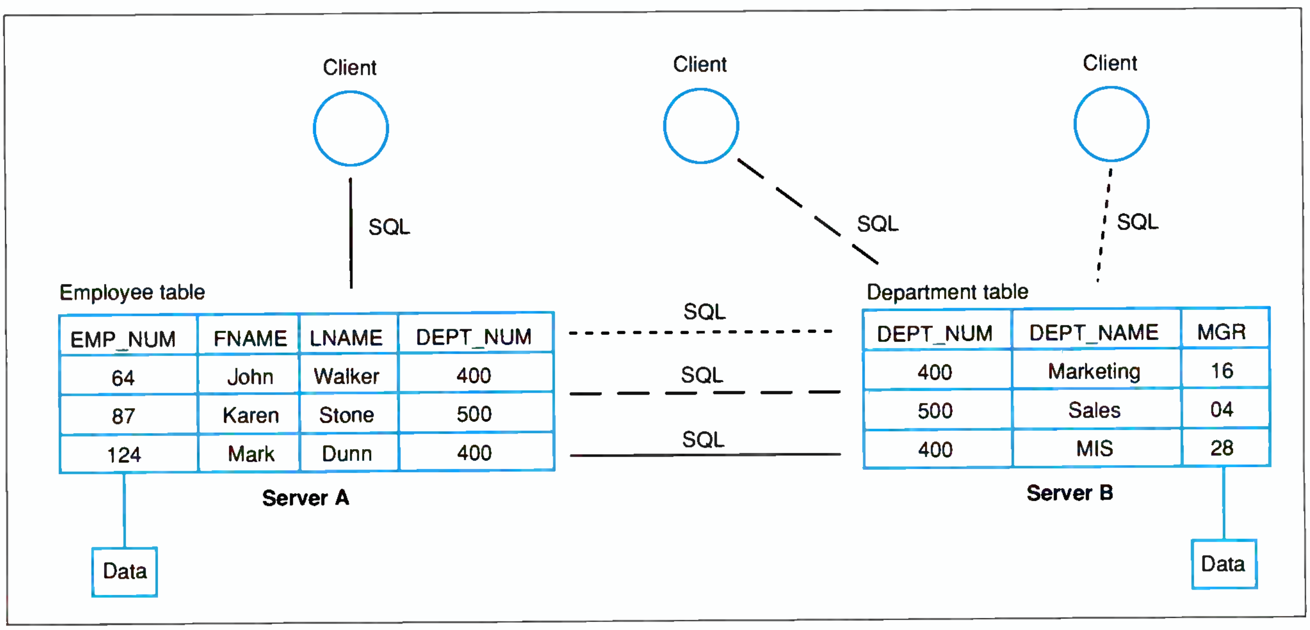

Figure 4: *A distributed database. You can access data dispersed among several physically remote servers. This technology provides you with a global view of the data.*

cessing requirements.

The next model uses a front-end processing system that handles a subset of the processing. Then the transaction is sent to the main system. For example, in a system responsible for credit-card authorization, the front-end system does a quick check for lost or stolen cards before routing the transaction to the main system. This approach is more flexible than a single central system and lets the main system handle more transactions.

The third model employs peer-to-peer applications. Again, it breaks a large problem into smaller tasks. The difference is that, here, the individual applications work together. An example would be an inventory-control system in which each warehouse has its own inventory levels but also has access to data at other warehouses. Inventory information can be shared. This model lets transactions process locally for speed while retaining access to remote information.

For distributed transaction systems to be possible, the distributed database must be able to run on all the machines you have in your environment. In addition, the distributed database is more complex to manage than the central database. However, the biggest barrier to deploying distributed technology is probably the perceived loss of control by the owners of the data. Once the data is no longer in a single room, people believe that they lose control of it. Distrust of the system, uneasiness about the lack of control over the data, and the possibility of data contamination may be the strongest deterrents to implementation. Recent computer virus scares have done nothing to assuage these fears.

Options Up, Limitations Down

Improved options for distributed processing continue to develop. The wide range of server machines and choices for data location have increased the flexibility of the client/server options available. The ability to offload processing to low-cost machines and the improved response time of various distributed processing models have made anticipated cost advantages a reality.

As distributed processing evolves, it will continue to take advantage of the technology available today while reducing the limitations with every advance. ■

Gilbert Wai is director of product marketing for Informix Software in Menlo Park, California. He has a B.S. in electrical engineering and computer science from the University of California at Berkeley. He can be reached on BIX c/o "editors."

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A Transparent Environment

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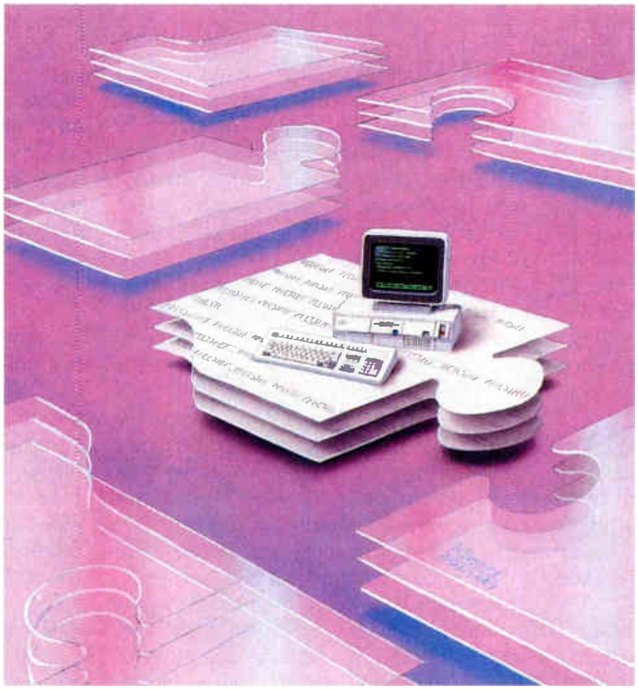
Bruce J. Walker and Gerald J. Popek



In today's mixed computing environment, transparent access to resources of other machines has become increasingly desirable. With a high degree of transparency, you can take advantage of a distributed and heterogeneous environment without making significant changes to your existing software. You can run some existing applications so that parts of them execute on one machine while other parts execute on other machines of possibly different architectures. For example, a display-oriented function could execute on the machine that has the display, while the data-acquisition portion of the same application executes near where the data is stored.

Transparency can allow inherently parallel tasks to take advantage of multiple CPUs without losing the autonomy of each. In an environment where you see the same view of system resources regardless of the machine you're working on, you can make processes execute on less-loaded CPUs and even relocate them during execution, without modifying the application. You can also grow or shrink the underlying computing environment without disrupting ongoing activity. You simply add or remove processors or storage. In addition, you can use specialized machines for particular tasks without building specialized communications software.

What Is Transparency?

Transparency is a widely used term with many facets. The first, *access transparency* (which applies to files, devices, processes, and interprocess-communications entities), means you can use the same system calls regardless of the resource's location.

Device transparency is a subset of access transparency but is distinguished from it because some companies claim access transparency when only the data file access is transparent. *Process transparency* is also a subset of access transparency, but it takes the concept far beyond the remote-mount distributed file-system products available today.

The next two facets deal with naming your resources, particularly the files. *Location transparency* means that the name of the CPU where the resource resides is *not* embedded in the path name; this means that the resource can be moved without changing its name. *Name transparency* means that the same name used on different CPUs will access the same resource. In other words, within a distributed environment, each resource must have a globally unique name that is accessible from all the CPUs.

Performance transparency means that the overhead referencing involved in

continued

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remote resources is so small when compared to local access that you can ignore it. These six transparency components combine to make up *network transparency*, a concept embodied in the LOCUS Distributed System Architecture.

Network Transparency

What does a transparent environment look like, and how does transparency make that environment more productive? Here are the characteristics of transparency and the benefits that each of them provides.

Hidden underlying network. First, as much as possible, the existence of a network and the division of resources between processing nodes should be hidden from you. This operates in the same way that virtual memory relieves you from dealing with the boundary between primary and secondary storage.

LANs make this radical departure from traditional networking possible with their high capacity, low delay, low error rate, and low cost. Each of these attributes plays a role in facilitating transparency. High capacity helps avoid queuing delays and frees you from needing to know where data is stored. Low delay allows intimate interactions between nodes.

High bandwidth alone can allow the time required for large data transfers to approach local disk-access times. Most other types of interaction can't be pipelined, so you can consider them transparent only if the round-trip delay is suitably small.

A low error rate is always desirable, and it's important in hiding the network, reducing delay, and simplifying network interactions, thereby reducing transparency's CPU-cycle overhead.

The low cost of LANs is important in two ways. First, it reduces the cost of transparency. Second, it frees you from trying to maximize bandwidth utilization. As a result, you can achieve lower delays and provide more performance transparency.

Hiding the network and providing a seamless interface to a collection of distributed resources is the key to a more productive environment, just as data independence is the key in the database world. Hiding the way in which the data is organized allows a simpler interface and lets you rearrange the data as your needs change without disrupting existing programs. Regardless of initial performance considerations, data independence is now widely accepted.

Network transparency will follow a similar pattern. Where data is stored and where programs are executed will be of little day-to-day concern. However, it will be useful to have tools that let you look "under the covers" to see and control the details of resource location and execution, especially if transparency is not complete.

The virtual memory analogy also applies. Few new systems are built without it, and you rarely have reason to deal with detailed control of the virtual memory mechanism. Network transparency may well end up the same way.

> *As much as possible, the location of your data, the allocation of resources, and even the existence of a network should be hidden from you.*

Single user name space. A key component to attaining a network-transparent environment is to present the same view of all resources to each machine. Thus, account names and numbers must be globally unique. Benefits include simplifying administration and access protection and providing a simpler view for users and programs.

Name transparency. A globally unique file-naming space ensures that a given path name on any machine will translate to the same data. This requirement means consistent naming for user data files, commands, and system data files. Thus, you can treat CPUs as interchangeable resources and attain better availability, more parallelism, and easier load balancing. Without the guarantee of a consistent view from each machine, you can only attain these objectives in limited circumstances or with case-specific specialized adaptations.

Location transparency. Resources don't have a site's location built into their names. Embedding the site defeats transparency in two ways. First, you can't transparently relocate the data. As with data independence in databases, you should not expose the underlying layout in a way that prevents changing it. Second, encoding the name of the storage site makes it difficult to replicate the resource so that you can use the replicas to attain performance improvements or higher availability.

Consistent file-access semantics. Preserving file access, modification, and synchronization semantics in the face of processes executing on several different machines simultaneously is also important to a transparent environment. It is not often achieved today.

Sun's Network File System (NFS) doesn't meet this goal, partly because, when it was created, there was no remote-process capability. Thus, since processes on different machines couldn't cooperate, synchronizing their accesses to a file wasn't important. To provide synchronization, you must keep the state at the storage site, and NFS is specifically designed to be stateless.

IBM's Distributed Services (DS) and the Transparent Computing Facility (TCF) both retain the state at the storage site to provide file-access synchronization, mask machine boundaries, and provide an environment closer to that of the single machine.

Process transparency. Process transparency is key to overall network transparency. Each process should see all the other processes as if they were executing on the same CPU. This implies that there must be a cluster-wide unique process-naming space. It also implies that the underlying system can reliably send signals to and get process status from processes executing on any CPU.

A parent process shouldn't have to know where its descendants are executing and shouldn't need any extra code to deal with remote processes. This means that a process created on a remote machine must inherit all the same objects that those created on the local machine inherit—open files and offsets, open pipes and terminals, current working directory, process ID, process group, and so on. These objects must have the same effects when used remotely as they would have had locally.

With such an environment, you could take software written with only a single machine in mind and run part of it on one CPU and the rest on another, even if the architectures differ.

Device transparency. Device transparency implies several design constraints. First, devices should have globally unique names, like files. This would mean that a device could be accessed by the same name, no matter which machine it is actually attached to and no

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Transparency Today

The Transparent Computing Facility (TCF) clustering service for IBM's AIX operating system is an interesting example of network transparency today. It contains most of the important characteristics of transparency in a distributed system. TCF is primarily a set of enabling code that is included in the kernel of each computer in the cluster. As such, each machine is a full-function Unix system and yet can cooperate with other systems, even those with different architectures, to provide a multimachine single-system image.

A Global Hierarchy

A cluster-wide file-system hierarchy is the key to allowing users and processes to execute on any CPU as if it were the local CPU. To achieve it, the kernels at each site keep the local tables of mounted file systems identical to one another. Anything mounted at any site becomes visible to all the other sites.

The global file-system hierarchy provides *name transparency*; each file has a globally unique name, so no matter which site calls that name, it leads to the same data.

To achieve *location transparency* in TCF, only the global mount table (a kernel data structure) records the location of files. Because the kernels all agree where file systems are mounted, TCF can expand path names efficiently without needing explicit location information.

The global hierarchy also extends to the root-file system. An independent root-file system for each machine would violate name transparency since you couldn't guarantee that the same name would access the same data on different machines. A single root stored at one site would work, but performance transparency and availability would be likely to suffer.

File replication lets you have one *logical* root, while a copy of the root exists at each cluster site. Then, TCF must ensure that all the copies are kept up-to-date. It should also guarantee that any open request receives the latest version of the file, whether or not it has been propagated to all sites yet. In addition, TCF must synchronize file access: After a process writes a byte to a given file on one machine, any subsequent read from other machines should see the new byte.

File Replication

The TCF replication scheme differs for system and user files. For example, the root-file system must contain, for each command, binaries for each machine type. Replicating 370 binaries on an IBM PS/2 disk seems unnecessary, so, for each file in a system-replicated file system, you can mark what machine type, subtype, or set of machine types should store the file. For user-replicated file systems, you typically specify precisely which machine or machines will store the file.

TCF replication differs substantially from shadow disks (where you simultaneously write the same data to two disks on one machine), primarily in that replication can be controlled on a file basis. Also, different copies exist on different CPUs and may be physically quite far apart. Each machine that agrees to store a file in a given file system has a disk structure for it. The various file-system structures need not all be the same size; not all files will be stored at each eligible site.

To avoid the possibility of conflicting updates during network partitioning or a sequence of failures, TCF designates one storage site as primary for a file system, and all updating occurs on that copy. The system then propagates the changes to the other copies.

You can use these copies for read access as long as they are current and no one is modifying the file. The operating system is responsible for maintaining copies and ensuring that an open request always receives the current copy; it substitutes another copy if the storage site crashes or for any reason leaves the cluster.

Hidden Directories

The root-file system must store a binary for each command and each machine type. However, if only one machine type has a binary, the system will run the command transparently on that type, regardless of which machine invoked the command.

When there is more than one binary type for a given command, how do you store the various representations? Users and programs expect to reference commands by specific names. Thus, the TCF implementation stores a slightly modified directory in the name hierarchy where you would expect to find a binary load module. Inside these "hidden" directories are the binaries, with names like "i370" and "i386."

If you attempt to execute or open a hidden directory, the kernel will "slide through" to the appropriate component. You can treat the hidden directory like a regular directory through an escape mechanism, so you can replace load modules in it or look at its complete contents.

Tokens for Synchronization

To synchronize file access in a single-system-image manner, TCF uses two *token* schemes. The first uses file or data tokens. Multiple reading sites or a single writing site can hold a token at any time, and you can keep caches of remote data at sites holding a token. Fairness strategies exist to ensure that sites receive a given token in the requesting order.

File-offset tokens support the remote execs and forks. In Unix, a child process shares file offsets with its parent; thus, if the parent reads a byte and then the child issues a read, the child sees the bytes following those that the parent has read. With parents and children on different CPUs, you still need to maintain these semantics; the offset token accomplishes this.

The token mechanisms also synchronize cluster-wide named and unnamed pipes. In some Unix implementations, pipes are a special form of file, using file information structures (*i-nodes*) and disk data blocks. Providing simultaneous and synchronized read/write access around the cluster is natural.

Pipe semantics dictate that readers read in the order that writers write, and writers can't get too far ahead of readers. Also, readers naturally wait in the kernel read call for writers to write. Dealing with remote waiting and remote wake-ups requires an extra mechanism. Remote waiting also occurs when you use remote devices; it is supported similarly.

Remote Process Support

The kernel provides remote-tasking support, which is transparent to processes and users. You don't need to change application code to take advantage of it. The exec system call can execute the requested code on a CPU other than the one that made the call.

The remote process inherits the entire state that a local exec inherits. That state includes process identification (ID); process group; parent process group; user ID; current working directory; signal and environment information; and open files, devices, and pipes, and the current offsets into each. A kernel-to-kernel protocol transfers the required information, so neither process is aware of the network.

Keeping the process and process-group IDs the same is essential for transparency. Without it, signaling and general control would be either cumbersome or impossible. TCF supports globally unique process IDs, and it doesn't change them when migration occurs but still permits each site to allocate them rapidly without a global agreement protocol.

To do this, TCF uses some of the high-order bits in the process ID for the ID of the site that created the process. That ID then stays with the process even after a remote exec. Examining an ID tells you only where a process originated, not where it is currently executing. Knowing the current execution site is important in guaranteeing signal delivery, so part of the remote-process creation protocol maintains process and process-group tracking information.

Process Migration

If you try to invoke a load module that will run only on a hardware architecture different from the one you have, the kernel will choose the right type of CPU as the execution site and migrate the task. You can set up a profile to help the system choose an appropriate machine if you wish, or you can just leave it up to the system. For explicit control, TCF provides a new remote exec call with all the functions of exec plus an extra site argument.

TCF also includes a remote system call (`rfork`) that is the same as `fork` except for an additional site parameter. Remote `fork` shares much of the code of remote `exec`. However, `rfork` must also provide a copy of the process data space. You don't need a copy of the text, since the child process will just "page-fault" the image as needed, either from a local copy or across the network. The `rfork` capability lets you take a parallel task and spread it across several CPUs.

You can also move a process in the middle of execution and continue to run it on another CPU. Migration uses much of the same code that `rfork` does; the difference is that the new process keeps the ID of the old process, and the old process image is destroyed. When TCF transfers control, it takes special care to ensure that signals are seen only once—not lost and not duplicated.

Migration can be initiated in one of two ways. A process can issue the `migrate` system call or the new SIGMIGRATE signal. SIGMIGRATE takes a site number as an added argument (via a `kill3` system call, which has all the protection rules of `kill`). The operating system services the signal, so the migration can proceed without the process's knowledge.

The standard command shells have been enhanced to include a built-in `migrate` command so you can use this tool for dynamic load balancing. Migration can be useful if you have to take a given CPU down for service.

Graceful Addition of CPUs

To make adding or deleting CPUs as transparent as possible, the kernels in the cluster run a distributed protocol when any of them notices a change in the topology. This protocol determines which machines exist in the cluster and the locations of available file systems. During most of the reconfiguration protocol, normal activity can proceed.

Executing the algorithm or protocol cleans up after resources that are no longer available, handles resource substitution, and cleans up after processes that have left the cluster. That dynamic reconfiguration doesn't require any user or operator intervention. The act of taking a CPU to multiuser mode causes it to join the cluster. The new CPU, its devices, and its mounted file systems become available to the rest of the cluster, and their CPUs, devices, and mounted file systems become available to the local machine.

Exceptions to Transparency

TCF includes some exceptions to transparency, however. While the environment provides a high level of transparency, it doesn't completely meet a few of the ideal characteristics.

The first exception concerns error transparency. While TCF will substitute a replicated copy of an open file in the event of a failure, it keeps no *hot shadows* (where you simultaneously update the same data on two disks on two different machines) of files that would permit updating to continue if the storage site were to fail. It also includes no process checkpointing to restart a process that didn't complete due to processor failure. Adding support for hot shadows will be easier due to the already existing file replication. Adding process checkpointing is an extension of the process-migration facility.

The second exception involves CPU-specific accounting files. These files, stored outside the kernel, help to maintain system operability even when the CPU is unable to join the cluster. While a special form of symbolic link is used to minimize the effect of this change, it's visibly different from normal operations.

Another problem lies with the `/tmp` directory, typically used in Unix for transient temporary storage and occasionally for exchanging user information. A copy of `/tmp` should reside on each site for performance and availability. In TCF, `/tmp` is a local file system, although each `/tmp` does have another globally unique name. You can become confused if you use the local name.

Device names are handled the same way. Each device has a globally unique name. In addition, you can use the local name `/dev/tty00`, for example, to refer to a local terminal.

Another general class of exceptions involves some interprocess-communications mechanisms. The semaphore, message queues, and shared-memory mechanism of Unix System V are not supported cluster-wide, so processes on different CPUs cannot communicate via these mechanisms. This is an example of incomplete implementation of transparency, and it can be addressed within the framework of the overall architecture.

Most Objectives Provided

TCF, which will be available soon from IBM for 370-class machines and PS/2-386 machines, provides most of transparency's objectives: the global file-system hierarchy, transparent file access, file replication, remote pipes and signals, and transparent heterogeneous process execution. The exceptions are few and largely unnoticed.

matter which machine you access it from. While necessary for complete transparency, this is not always as important as the globally unique names for data files and directories; access to devices is more stylized and accomplished with fewer commands.

Second, the functions you can apply to devices should be uniformly available from all machines. Uniform access includes not only `open`, `read`, and `write`, but also the catch-all Unix system call for manipulating devices, `ioctl`.

There are several different classes of devices in Unix, and uniform access is more practical for some of them than for others. For terminal devices that are buffered through kernel data structures, it is critical and feasible. For memory-mapped screen manipulation, however, it is considerably harder to get good performance. For block-mode devices, which are implemented by way of the kernel file I/O buffer cache, providing device transparency is reasonably straightforward.

You can provide device transparency for so-called *raw mode* devices like magnetic tape, but the performance degradation can be significant. It may prompt you to use process transparency and run the process on the machine local to the device.

User transparency. Uniform access to devices is important in accessing the terminals of users attached to other CPUs. Current loosely coupled systems use specialized programs and a variety of Unix daemons to determine where other users are logged in.

For example, in Berkeley Unix, the `rwho` daemon broadcasts information about who is logged on locally and collects information about who is logged onto other machines; the `talk` daemon supports a conversation with a remote user; the `rsh`, `rlogin`, and `telnet` daemons provide a command interpreter on a remote machine; and so on.

None of these fragile application-specific daemons should be necessary in a transparent environment. The standard single-machine utilities should operate correctly.

"Under the covers" access. Sometimes, it's worthwhile to move a processing component to the data rather than move the data to the process. Semantically, such an action should have no effect on the execution of the application, but it may be useful nonetheless. You can improve both availability and performance by, for example, anticipating site failures and taking advantage of replicated data.

Control of process-execution sites. Processes need some criteria to know where to execute. You should at least be able to specify where to run a process. However, the method shouldn't require altering existing software to use it.

One alternative would have you supply information external to the specified program: an ordered list of machines to try to execute on, or criteria like the least-busy site, the machine nearest the data, or the one without a communications bottleneck.

In another situation, you could attach information to the program so that particular processing units could act as cycle servers for particular programs. What is important is that the underlying machine allows you to start processes on specific machines.

Process relocation during execution. To fully attain the goal of load balancing, you need to be able to do more than just start a task on a given machine. You also need to be able to change the execution site of all or part of the task during execution. This is a rigorous test of how transparent the environment is. If, in general, you can move a process from processor to processor and still accomplish the same task unaware of the change, then CPUs really are just interchangeable resources, and the environment is network-transparent.

But this functionality is important for more reasons than just to prove how transparent the environment is. You can use process migration to spread loads evenly and improve availability. A user, system administrator, program, or load-leveling daemon should be able to direct a process to change its execution site. In addition, the process itself may want to move during the execution, either to get closer to the data or a device or to spread the load.

You can also increase availability if you move processes off a CPU before you take it down for maintenance. However, this may not always be successful, because the process may need other resources on the CPU in question.

While process migration may seem like an ambitious requirement, it's not a significant extension to remote execution if the required context is maintained. It appears more difficult than it is, because the common remote-job facilities typically in use don't extend easily.

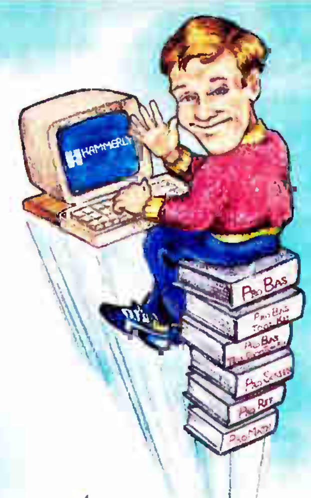
Process creation on other CPUs. Process migration and transparent remote execution help you run processes on a collection of CPUs, but the standard Unix way of setting up parallel activity is to use the `fork` mechanism. (The Unix `fork` creates another process that is largely identical to the one that issues it.) With remote execution and migration, implementing remote forking is straightforward.

You need various criteria to determine the execution site. You could either choose a site at random or base your decision on load, as in the multiprocessor environment. The user's environment might also provide hints. In any case, given that communication is more expensive in this network environment than in the multiprocessor environment, you need a way to explicitly state which CPU you want `fork` to create a process on. Thus, even if the underlying system can't perfectly spread out a highly parallel function, the program or compiler can.

Cost benefits, particularly with local resources. One way to assess whether network transparency would be valuable to you is to use the yardstick frequently applied to multiprocessor systems. As you add processing elements, what fraction of an additional processor is performing useful work? In addition, the cost of having network-transparency capabilities in the system should be low for a single-site operation.

Resource addition without disrupting ongoing work. The system should be able to use added resources automatically. Similarly, you should be able to create file replicas during normal operation and use them immediately. Adding printers and tape drives should also be transparent. Adding users should simply require integrating them into the whole cluster, subject only to protection and resource-management controls. Installing a software package once should make it available everywhere. You should need to

continued



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perform software-maintenance activities only once; the system should propagate any changes to all replicas.

Resource removal without loss of service. Removing resources can be either a planned or an unplanned event. With error transparency, you shouldn't notice in either case, except perhaps for degraded performance. Several interesting, but not absolute, degrees of error transparency exist.

First, activities that don't involve the lost resource shouldn't be disrupted. Second, the system should automatically substitute equivalent resources. File substitution should be possible if copies exist, and process transparency should allow CPU substitution. However, these substitutions may be difficult in ongoing operations.

For example, if a file was partially updated and some of the changes were cached, losing the site with the cache may preclude a simple substitution and require more extensive checkpoint/restart facilities. Similarly, if a process is partway through execution on a CPU that fails, the process can be restarted from the beginning on another CPU. But, in general, that won't be completely transparent to other processes and users who may have already seen partial results.

A Significant Step Forward

Designing a system to provide this collection of characteristics and requirements is an ambitious endeavor, but the result would be a significant step forward in Unix functionality and in distributed computing. "Single-system image" may be a buzzword, but it's certainly descriptive of the goal of network transparency. IBM's TCF implementation of the LOCUS Distributed System Architecture demonstrates that most of the transparency requirements outlined are feasible, even while maintaining single-machine Unix semantics (see the text box "Transparency Today" on page 228).

Transparency as a concept has many degrees and dimensions. Single-machine Unix users who have struggled with limited cross-machine services generally are excited by it and find the transparent environment greatly superior. We expect that interactive terminal-intensive tasks will naturally run near the keyboard and screen, while back-end machines will get file- and CPU-intensive assignments.

System administration will be much easier than for *n* individual machines. However, more is involved in managing a transparency cluster than a single machine because of the opportunities to improve performance and availability by relocating or replicating data and by allocating CPUs. The ease with which you can run tasks in parallel on different CPUs will probably result in a flurry of engineering and scientific applications.

Due to the high level of transparency, you should be able to smoothly expand the environment by adding front-end terminal machines, file-server-type machines, cycle-server machines, or combinations of these without disturbing the existing installation and with immediate integration. We expect that a high level of transparency will open many doors. ■

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Q. What is the DataSentry system?

A. The DataSentry protection system consists of a combination of a hardware encryption device – Personal Access Key – and associated software that runs on an IBM or compatible PC having a parallel printer port and a floppy disk drive. The DataSentry provides three types of security: mandatory use of the access key to open a file, encryption and password protection.

Q. What is inside the Personal Access Key?

A. Inside each pocket-sized Personal Access Key is a proprietary custom-designed integrated circuit, often referred to as an Application Specific Integrated Circuit (ASIC). This ASIC was designed by engineers at Rainbow Technologies specifically for the DataSentry system. The full capabilities of the ASIC are known only to Rainbow. In operation, the proprietary ASIC implements a special function called an algorithm, chosen from many thousands of possible algorithms when the key is being manufactured at the Rainbow factory.

Q. What is the disadvantage of password-only software protection?

A. The main disadvantage of password-only protection is that users find it difficult to remember a password unless it is something quite familiar to them – like their spouse's name, their dog or the street they live on. It was recently estimated that about 75% of ARPANET passwords could be discovered by trying these three choices. Choosing a less familiar name requires that it be written down. This, of course, is a security risk. As a result, password-only protection is fairly easy to defeat.

Q. What is the advantage of external hardware keys over internal security boards?

A. Some protection systems depend on circuit boards being installed inside the PC. In addition to objection to the expense of installation and training, many users are reluctant to open their PCs. IBM PS/2s and laptop PCs do not accept the standard add-in boards. As a result, nearly all PC users have a strong preference to the addition of low-cost external hardware to achieve the desired protection.

Q. Is the DES (Data Encryption Standard) government-specified algorithm available with the DataSentry system?

A. Yes. The DES algorithm as defined by U.S. government standard FIPS 46 is implemented in the DataSentry system.

Q. Can the DataSentry system be used on local area networks?

A. Yes. It can be used on LANS as long as the automatically protected files are stored on a local computer. It does not matter if the application is stored on the local PC, on a shared file server or on any other PC.

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A. Yes. The mainframe could send files to the PC for encrypting or decrypting.

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Remote Control

Distributing computing tasks over a multivendor network is a lot easier if you know your RPCs

Carl Manson and Ken Thurber

The basic limitation of all single-processor systems is that they execute only one instruction at a time. There are a couple of ways around this limitation. One is parallel processing. Parallel processors can achieve supercomputing speeds at near microcomputing prices by combining varying numbers of tightly coupled CPUs.

The network offers another way around the one-instruction limitation: distributed processing. On a network, you can integrate multiple, loosely coupled processors into a single computing environment by using remote procedure calls.

Spreading the Work Around

As the name implies, a remote procedure call (RPC) invokes a procedure on a machine that is remote from where the call originates. In its basic form, an RPC identifies the procedure to be executed, the machine it is to be executed on, and any arguments required. The application of this RPC model results in a client/server arrangement where the client is the application that issued the call and the server is the processor that handles the call.

An early implementation of the RPC model, Courier, was developed by Xerox as part of the Xerox Network System. Courier is defined as a three-layer protocol that uses virtual circuits for communication (see figure 1). At the top layer, the Courier protocol consists of a message stream that includes the call and return information. The bottom layer consists of a block stream for data transfer. The middle layer—the object stream—defines the data types that can be used in transferring information. The idea behind Courier was to allow distributed systems to use the higher-level abstractions it provides.

Using RPCs, Courier made it possible to distribute the processing of a job over the network. However, it lacked a way to match processing requests to processors—the Courier model required that you specify the server as part of the call. Other issues not addressed by Courier: load balancing, resource naming, reliability, error handling, process blocking, and data translation.

Currently, the two RPC implementations receiving a lot of attention are Sun Microsystems' RPC, which is part of the Network File System (NFS), and Apollo Computer's RPC, which is a component of its Network Computing System (NCS).

RPCs in the Sun

The Sun RPC mechanism is relatively simple (see figure 2). Like Courier, it executes a process on a remote machine as if the process were being executed

continued

locally. A major difference, however, is the requirement that the Sun RPC system work in multivendor environments. This led to the inclusion of a data-translation mechanism called the External Data Representation (XDR) protocol.

The Sun RPC is a library of routines you can use to develop distributed applications. It consists of three layers. The highest is a set of routines that perform network functions such as determining how many users are logged onto a remote machine. The lowest layer involves direct network manipulation.

You use the middle layer of routines to construct the higher-level functions. These are the routines that actually invoke remote procedures.

For example, `callrpc()`, the simplest RPC in the library, requires eight parameters that illustrate the Sun RPC model. The first parameter is the name of the remote machine that will handle the call. The next three are the program, version, and procedure numbers. The fifth parameter is an XDR routine that is used to convert the arguments being passed to an intermediate data representation defined by the XDR protocol. This is followed by the actual arguments to the remote procedure. The last two parameters, an XDR routine and the return arguments, are for the return call. Thus, with the exception of the data conversion that ensures processor independence, the Sun RPC uses the same model used by Xerox for its Courier protocol.

The NFS Idea

Based on the Sun RPC, NFS provides transparent file access among computers of different architectures over one or more networks. NFS keeps different file structures and operating systems transparent to users. Access techniques also remain invisible to users. In addition, file access performance with NFS is comparable to local file access.

NFS is an open approach to solving the problems inherent in networking in today's heterogeneous world of computers. Important design goals include machine and operating-system independence, simple crash recovery, transparent file access, and good performance. Sun also wanted NFS to provide a Unix-like way of making remote files available to local programs without having to modify, or even recompile, them. To achieve these goals, Sun designed the NFS protocols independently of the operating system and transport network. Thus, NFS is not a network operating system but an independent network service.

Implementing NFS

NFS extends the standard Unix `mount` command, allowing system administrators and network users to mount remote files and directories on their machines for local use. Under NFS, you can mount files immediately when you bring a network server or computer on-line, or later as you need them. Access to these files follows the same operating-system procedures as local file retrieval. With Unix, for example, you locate a file with the `cat` command plus the appropriate path name to the file. As long as the client and server share the same network, this doesn't change under NFS, regardless of the file's location. NFS automatically determines whether a request for a file should take place locally or over the network. For performance reasons, NFS is integrated with the kernel of Sun's operating system.

NFS perceives machines on a network as being servers, clients, or both. Any system with a disk can function as both a server and a client. Diskless nodes operate only as clients, and dedicated servers only as servers.

Because NFS is used with multiple operating systems, servers on the network are stateless. They do not maintain tables relating to each file being served. Each file request is shipped across the network with exactly the parameters (such as read/write privileges) that are attached to it locally. This makes for simple recovery in the event of a system or network crash. For example, the system doesn't have to reconstruct file-locking tables.

The NFS Protocol

NFS starts with a remote-execution system protocol. This defines the operations available (the remote procedures), the arguments passed to them, and the results returned. The principal operation in the protocol is START, which initiates a remote program. The START procedure takes the name of the command and its arguments, the working directory (including the name of the server providing it), a list of environment variables with their values, and port numbers for the standard input, output, and error channels. START returns the status of the initial execution in both machine-readable and human-readable form.

When START concludes, the remote program executes. Its standard input is read from, and standard output written to, the indicated network ports (with an optional third network port for standard error). The WAIT operation waits for the command to terminate, and it returns the exit status, also in both machine-readable and human-readable form.

NFS protocol procedures use this mechanism to provide the basic functionality of the Unix file-system routines. For example, under NFS you can use Unix functions such as `read`, `write`, `create`, and `mkdir` even if the server is running some other operating system.

In addition to the protocol procedures themselves, the NFS design also deals with the problems inherent in both the server and the client side of a transparent distributed processing network.

Servicing NFS Requests

Because servers are stateless under NFS, any modified data must be committed to stable storage before the system returns the results of an NFS service request.

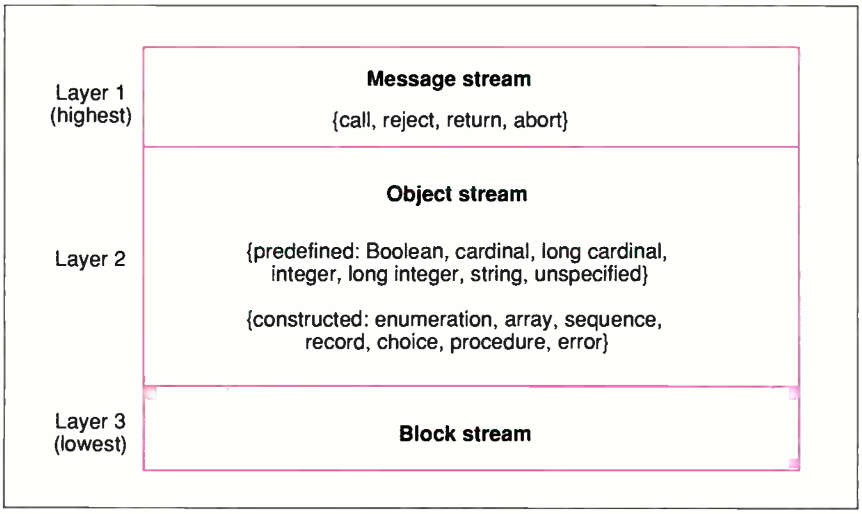

Figure 1: *The protocol layers of XNS Courier show the built-in data types supported by the remote procedure call (RPC) mechanism.*

The implication for Unix-based servers is that NFS requests that modify the file system must flush all modified data to disk before returning. For example, when NFS performs a write operation, the server must flush not only the data block but also any modified indirect blocks and the block containing the system file descriptor (the *i-node*).

Another modification to Unix necessary to make the server work properly is the addition of a generation number in the i-node and a unique file-system ID for the file system on the server. These extra numbers make it possible for the server to use the i-node number, the i-node-generation number, and the file-system ID together as the network ID for a file. The i-node-generation number is necessary because the server may hand out a network ID with an i-node number for a file that is later removed and the i-node reused. When the original network ID comes back, the server must be able to tell that this i-node number now refers to a different file. The generation number has to be incremented every time the i-node is freed.

Client Worries

The client side provides the transparent interface to the NFS functions. To ensure transparent access to remote files, NFS uses a method of locating remote files that does not change the structure of path names. Some Unix-based remote-file-access schemes use `host:path` to name remote files. This "late binding" does not allow true transparent access since it requires the modification of existing programs that parse path names.

Sun's solution is to perform the host-name lookup and file-address binding once per file system. The NFS `mount` command accomplishes this by allowing you to attach a remote file system to a directory. The advantage to this system is that you deal with host names only once, at mount time. It also allows the server to limit access to file systems by checking client credentials. The disadvantage is that remote files are not available to the client until a mount is done.

Transparent access to different types of file systems mounted on a single machine is provided by different file-system interfaces in the kernel. Each file-system type requires two sets of interface operations. The virtual file-system (VFS) interface defines the procedures that operate on the file system as a whole. The virtual node (*v-node*) interface defines the procedures that operate on an individual file within that file-system type.

The VFS interface's structure contains the operations that can be done on the file system as a whole. Likewise, the v-node interface's structure contains the operations that can be done on a file or directory within the file system. There is one VFS structure in the kernel for each mounted file system and one v-node structure for each active file or directory. This use of abstract data types allows the kernel to treat all file systems and nodes the same way without having to know the details of the underlying file system. The v-node and VFS interfaces ensure that programs that parse Unix path names will be able to find remote files on many different file systems.

Locks and Open Files

Being stateless, NFS does not support remote record and file locking. It contains separate lock managers that handle file and record locking. Lock managers are provided at both the client and the server. Lock requests from the client are forwarded to the server lock manager using RPC routines. The network status monitor service then notifies the lock managers of any change in status of either the server or the client.

If the status monitor detects the failure of a client, it notifies the server, which then releases the failed client's lock. If the status monitor detects the failure and recovery of a server, the client-lock manager retransmits any client-lock requests.

In addition to record and file locking, NFS attempts to obey Unix file-system semantics without modifying the server or the NFS protocol. In some cases, this is difficult. For example, Unix allows the removal of open files. A process can open a file, remove its directory entry, and still read and write to the file. This procedure defines temporary files.

Of course, not all operating systems or file systems support the removal of open files. To provide this capability, NFS checks the client VFS during a removal operation. If the file is open, NFS renames the remote file instead of removing it. This makes the file "sort of" invisible to the client and still allows reading and writing to the file. The new name is not removed until its v-node becomes inactive. NFS calls this the "three-quarter solution" because, if the client crashes between the rename operation and the remove operation, a garbage file is left on the server.

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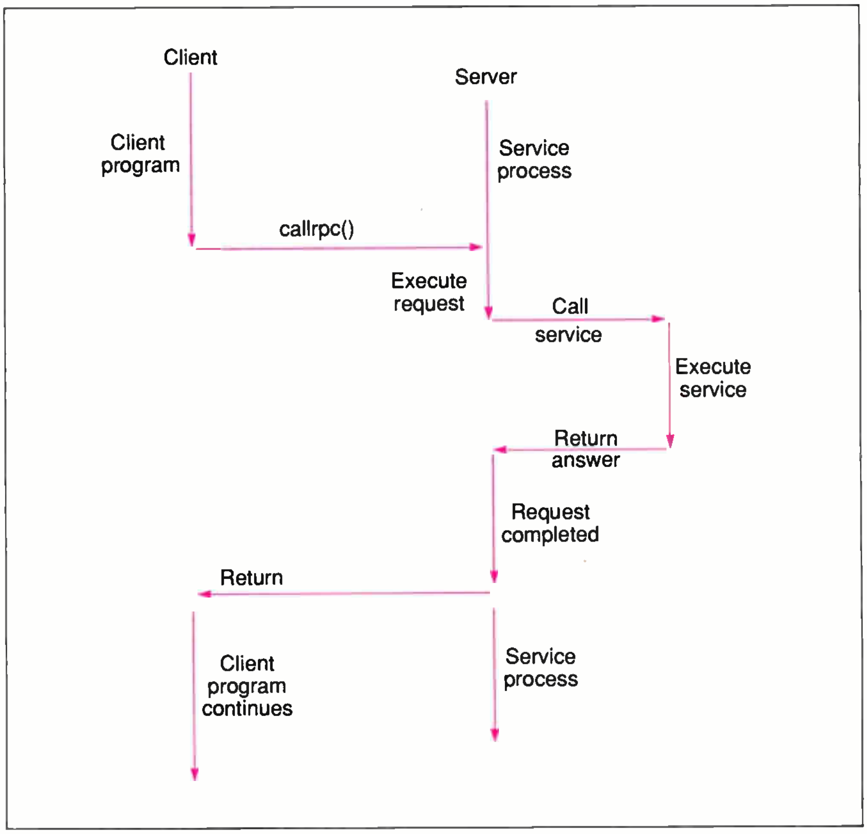

Figure 2: *A typical call using the Sun RPC shows the flow of control from the client to the server and back again.*

However, NFS does not preserve all the Unix open-file semantics because interactions between two clients using the same remote file cannot be controlled on a single client. For example, if one client opens a file and another client removes that file, the first client's read request will fail even though the file is still open.

Another source of difficulty for NFS is time skew. Time skew between two clients or between a client and a server can cause the time associated with a file to be inconsistent. For example, the Unix command `ranlib`, which converts archives into libraries, saves the current time in a library entry. The Unix dynamic linker `ld` checks the modify time of the library against the time saved in the library. When `ranlib` is run on a remote file, the modify time comes from the server, while the current time saved in the library comes from the client. If the server's time is far ahead of the client's, it appears to `ld` as if the library is out of date. This problem can be handled by taking the network-status-monitor approach with file and record locking. Time requests would then be implemented as remote procedure calls.

NFS is a good example of a distributed processing application that uses RPCs. It remains dependent, however, on clients mounting remote file systems. Apollo Computer's RPC-based system automates the selection of servers to a greater degree than NFS.

The Apollo Approach

Apollo's approach to RPCs is to provide a set of routines that look like standard, stand-alone subroutines to client applications. These stand-in routines are called *stubs*. Likewise, servers also use stubs that stand in for the applications calling a subroutine. The client application invokes remote procedures using standard calling conventions, as if the procedures were part of the local program. The client stub acts as the "local representative" of the procedures, organizing the data into a format that can be meaningfully transmitted to the server. The stub then uses the Apollo RPC Runtime library routines to communicate with the server. Within the server, a similar chain of events occurs. The RPC Runtime routines pass the request to a server stub that stands in for the calling program and invokes the requested procedure. After execution, the server stub passes return information to the RPC Runtime routines, which in turn communicate with the client (see figure 3).

The RPC Runtime library is an integral part of Apollo's RPC strategy. It provides the system calls required to implement both calling clients and called servers. These calls provide the mechanisms for transferring requests from the clients to the servers and transmitting and receiving responses.

Characteristics of RPC Runtime

The Apollo RPC Runtime system contains most of the facilities required to implement distributed processing. It includes error-handling capabilities and is robust in the face of lost, duplicated, or long-delayed messages, messages arriving out of order, and server crashes. RPC Runtime ensures that no call ever executes more than once. Because the error handling is built into RPC Runtime, the application can call for only as much error correction as is needed. For example, if you can execute a subroutine more than once without side effects, you can eliminate the overhead required to guard against this.

The RPC Runtime environment includes conversion routines for changing byte order and converting floating-point representations. You can use the source code provided for these routines to create run-time procedures that handle data conversion between different machines.

System-level support for RPC operations is also provided. In most cases, you don't use RPC Runtime calls directly. Instead, you create an interface definition in the Network Interface Definition Language. The NIDL compiler automatically generates the stub code, including RPC calls, for both the server and client from a single interface definition. This layered design simplifies and isolates the operations required to make a remote procedure call work.

RPC Runtime is as independent of particular network layer protocols as possible. It is written in portable C and uses the Berkeley Unix socket abstraction, which masks the details of various protocol families so you can write protocol-independent networking code.

Networking facilities designed to move long byte streams reliably, such as TCP/IP, are not suited to handling the way an RPC system exchanges messages because the cost of setting up and maintaining a connection using such facilities is quite high. RPC Runtime implements exactly the reliability it needs on top of a connectionless network service such as the User Datagram Protocol. Because they lack sophisticated handshaking protocols, datagram services have less overhead than connection-oriented services and are thus ideal for RPC systems.

Less overhead, however, also means less reliability in error recovery. RPC Runtime makes up for this by providing its own error checking and recovery procedures on top of the datagram service. This approach has the additional advantage of reliably handling those systems—embedded microprocessors, for instance—that supply a less-than-reliable service when connected to a network.

The protocol that RPC Runtime implements on top of a datagram service is lightweight yet robust in the face of problems with messages. The user is not required to switch to a standard transport layer like TCP/IP in order to achieve reliable network service.

Programming RPC Runtime

The NIDL compiler automatically generates the stub procedures that stand in

continued

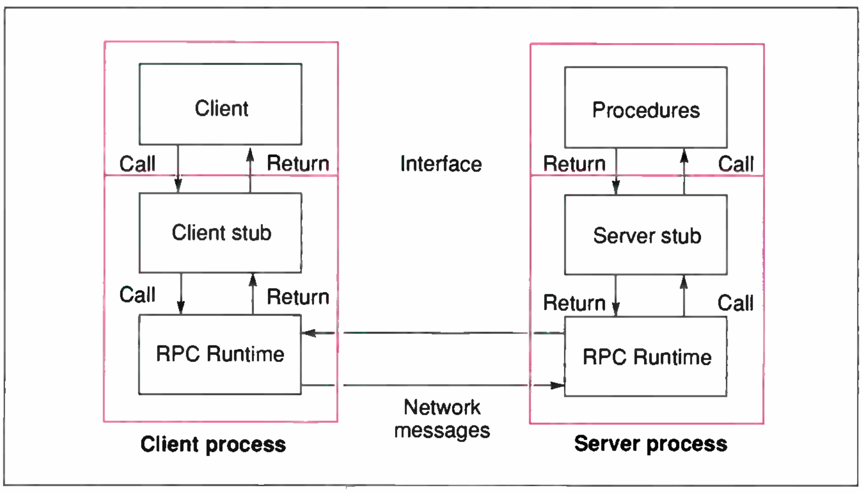

Figure 3: *The Apollo RPC facility uses stubs on both the client and server side to stand in for the called procedure and the calling application, respectively.*

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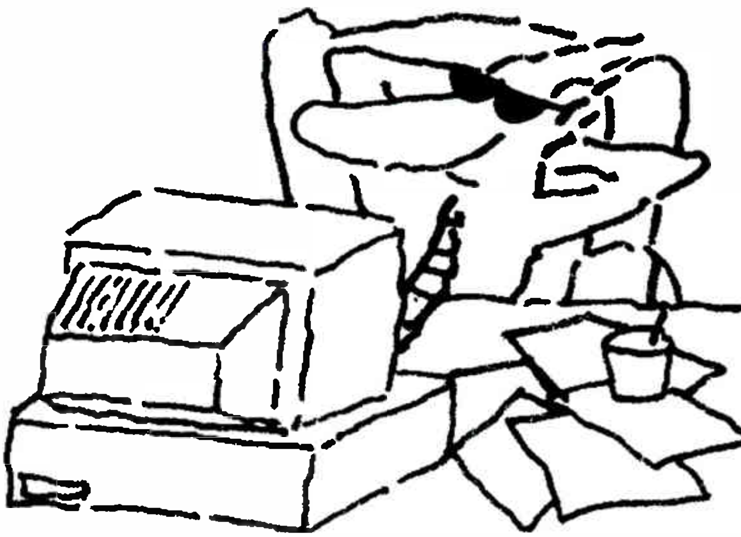

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for the remote procedure on the call side, and for the caller's procedure on the server side (see figure 4). You describe the stub routines in an interface specification (written in NIDL) that describes the procedures that can be called remotely, as well as the numbers and types of their arguments.

NIDL contains constructs for describing the data types, functions, and procedures associated with a remote interface. It is a declarative language and contains no executable constructs. It comes in two flavors: NIDL/C with a C-like syntax, and NIDL/Pascal with a syntax like the Pascal/Modula-2 family of languages.

All RPC Runtime calls are tagged with a description of how the calling machine represents basic data such as integers, characters, and floating-point numbers. The representation of aggregates does not differ across machine types because aggregates are defined by the stubs (which actually pack the components of the aggregates), not the underlying machine architecture. All stubs are thus capable of converting data to the appropriate type. The compiler also lets you write separate procedures to handle pointers. Thus, you can pass complex data structures between machines.

The NIDL compiler generates stubs that can employ the following data types: signed and unsigned integers, single- and double-precision floating-point numbers, characters, strings, fixed- and varying-length arrays, enumerations, sets, records, discriminated unions, and simple pointers. The compiler supports three types of binding for the RPC and the remote procedure to be executed: explicit, implicit, and automatic.

Explicit binding means that the NIDL specification states exactly which server to use whenever the application is run. In implicit binding, the client defines the server in a variable before making any remote procedure calls, thus deferring binding to run time. Automatic binding is provided as a service of the *location broker*. The binding options available allow greater flexibility than systems that use explicit binding exclusively.

The Location Broker

To be truly distributed, an application should not contain hard-coded information about its execution environment. For example, if you add an array processor to a network, you shouldn't have to modify applications to have them recognize and use the new machine. The Apollo NCS uses a location broker to automatically match tasks to servers. Servers register their capabilities with the location broker, and clients query the location broker at run time to determine which servers to use for particular RPC calls.

The location broker maintains a replicated database that contains the identities and locations of server objects available on the network. Client programs can access different resources through the location broker without knowing the location of each object beforehand. The location broker provides a forwarding facility and invocation facility. Forwarding provides an address to the objects on a server. Invocation can start the server if it is not running at the time the location broker receives a request for the object.

Other location-broker components include a client agent, called by programs that want to use location-broker facilities; local brokers, which manage information about resources on the local host; replicated global brokers, which manage information about resources available to all clients; and administrative tools that update the location broker.

The location broker is a large step toward providing transparent distributed processing on a network. Using a broker, applications can dynamically bind to resources in the network without any changes in their source or object code.

Distributed Applications

Although networks can never achieve the raw processing speed of a tightly coupled parallel processor, distributed processing using RPCs offers many of the advantages of parallel processing.

Presently, there is not a lot of commercial work in the area of building a distributed processing network to perform a particular function. This area is wide open for applications development. With the availability of distributed processing tools based on RPCs, you will see the development of such applications. ■

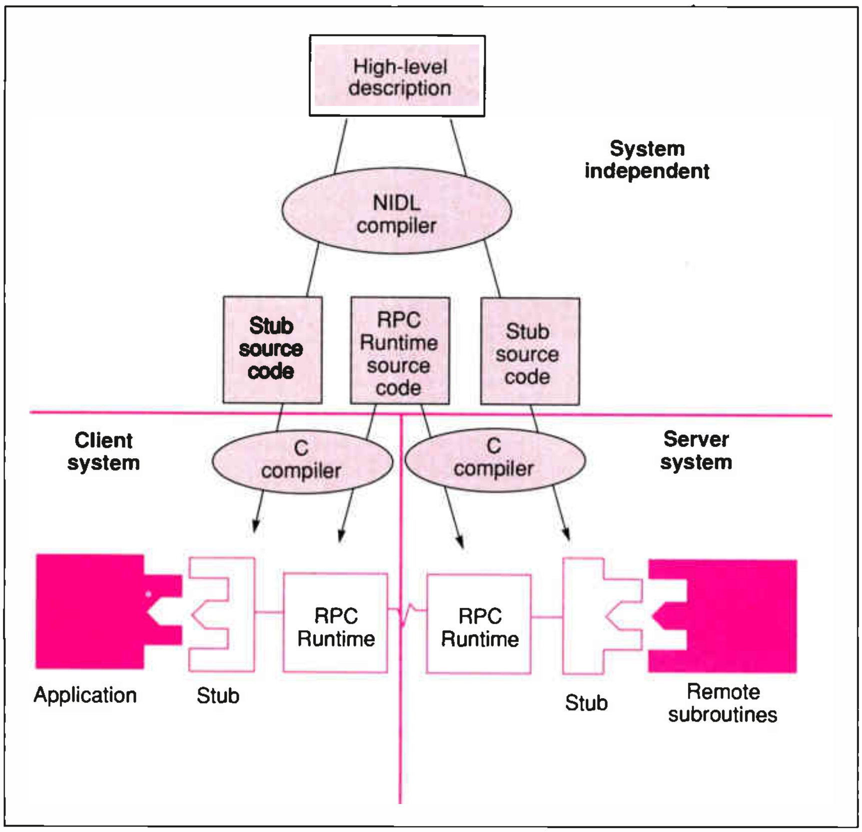

Figure 4: *The NIDL compiler generates complementary stubs that are used on both the client and the server side. The declarations produced by the NIDL are used by native compilers on both the client and server to produce the actual stub code.*

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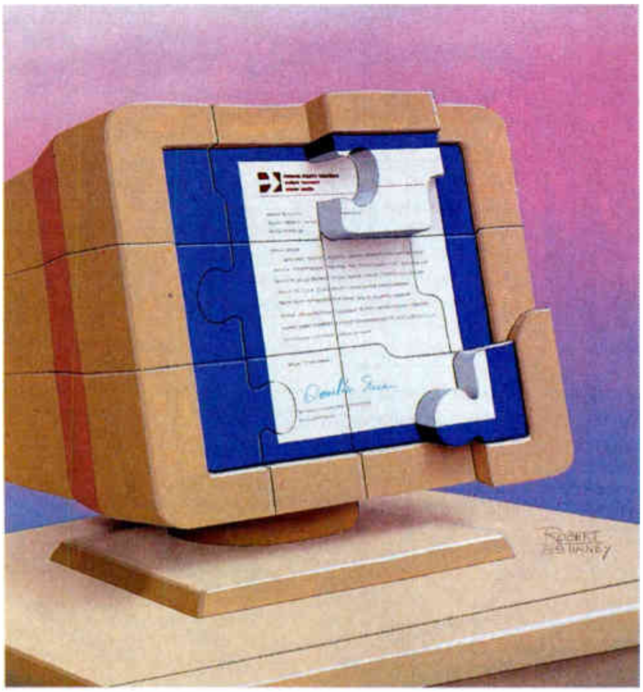
The Paperless Office

Distributed PC-based document image processing may change the way you do business

Dean Hough

For years you've heard how computer technology was going to create an office environment where paper would be obsolete. It appears, however, that computers have had the opposite effect: Offices now create more paper than ever before. The difficulties in creating a paperless office are in getting real-world documents into and out of a computer system, and in working with them once they have been acquired. One solution is document image processing.

DIP is the storage, management, and retrieval of images on a computer system. Once the exclusive domain of large dedicated systems, it is emerging as a bona fide personal computer-based office-automation application. It may change the way you do business.



Elements of a DIP System

DIP systems consist of page scanners, database managers, and mass storage devices that capture and manage original documents as images. You use standard or high-resolution displays to view these images, and laser printers to generate hard copy. Specialized DIP functions are controlled by dedicated image-processing hardware and software.

DIP is most useful when you integrate it into a LAN that provides access to shared laser printers, scanners, optical disks, and databases. Such a distributed environment lets your DIP system automate and manage the flow of documents electronically. If you're on the network, you can access thousands of documents without ever leaving your own machine. Further, the same document can be viewed simultaneously at different workstations. You can also integrate DIP with applications such as fax, forms, and desktop publishing to help manage the distribution and output of graphics information.

The computers on your DIP system must perform some or all of the following functions: image compression and expansion, scanning, printing, retrieving, and scaling and rotating. The machines that function as print and scan servers should be specialized to speed these processes. Specialized hardware can handle image compression and manipulation. Finally, the systems you use as DIP workstations to retrieve and view images require a retrieval engine and may need enhanced graphics capabilities.

The ideal DIP network configuration contains many elements (see figure 1). A file server stores the database application and image data. A DIP server provides image compression and decompression, and I/O via the attached scanner and printer. The workstations, running either DOS or Windows, have either a

continued

ILLUSTRATION: ROBERT TINNEY © 1989

hardware or software retrieval capability, which includes image decompression and manipulation.

The Software Side

As usual, DIP hardware technology has progressed faster than the software, which must catch up before DIP can gain wide acceptance. Fortunately, the necessary software pieces are beginning to fall into place.

The increasing acceptance of Windows marks a long overdue shift from character-based applications to a standard graphics interface. This is particularly important to a graphics-intensive application such as DIP. Windows represents a major step toward integrated image-processing systems, but it has some limitations.

The major obstacle in using standard Windows as the front end to a DIP application is that it lacks free-form image capabilities. This is illustrated by the absence of Windows support for scanners. Existing Windows applications deal primarily with structured data such as fonts, patterns, and vector graphics. This is fine for standard word processing, database, and spreadsheet applications, but not for graphics-intensive ones. Structured graphics definitions can't handle handwriting, photographs, and free-form drawings. By contrast, raster representation can describe all types of image and graphics information, since it makes no assumptions about image content.

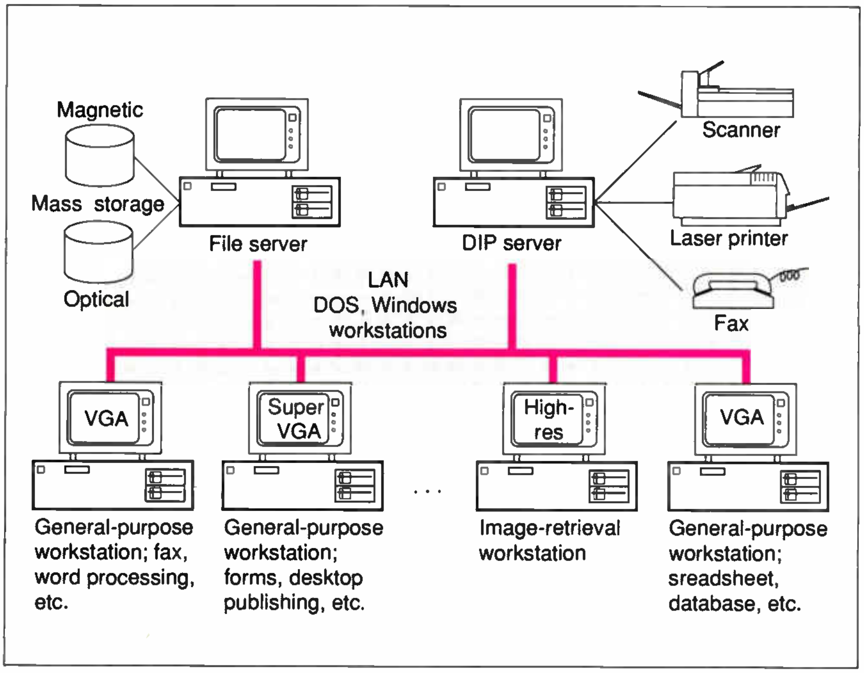


Figure 1: *An idealized distributed document-image-processing system provides specialized imaging services, such as scanning and image manipulation, in addition to standard network services.*

Listing 1: *These code fragments contrast how you display large raster images using the standard Windows' graphics device interface and an extended GDI.*

```
STANDARD GDI

get window
  do {
    create compatible bitmap
    read into map
    create memory DC
    select bitmap
    stretch blt DC to window
    deselect bitmap
    delete bitmap
    delete memory DC
  } while(not end of image)
return
```

```
EXTENDED GDI

get window
DISPLAYIMAGE
return
```

Opening Windows

For DIP applications, one solution is to extend Windows so it can work more easily with raster images. You can accomplish this by providing extensions to the graphics device interface (GDI) that forms the foundation of Windows.

The Windows GDI provides the font and graphics resources that enable applications to display and print structured data. GDI functions operate on a device context that can be a memory bit map or a display window. Due to memory limitations and performance considerations under Windows, device contexts are usually limited to less than 64K bytes. This limitation creates problems. For example, when displaying a 300-dot-per-inch scanned page, many iterations of standard GDI operations are required to process the entire 1-megabyte image. In fact, it takes standard GDI commands about 2½ minutes to read, scale, and display a 1-megabyte image on a 20-MHz 80386 machine. By extending the GDI to handle large raster images, the same machine displays the image in about 2 seconds (see listing 1).

A part of the speed improvement comes when you compress the scanned image using the same CCITT standard compression techniques used in fax communication. Compression is a necessary component of DIP systems because raster images are bigger than structured graphics definitions. For example, compressing a CCITT Group 4 two-dimensional image results in about a 15-to-1 savings in disk storage space. The image, therefore, can be read from a disk or a network 15 times faster than an uncompressed image.

You can also use extended GDI calls with page scanners and printers. A single call can scan a page, compress it, format it, and write it to disk. If specialized hardware is available, the compression, formatting, and disk operations can take place concurrently with scanning and printing. Concurrency lets scanners and printers that are controlled by library extensions operate at "rated speed." For example, an HP LaserJet printer can print images at 8 pages per minute without any delays between pages.

Because image files can be formatted in a variety of ways with a variety of file

continued

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KoFax Delivers

Founded in 1985, KoFax Image Products in Irvine, California, brings personal computer-based solutions to bear on the problems of creating document-image-processing systems. Its latest solution is an integrated series of products that you can use to create customized DIP applications.

The KoFax 9200 Document Image Processing Series consists of a number of hardware and software products that enable you to create a DIP system of any size or complexity. The heart of the 9200 Series is the developer's toolkit. It includes device-independent DOS and Windows libraries that support vital DIP functions such as image retrieval, display, and manipulation; document scanning and printing; and file compression and decompression. Also included are support for 4GL and object-oriented development environments, and a DIP application.

The KoFax library extensions use storage filters to import and export files. These aid the library extensions in decoding file data into raster information. The storage filter module allows the graphics device interface (GDI) extension to utilize the concurrency features built into the libraries.

Printer Driver Emulations

Another component of the developer's toolkit is the GDI printer driver emulation. Installed like a standard Windows printer driver, this emulation provides many important benefits, one of which is a significant increase in printing performance.

For example, printing with the HP LaserJet under Windows requires many steps (see figure A). First, the printer driver translates GDI printer functions into equivalent HP PCL (printer-control language) commands. These are transmitted via a serial or parallel connection to the printer where the PCL formatter creates the raster image for printing. The laser engine then prints the raster image.

KoFax eliminates much of this overhead. The KoFax driver creates a raster image of the page inside the computer. It then transmits the raster image directly to the laser-printer engine, which produces the page. Pages are printed in about half the time it normally takes with a LaserJet. All Windows applications benefit from this accelerated image-printing approach.

Another benefit of the printer driver emulation is not so apparent. You can route the raster produced by the driver not only to the printer but to a fax board or disk (as an image file) as well. Thus, all Windows applications gain the ability to transmit directly to fax machines.

A third feature of the emulation applies to forms and database applications. The driver can print text over an image background with no performance degradation. Thus, a complex form containing graphics can be spooled out to disk as a raster image file and merged later with text from a database application. The forms production effort is reduced to processing the limited amount of character data required to fill in the blanks of a form template.

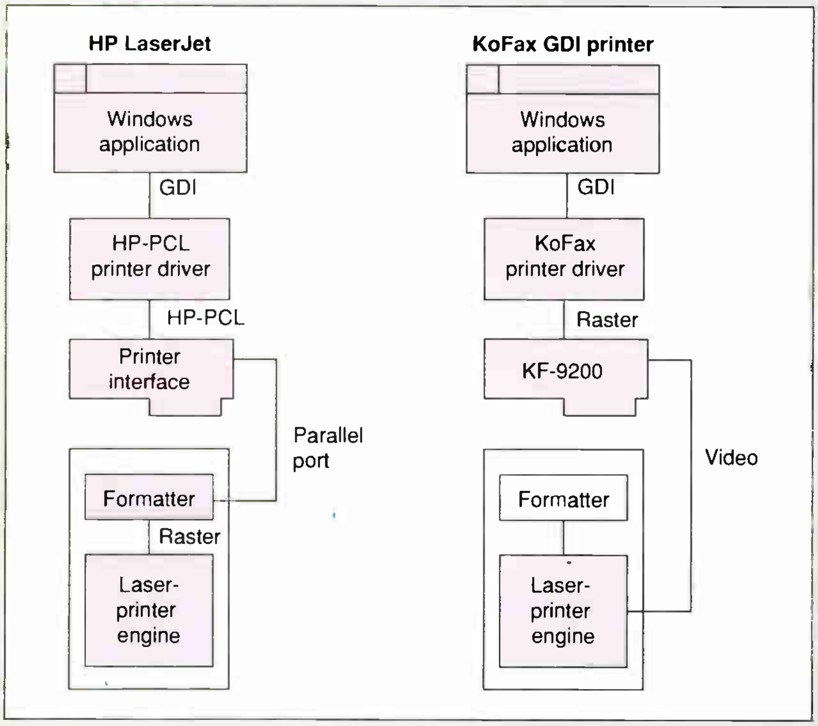

Figure A: *Using the standard Windows LaserJet driver, a raster image must be translated into HP printer-control language commands, transmitted to the printer, and re-created by the formatter before it can be printed. The KoFax emulator eliminates the PCL coding and decoding by sending the raster image directly to the laser engine.*

Engines That Can

Complementing the developer's toolkit are the hardware and software products that provide the image-processing engines required by the library extensions. The basic hardware engine is the KF 9100 Image Retrieval Engine. Available on both IBM PC AT and Micro Channel boards, the 9100 provides basic functions such as `expand`, `scale`, and `rotate`. In a distributed environment, it also retrieves and decompresses images from the network for display on its host computer. The functions of the 9100 are also available from the KF 910 Software Image Retrieval engine, which is a low-cost solution for occasional network viewing.

The most important hardware component of the 9200 Series is the KoFax 9200 Multifunction Document Processor (see figure B). It provides many vital services to a distributed DIP system. (It can also act as a complete single-station system.) Like the 9100, it comes in both AT and Micro Channel flavors and performs basic image manipulation using custom application-specific IC chips. The Advanced Micro Devices Am95C71 performs compression and decompression. Finally, the 9200 pro-

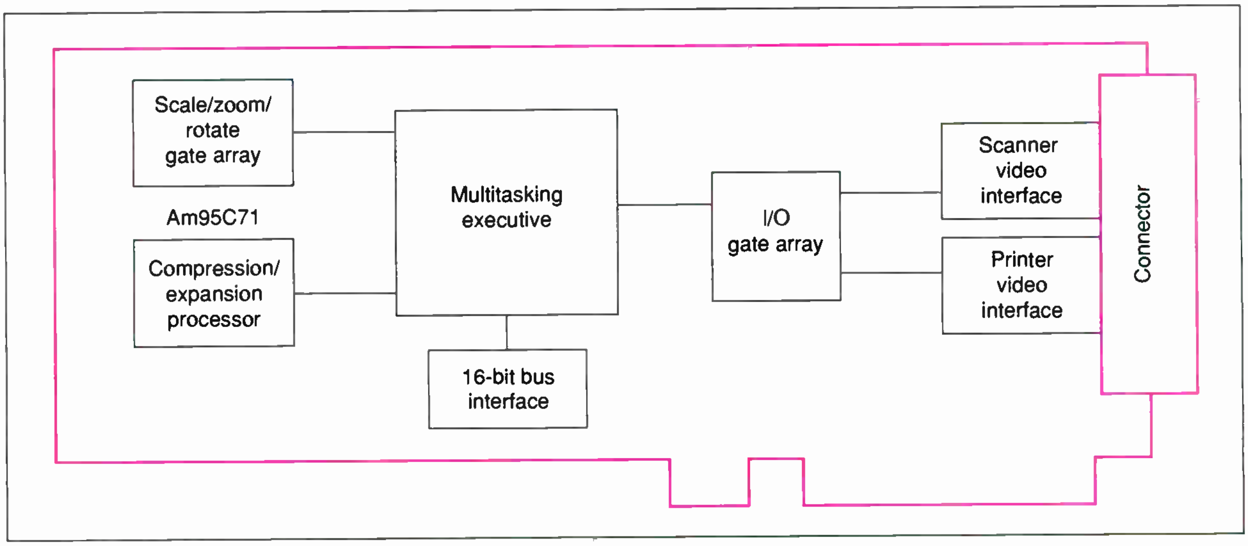

Figure B: *The block diagram of the KoFax 9200 Multifunction Document Processor shows how both the image-manipulation functions and the I/O ports can access images stored in the on-board memory cache.*

vides direct support for both a scanner and a printer. It is the basic I/O server for a DIP system.

A Custom Fix

The components of the 9200 Series work together to give you access to all the specialized functions required by a DIP application (see figure C). At the lowest level, you find the hardware and software DIP engines that handle all scanning, printing, retrieval, and image-manipulation functions. Above the engines are the image libraries and drivers provided by the developer's toolkit.

You access the components of the Image Library Layer in many different ways. You can write a C application to use the KoFax libraries directly through dynamic link library calls. You can also have any Windows application use the KoFax printer drivers directly for printing or fax transmission. Or, you can develop at the Windows Application Support Layer, where you have two options. First, you could use 4GL development tools to develop a Windows application with DIP capabilities. Second, by direct calls to the KoFax libraries, you could use an existing Windows application, such as Excel, to access the QuickApp high-level image application module using dynamic data exchanges.

The KoFax 9200 Series gives you the hardware and software tools you need to create powerful DIP applications. In a network environment, it also gives you the means to create a paperless office.

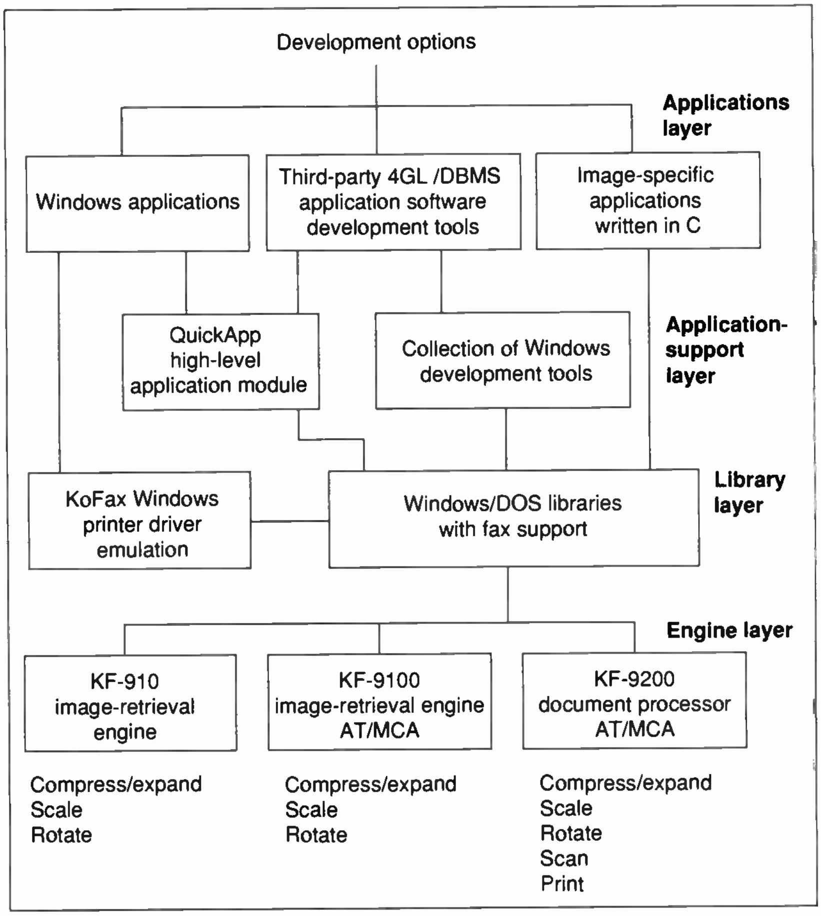

Figure C: *The KoFax 9200 Document Image Processing Series uses a layered approach in delivering DIP solutions. You have two options to systems development: You can write an application that accesses the image libraries directly, or you can employ a Windows-based front end.*

headers, GDI extensions must be able to generate and interpret different types of file formats. File filters allow you to display different types of images, such as scanned documents, fax pages, and raster images that are generated by other applications.

In addition to extending Windows' imaging functions, you can also extend the standard GDI printer functions to speed up printing and to directly support devices like fax machines.

PC-based DIP in a distributed environment is not limited by technological barriers, but by lack of creative development.

Image-Processing Engines

Library extensions to the GDI require either a hardware or a software image-processing engine. Hardware accelerators for decompressing and scaling images are naturally faster than any software solution. They are also naturally more expensive. By working in the background, they allow concurrent image processing to overlap disk I/O and screen paints.

Image compression coupled with concurrent image processing provides significant performance improvements to the Windows environment. This is true for standard Windows applications as well as DIP applications. Hardware retrieval engines are often used with high-resolution (1664 by 1200 pixels) displays on image-retrieval workstations.

Software solutions provide the same image-processing features as hardware accelerators do. They are cheaper, but they lack the concurrency and performance of hardware. However, because not everyone on a network requires rapid image retrieval, the software solution is a cost-effective way to let all network users access an image database.

Developing DIP Applications

To make a DIP system useful, you need to develop a tailored DIP application that meets your requirements and the specifications of your system. DIP vendors provide a significant amount of application support to assist you in adding imaging to existing applications. This support takes two forms: direct support using high-level image library routines, or remote support using a high-level application module with Dynamic Data Exchange (DDE).

High-level applications can use image script language commands to invoke image operations. For example, a command such as DISPLAY_IMG might pop up a window on the screen and display a specified image within it. These superimposed images appear as child windows from within the application. You could move this window around and manipulate the images within it. Image manipulation capabilities include panning, scrolling, rotating, and zooming up or down within the image window.

Existing Windows applications with DDE command capability can use the extended GDI to access and display image information. For example, you can use the macro, database, and DDE capabilities of Microsoft Excel to build custom imaging procedures. Thus, Excel can act as a simple applications builder. You can use Excel's macro language to issue commands directly to Windows extensions, or you can use its DDE capability to issue commands to a higher-level application module.

Windows development packages, such as Bridge from Softbridge, generate custom image applications quickly. DBMS-based development packages, such as SQL Windows and SQLBase from Gupta Technologies, provide a relational database foundation to manage image filing. You can construct powerful storage and retrieval systems with a multiuser networked version of SQLBase.

DIP on the Horizon

Microcomputer-based DIP in a distributed environment holds great potential for the world of office automation. It is no longer limited by technological barriers, but by the paucity of creative development for tailored applications.

The release of developer toolkits and libraries, however, herald the arrival of sophisticated personal computer–based DIP applications and, with them, the fulfillment of the paperless office. ■

Dean Hough is vice president of engineering at KoFax Image Products. He holds a BSEE from San Diego State University and can be reached on BIX c/o "editors."

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Distributed Processing Roundup

The list below contains the names and manufacturers of some products that distribute processing over different architectures, operating systems, or networks. The focus is on products that provide distributed processing services to personal computer and workstation users. A listing of distributed database applications is planned as part of the September In Depth.

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Lets you develop distributed applications for NetWare implementations. It consists of the RPC Compiler, which produces client and server source code, and the Network Library, which manages the execution of RPCs. NetWare RPC supports Microsoft C and Turbo C, produces International Standards Organization–compatible code, and supports DOS and OS/2 (OS/2 support with Microsoft C 5.1 only).
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A GUIDE TO GUIs

Graphical user interfaces make computers easy to use; keeping them all straight is the hard part

Frank Hayes and Nick Baran

The world of graphical user interfaces (GUIs) seemed pretty simple in 1984, when Apple introduced the Macintosh. Back then, the genealogy was straightforward: Researchers at Xerox's Palo Alto Research Center begat the Xerox Star; Steve Jobs visited PARC, saw the Star, went back to Apple, and begat the Mac.

But five years later, the begats have become bewildering. The Mac begat Windows—or was it just a cousin? Windows begat Presentation Manager—which doesn't look much like the Mac at all, thanks to IBM, which begat Systems Application Architecture (SAA). MIT begat X Window, which crossbred with PM and NewWave to give birth to Motif. Tandy begat DeskMate, Japan, Inc., begat BTRON, Steve Jobs—back again for a second try—begat NextStep, and Apple has filed a paternity suit against Microsoft. What a mess.

But though there seem to be dozens of GUIs today, it's clear that they all still share similarities that reach below the surface.

Just One of the GUIs

Turn on a Macintosh, and you'll come face to face with the original definition of a GUI for desktop computers. The Mac defined the parts we've come to associate with a GUI:

- a pointing device, typically a mouse
- on-screen menus that can appear or disappear under pointing-device control
- windows that graphically display what the computer is doing
- icons that represent files, directories, and so on
- dialog boxes, buttons, sliders, check boxes, and a plethora of other graphical widgets that let you tell the computer what to do and how to do it

Of course, today's GUIs come in many varieties—not everything that's called a GUI has all these features. For example, some GUIs don't use icons. On others, the icons are optional or available only sometimes. Some require a mouse, while others will let you work from the keyboard.

GUIs are more similar beneath the surface. Although there are some hybrids, most GUIs consist of three major components: a windowing system, an imaging model, and an application program interface (API): (See figure 1.)

The windowing system is a set of programming tools and commands for building the windows, menus, and dialog boxes that appear on the screen. It controls how windows are created, sized, and moved on-screen, and how the user moves from one window to another, among other functions.

One example of a windowing system is X Window. X Window is *not* a complete GUI—it's just the windowing system shared by a group of different GUIs. Because all the X Window GUIs share the same windowing system, they can also share programming tools for developing applications. (By contrast, Microsoft Windows, for example, is a complete GUI with its own windowing system, imaging model, and API.)

The imaging model defines how fonts and graphics are actually created on-screen. For example, the typeface and size of text in a word processor or desktop publishing program is specified through the imaging model; so are the lines and curves of a CAD program. PostScript may be the best-known imaging model, familiar from laser printers; Display PostScript is a screen version of the PostScript imaging model. The Macintosh imaging model is QuickDraw, and Microsoft's PM for OS/2 uses an imaging model called GPI (for Graphic Programming Interface).

Some GUIs support more than one imaging model. For example, while Sun's NeWS (for Network Extensible Window System) is similar to the PostScript imaging model, it can also turn the screen over to a complete graphics imaging system (such as PHIGS or GKS) for controlling a CAD program.

The API is a set of programming-language function calls—it's how the programmer specifies which windows, menus, scroll bars, and icons will appear on the screen. Both PM and

continued

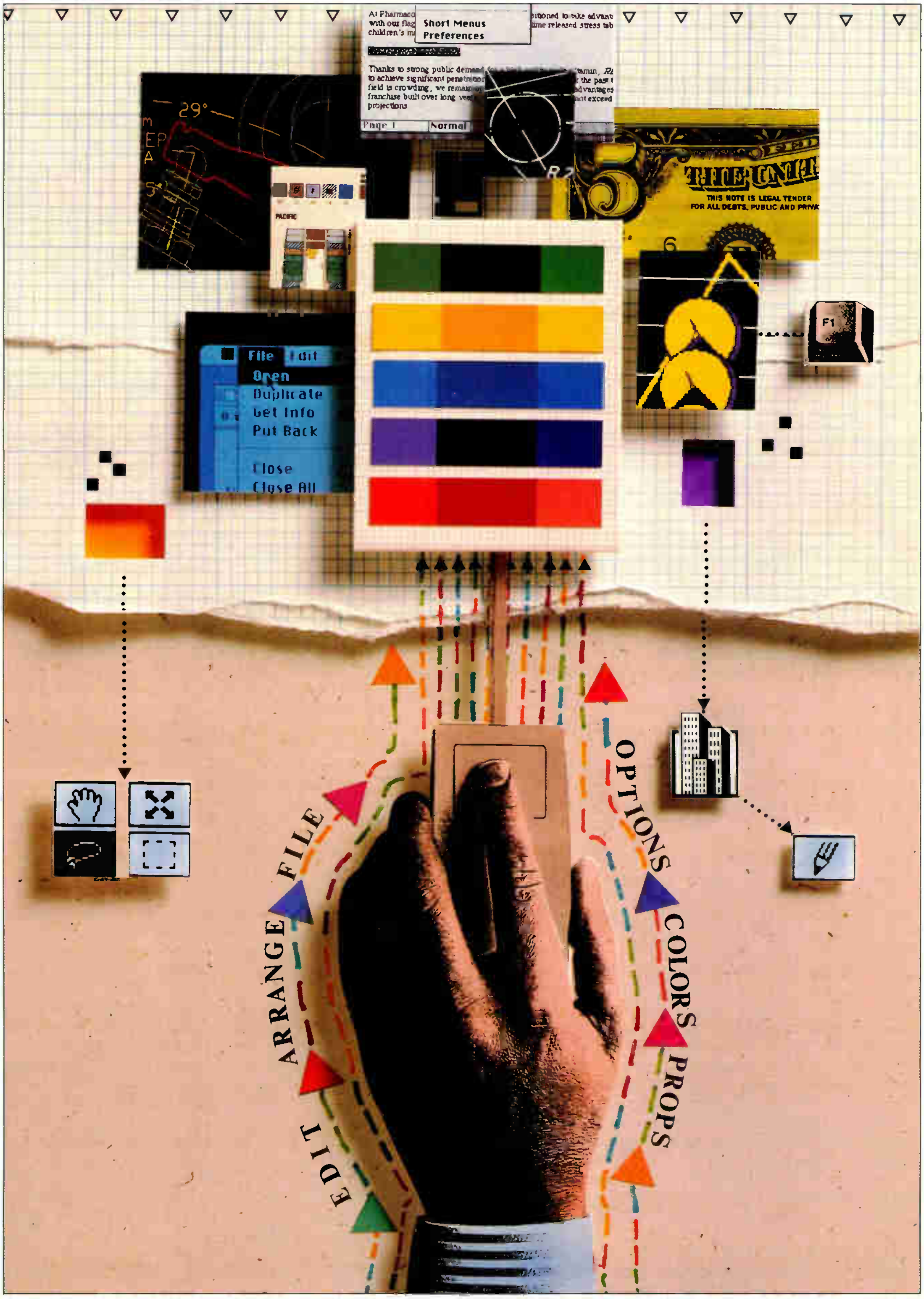
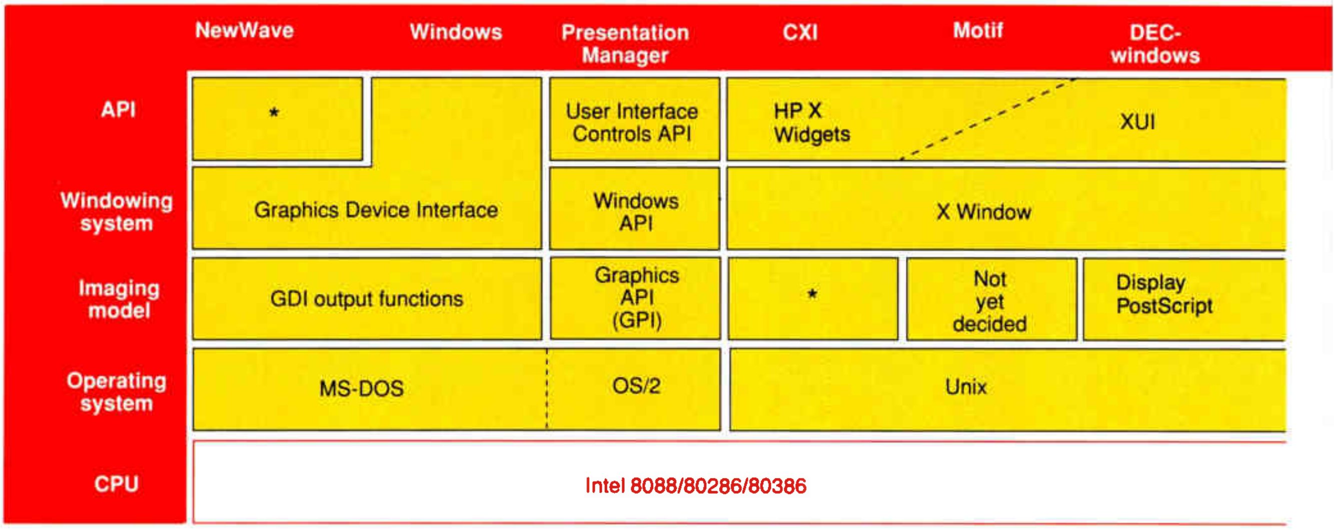


ILLUSTRATION: R. M. SCHNEIDER © 1989

Figure 1: *Graphical user interfaces tend to fall into a few camps: those based on IBM's Systems Application Architecture (primarily Windows and Presentation Manager), Unix systems generally built around X Window, and Mac-like systems*



Microsoft Windows have their own APIs. DECwindows uses an API called XUI (for X User Interface), which includes function calls for the X Window System. Open Look is the new API for Sun's operating system. NextStep uses its own API (defined by a library of objects called *kits*) and its own windowing system (the *window server*).

On top of these three elements—windowing system, imaging model, and API—some systems also have tools for creating interfaces and developing integrated applications. Hewlett-Packard's NewWave, for example, is not a user interface, but a method for integrating applications and objects from multiple applications—it's a development tool for application programmers. Similarly, NextStep includes a set of tools for object-oriented programming.

Another characteristic that varies widely is the level of integration between the GUI and the operating system. Some GUIs are tightly bound to the system—turn on a Mac, an Amiga, or a NeXT computer, and the GUI appears automatically. By contrast, you must specifically choose Microsoft Windows and most of the X Window GUIs that run under Unix—which could be a hindrance for Unix-based systems trying to appeal to a mass market.

Some GUIs provide access to a conventional command-line interface that lets you, for example, pass arguments to applications or view the text of a file without using the mouse, menus, and icons. NextStep has a console window that lets you get at the command line, whereas the Mac makes you use a desktop accessory to examine files, manipulate them, and so on.

With the similarities and differences defined, it's easier to break the GUI family tree into a few large groups: those based on the distinctive look of IBM's SAA; those built upon X Window and the Macintosh and its apparent offshoots; and a few hard-to-define hybrids and special cases.

We'll begin by going back to the Mac.

A GUI for the Rest of Us

The idea of a standard user interface, regardless of the machine the user is facing, was part of the dream that built the Macintosh. Ironically, the Mac has become one of the most isolated of GUI-based machines, largely because of Apple's litigiousness. Any company that even looked like it might be copying the Mac was threatened with a lawsuit. (See the text box "Of Mice, Menus, and Lawyers" on page 256). The result is that, while the whole world has followed the Macintosh in its use of GUIs, most of that world has gone its own way.

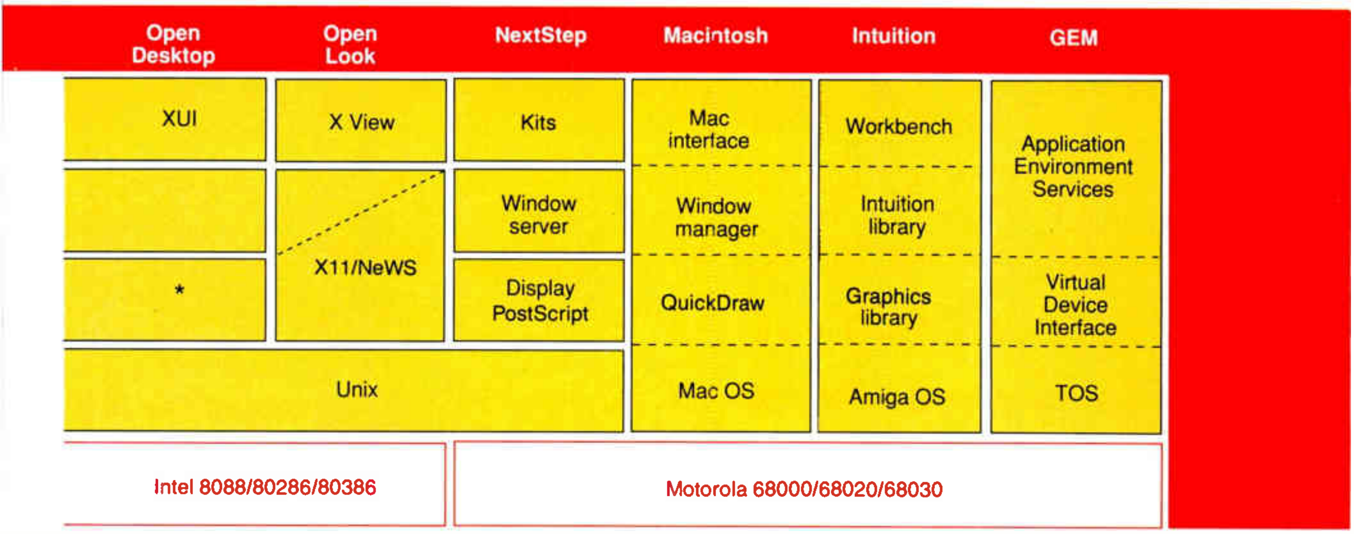
The Mac GUI (see photo 1) was the first widely available mouse-and-menu interface. It established several conventions that have reached beyond GUIs, including the "point and shoot" approach to menus. Before the Mac, you'd look at a menu and choose a key to type. After the Mac, your selections were limited to contextually correct answers—you simply couldn't choose something meaningless. Point-and-shoot interfaces—whether graphical or character-based—eliminated "wrong" answers, since it's impossible to select a choice that isn't available.

Although its stylistic guidelines are certainly heavily documented, the Mac interface really specifies just three distinct operating systems: the single-tasking Mac Finder, the multitasking MultiFinder, and Apple's own Finder clone for the Apple IIGS, ProDOS-16.

The Mac GUI combines all the functions of an API, windowing system, and imaging model in its ROM Toolbox, QuickDraw graphics primitives, and Finder, and these pieces are tightly integrated. The stark efficiency of the QuickDraw imaging model allows the Mac GUI to have reasonable performance, even with a relatively slow microprocessor like the 68000.

The Big Blue Look

IBM's SAA is both more and less than a GUI. SAA is actually a whole family of user interfaces that IBM defined two years ago. SAA interfaces include everything from ground-level character-only systems up to high-powered graphical workstations, and they span machines from PCs up to mainframes running IBM's MVS and VM operating systems. SAA is a complete system architecture, and as a result it covers things that most user *that tend to be tightly integrated and distinctive. In this figure, a dotted line indicates some overlap between the objects on either side of it. An asterisk indicates that the technology is proprietary or that the company has no specific name for it.*



interfaces don't—including a standard for networking called the Systems Network Architecture (SNA), and one for database queries, the Structured Query Language (SQL). It also specifies, but doesn't rigorously define, the user interface. An SAA user interface isn't necessarily a GUI, complete with mouse and graphics. Remember, SAA is a standard for everything from glass teletypes on up, so SAA GUIs are really just a subset of SAA user interfaces.

SAA seeks to let any terminal handle any SAA application. Thus, while all SAA applications use the same style of drop-down menus, character-only systems will display only characters—and send only characters back to the application—while mouse-based graphics systems will let the user point and click. However, SAA does create a least-common-denominator situation: The application software ultimately has to choose what the minimum configuration for the SAA terminal is going to be. Fortunately, SAA applications that use terminals are much more likely to involve transaction processing—things like airline ticket reservation systems—rather than CAD systems or paint programs.

The PC-level GUIs that implement SAA are Windows for MS-DOS systems (see photo 2) and PM for OS/2 (see photo 3). Several GUIs based on X Window, including CXI, Motif, and PM/X (discussed below), have an SAA/Windows/PM look and feel designed to let users adapt easily from DOS-based systems to Unix-based systems. (In its original version, Windows was much more Mac-like in its appearance, but between a threatened lawsuit by Apple in 1985 and IBM's definition of SAA in 1987, it has come to look and act like the rest of its close brethren.)

The critical and most distinctive element of SAA GUIs is the fact that they don't depend on a mouse at all. You can do anything in an SAA GUI without a mouse, and, in fact, the system leans heavily on keyboard equivalents, including function keys. (You can gauge the pervasiveness of SAA's influence in the PC world by counting the number of DOS applications that now use the F1 key as the Help key.)

A characteristic element of the mouse-independent nature of SAA GUIs is the menu bar, which in SAA-speak is called the Action Bar. While the Mac interface requires a mouse-click to pull down a menu, you can do it in an SAA GUI by pressing a key instead.

Another characteristic of SAA GUIs is the style of windows they use. Unlike the Mac window, the size and shape of which you change by dragging the box in the lower right corner, an SAA window can be stretched by any of its borders. And under OS/2, there's an added feature: You can "minimize" a window down to an icon, and the program running in the window will continue to run. (You can also minimize a window under Microsoft Windows, but since Windows is not a multitasking operating system, the program in the window suspends operation until you "maximize" it again.)

While the DOS-based Windows and OS/2's PM share the SAA look and feel, each has its own API, imaging model, and windowing system. Although these parts are similar, they are not directly compatible, and porting an application from Windows to PM is not necessarily an easy task.

The emergence of powerful 80386 machines and the increasing acceptance of Unix as an operating system for them has led to a curious convergence between PM and Unix-based GUIs.

The Unix Brand: X

X Window user interfaces are a wide-ranging group—but underneath it all, X is X. The current version, X11, has become the most popular windowing system for Unix workstations, for two reasons. First, software that's written for the X Window System can (at least in theory) use any X Window display. The application program sends calls to the X Window library, which packages the display requests as X packets and sends them along to the X Window server, which decodes the X packets and displays them on the screen.

If that sounds a little complicated, it's because of X Window's second advantage: Since X Window is designed to work with networks, the software (called a *client application*) and the display may be on different computers. For example, the

continued

A GUI Gallery

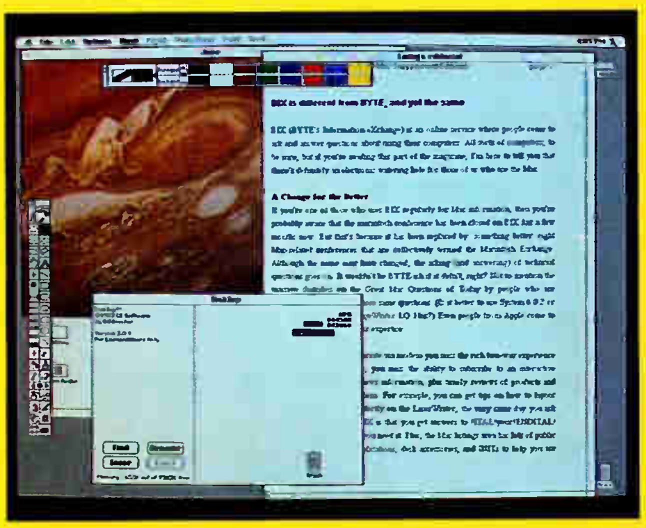


Photo 1: *The familiar Macintosh interface, with its windows, icons, and pull-down menus, launched a thousand graphical user interfaces—which promptly took off in their own directions.*

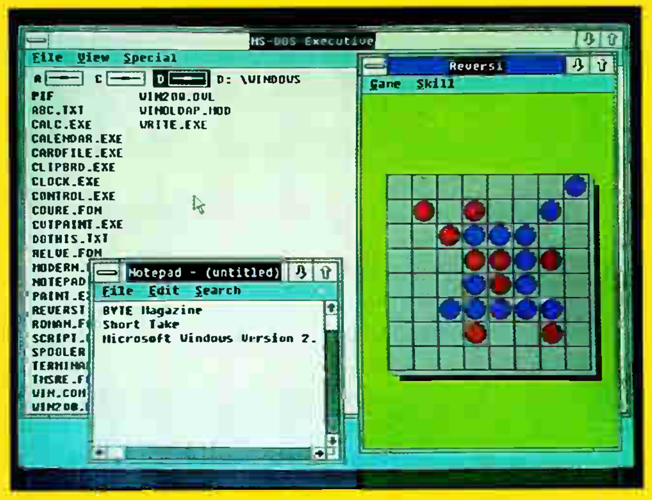


Photo 2: *In its original incarnation, Microsoft Windows looked more like the Macintosh interface; a threatened lawsuit from Apple, as well as IBM's solidification of its Systems Application Architecture, forced a shift to what is now the standard SAA look.*

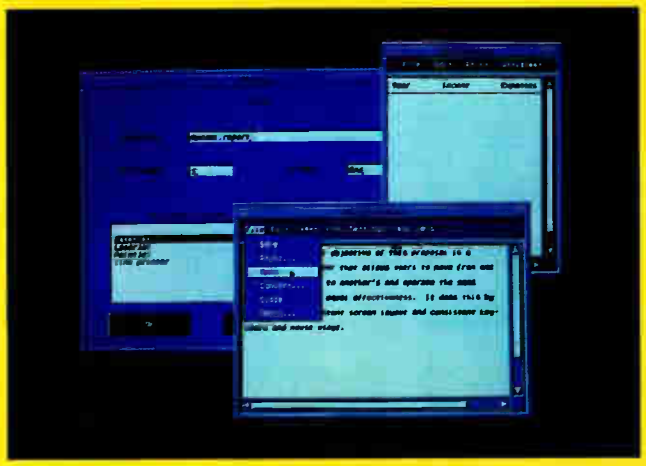


Photo 5: *The Common X Interface (CXI), developed by Hewlett-Packard and Microsoft, features a Presentation Manager look on an X Window platform.*

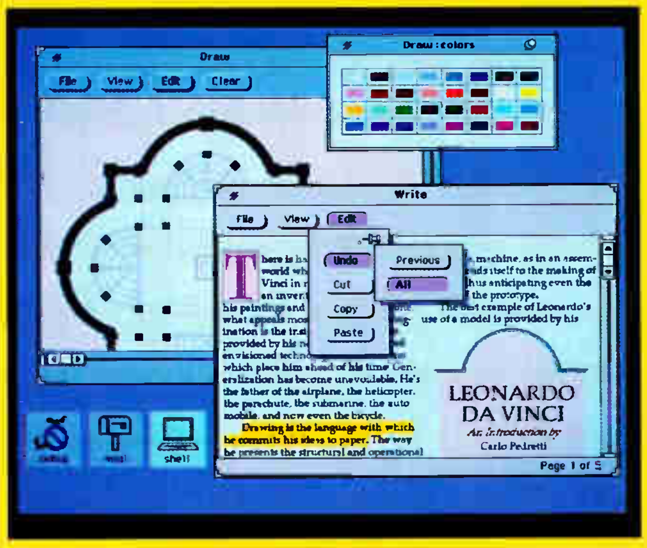
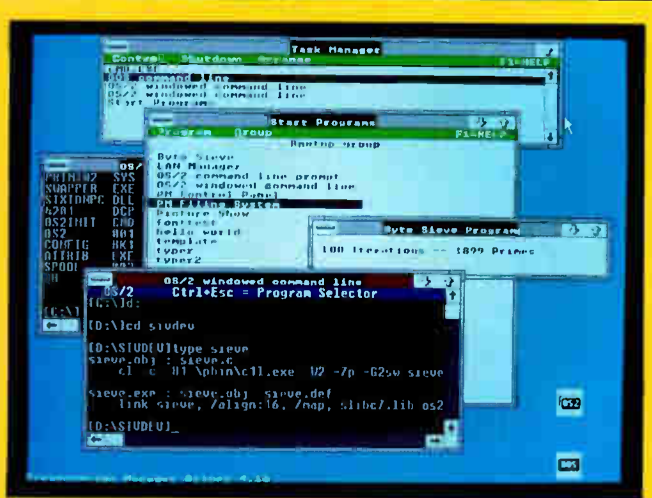


Photo 6: *Open Windows, from Sun Microsystems, features the Open Look interface, which provides several enhancements to the classic windows, icons, and pull-down menus interface.*

display can be on a workstation, while the application itself can be running on a mainframe or supercomputer. That's why the display requests have to be put into packets, so they can go zipping along the network as quickly as possible.

Exactly how those packets will be displayed on a workstation depends on the set of *widgets*, or predesigned window elements, the workstation uses. A radically different set of widgets could make the same program appear different on two separate workstations. But even if the look is different, the behavior of the program will be the same. For example, one workstation might have windows with a Close box in the upper left corner, while another might include it in a pop-up submenu. They'll look different—but whether you click on the Close box or select Close, the window will still close.



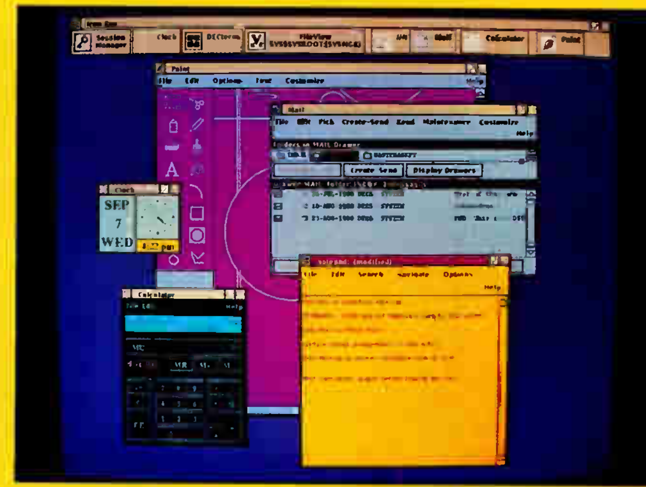


Photo 3: *OS/2's Presentation Manager is heir to the Microsoft Windows look and feel, although application developers have found that some similarities are only skin deep. Currently, several developers of graphical user interfaces for Unix systems are licensing the PM look for X Window–based interfaces.*

Photo 4: *DECwindows, Digital Equipment Corp.'s graphical user interface, was recently licensed by SCO for its integrated Open Desktop product.*

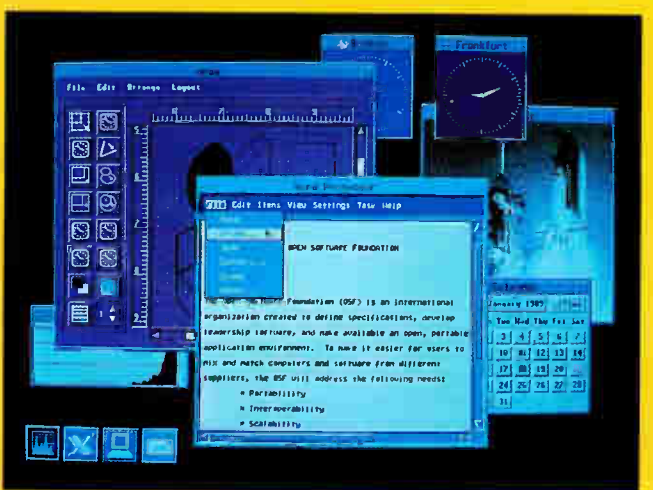


Photo 7: *Motif, the graphical user interface designed by the Open Software Foundation, combines DEC's XUI and HP's X Widgets with a Presentation Manager look and NewWave's three-dimensional windows on an X Window platform.*

Photo 8: *NextStep, the user interface for Steve Jobs's NeXT machine, includes a set of tools for object-oriented programming.*

Because X Window is so widespread on Unix workstations, hybrids have cropped up—on some systems, not all display operations are routed through it. For example, Sun's Open Windows system runs on NeWS in parallel with X Window; some display functions go through X Window, while others are handled by NeWS.

Currently, the "look" of X Window GUIs is divided into several camps: Hewlett-Packard uses an API called HP X Widgets. DEC based its DECwindows interface (see photo 4) on its XUI. Recently, Hewlett-Packard and Microsoft developed the Common X Interface (CXI) (see photo 5), with the look and feel of PM but working within an X Window environment. The Open Windows system from Sun Microsystems (see photo 6)

continued

Of Mice, Menus, and Lawyers

In 1985, Apple Computer threatened legal action against Digital Research, for its GEM operating environment, and Microsoft, for Windows. It claimed that the products infringed on Apple's copyright for the visual display of the Macintosh. Both companies signed agreements with Apple to resolve the disputes out of court.

According to the Apple-Microsoft agreement, Apple was willing to tolerate Windows 1.0 and several other programs (such as Excel) as long as Microsoft acknowledged that the displays of those programs were "derivative works of the visual displays generated by Apple's Lisa and Macintosh graphic user interface programs."

Then, in March 1988, Apple Computer filed a lawsuit against Microsoft and Hewlett-Packard, claiming that Microsoft Windows 2.03 and Hewlett-Packard's NewWave (which runs on top of Windows) infringed on the Macintosh's copyrighted visual display. Although versions 1.0 and 2.0 of Windows are not all that different (version 2.0 has overlapping windows, fatter screen borders, minimum/maximum icons for sizing windows, and mnemonic keyboard selections in menus and dialog boxes), Apple apparently thought that the program was beginning to look too much like the Mac interface.

Microsoft—mindful of its role as a major provider of Mac software—responded that the latest versions of Windows were covered by the 1985 agreement. Hewlett-Packard, which sells very little software for the Mac, went further, filing a countersuit against Apple. According to the Hewlett-Packard suit, the Macintosh copyrights were invalid because Apple didn't originate its displays but copied them from the work of windowing-interface pioneers such as Xerox's Smalltalk and Star interfaces. The suit also claimed that Apple had coerced Microsoft into signing the 1985 agreement and was trying to illegally prevent competition in the market for window-and-icon user interfaces.

While many observers thought that Apple could not win the suit, the judge in the case surprised them: In March, he ruled that version 2.03 of Windows was *not* covered by the 1985 agreement. (A ruling that it was covered would have ended the case in Microsoft's favor.)

At this writing, the case is headed for trial to determine whether or not Windows and NewWave infringe on Apple's copyrights. While an out-of-court settlement is again a possibility, some industry observers are concerned that a victory for Apple could spell trouble for other user interfaces and developers of software for those interfaces.

uses Sun's Open Look interface (see "Face to Face with Open Look" by Tony Hoeber, December 1988 BYTE).

Now, however, there is some movement toward a consensus, thanks in part to the Open Software Foundation. Last year, the OSF asked major software developers to submit GUI technologies for consideration as part of a standard operating environment for Unix. To most people's surprise, the OSF chose pieces from three companies—DEC, Hewlett-Packard, and Microsoft. Motif, as the OSF GUI is called, looks like PM, uses parts of the DEC and Hewlett-Packard APIs (as well as the three-dimensional windows from Hewlett-Packard's NewWave), and is based on X Window (see photo 7). The imaging model for Motif has not yet been selected.

Following the announcement of Motif, many companies announced support for the OSF standard and began tweaking their GUI software to be compatible with it. Hewlett-Packard and Microsoft are working on a version of PM for Unix (PM/X), with pieces similar to CXI and Motif. (While CXI merely *looks* like PM but is still based on X Window, PM/X will have its own windowing system. The idea is that PM/X will make it easy for application developers who have created applications under OS/2 to port those programs to Unix.)

Then, in February, The Santa Cruz Operation (SCO), which supplies Xenix, announced Open Desktop. This is a complete user interface for 80386-based Unix systems that incorporates the Motif GUI, DOS compatibility, SQL database facilities, and network support. Even IBM has announced support for Motif, despite the fact that it had earlier licensed the NextStep interface from NeXT. Although it's unlikely that IBM will support two different and incompatible user interfaces on its Unix platform, it could use some of the NextStep technology, such as the development toolkit and object-oriented programming features. Or IBM may have just been hedging its bets when it licensed NextStep, in case OSF failed to come up with an accepted standard interface.

Yet another GUI for X Window is X.Desktop, from IXI, Ltd., of Cambridge, England (see the text box "Managing the X Window Desktop" by Dick Pountain, page 356, January BYTE). X.Desktop incorporates its own API, although the company is working on implementations that use the Motif and Open Look APIs.

The multitude of SAA GUIs for Unix points up one of the major problems in trying to sort out GUIs—these things don't belong to simple categories. For example, CXI and Motif are X Window GUIs with an SAA look and feel. From the programmer's point of view, they belong to the X camp; from the user's standpoint, they've clearly got the PM look and feel.

Because X Window works on networks, it makes distributed computing a real possibility with mouse-and-menu GUIs. Unfortunately, anything that is graphics-intensive requires a lot of information to pass along a network, which can really slow down response time. X Window users complain that when you move the mouse, you have to wait several seconds for its on-screen pointer to catch up. On the other hand, X Window is the only GUI system that really does work in a multiuser, multicomputer, networked environment. For now, if you want to run windowing software on a Cray supercomputer and see the result on your personal desktop machine, X marks the spot.

The Mac-Like GUIs

Although the Macintosh essentially stands on an island in the GUI world, there are at least two other Mac-like GUIs. One is the original version of GEM from Digital Research (which survives on the Atari ST). Another is the user interface for Intuition, the operating system for the Commodore Amiga.

GEM was originally intended to be highly Mac-like, and so it was; so much so that in 1985, Apple threatened to sue Digital Research for copyright infringement. Digital Research responded by removing the offending features (including overlapping and movable windows) from the PC version of GEM, but the Atari ST version still has a Mac-like GUI. However, the ST lacks many of the Mac Desktop's niceties of implementation, such as long filenames, the ability to remove things from the Trashcan, proportional typefaces, and automatic saving of the desktop.

While the Amiga's Intuition wasn't threatened with an Apple lawsuit when it first appeared, it too shared many Mac-like characteristics. But Intuition added a feature that Apple didn't include until several years later: It was the first widely used multitasking GUI. Unlike X Window and SAA, Intuition isn't really designed for remote applications—it's a single-user multitasking system. But if the Finder is the father of desktop computer GUIs, Intuition is arguably the father of MultiFinder.

The Next Wave

NextStep (see photo 8) represents the high end of GUIs for single-user computers. NextStep itself is a huge piece of the operating system of the NeXT computer, including a number of utilities that would probably be viewed as applications on most systems. More than any other GUI, NextStep resembles the Mac in its ambition—it wants to change the world. But it also scrupulously avoids being too Mac-like. Unlike the Mac, where a file-selector box can display the files of only one directory at a time, the NeXT GUI can display files in multiple hierarchical pop-ups. It's sort of an improved version of the Mac file-selector box.

NextStep does have application icons; in fact, you can drag an icon out of a window and onto the desktop for convenient use. The idea is to keep regular-use items handy.

The other way NextStep resembles the Mac philosophically is in its rejection of anyone else's standards. In the Unix world, the windowing standard is X Window—but NextStep doesn't use X Window. In fact, nothing in the networking world works with NextStep except NextStep—in many ways, it is designed for a powerful single-user PC running Unix rather than for a fully networked machine.

Another hard-to-classify system is Hewlett-Packard's NewWave, which the company likes to call a "software applications environment." Currently built upon Windows, NewWave features an Object Management Facility that lets you incorporate pieces from different types of applications—word processor, spreadsheet, graphics program, whatever—into NewWave documents. A task manager, called the Agent, acts as a kind of supermacro processor to let you automate repetitive tasks involving a number of different applications. As such, NewWave is part GUI, part "super-application." Hewlett-Packard is developing one version of NewWave that will run on top of PM and another that will run on Unix using the Motif GUI.

Windows of Opportunity

In the months and years to come, you can expect to see even more interesting things popping up in the windows on your screens: extremely high-resolution images, multimedia applications, full-motion video, and new ways of interacting with data. Programs like NextStep and NewWave point the way to the future, where intelligent interfaces may not only help you to automate everyday tasks, but may even anticipate your actions and thereby increase productivity.

The real question is no longer the one the Macintosh raised in 1984—whether to use a GUI. Today the issue is what *sort* of GUI: which elements are most important, and which you can sacrifice in favor of things like better network performance or low cost. ■

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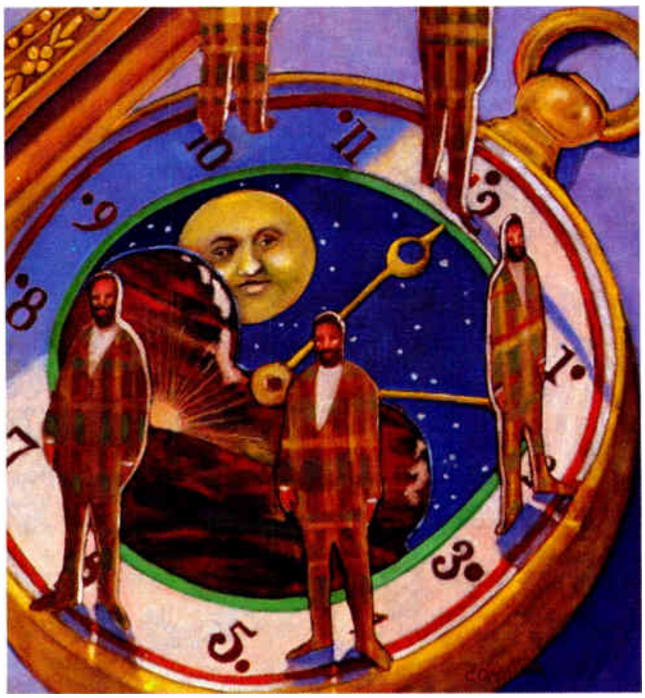
The Qsim Simulation Toolkit

Qsim lets you simulate the behavior of everything from atomic particles to galaxies

Roy E. Kimbrell, Linda Correll, and Robert Bass

With the right simulation tools, you can create a model of the universe or of the computer used to model the universe. You can answer questions that would be impractical or impossible to answer otherwise. With the right tools, simulation can be enlightening. With the wrong tools, it can be exasperating.

Some of the tools that modelers have developed are as specialized as a surgeon's, others as general as a hammer. The kind that you might use depends on what kind of model you're making. Some of these models describe and predict the behavior of the atmosphere, or fluids, or plasmas, or the earth during seismic activity. The stresses and strains on a structure, such as a bridge withstanding traffic and wind, require a special-purpose program called a finite-element model and often use a lot of computer power to complete the simulation. Simulations that use sets of partial differential equations to describe the models use custom programs on high-powered machines such as the Cray. Engineers use models of complex VLSI circuits to design and develop the chips. They use special-purpose programs and, perhaps, special-purpose machines to run them.



But we designed our own toolkit, Qsim, for using personal computers to model systems and LANs. Here, we will provide the Qsim Toolkit, with which you can also model factories, highways, banks, fast-food restaurants, mail rooms, magazine offices, and many other human endeavors.

Two manufacturers that make general-purpose modeling toolkits for the IBM PC are Pritsker & Associates (makers of Slam) and CACI (makers of Simscript). You can expect to pay $1500 for Slam or (gasp!) $8600 for Simscript. Either will give you a good start on creating many kinds of models. The documentation and training offered with either package might be just what you need.

By developing Qsim, we found we had better control over the modeling process because of our intimate understanding of the operations of the model. Model development became easier because we used a common programming language, C. Also, we were able to model many difficult processes because we could modify and add to the tools in the toolkit.

The Qsim tools are for creating queuing system models, but you can combine them with various modeling techniques to create other kinds of system models. Examples of queuing systems are everywhere. In the customer line for bank tellers, the customers are the *entities*, the line is the *queue* (the structure holding the entities awaiting

continued

ILLUSTRATION: CAROL O'MALIA © 1989

service), and the tellers provide the *service*. Mathematical models of simple queuing systems can describe the lengths of the queues, the waiting time in the queues, and other details quite well. But whenever a few complications enter the picture, the mathematical models fail miserably, and a more direct modeling method is needed. You have to build a simulation of the system with model parts: queues, services, and entities. With the simulated system, you want to find the average behavior and the amount of variation in the system.

You may want to specify both the rate of arrival of entities and the time to service an entity as random variables with specified distributions (time variables that have a probability associated with each possible value). For example, the time you have to wait in line at McDonald's for lunch on Wednesdays will vary from zero (if no one else is in line at the counter) to several minutes (if you came in behind a crowd). There is an average wait at McDonald's on Wednesdays, and the probability of having to wait a longer time decreases the longer you wait.

The relationship between the length of time and its associated probability is a distribution. The interval between customer arrivals might be modeled by an exponential distribution. In a normal distribution, the values near the mean are more probable than those far from the mean. Both the mean and the standard deviation describe the particular normal distribution. Modelers use random distributions to describe the arrival rates of entities, the time to service an entity, and other features of a model.

The Model as an Interpreter

A model developed using the Qsim Toolkit is like an interpreter—similar to a BASIC, APL, or Pascal interpreter. Compiling a program results in machine language instructions that the computer performs to take on the programmer's design. But a program interpreter only models the design. It actually executes many machine language instructions while interpreting (modeling) each program command.

A system is to its model as a compiled program is to its interpreted counterpart. In order to answer questions about throughput and saturation of an Ethernet network at different work loads, we could build a network, run traffic over it, and measure the various details. This is similar to a compiled program. But if we build a model of a network that simulates its actions, we have something similar to an interpreted program. A model built using the Toolkit is interpreted. The scheduler, the create, the queue, and other tools perform the native functions. The data produced by the model approximates the data produced by the real system, just as the interpreted program approximates the actions of a compiled program.

Building a Model

To build a model, first you identify the basic processes in the system, and then you select the tools for modeling each process. You identify which processes create entities, which ones hold entities waiting for service, which ones service the entities, and which ones make decisions about what to do with the entities. You will have to design tools to model the processes that don't fit into these categories. For example, in modeling the low-level contention-backoff mechanisms in the Ethernet protocols, we had to add a tool we called a *trigger*. (We've seen other kinds of tools used to good effect, such as gates, collectors, and event detectors. Their names hint at their functions.)

When designing a new tool, try to keep it simple. If you can, break it down into several tools. This will simplify your design, make it easier to build the model, and, in the process, ensure that you really understand what you are trying to model.

You will also need one or more processes to terminate the entities you create unless you intend them to circulate through your network for the whole simulation. You may also need a process to stop the simulation. However, this service can be performed by a termination process, which counts the number of entities it terminates and then stops the simulation at a threshold. If you have indefinitely circulating entities, use a service routine to count them and terminate at an appropriate time. This service need not take any time; it just counts.

A Simple Example

Figure 1 illustrates a simple computer system. The system consists of a host computer, two operator workstations, and an analyst workstation connected by a LAN. (In this example, the transmission medium is not important, although the actual system modeled was an Ethernet LAN.)

The host receives messages from an outside source and performs an automated analysis of the messages. After the analysis is complete, the host sends the messages to one of the operators. The operator verifies the message and checks for sanity. If a message is garbled or contains questionable information, the operator flags it for review by the analyst. If the message appears to be in order, the operator sends it to the database and processing of the message is complete.

The analyst attempts to restore garbled messages, complete incomplete messages, and verify questionable data. If the message is hopeless, the analyst may terminate the message. Otherwise, it corrects the message and resends it to an operator for processing and entry into the database.

To make this example interesting, we've assumed that 40 percent of the messages need to be sent to the analyst, and, after analysis, 85 percent of those terminate. The other 15 percent go back to operators. We've also assumed that the host releases a message every 15 minutes, and each message spends 20 to 30 minutes with an operator. The analyst may take less time to process a message than the operator does, but the analyzed message might have to sit waiting to get the operator's attention. If a message has to go to the analyst first, the whole process can take an additional 45 minutes. The system administrator wants to know how long a message is in the system.

A run of the simulation for an 8-hour day using 27 messages showed that each message was in the system for an average of 62 minutes. The average wait to get to an operator was 29 minutes, and the average wait to get to the analyst was 8 minutes. Some messages went back and forth between the operators and the analyst—a typical problem in any bureaucracy.

We conducted the simulation using a model constructed with the Qsim Toolkit. This kit contains C language functions and data structures, and macros to help define them. A little "glue" code binds the model together. The functions and data structures are in five basic device groups: creates, queues, decisions, services, and terminates. The packets of data passed from one device to another are called *entities*. Figure 2 diagrams this example.

We selected three different random-number distributions for this model. Messages come in about every 15 minutes using an exponential distribution, a good choice for any kind of arrival distribution, such as customers, messages, and jobs. The operators take from 20 to 30 minutes using a uniform distribution, which delivers equally probable numbers falling into its range. Finally, the analyst needs about 45 minutes using a normal distribution, which produces random numbers grouped about a mean (average). After a simulated 8 hours, the scheduler stops the simulation and prints the results (see listing 1). The simulation takes between 3 and 4 seconds to run on an IBM PC.

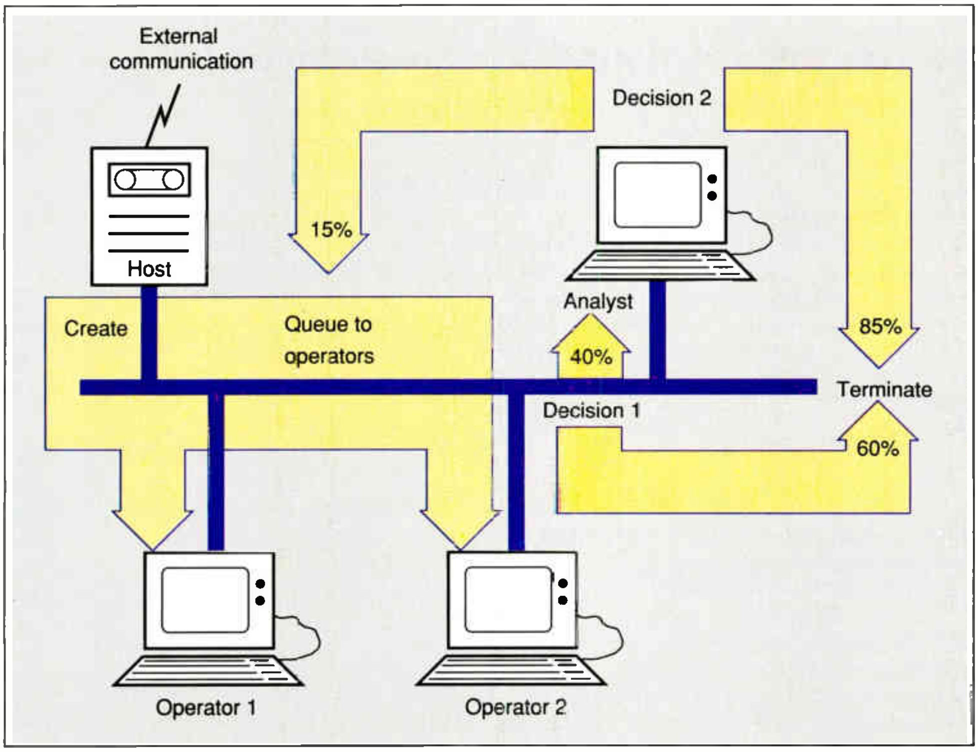


Figure 1: *We used Qsim to model an Ethernet LAN with a host computer, two operator workstations, and an analyst workstation.*

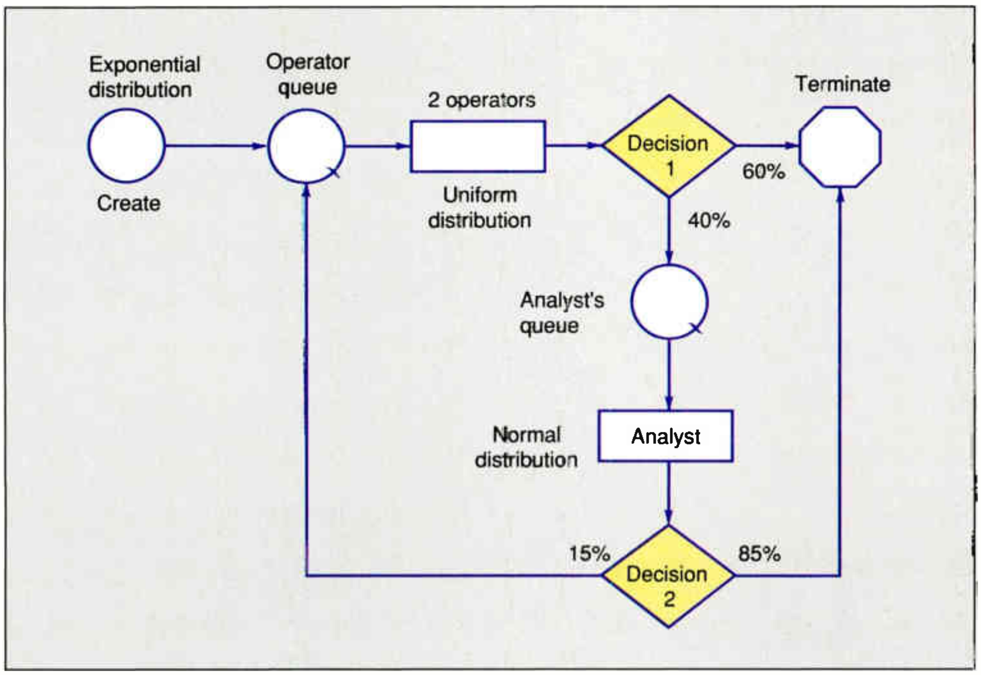


Figure 2: *The simulation model is a queue system: Entities (messages) are created by the host every 15 minutes or so and wait in the operator queue until one of the operator servers is free. After waiting from 20 to 30 minutes in the service, the entity enters a decision. The decision sends 60 percent to the terminate device and 40 percent to the analyst. The analyst queue holds each entity until the analyst service is free. After a random time (average 45 minutes), the entity enters the second decision, which sends 85 percent to the terminate device and 15 percent back to the operator queue to await a free server.*

The Scheduler

The scheduler operates behind the scenes and coordinates the activities of all the devices; it actually transfers entities among some devices. The scheduler has two parts: the event calendar and the engine. The various devices place data on the calendar by calling a Toolkit library function. The records placed on the calendar contain a pointer to a function, an optional pointer to an entity, and a time. When that simulated time arrives, the engine calls the function and passes an entity, if there is one.

Here is how it all works: The initialization device places calls to the create device in the model and a call to the stop function on the event calendar. Then, `initialization` calls the engine, which takes the next record from the event calendar and calls the function indicated by the pointer in the record, handing over any entity that is pointed to in the record. Suppose this is a call to `create`. The create device allocates memory for an entity and calls the operator queue, handing over the entity.

The operator queue puts the entity on its own internal queue and calls the operator service. The service looks at a local static

continued

String and Variable Construction Using an ANSI C Preprocessor

Before ANSI C, C programmers used peculiarities of their particular C preprocessors to facilitate code writing. A generation of C programmers established these tricks as an unwritten set of rules.

Two special features of the preprocessor seemed most vulnerable to this abuse: parameter substitution in strings, and comment elimination.

Parameter Substitution in Strings

The expansion of baker(foo) by

```
#define baker(X)   "X"
```

might be either "X" or "foo" depending on the implementation of the preprocessor. In the first case, the preprocessor protects strings from parameter substitution. In the second, the substitution is made.

The ANSI X3J11 committee specified the # operator to accomplish the equivalent of substituting parameters into strings within the macro's body. With this, the programmer can build up strings consisting of substituted parameters and explicit strings. The preprocessor looks for a parameter name following a #. When it finds one, it creates a string consisting of the substitution argument. When all strings have been created, those separated only by white space are joined. For example,

```
#define fubar(able, baker)\
   #able " and " #baker " or " #able #baker\
   " or " #able#baker
```

would expand fubar(foo,bar) to

```
 "foo" " and " "bar" " or " "foo bar" " or "
    "foobar"
```

which, after string concatenation, becomes

```
 "foo and bar or foo bar or foobar"
```

(The # and the parameter name can be separated by white space, as in # able.)

Comment Elimination

When the preprocessor eliminates comments after parameter substitution but before passing the program text on to the compiler, programmers can use the comment delimiters /* and */ to create variable names. /**/ is a signal to other programmers that parameter concatenation is intended. Take, for example, the statement

```
#define able(X,Y)   X/**/Y
```

The statement able(foo,bar) would expand to foobar. Suppose you wanted to create a debug statement to print the values of a couple of variables. Further suppose that the variables you are printing all start with dog but end in a unique string. You might write the preprocessor statement like this:

```
#define debug(first, second)\
printf("first = %f, second = %d\n",dog/**/first,
  dog/**/second)
```

But, depending on how your preprocessor works, debug(1,2); might expand to

```
printf("1 = %f, 2 = %d\n",dog1,dog2);
```

or

```
printf("first = %f, second = %d\n",dog1, dog2);
```

or, if comments are removed before parameter substitution, it might expand to

```
printf("first = %f, second = %d\n",dogfirst,
 dogsecond).
```

The ## operator is used to join parameters with other text or with parameters in the macro's body. It is a concatenation operator. For example, #define fubar(X,Y) X ## Y expands fubar(foo,bar) to foobar; #define snafu(Y) printf("%d\n", rhythm_ ## Y) expands snafu(aces) to printf("%d\n", rhythm_aces); and #define secret(Y) printf("%d\n", Y ## _o_mine) expands secret(pal) to printf("%d\n", pal_o_mine).

ANSI Standard C Compilers

We use the latest versions of Lattice C, Microsoft QuickC, and Borland Turbo C on an IBM PC. At the present, the only one of the three that can successfully support these operators is Borland Turbo C.

Microsoft claims QuickC supports the full draft ANSI standard, but a bug prevents the preprocessor from properly expanding the ## operator. Perhaps this will be fixed soon. However, the standard is quickly nearing approval. When this happens, there will be a mad rush to issue compilers meeting the full standard.

Until that time, it is well to be aware of the new things in the draft standard and to attempt to write code using them.

variable to see if it's busy. (Since the service has two servers, the busy variable is really an array of two.) The variable contains the time at which the server expects to be free. If the current time is earlier than the scheduled time, the server is assumed to be busy. But if a server is free, the service calculates a service time and sets the server's variable. It then places a call to the first decision on the event calendar. The time in the call record is the time the service expects to be done with the entity. The service also places a pointer to the entity in the record. Then it returns the service time to the queue.

If the service rejects the entity because it's busy, it returns a −1. If the service accepts the entity, queue removes it from the queue and places a call (back to itself, but without an attached entity) on the event calendar. The time in the call is the current time plus the service time. When the service time has passed, the queue can try to pass another entity off the top of its queue

Listing 1: *The output from Qsim Toolkit.*

```
Total time in system =    1670.2085, count = 27
Average time in system =    61.8596
Max time in system =       132.1292
Min time in system =        20.1056

SERVICES:
      name|total|total busy|utilization|
----------|-----|----------|-----------|
s_operator|   30|  745.3597|     1.5844|
 s_analyst|    4|  158.3463|     0.3280|

QUEUES:
      name|max_len|cur_len|total_wait|count|avg_wait|
----------|-------|-------|----------|-----|--------|
q_operator|      5|      0|  871.8822|   30| 29.0627|
 q_analyst|      2|      2|   46.4740|    6|  7.7457|
```

to the service.

The queue now returns to the create device, which computes the next time it should create an entity, places a call to itself on the event calendar with that time, and then returns control to the engine. The engine takes the "soonest" record off the event calendar and calls the function pointed to. Eventually, it will call the first decision and pass the entity stored there by the service. The first decision will generate a random number between 0 and 1. If this number is less than 0.65, it will call the terminate passing the entity. Otherwise, it calls the analyst's queue. The analyst's queue, the analyst's service, and the second decision all behave as previously described. The terminate device tallies the counts and times associated with the entity.

Eventually, the engine will call the stop function placed on the event calendar by `initialization`. The stop function will print statistics and exit, thereby ending the simulation.

The Qsim Toolkit

We designed the Toolkit with two principles in mind:

- All the programming should be in ANSI C (or as close to the proposed standard as we can make it), thereby obviating the need for a special preprocessor to create modeling code or the need for a "simulation" language such as Simscript or Slam.
- The programming should be as simple as possible.

We tested the simulation Toolkit by coding both simple and complex models in Slam and with a combination of Qsim and Turbo C. The results were somewhat different because of the different random-number-generation techniques.

However, we ran all the models for extended periods to assure ourselves that the statistical results were valid. Averages and standard deviations, for example, approached the same values for the same model in both Slam and C. Finally, using mathematical techniques, we computed the results of the simplest models and found the Toolkit to give the proper values.

Coding the Example

Listing 2 contains the macros that generate the code describing the devices. The three DEFINE macros declare function prototypes and allocate storage for queue and service structures. The queue structure holds the top of a queue, as well as performance data such as maximum and minimum numbers in the queue. The service structure holds performance data only. The type of data in these structures is up to the modeler.

The SCHEDULE macro is just an easier way of calling the schedule function. The casts are necessary when constants (such as 0) are used as parameters.

CREATE calls the `create()` library function to make a new entity. It then passes an entity pointer to the device named in

continued

Listing 2: *The macros that are used to define function prototypes and allocate storage to queues and service structures. (The #s and ##s internal to the define statements are ANSI C extensions to the C preprocessor directives. See the text box "String and Variable Construction Using an ANSI C Preprocessor.")*

```
#define DEFINE_CREATE(c_name)   \
  void c_name();\
#define DEFINE_QUEUE(q_name)   \
  void q_name(ENTITY *);\
  QUEUE_STRUCT q_name ## _q={#q_name};
#define DEFINE_SERVICE(s_name)   \
  systime_t s_name(ENTITY *);\
  SERV_DATA s_name ## _s={#s_name};
#define SCHEDULE(name, entity, time)   \
  schedule(name, (ENTITY *)(entity), \
  (systime_t)(time));
#define CREATE(c_name, create_time, feature, \
  create_freq, next_device)\
  void c_name(){\
  extern systime_t now;\
       next_device(create((systime_t)create_time, \
       (double)feature));\
       SCHEDULE(c_name, 0, now+create_freq);\
       }
#define QUEUE(q_name, next_device)   \
  void q_name(ENTITY *entity){\
  systime_t srvtime;\
  ENTITY * top;\
       if (entity) nq(&q_name ## _q,entity);\
       if ((top = topq(&q_name ## _q)) &&\
            srvtime=next_device(top)) >= 0){\
            dq(&q_name ## _q);\
            SCHEDULE(q_name, 0, srvtime);\
       }\
  /* increment counters (if desired) */\
  }
#define SERVICE(s_name, number_servers, \
  service_time, next_device)\
  double s_name(ENTITY *entity){\
       static systime_t srvtime[number_servers],
       wait_time;\
       extern systime_t now;\
       unsigned short i;\
       for (i=0; i<number_servers; i++) \
       if (srvtime[i] <=now)
break;\
       if (i == number_servers) return -1;\
       /* note: service_time may be a function call */\
       wait_time = service_time;\
       srvtime[i] = now + wait_time;\
       SCHEDULE(next_device, entity, srvtime[i]);\
       /* increment counters */\
       q_name ## _s.total++;\
       q_name ## _s.total_busy += wait_time;\
       q_name ## _s.srvtime = srvtime[i];\
       return srvtime[i];\
       }
```

Listing 3: *A simple example of Qsim's decision devices, terminate devices, and the stop function.*

```
void decision_1(ENTITY *entity){
  if (drand() < .6) term(entity);
  else q_analyst(entity);
  }

void term(ENTITY *entity){
  /* increment counters then ... */
  free(entity);
  }

void stop(void){
  /* compute and print statistics then ... */
  exit(0);
  }
```

Listing 4: *The C language source code using the Qsim Toolkit for the example in figure 1.*

```
#include <stdio.h>
#include "sim.h"
#include "sim_lib.h"
#include <float.h>

DEFINE_CREATE(messages);

DEFINE_QUEUE(q_operator);
DEFINE_QUEUE(q_analyst);
QUEUE_STRUCT
     *q_array[]={&q_operator_q,&q_analyst_q,NULL};

DEFINE_SERVICE(operator);
DEFINE_SERVICE(analyst);
SERV_DATA *s_array[]={&operator_s,&analyst_s,NULL};

void decision_1(ENTITY *);
void decision_2(ENTITY *);
void term(ENTITY *);
void stop(void);

void main(int ac,char **av) {
  SCHEDULE(messages,0,0);
  SCHEDULE(stop,0,8*60.0*10);
  engine();
  }

CREATE(messages,now,0,expon(15.0),q_operator)

QUEUE(q_operator,operator)
SERVICE(operator,2,unfrm(20.0,30.0),decision_1)

void decision_1(ENTITY *entity){
  if (drand() < .6) term(entity);
  else q_analyst(entity);
  }

QUEUE(q_analyst,analyst)
SERVICE(analyst,1,normal(45.0,10.0),decision_2)

void decision_2(ENTITY *entity){
  if (drand() < .85) term(entity);
  else q_operator(entity);
  }

static systime_t total_time, max_time, min_time
     =FLT_MAX;
static unsigned count;

void term(ENTITY *entity){
  systime_t tis;

  count++;
  tis = now - entity->time;
  total_time += tis;
  if (max_time < tis) max_time = tis;
  if (min_time > tis) min_time = tis;
  free(entity);
  }

void stop(void){
  int i;

  printf("Total time in system = %f, count =
    %d\n",total_time,count);
  printf("Average time in system =
    %f\n",total_time/count);
  printf("Max time in system = %f\n",max_time);
  printf("Min time in system = %f\n",min_time);
  printf("\nSERVICES:  name|total|total busy|total
        |utilization|\n\---------------|-----|
    ----------|-----------|\n");
  for (i=0;s_array[i];i++)
    printf("%15.s\t%ld\t%f\t%f\n",
    s_array[i]->name,
    s_array[i]->total,
    s_array[i]->total_busy,
    (s_array[i]->srvtime)
      ? s_array[i]->total_busy/s_array[i]->srvtime
      : 0
    );
  printf("QUEUES\n");name|max_len|cur_len|total wait|\
        count|average_wait|\n---------------|-------|
        -------|----------|-----|------------|\n");
  for (i=0;q_array[i];i++)
    printf("%15.s\t%d\t%d\t%d\t%f\t%d\t%f\n",
      q_array[i]->name,
      q_array[i]->max_len,
      q_array[i]->cur_len,
      q_array[i]->total_wait,
      q_array[i]->count,
      (q_array[i]->count)
      ? q_array[i]->total_wait/q_array[i]->count
      : 0
      );
  exit(0);
  }
```

the macro's parameter list. Finally, it schedules a call to itself. Notice that the function makes no provision for rejecting the entity. The device must be a service with a short service time, a service with plenty of servers, or a queue. If the device is not a queue, there is room here for a subtle bug when it rejects entities and the create doesn't test for it.

QUEUE defines a function that accepts a pointer to an entity. When an entity pointer exists, QUEUE calls nq( ) to place the pointer on its queue. Then, if an entity pointer is on the top of its queue, it calls the service s_name, passing on the entity pointer. The service returns a positive number (or 0) when it has accepted the entity. QUEUE removes it from the queue and schedules a call to itself with a null entity pointer. When this call to itself is made, the queue attempts to pass another entity

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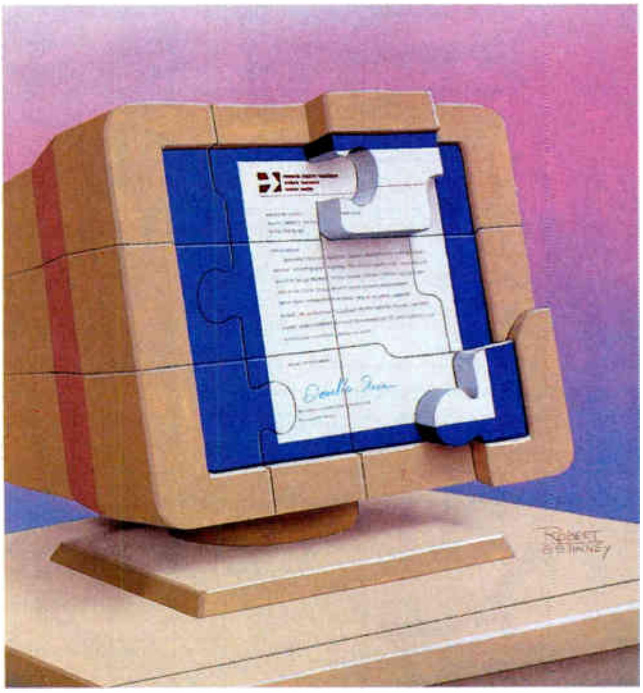
The Paperless Office

Distributed PC-based document image processing may change the way you do business

Dean Hough

For years you've heard how computer technology was going to create an office environment where paper would be obsolete. It appears, however, that computers have had the opposite effect: Offices now create more paper than ever before. The difficulties in creating a paperless office are in getting real-world documents into and out of a computer system, and in working with them once they have been acquired. One solution is document image processing.

DIP is the storage, management, and retrieval of images on a computer system. Once the exclusive domain of large dedicated systems, it is emerging as a bona fide personal computer-based office-automation application. It may change the way you do business.



Elements of a DIP System

DIP systems consist of page scanners, database managers, and mass storage devices that capture and manage original documents as images. You use standard or high-resolution displays to view these images, and laser printers to generate hard copy. Specialized DIP functions are controlled by dedicated image-processing hardware and software.

DIP is most useful when you integrate it into a LAN that provides access to shared laser printers, scanners, optical disks, and databases. Such a distributed environment lets your DIP system automate and manage the flow of documents electronically. If you're on the network, you can access thousands of documents without ever leaving your own machine. Further, the same document can be viewed simultaneously at different workstations. You can also integrate DIP with applications such as fax, forms, and desktop publishing to help manage the distribution and output of graphics information.

The computers on your DIP system must perform some or all of the following functions: image compression and expansion, scanning, printing, retrieving, and scaling and rotating. The machines that function as print and scan servers should be specialized to speed these processes. Specialized hardware can handle image compression and manipulation. Finally, the systems you use as DIP workstations to retrieve and view images require a retrieval engine and may need enhanced graphics capabilities.

The ideal DIP network configuration contains many elements (see figure 1). A file server stores the database application and image data. A DIP server provides image compression and decompression, and I/O via the attached scanner and printer. The workstations, running either DOS or Windows, have either a

continued

ILLUSTRATION: ROBERT TINNEY © 1989

hardware or software retrieval capability, which includes image decompression and manipulation.

The Software Side

As usual, DIP hardware technology has progressed faster than the software, which must catch up before DIP can gain wide acceptance. Fortunately, the necessary software pieces are beginning to fall into place.

The increasing acceptance of Windows marks a long overdue shift from character-based applications to a standard graphics interface. This is particularly important to a graphics-intensive application such as DIP. Windows represents a major step toward integrated image-processing systems, but it has some limitations.

The major obstacle in using standard Windows as the front end to a DIP application is that it lacks free-form image capabilities. This is illustrated by the absence of Windows support for scanners. Existing Windows applications deal primarily with structured data such as fonts, patterns, and vector graphics. This is fine for standard word processing, database, and spreadsheet applications, but not for graphics-intensive ones. Structured graphics definitions can't handle handwriting, photographs, and free-form drawings. By contrast, raster representation can describe all types of image and graphics information, since it makes no assumptions about image content.

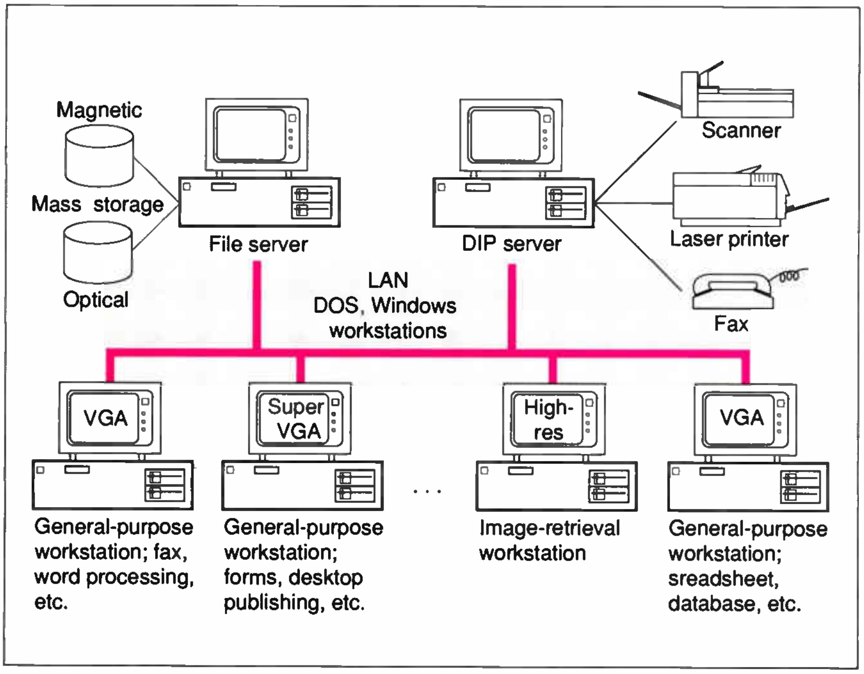


Figure 1: *An idealized distributed document-image-processing system provides specialized imaging services, such as scanning and image manipulation, in addition to standard network services.*

Listing 1: *These code fragments contrast how you display large raster images using the standard Windows' graphics device interface and an extended GDI.*

```
STANDARD GDI

get window
  do {
    create compatible bitmap
    read into map
    create memory DC
    select bitmap
    stretch blt DC to window
    deselect bitmap
    delete bitmap
    delete memory DC
  } while(not end of image)
return
```

```
EXTENDED GDI

get window
DISPLAYIMAGE
return
```

Opening Windows

For DIP applications, one solution is to extend Windows so it can work more easily with raster images. You can accomplish this by providing extensions to the graphics device interface (GDI) that forms the foundation of Windows.

The Windows GDI provides the font and graphics resources that enable applications to display and print structured data. GDI functions operate on a device context that can be a memory bit map or a display window. Due to memory limitations and performance considerations under Windows, device contexts are usually limited to less than 64K bytes. This limitation creates problems. For example, when displaying a 300-dot-per-inch scanned page, many iterations of standard GDI operations are required to process the entire 1-megabyte image. In fact, it takes standard GDI commands about 2½ minutes to read, scale, and display a 1-megabyte image on a 20-MHz 80386 machine. By extending the GDI to handle large raster images, the same machine displays the image in about 2 seconds (see listing 1).

A part of the speed improvement comes when you compress the scanned image using the same CCITT standard compression techniques used in fax communication. Compression is a necessary component of DIP systems because raster images are bigger than structured graphics definitions. For example, compressing a CCITT Group 4 two-dimensional image results in about a 15-to-1 savings in disk storage space. The image, therefore, can be read from a disk or a network 15 times faster than an uncompressed image.

You can also use extended GDI calls with page scanners and printers. A single call can scan a page, compress it, format it, and write it to disk. If specialized hardware is available, the compression, formatting, and disk operations can take place concurrently with scanning and printing. Concurrency lets scanners and printers that are controlled by library extensions operate at "rated speed." For example, an HP LaserJet printer can print images at 8 pages per minute without any delays between pages.

Because image files can be formatted in a variety of ways with a variety of file

continued

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headers, GDI extensions must be able to generate and interpret different types of file formats. File filters allow you to display different types of images, such as scanned documents, fax pages, and raster images that are generated by other applications.

In addition to extending Windows' imaging functions, you can also extend the standard GDI printer functions to speed up printing and to directly support devices like fax machines.

PC-based DIP in a distributed environment is not limited by technological barriers, but by lack of creative development.

Image-Processing Engines

Library extensions to the GDI require either a hardware or a software image-processing engine. Hardware accelerators for decompressing and scaling images are naturally faster than any software solution. They are also naturally more expensive. By working in the background, they allow concurrent image processing to overlap disk I/O and screen paints.

Image compression coupled with concurrent image processing provides significant performance improvements to the Windows environment. This is true for standard Windows applications as well as DIP applications. Hardware retrieval engines are often used with high-resolution (1664 by 1200 pixels) displays on image-retrieval workstations.

Software solutions provide the same image-processing features as hardware accelerators do. They are cheaper, but they lack the concurrency and performance of hardware. However, because not everyone on a network requires rapid image retrieval, the software solution is a cost-effective way to let all network users access an image database.

Developing DIP Applications

To make a DIP system useful, you need to develop a tailored DIP application that meets your requirements and the specifications of your system. DIP vendors provide a significant amount of application support to assist you in adding imaging to existing applications. This support takes two forms: direct support using high-level image library routines, or remote support using a high-level application module with Dynamic Data Exchange (DDE).

High-level applications can use image script language commands to invoke image operations. For example, a command such as DISPLAY_IMG might pop up a window on the screen and display a specified image within it. These superimposed images appear as child windows from within the application. You could move this window around and manipulate the images within it. Image manipulation capabilities include panning, scrolling, rotating, and zooming up or down within the image window.

Existing Windows applications with DDE command capability can use the extended GDI to access and display image information. For example, you can use the macro, database, and DDE capabilities of Microsoft Excel to build custom imaging procedures. Thus, Excel can act as a simple applications builder. You can use Excel's macro language to issue commands directly to Windows extensions, or you can use its DDE capability to issue commands to a higher-level application module.

Windows development packages, such as Bridge from Softbridge, generate custom image applications quickly. DBMS-based development packages, such as SQL Windows and SQLBase from Gupta Technologies, provide a relational database foundation to manage image filing. You can construct powerful storage and retrieval systems with a multiuser networked version of SQLBase.

DIP on the Horizon

Microcomputer-based DIP in a distributed environment holds great potential for the world of office automation. It is no longer limited by technological barriers, but by the paucity of creative development for tailored applications.

The release of developer toolkits and libraries, however, herald the arrival of sophisticated personal computer–based DIP applications and, with them, the fulfillment of the paperless office. ■

Dean Hough is vice president of engineering at KoFax Image Products. He holds a BSEE from San Diego State University and can be reached on BIX c/o "editors."

Distributed Processing Roundup

The list below contains the names and manufacturers of some products that distribute processing over different architectures, operating systems, or networks. The focus is on products that provide distributed processing services to personal computer and workstation users. A listing of distributed database applications is planned as part of the September In Depth.

NetWare RPC .... from $950
Lets you develop distributed applications for NetWare implementations. It consists of the RPC Compiler, which produces client and server source code, and the Network Library, which manages the execution of RPCs. NetWare RPC supports Microsoft C and Turbo C, produces International Standards Organization–compatible code, and supports DOS and OS/2 (OS/2 support with Microsoft C 5.1 only).
Novell, Inc.
Novell Development Products Div.
6034 West Courtyard Dr., Suite 220
Austin, TX 78730
(512) 346-8380
Inquiry 1188.

Netwise RPC Tool .... from $1250
Supplies C and Ada tools to develop RPC applications. The Netwise RPC Tool supports many architectures (including PC, PS/2, Sun, and VAX), operating systems (including DOS, OS/2, Unix, and VAX/VMS), and networks and protocols (including TCP/IP, Touch OSI, NetWare, LAN Manager, and DECnet).
Netwise, Inc.
2477 55th St.
Boulder, CO 80301
(303) 442-8280
Inquiry 1189.

Network Computing System .... from $500
Network software that implements transparent distributed processing using RPCs, a descriptive compiler, and a location broker. Supports Ultrix, VAX/VMS, and SunOS, and Pascal and C compilers.
Apollo Computer, Inc.
330 Billerica Rd.
Chelmsford, MA 01824
(508) 256-6600
Inquiry 1190.

Network File System
(bundled with SunOS)
Allows remote file access over a network. NFS supports many architectures, operating systems, and networks.
Sun Microsystems
2550 Garcia Ave.
Mountain View, CA 94043
(415) 960-1300
Inquiry 1191.

PCILIB $995
An applications programming interface used to create distributed DOS and Unix applications. PCILIB works in conjunction with other Locus connectivity products such as PC-Interface and Merge 386.
Locus Computing Corp.
9800 La Cienega Blvd.
Inglewood, CA 90301
(213) 670-6500
Inquiry 1192.

TCF for AIX .... from $400
Creates a transparent distributed processing environment using TCF LAN under AIX (IBM's Unix). Provides load leveling, shared resources, parallel processing, redundancy, data integrity, and a global file system.
IBM Corp.
Old Orchard Rd.
Armonk, NY 10504
(914) 765-1900
Inquiry 1193.

A GUIDE TO GUIs

Graphical user interfaces make computers easy to use; keeping them all straight is the hard part

Frank Hayes and Nick Baran

The world of graphical user interfaces (GUIs) seemed pretty simple in 1984, when Apple introduced the Macintosh. Back then, the genealogy was straightforward: Researchers at Xerox's Palo Alto Research Center begat the Xerox Star; Steve Jobs visited PARC, saw the Star, went back to Apple, and begat the Mac.

But five years later, the begats have become bewildering. The Mac begat Windows—or was it just a cousin? Windows begat Presentation Manager—which doesn't look much like the Mac at all, thanks to IBM, which begat Systems Application Architecture (SAA). MIT begat X Window, which crossbred with PM and NewWave to give birth to Motif. Tandy begat DeskMate, Japan, Inc., begat BTRON, Steve Jobs—back again for a second try—begat NextStep, and Apple has filed a paternity suit against Microsoft. What a mess.

But though there seem to be dozens of GUIs today, it's clear that they all still share similarities that reach below the surface.

Just One of the GUIs

Turn on a Macintosh, and you'll come face to face with the original definition of a GUI for desktop computers. The Mac defined the parts we've come to associate with a GUI:

- a pointing device, typically a mouse
- on-screen menus that can appear or disappear under pointing-device control
- windows that graphically display what the computer is doing
- icons that represent files, directories, and so on
- dialog boxes, buttons, sliders, check boxes, and a plethora of other graphical widgets that let you tell the computer what to do and how to do it

Of course, today's GUIs come in many varieties—not everything that's called a GUI has all these features. For example, some GUIs don't use icons. On others, the icons are optional or available only sometimes. Some require a mouse, while others will let you work from the keyboard.

GUIs are more similar beneath the surface. Although there are some hybrids, most GUIs consist of three major components: a windowing system, an imaging model, and an application program interface (API): (See figure 1.)

The windowing system is a set of programming tools and commands for building the windows, menus, and dialog boxes that appear on the screen. It controls how windows are created, sized, and moved on-screen, and how the user moves from one window to another, among other functions.

One example of a windowing system is X Window. X Window is *not* a complete GUI—it's just the windowing system shared by a group of different GUIs. Because all the X Window GUIs share the same windowing system, they can also share programming tools for developing applications. (By contrast, Microsoft Windows, for example, is a complete GUI with its own windowing system, imaging model, and API.)

The imaging model defines how fonts and graphics are actually created on-screen. For example, the typeface and size of text in a word processor or desktop publishing program is specified through the imaging model; so are the lines and curves of a CAD program. PostScript may be the best-known imaging model, familiar from laser printers; Display PostScript is a screen version of the PostScript imaging model. The Macintosh imaging model is QuickDraw, and Microsoft's PM for OS/2 uses an imaging model called GPI (for Graphic Programming Interface).

Some GUIs support more than one imaging model. For example, while Sun's NeWS (for Network Extensible Window System) is similar to the PostScript imaging model, it can also turn the screen over to a complete graphics imaging system (such as PHIGS or GKS) for controlling a CAD program.

The API is a set of programming-language function calls—it's how the programmer specifies which windows, menus, scroll bars, and icons will appear on the screen. Both PM and

continued

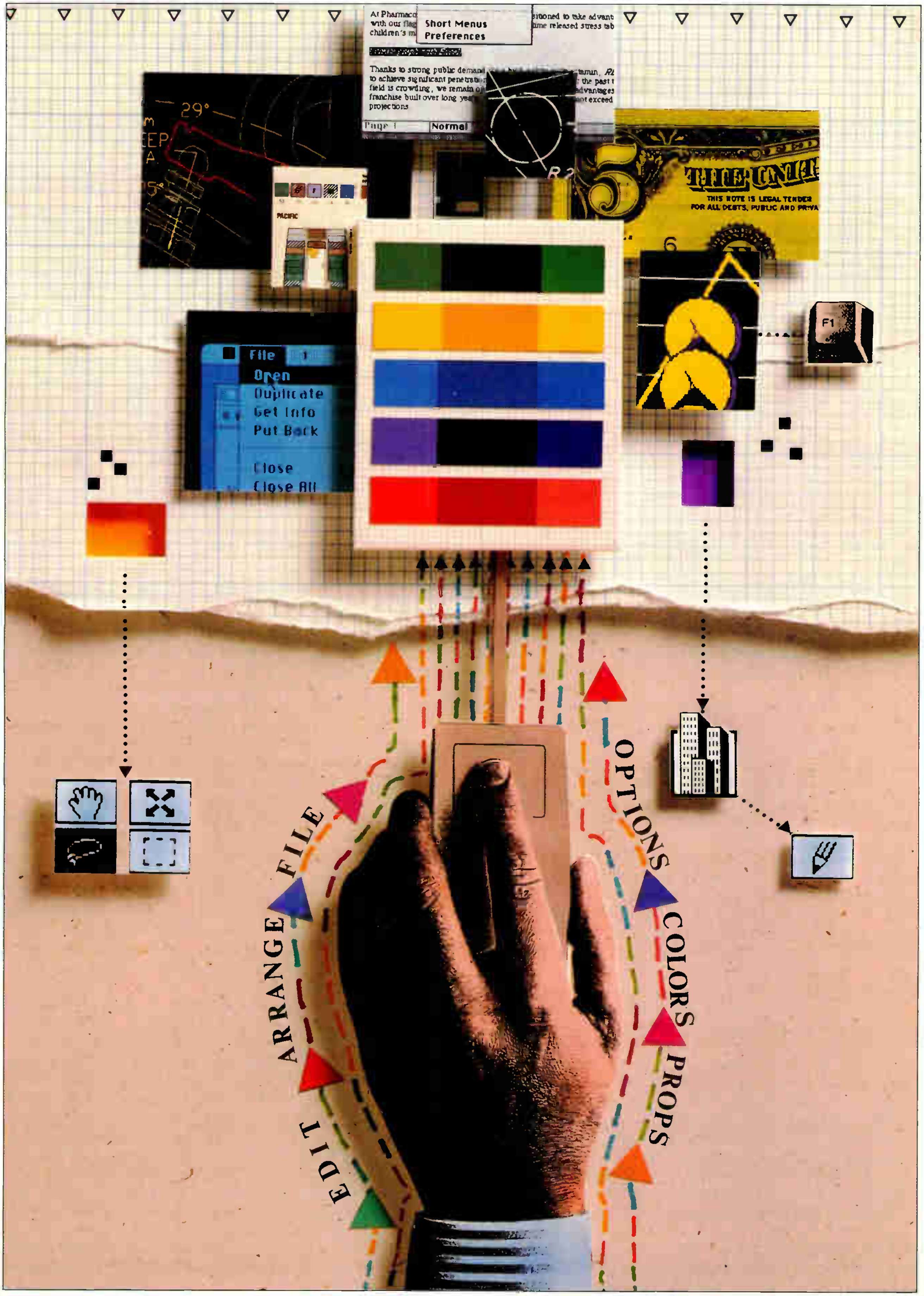
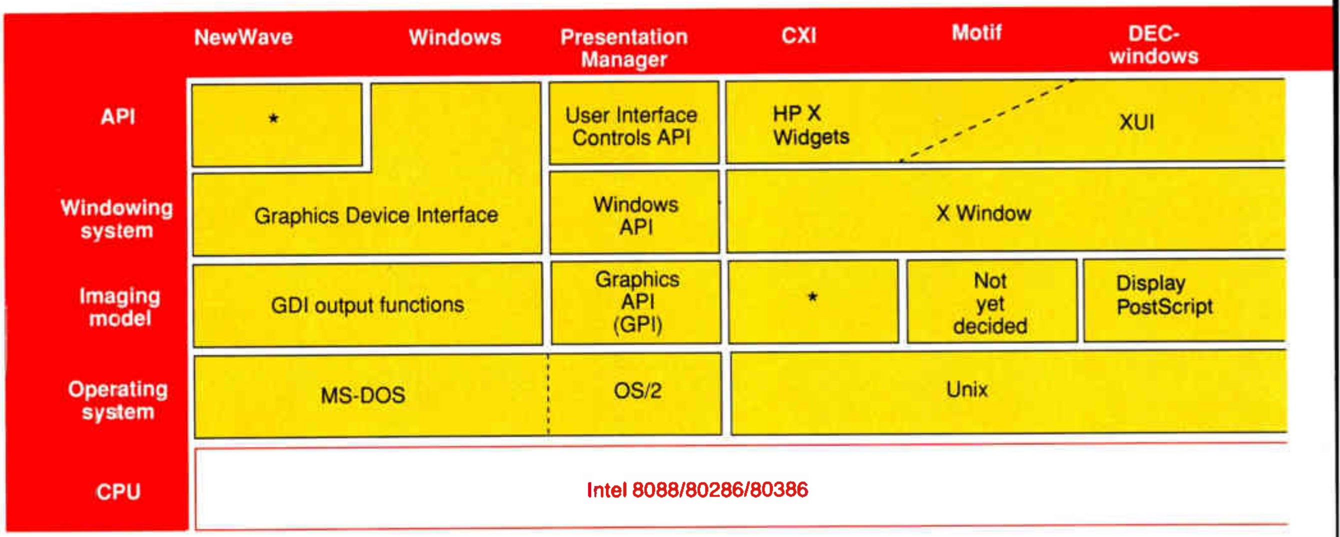


ILLUSTRATION: R. M. SCHNEIDER © 1989

Figure 1: *Graphical user interfaces tend to fall into a few camps: those based on IBM's Systems Application Architecture (primarily Windows and Presentation Manager), Unix systems generally built around X Window, and Mac-like systems*



Microsoft Windows have their own APIs. DECwindows uses an API called XUI (for X User Interface), which includes function calls for the X Window System. Open Look is the new API for Sun's operating system. NextStep uses its own API (defined by a library of objects called *kits*) and its own windowing system (the *window server*).

On top of these three elements—windowing system, imaging model, and API—some systems also have tools for creating interfaces and developing integrated applications. Hewlett-Packard's NewWave, for example, is not a user interface, but a method for integrating applications and objects from multiple applications—it's a development tool for application programmers. Similarly, NextStep includes a set of tools for object-oriented programming.

Another characteristic that varies widely is the level of integration between the GUI and the operating system. Some GUIs are tightly bound to the system—turn on a Mac, an Amiga, or a NeXT computer, and the GUI appears automatically. By contrast, you must specifically choose Microsoft Windows and most of the X Window GUIs that run under Unix—which could be a hindrance for Unix-based systems trying to appeal to a mass market.

Some GUIs provide access to a conventional command-line interface that lets you, for example, pass arguments to applications or view the text of a file without using the mouse, menus, and icons. NextStep has a console window that lets you get at the command line, whereas the Mac makes you use a desktop accessory to examine files, manipulate them, and so on.

With the similarities and differences defined, it's easier to break the GUI family tree into a few large groups: those based on the distinctive look of IBM's SAA; those built upon X Window and the Macintosh and its apparent offshoots; and a few hard-to-define hybrids and special cases.

We'll begin by going back to the Mac.

A GUI for the Rest of Us

The idea of a standard user interface, regardless of the machine the user is facing, was part of the dream that built the Macintosh. Ironically, the Mac has become one of the most isolated of GUI-based machines, largely because of Apple's litigiousness. Any company that even looked like it might be copying the Mac was threatened with a lawsuit. (See the text box "Of Mice, Menus, and Lawyers" on page 256). The result is that, while the whole world has followed the Macintosh in its use of GUIs, most of that world has gone its own way.

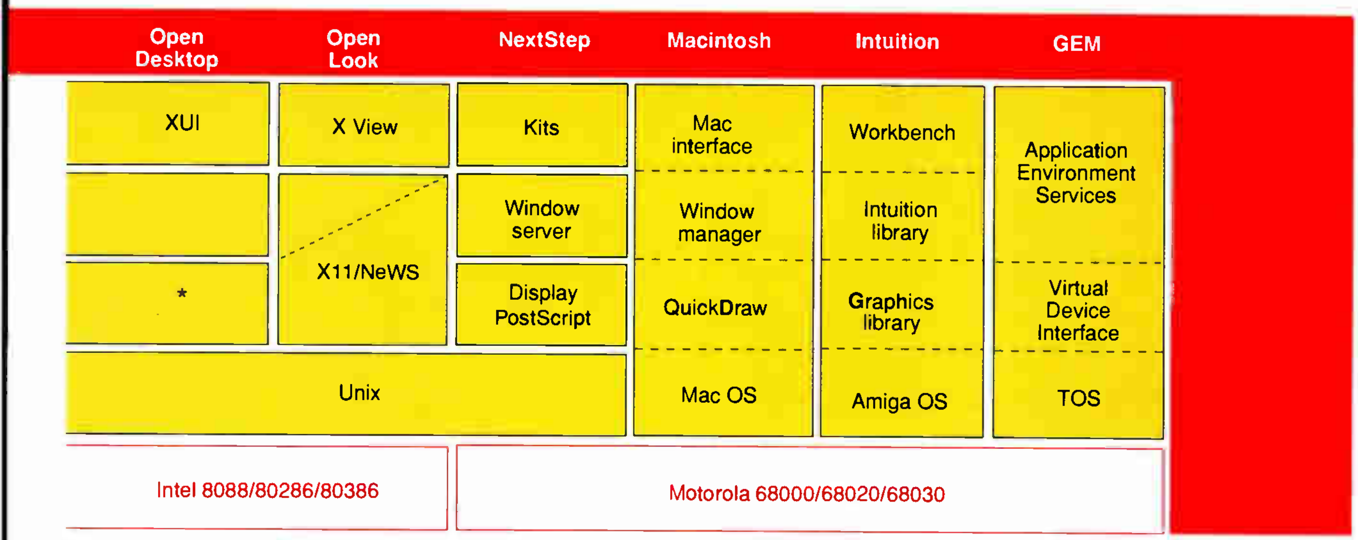
The Mac GUI (see photo 1) was the first widely available mouse-and-menu interface. It established several conventions that have reached beyond GUIs, including the "point and shoot" approach to menus. Before the Mac, you'd look at a menu and choose a key to type. After the Mac, your selections were limited to contextually correct answers—you simply couldn't choose something meaningless. Point-and-shoot interfaces—whether graphical or character-based—eliminated "wrong" answers, since it's impossible to select a choice that isn't available.

Although its stylistic guidelines are certainly heavily documented, the Mac interface really specifies just three distinct operating systems: the single-tasking Mac Finder, the multitasking MultiFinder, and Apple's own Finder clone for the Apple IIGS, ProDOS-16.

The Mac GUI combines all the functions of an API, windowing system, and imaging model in its ROM Toolbox, QuickDraw graphics primitives, and Finder, and these pieces are tightly integrated. The stark efficiency of the QuickDraw imaging model allows the Mac GUI to have reasonable performance, even with a relatively slow microprocessor like the 68000.

The Big Blue Look

IBM's SAA is both more and less than a GUI. SAA is actually a whole family of user interfaces that IBM defined two years ago. SAA interfaces include everything from ground-level character-only systems up to high-powered graphical workstations, and they span machines from PCs up to mainframes running IBM's MVS and VM operating systems. SAA is a complete system architecture, and as a result it covers things that most user *that tend to be tightly integrated and distinctive. In this figure, a dotted line indicates some overlap between the objects on either side of it. An asterisk indicates that the technology is proprietary or that the company has no specific name for it.*



interfaces don't—including a standard for networking called the Systems Network Architecture (SNA), and one for database queries, the Structured Query Language (SQL). It also specifies, but doesn't rigorously define, the user interface. An SAA user interface isn't necessarily a GUI, complete with mouse and graphics. Remember, SAA is a standard for everything from glass teletypes on up, so SAA GUIs are really just a subset of SAA user interfaces.

SAA seeks to let any terminal handle any SAA application. Thus, while all SAA applications use the same style of drop-down menus, character-only systems will display only characters—and send only characters back to the application—while mouse-based graphics systems will let the user point and click. However, SAA does create a least-common-denominator situation: The application software ultimately has to choose what the minimum configuration for the SAA terminal is going to be. Fortunately, SAA applications that use terminals are much more likely to involve transaction processing—things like airline ticket reservation systems—rather than CAD systems or paint programs.

The PC-level GUIs that implement SAA are Windows for MS-DOS systems (see photo 2) and PM for OS/2 (see photo 3). Several GUIs based on X Window, including CXI, Motif, and PM/X (discussed below), have an SAA/Windows/PM look and feel designed to let users adapt easily from DOS-based systems to Unix-based systems. (In its original version, Windows was much more Mac-like in its appearance, but between a threatened lawsuit by Apple in 1985 and IBM's definition of SAA in 1987, it has come to look and act like the rest of its close brethren.)

The critical and most distinctive element of SAA GUIs is the fact that they don't depend on a mouse at all. You can do anything in an SAA GUI without a mouse, and, in fact, the system leans heavily on keyboard equivalents, including function keys. (You can gauge the pervasiveness of SAA's influence in the PC world by counting the number of DOS applications that now use the F1 key as the Help key.)

A characteristic element of the mouse-independent nature of SAA GUIs is the menu bar, which in SAA-speak is called the Action Bar. While the Mac interface requires a mouse-click to pull down a menu, you can do it in an SAA GUI by pressing a key instead.

Another characteristic of SAA GUIs is the style of windows they use. Unlike the Mac window, the size and shape of which you change by dragging the box in the lower right corner, an SAA window can be stretched by any of its borders. And under OS/2, there's an added feature: You can "minimize" a window down to an icon, and the program running in the window will continue to run. (You can also minimize a window under Microsoft Windows, but since Windows is not a multitasking operating system, the program in the window suspends operation until you "maximize" it again.)

While the DOS-based Windows and OS/2's PM share the SAA look and feel, each has its own API, imaging model, and windowing system. Although these parts are similar, they are not directly compatible, and porting an application from Windows to PM is not necessarily an easy task.

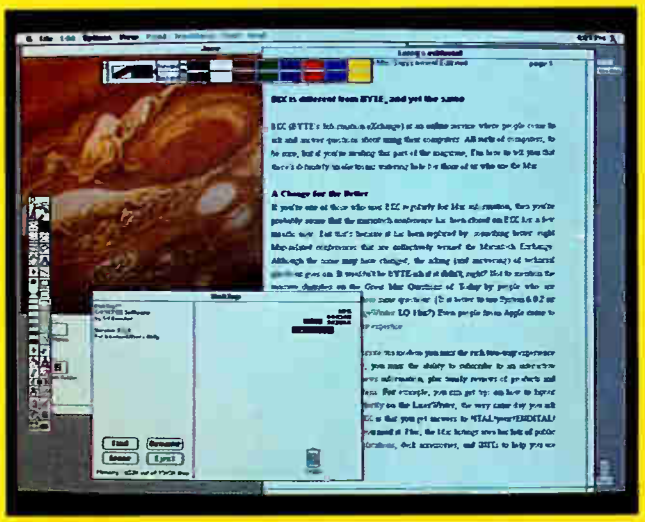
The emergence of powerful 80386 machines and the increasing acceptance of Unix as an operating system for them has led to a curious convergence between PM and Unix-based GUIs.

The Unix Brand: X

X Window user interfaces are a wide-ranging group—but underneath it all, X is X. The current version, X11, has become the most popular windowing system for Unix workstations, for two reasons. First, software that's written for the X Window System can (at least in theory) use any X Window display. The application program sends calls to the X Window library, which packages the display requests as X packets and sends them along to the X Window server, which decodes the X packets and displays them on the screen.

If that sounds a little complicated, it's because of X Window's second advantage: Since X Window is designed to work with networks, the software (called a *client application*) and the display may be on different computers. For example, the

continued



A GUI Gallery

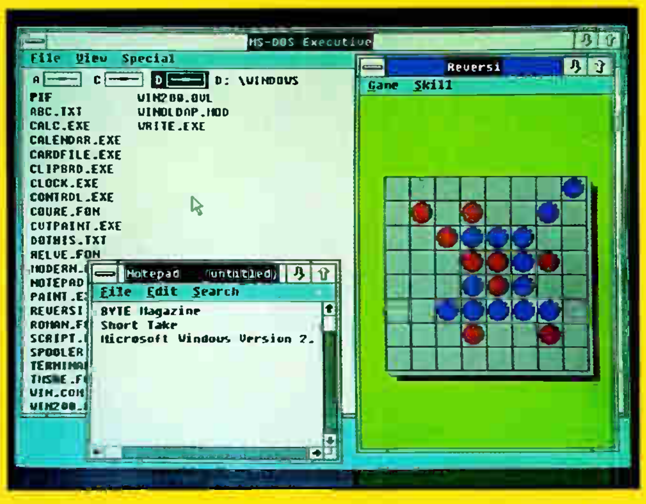


Photo 1: *The familiar Macintosh interface, with its windows, icons, and pull-down menus, launched a thousand graphical user interfaces—which promptly took off in their own directions.*

Photo 2: *In its original incarnation, Microsoft Windows looked more like the Macintosh interface; a threatened lawsuit from Apple, as well as IBM's solidification of its Systems Application Architecture, forced a shift to what is now the standard SAA look.*

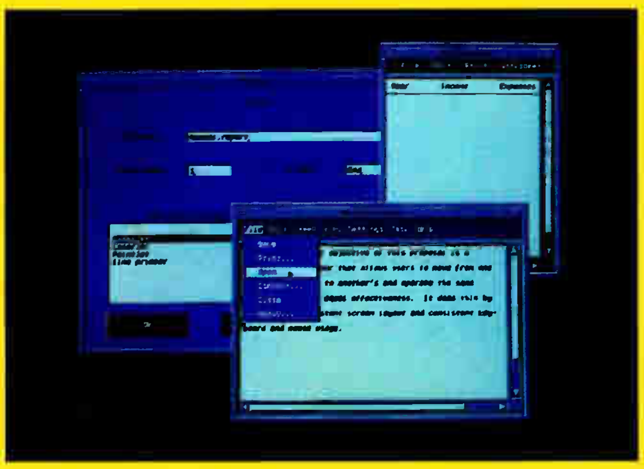


Photo 5: *The Common X Interface (CXI), developed by Hewlett-Packard and Microsoft, features a Presentation Manager look on an X Window platform.*

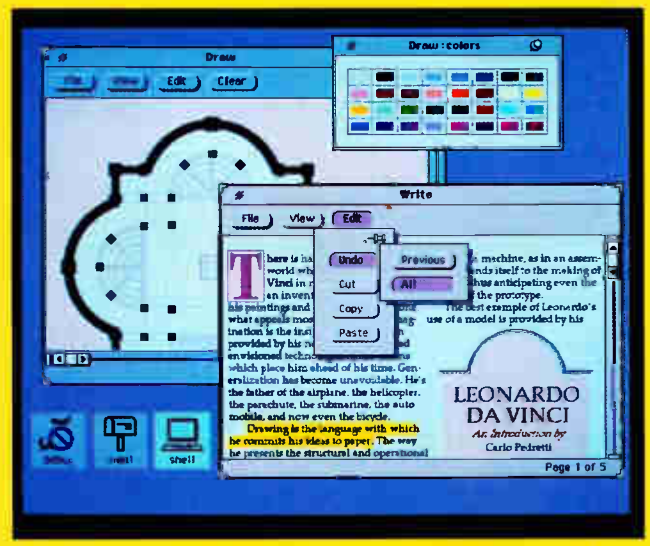


Photo 6: *Open Windows, from Sun Microsystems, features the Open Look interface, which provides several enhancements to the classic windows, icons, and pull-down menus interface.*

display can be on a workstation, while the application itself can be running on a mainframe or supercomputer. That's why the display requests have to be put into packets, so they can go zipping along the network as quickly as possible.

Exactly how those packets will be displayed on a workstation depends on the set of *widgets*, or predesigned window elements, the workstation uses. A radically different set of widgets could make the same program appear different on two separate workstations. But even if the look is different, the behavior of the program will be the same. For example, one workstation might have windows with a Close box in the upper left corner, while another might include it in a pop-up submenu. They'll look different—but whether you click on the Close box or select Close, the window will still close.

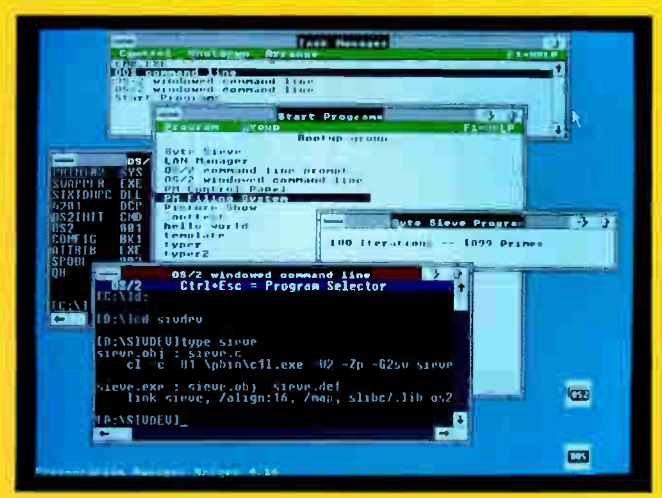


Photo 3: *OS/2's Presentation Manager is heir to the Microsoft Windows look and feel, although application developers have found that some similarities are only skin deep. Currently, several developers of graphical user interfaces for Unix systems are licensing the PM look for X Window–based interfaces.*

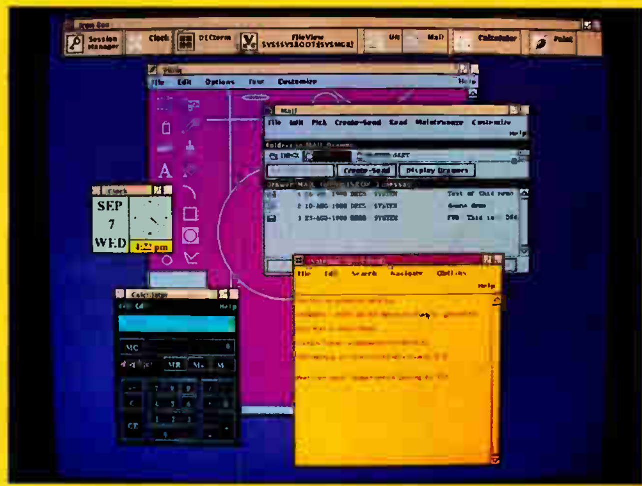


Photo 4: *DECwindows, Digital Equipment Corp.'s graphical user interface, was recently licensed by SCO for its integrated Open Desktop product.*

Photo 7: *Motif, the graphical user interface designed by the Open Software Foundation, combines DEC's XUI and HP's X Widgets with a Presentation Manager look and NewWave's three-dimensional windows on an X Window platform.*

Photo 8: *NextStep, the user interface for Steve Jobs's NeXT machine, includes a set of tools for object-oriented programming.*

Because X Window is so widespread on Unix workstations, hybrids have cropped up—on some systems, not all display operations are routed through it. For example, Sun's Open Windows system runs on NeWS in parallel with X Window; some display functions go through X Window, while others are handled by NeWS.

Currently, the "look" of X Window GUIs is divided into several camps: Hewlett-Packard uses an API called HP X Widgets. DEC based its DECwindows interface (see photo 4) on its XUI. Recently, Hewlett-Packard and Microsoft developed the Common X Interface (CXI) (see photo 5), with the look and feel of PM but working within an X Window environment. The Open Windows system from Sun Microsystems (see photo 6)

continued

Of Mice, Menus, and Lawyers

In 1985, Apple Computer threatened legal action against Digital Research, for its GEM operating environment, and Microsoft, for Windows. It claimed that the products infringed on Apple's copyright for the visual display of the Macintosh. Both companies signed agreements with Apple to resolve the disputes out of court.

According to the Apple-Microsoft agreement, Apple was willing to tolerate Windows 1.0 and several other programs (such as Excel) as long as Microsoft acknowledged that the displays of those programs were "derivative works of the visual displays generated by Apple's Lisa and Macintosh graphic user interface programs."

Then, in March 1988, Apple Computer filed a lawsuit against Microsoft and Hewlett-Packard, claiming that Microsoft Windows 2.03 and Hewlett-Packard's NewWave (which runs on top of Windows) infringed on the Macintosh's copyrighted visual display. Although versions 1.0 and 2.0 of Windows are not all that different (version 2.0 has overlapping windows, fatter screen borders, minimum/maximum icons for sizing windows, and mnemonic keyboard selections in menus and dialog boxes), Apple apparently thought that the program was beginning to look too much like the Mac interface.

Microsoft—mindful of its role as a major provider of Mac software—responded that the latest versions of Windows were covered by the 1985 agreement. Hewlett-Packard, which sells very little software for the Mac, went further, filing a countersuit against Apple. According to the Hewlett-Packard suit, the Macintosh copyrights were invalid because Apple didn't originate its displays but copied them from the work of windowing-interface pioneers such as Xerox's Smalltalk and Star interfaces. The suit also claimed that Apple had coerced Microsoft into signing the 1985 agreement and was trying to illegally prevent competition in the market for window-and-icon user interfaces.

While many observers thought that Apple could not win the suit, the judge in the case surprised them: In March, he ruled that version 2.03 of Windows was *not* covered by the 1985 agreement. (A ruling that it was covered would have ended the case in Microsoft's favor.)

At this writing, the case is headed for trial to determine whether or not Windows and NewWave infringe on Apple's copyrights. While an out-of-court settlement is again a possibility, some industry observers are concerned that a victory for Apple could spell trouble for other user interfaces and developers of software for those interfaces.

uses Sun's Open Look interface (see "Face to Face with Open Look" by Tony Hoeber, December 1988 BYTE).

Now, however, there is some movement toward a consensus, thanks in part to the Open Software Foundation. Last year, the OSF asked major software developers to submit GUI technologies for consideration as part of a standard operating environment for Unix. To most people's surprise, the OSF chose pieces from three companies—DEC, Hewlett-Packard, and Microsoft. Motif, as the OSF GUI is called, looks like PM, uses parts of the DEC and Hewlett-Packard APIs (as well as the three-dimensional windows from Hewlett-Packard's NewWave), and is based on X Window (see photo 7). The imaging model for Motif has not yet been selected.

Following the announcement of Motif, many companies announced support for the OSF standard and began tweaking their GUI software to be compatible with it. Hewlett-Packard and Microsoft are working on a version of PM for Unix (PM/X), with pieces similar to CXI and Motif. (While CXI merely *looks* like PM but is still based on X Window, PM/X will have its own windowing system. The idea is that PM/X will make it easy for application developers who have created applications under OS/2 to port those programs to Unix.)

Then, in February, The Santa Cruz Operation (SCO), which supplies Xenix, announced Open Desktop. This is a complete user interface for 80386-based Unix systems that incorporates the Motif GUI, DOS compatibility, SQL database facilities, and network support. Even IBM has announced support for Motif, despite the fact that it had earlier licensed the NextStep interface from NeXT. Although it's unlikely that IBM will support two different and incompatible user interfaces on its Unix platform, it could use some of the NextStep technology, such as the development toolkit and object-oriented programming features. Or IBM may have just been hedging its bets when it licensed NextStep, in case OSF failed to come up with an accepted standard interface.

Yet another GUI for X Window is X.Desktop, from IXI, Ltd., of Cambridge, England (see the text box "Managing the X Window Desktop" by Dick Pountain, page 356, January BYTE). X.Desktop incorporates its own API, although the company is working on implementations that use the Motif and Open Look APIs.

The multitude of SAA GUIs for Unix points up one of the major problems in trying to sort out GUIs—these things don't belong to simple categories. For example, CXI and Motif are X Window GUIs with an SAA look and feel. From the programmer's point of view, they belong to the X camp; from the user's standpoint, they've clearly got the PM look and feel.

Because X Window works on networks, it makes distributed computing a real possibility with mouse-and-menu GUIs. Unfortunately, anything that is graphics-intensive requires a lot of information to pass along a network, which can really slow down response time. X Window users complain that when you move the mouse, you have to wait several seconds for its on-screen pointer to catch up. On the other hand, X Window is the only GUI system that really does work in a multiuser, multicomputer, networked environment. For now, if you want to run windowing software on a Cray supercomputer and see the result on your personal desktop machine, X marks the spot.

The Mac-Like GUIs

Although the Macintosh essentially stands on an island in the GUI world, there are at least two other Mac-like GUIs. One is the original version of GEM from Digital Research (which survives on the Atari ST). Another is the user interface for Intuition, the operating system for the Commodore Amiga.

GEM was originally intended to be highly Mac-like, and so it was; so much so that in 1985, Apple threatened to sue Digital Research for copyright infringement. Digital Research responded by removing the offending features (including overlapping and movable windows) from the PC version of GEM, but the Atari ST version still has a Mac-like GUI. However, the ST lacks many of the Mac Desktop's niceties of implementation, such as long filenames, the ability to remove things from the Trashcan, proportional typefaces, and automatic saving of the desktop.

While the Amiga's Intuition wasn't threatened with an Apple lawsuit when it first appeared, it too shared many Mac-like characteristics. But Intuition added a feature that Apple didn't include until several years later: It was the first widely used multitasking GUI. Unlike X Window and SAA, Intuition isn't really designed for remote applications—it's a single-user multitasking system. But if the Finder is the father of desktop computer GUIs, Intuition is arguably the father of MultiFinder.

The Next Wave

NextStep (see photo 8) represents the high end of GUIs for single-user computers. NextStep itself is a huge piece of the operating system of the NeXT computer, including a number of utilities that would probably be viewed as applications on most systems. More than any other GUI, NextStep resembles the Mac in its ambition—it wants to change the world. But it also scrupulously avoids being too Mac-like. Unlike the Mac, where a file-selector box can display the files of only one directory at a time, the NeXT GUI can display files in multiple hierarchical pop-ups. It's sort of an improved version of the Mac file-selector box.

NextStep does have application icons; in fact, you can drag an icon out of a window and onto the desktop for convenient use. The idea is to keep regular-use items handy.

The other way NextStep resembles the Mac philosophically is in its rejection of anyone else's standards. In the Unix world, the windowing standard is X Window—but NextStep doesn't use X Window. In fact, nothing in the networking world works with NextStep except NextStep—in many ways, it is designed for a powerful single-user PC running Unix rather than for a fully networked machine.

Another hard-to-classify system is Hewlett-Packard's NewWave, which the company likes to call a "software applications environment." Currently built upon Windows, NewWave features an Object Management Facility that lets you incorporate pieces from different types of applications—word processor, spreadsheet, graphics program, whatever—into NewWave documents. A task manager, called the Agent, acts as a kind of supermacro processor to let you automate repetitive tasks involving a number of different applications. As such, NewWave is part GUI, part "super-application." Hewlett-Packard is developing one version of NewWave that will run on top of PM and another that will run on Unix using the Motif GUI.

Windows of Opportunity

In the months and years to come, you can expect to see even more interesting things popping up in the windows on your screens: extremely high-resolution images, multimedia applications, full-motion video, and new ways of interacting with data. Programs like NextStep and NewWave point the way to the future, where intelligent interfaces may not only help you to automate everyday tasks, but may even anticipate your actions and thereby increase productivity.

The real question is no longer the one the Macintosh raised in 1984—whether to use a GUI. Today the issue is what *sort* of GUI: which elements are most important, and which you can sacrifice in favor of things like better network performance or low cost. ■

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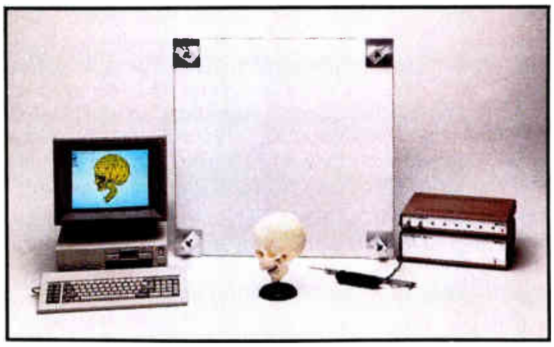

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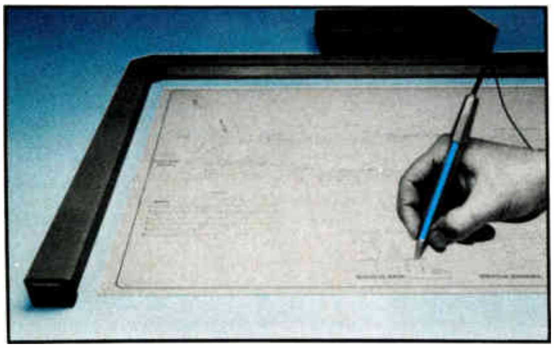

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THE QSIM SIMULATION TOOLKIT

Qsim lets you simulate the behavior of everything from atomic particles to galaxies

Roy E. Kimbrell, Linda Correll, and Robert Bass

With the right simulation tools, you can create a model of the universe or of the computer used to model the universe. You can answer questions that would be impractical or impossible to answer otherwise. With the right tools, simulation can be enlightening. With the wrong tools, it can be exasperating.

Some of the tools that modelers have developed are as specialized as a surgeon's, others as general as a hammer. The kind that you might use depends on what kind of model you're making. Some of these models describe and predict the behavior of the atmosphere, or fluids, or plasmas, or the earth during seismic activity. The stresses and strains on a structure, such as a bridge withstanding traffic and wind, require a special-purpose program called a finite-element model and often use a lot of computer power to complete the simulation. Simulations that use sets of partial differential equations to describe the models use custom programs on high-powered machines such as the Cray. Engineers use models of complex VLSI circuits to design and develop the chips. They use special-purpose programs and, perhaps, special-purpose machines to run them.

But we designed our own toolkit, Qsim, for using personal computers to model systems and LANs. Here, we will provide the Qsim Toolkit, with which you can also model factories, highways, banks, fast-food restaurants, mail rooms, magazine offices, and many other human endeavors.

Two manufacturers that make general-purpose modeling toolkits for the IBM PC are Pritsker & Associates (makers of Slam) and CACI (makers of Simscript). You can expect to pay $1500 for Slam or (gasp!) $8600 for Simscript. Either will give you a good start on creating many kinds of models. The documentation and training offered with either package might be just what you need.

By developing Qsim, we found we had better control over the modeling process because of our intimate understanding of the operations of the model. Model development became easier because we used a common programming language, C. Also, we were able to model many difficult processes because we could modify and add to the tools in the toolkit.

The Qsim tools are for creating queuing system models, but you can combine them with various modeling techniques to create other kinds of system models. Examples of queuing systems are everywhere. In the customer line for bank tellers, the customers are the ***entities***, the line is the ***queue*** (the structure holding the entities awaiting

continued

ILLUSTRATION: CAROL O'MALIA © 1989

service), and the tellers provide the *service*. Mathematical models of simple queuing systems can describe the lengths of the queues, the waiting time in the queues, and other details quite well. But whenever a few complications enter the picture, the mathematical models fail miserably, and a more direct modeling method is needed. You have to build a simulation of the system with model parts: queues, services, and entities. With the simulated system, you want to find the average behavior and the amount of variation in the system.

You may want to specify both the rate of arrival of entities and the time to service an entity as random variables with specified distributions (time variables that have a probability associated with each possible value). For example, the time you have to wait in line at McDonald's for lunch on Wednesdays will vary from zero (if no one else is in line at the counter) to several minutes (if you came in behind a crowd). There is an average wait at McDonald's on Wednesdays, and the probability of having to wait a longer time decreases the longer you wait.

The relationship between the length of time and its associated probability is a distribution. The interval between customer arrivals might be modeled by an exponential distribution. In a normal distribution, the values near the mean are more probable than those far from the mean. Both the mean and the standard deviation describe the particular normal distribution. Modelers use random distributions to describe the arrival rates of entities, the time to service an entity, and other features of a model.

The Model as an Interpreter

A model developed using the Qsim Toolkit is like an interpreter—similar to a BASIC, APL, or Pascal interpreter. Compiling a program results in machine language instructions that the computer performs to take on the programmer's design. But a program interpreter only models the design. It actually executes many machine language instructions while interpreting (modeling) each program command.

A system is to its model as a compiled program is to its interpreted counterpart. In order to answer questions about throughput and saturation of an Ethernet network at different work loads, we could build a network, run traffic over it, and measure the various details. This is similar to a compiled program. But if we build a model of a network that simulates its actions, we have something similar to an interpreted program. A model built using the Toolkit is interpreted. The scheduler, the create, the queue, and other tools perform the native functions. The data produced by the model approximates the data produced by the real system, just as the interpreted program approximates the actions of a compiled program.

Building a Model

To build a model, first you identify the basic processes in the system, and then you select the tools for modeling each process. You identify which processes create entities, which ones hold entities waiting for service, which ones service the entities, and which ones make decisions about what to do with the entities. You will have to design tools to model the processes that don't fit into these categories. For example, in modeling the low-level contention-backoff mechanisms in the Ethernet protocols, we had to add a tool we called a *trigger*. (We've seen other kinds of tools used to good effect, such as gates, collectors, and event detectors. Their names hint at their functions.)

When designing a new tool, try to keep it simple. If you can, break it down into several tools. This will simplify your design, make it easier to build the model, and, in the process, ensure that you really understand what you are trying to model.

You will also need one or more processes to terminate the entities you create unless you intend them to circulate through your network for the whole simulation. You may also need a process to stop the simulation. However, this service can be performed by a termination process, which counts the number of entities it terminates and then stops the simulation at a threshold. If you have indefinitely circulating entities, use a service routine to count them and terminate at an appropriate time. This service need not take any time; it just counts.

A Simple Example

Figure 1 illustrates a simple computer system. The system consists of a host computer, two operator workstations, and an analyst workstation connected by a LAN. (In this example, the transmission medium is not important, although the actual system modeled was an Ethernet LAN.)

The host receives messages from an outside source and performs an automated analysis of the messages. After the analysis is complete, the host sends the messages to one of the operators. The operator verifies the message and checks for sanity. If a message is garbled or contains questionable information, the operator flags it for review by the analyst. If the message appears to be in order, the operator sends it to the database and processing of the message is complete.

The analyst attempts to restore garbled messages, complete incomplete messages, and verify questionable data. If the message is hopeless, the analyst may terminate the message. Otherwise, it corrects the message and resends it to an operator for processing and entry into the database.

To make this example interesting, we've assumed that 40 percent of the messages need to be sent to the analyst, and, after analysis, 85 percent of those terminate. The other 15 percent go back to operators. We've also assumed that the host releases a message every 15 minutes, and each message spends 20 to 30 minutes with an operator. The analyst may take less time to process a message than the operator does, but the analyzed message might have to sit waiting to get the operator's attention. If a message has to go to the analyst first, the whole process can take an additional 45 minutes. The system administrator wants to know how long a message is in the system.

A run of the simulation for an 8-hour day using 27 messages showed that each message was in the system for an average of 62 minutes. The average wait to get to an operator was 29 minutes, and the average wait to get to the analyst was 8 minutes. Some messages went back and forth between the operators and the analyst—a typical problem in any bureaucracy.

We conducted the simulation using a model constructed with the Qsim Toolkit. This kit contains C language functions and data structures, and macros to help define them. A little "glue" code binds the model together. The functions and data structures are in five basic device groups: creates, queues, decisions, services, and terminates. The packets of data passed from one device to another are called *entities*. Figure 2 diagrams this example.

We selected three different random-number distributions for this model. Messages come in about every 15 minutes using an exponential distribution, a good choice for any kind of arrival distribution, such as customers, messages, and jobs. The operators take from 20 to 30 minutes using a uniform distribution, which delivers equally probable numbers falling into its range. Finally, the analyst needs about 45 minutes using a normal distribution, which produces random numbers grouped about a mean (average). After a simulated 8 hours, the scheduler stops the simulation and prints the results (see listing 1). The simulation takes between 3 and 4 seconds to run on an IBM PC.

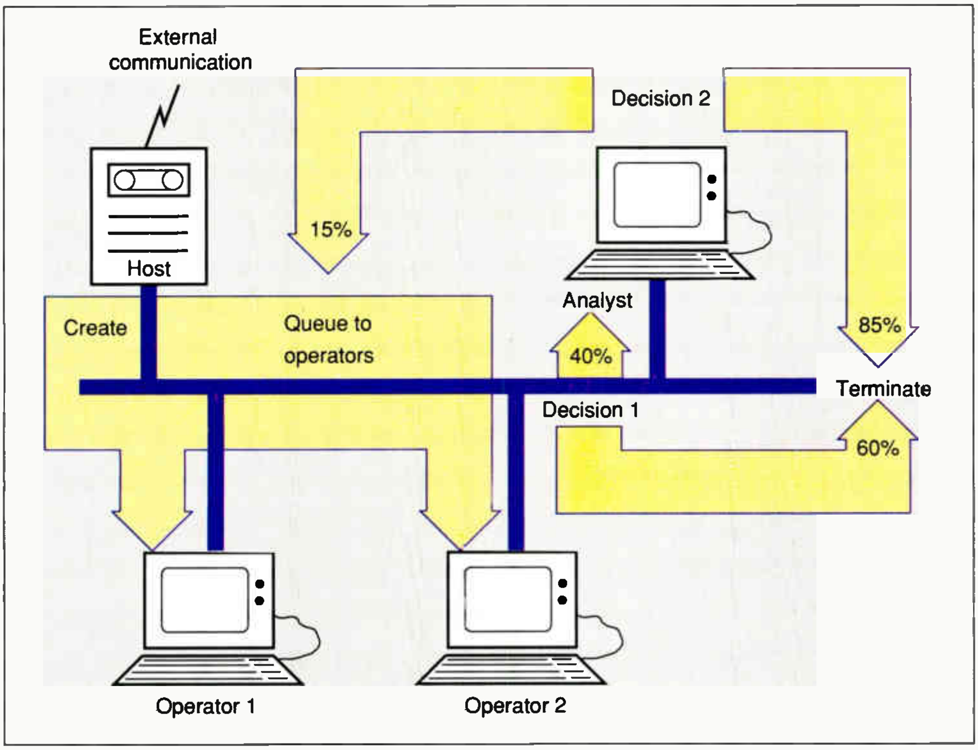

Figure 1: *We used Qsim to model an Ethernet LAN with a host computer, two operator workstations, and an analyst workstation.*

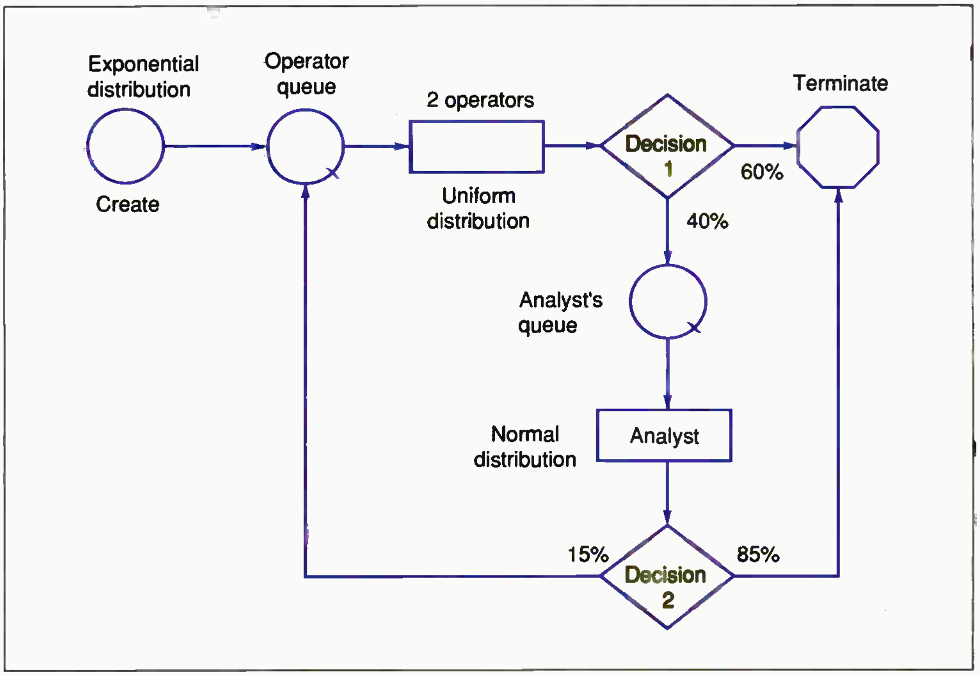

Figure 2: *The simulation model is a queue system: Entities (messages) are created by the host every 15 minutes or so and wait in the operator queue until one of the operator servers is free. After waiting from 20 to 30 minutes in the service, the entity enters a decision. The decision sends 60 percent to the terminate device and 40 percent to the analyst. The analyst queue holds each entity until the analyst service is free. After a random time (average 45 minutes), the entity enters the second decision, which sends 85 percent to the terminate device and 15 percent back to the operator queue to await a free server.*

The Scheduler

The scheduler operates behind the scenes and coordinates the activities of all the devices; it actually transfers entities among some devices. The scheduler has two parts: the event calendar and the engine. The various devices place data on the calendar by calling a Toolkit library function. The records placed on the calendar contain a pointer to a function, an optional pointer to an entity, and a time. When that simulated time arrives, the engine calls the function and passes an entity, if there is one.

Here is how it all works: The initialization device places calls to the create device in the model and a call to the stop function on the event calendar. Then, `initialization` calls the engine, which takes the next record from the event calendar and calls the function indicated by the pointer in the record, handing over any entity that is pointed to in the record. Suppose this is a call to `create`. The create device allocates memory for an entity and calls the operator queue, handing over the entity.

The operator queue puts the entity on its own internal queue and calls the operator service. The service looks at a local static

continued

String and Variable Construction Using an ANSI C Preprocessor

Before ANSI C, C programmers used peculiarities of their particular C preprocessors to facilitate code writing. A generation of C programmers established these tricks as an unwritten set of rules.

Two special features of the preprocessor seemed most vulnerable to this abuse: parameter substitution in strings, and comment elimination.

Parameter Substitution in Strings

The expansion of `baker(foo)` by

```
#define baker(X)   "X"
```

might be either "X" or "foo" depending on the implementation of the preprocessor. In the first case, the preprocessor protects strings from parameter substitution. In the second, the substitution is made.

The ANSI X3J11 committee specified the # operator to accomplish the equivalent of substituting parameters into strings within the macro's body. With this, the programmer can build up strings consisting of substituted parameters and explicit strings. The preprocessor looks for a parameter name following a #. When it finds one, it creates a string consisting of the substitution argument. When all strings have been created, those separated only by white space are joined. For example,

```
#define fubar(able, baker)\
  #able " and " #baker " or " #able #baker\
  " or " #able#baker
```

would expand `fubar(foo,bar)` to

```
 "foo" " and " "bar" " or " "foo bar" " or "
    "foobar"
```

which, after string concatenation, becomes

```
 "foo and bar or foo bar or foobar"
```

(The # and the parameter name can be separated by white space, as in `# able`.)

Comment Elimination

When the preprocessor eliminates comments after parameter substitution but before passing the program text on to the compiler, programmers can use the comment delimiters `/*` and `*/` to create variable names. `/**/` is a signal to other programmers that parameter concatenation is intended. Take, for example, the statement

```
#define able(X,Y)   X/**/Y
```

The statement `able(foo,bar)` would expand to `foobar`. Suppose you wanted to create a debug statement to print the values of a couple of variables. Further suppose that the variables you are printing all start with `dog` but end in a unique string. You might write the preprocessor statement like this:

```
#define debug(first, second)\
printf("first = %f, second = %d\n",dog/**/first,
  dog/**/second)
```

But, depending on how your preprocessor works, `debug(1,2);` might expand to

```
printf("1 = %f, 2 = %d\n",dog1,dog2);
```

or

```
printf("first = %f, second = %d\n",dog1, dog2);
```

or, if comments are removed before parameter substitution, it might expand to

```
printf("first = %f, second = %d\n",dogfirst,
 dogsecond).
```

The ## operator is used to join parameters with other text or with parameters in the macro's body. It is a concatenation operator. For example, `#define fubar(X,Y) X ## Y` expands `fubar(foo,bar)` to `foobar`; `#define snafu(Y) printf("%d\n", rhythm_ ## Y)` expands `snafu(aces)` to `printf("%d\n", rhythm_aces)`; and `#define secret(Y) printf("%d\n", Y ## _o_mine)` expands `secret(pal)` to `printf("%d\n", pal_o_mine)`.

ANSI Standard C Compilers

We use the latest versions of Lattice C, Microsoft QuickC, and Borland Turbo C on an IBM PC. At the present, the only one of the three that can successfully support these operators is Borland Turbo C.

Microsoft claims QuickC supports the full draft ANSI standard, but a bug prevents the preprocessor from properly expanding the ## operator. Perhaps this will be fixed soon. However, the standard is quickly nearing approval. When this happens, there will be a mad rush to issue compilers meeting the full standard.

Until that time, it is well to be aware of the new things in the draft standard and to attempt to write code using them.

variable to see if it's busy. (Since the service has two servers, the `busy` variable is really an array of two.) The variable contains the time at which the server expects to be free. If the current time is earlier than the scheduled time, the server is assumed to be busy. But if a server is free, the service calculates a service time and sets the server's variable. It then places a call to the first decision on the event calendar. The time in the call record is the time the service expects to be done with the entity. The service also places a pointer to the entity in the record. Then it returns the service time to the queue.

If the service rejects the entity because it's busy, it returns a −1. If the service accepts the entity, `queue` removes it from the queue and places a call (back to itself, but without an attached entity) on the event calendar. The time in the call is the current time plus the service time. When the service time has passed, the queue can try to pass another entity off the top of its queue

Listing 1: *The output from Qsim Toolkit.*

```
Total time in system =    1670.2085, count = 27
Average time in system =    61.8596
Max time in system =       132.1292
Min time in system =        20.1056

SERVICES:
      name|total|total busy|utilization|
----------|-----|----------|-----------|
s_operator|   30|  745.3597|     1.5844|
 s_analyst|    4|  158.3463|     0.3280|

QUEUES:
      name|max_len|cur_len|total_wait|count|avg_wait|
----------|-------|-------|----------|-----|--------|
q_operator|      5|      0|  871.8822|   30| 29.0627|
 q_analyst|      2|      2|   46.4740|    6|  7.7457|
```

to the service.

The queue now returns to the create device, which computes the next time it should create an entity, places a call to itself on the event calendar with that time, and then returns control to the engine. The engine takes the "soonest" record off the event calendar and calls the function pointed to. Eventually, it will call the first decision and pass the entity stored there by the service. The first decision will generate a random number between 0 and 1. If this number is less than 0.65, it will call the terminate passing the entity. Otherwise, it calls the analyst's queue. The analyst's queue, the analyst's service, and the second decision all behave as previously described. The terminate device tallies the counts and times associated with the entity.

Eventually, the engine will call the stop function placed on the event calendar by `initialization`. The stop function will print statistics and exit, thereby ending the simulation.

The Qsim Toolkit

We designed the Toolkit with two principles in mind:

- All the programming should be in ANSI C (or as close to the proposed standard as we can make it), thereby obviating the need for a special preprocessor to create modeling code or the need for a "simulation" language such as Simscript or Slam.
- The programming should be as simple as possible.

We tested the simulation Toolkit by coding both simple and complex models in Slam and with a combination of Qsim and Turbo C. The results were somewhat different because of the different random-number-generation techniques.

However, we ran all the models for extended periods to assure ourselves that the statistical results were valid. Averages and standard deviations, for example, approached the same values for the same model in both Slam and C. Finally, using mathematical techniques, we computed the results of the simplest models and found the Toolkit to give the proper values.

Coding the Example

Listing 2 contains the macros that generate the code describing the devices. The three DEFINE macros declare function prototypes and allocate storage for queue and service structures. The queue structure holds the top of a queue, as well as performance data such as maximum and minimum numbers in the queue. The service structure holds performance data only. The type of data in these structures is up to the modeler.

Listing 2: *The macros that are used to define function prototypes and allocate storage to queues and service structures. (The #s and ##s internal to the define statements are ANSI C extensions to the C preprocessor directives. See the text box "String and Variable Construction Using an ANSI C Preprocessor.")*

```
#define DEFINE_CREATE(c_name)  \
  void c_name();\
#define DEFINE_QUEUE(q_name)  \
  void q_name(ENTITY *);\
  QUEUE_STRUCT q_name ## _q={#q_name};
#define DEFINE_SERVICE(s_name)  \
  systime_t s_name(ENTITY *);\
  SERV_DATA s_name ## _s={#s_name};
#define SCHEDULE(name, entity, time)  \
  schedule(name, (ENTITY *)(entity), \
  (systime_t)(time));
#define CREATE(c_name, create_time, feature, \
  create_freq, next_device)\
  void c_name(){\
  extern systime_t now;\
       next_device(create((systime_t)create_time, \
       (double)feature));\
       SCHEDULE(c_name, 0, now+create_freq);\
       }
#define QUEUE(q_name, next_device)  \
  void q_name(ENTITY *entity){\
  systime_t srvtime;\
  ENTITY * top;\
       if (entity) nq(&q_name ## _q,entity);\
       if ((top = topq(&q_name ## _q)) &&\
            srvtime=next_device(top)) >= 0){\
            dq(&q_name ## _q);\
            SCHEDULE(q_name, 0, srvtime);\
       }\
  /* increment counters (if desired) */\
  }
#define SERVICE(s_name, number_servers, \
  service_time, next_device)\
  double s_name(ENTITY *entity){\
       static systime_t srvtime[number_servers],
       wait_time;\
       extern systime_t now;\
       unsigned short i;\
       for (i=0; i<number_servers; i++) \
       if (srvtime[i] <=now)
break;\
       if (i == number_servers) return -1;\
       /* note: service_time may be a function call */\
       wait_time = service_time;\
       srvtime[i] = now + wait_time;\
       SCHEDULE(next_device, entity, srvtime[i]);\
       /* increment counters */\
       q_name ## _s.total++;\
       q_name ## _s.total_busy += wait_time;\
       q_name ## _s.srvtime = srvtime[i];\
       return srvtime[i];\
       }
```

The SCHEDULE macro is just an easier way of calling the schedule function. The casts are necessary when constants (such as 0) are used as parameters.

CREATE calls the `create()` library function to make a new entity. It then passes an entity pointer to the device named in

continued

Listing 3: *A simple example of Qsim's decision devices, terminate devices, and the stop function.*

```
void decision_1(ENTITY *entity){
  if (drand() < .6) term(entity);
  else q_analyst(entity);
  }

void term(ENTITY *entity){
  /* increment counters then ... */
  free(entity);
  }

void stop(void){
  /* compute and print statistics then ... */
  exit(0);
  }
```

Listing 4: *The C language source code using the Qsim Toolkit for the example in figure 1.*

```
#include <stdio.h>
#include "sim.h"
#include "sim_lib.h"
#include <float.h>

DEFINE_CREATE(messages);

DEFINE_QUEUE(q_operator);
DEFINE_QUEUE(q_analyst);
QUEUE_STRUCT
     *q_array[]={&q_operator_q,&q_analyst_q,NULL};

DEFINE_SERVICE(operator);
DEFINE_SERVICE(analyst);
SERV_DATA *s_array[]={&operator_s,&analyst_s,NULL};

void decision_1(ENTITY *);
void decision_2(ENTITY *);
void term(ENTITY *);
void stop(void);

void main(int ac,char **av) {
  SCHEDULE(messages,0,0);
  SCHEDULE(stop,0,8*60.0*10);
  engine();
  }

CREATE(messages,now,0,expon(15.0),q_operator)

QUEUE(q_operator,operator)
SERVICE(operator,2,unfrm(20.0,30.0),decision_1)

void decision_1(ENTITY *entity){
  if (drand() < .6) term(entity);
  else q_analyst(entity);
  }

QUEUE(q_analyst,analyst)
SERVICE(analyst,1,normal(45.0,10.0),decision_2)

void decision_2(ENTITY *entity){
  if (drand() < .85) term(entity);
  else q_operator(entity);
  }

static systime_t total_time, max_time, min_time
     =FLT_MAX;
static unsigned count;

void term(ENTITY *entity){
  systime_t tis;

  count++;
  tis = now - entity->time;
  total_time += tis;
  if (max_time < tis) max_time = tis;
  if (min_time > tis) min_time = tis;
  free(entity);
  }

void stop(void){
  int i;

  printf("Total time in system = %f, count =
    %d\n",total_time,count);
  printf("Average time in system =
    %f\n",total_time/count);
  printf("Max time in system = %f\n",max_time);
  printf("Min time in system = %f\n",min_time);
  printf("\nSERVICES:  name|total|total busy|total
       |utilization|\n\---------------|-----|
       ----------|-----------|\n");
  for (i=0;s_array[i];i++)
    printf("%15.s\t%ld\t%f\t%f\n",
    s_array[i]->name,
    s_array[i]->total,
    s_array[i]->total_busy,
    (s_array[i]->srvtime)
      ? s_array[i]->total_busy/s_array[i]->srvtime
      : 0
    );
  printf("QUEUES\n");name|max_len|cur_len|total wait|\
       count|average_wait|\n---------------|-------|
       -------|----------|-----|------------|\n");
  for (i=0;q_array[i];i++)
    printf("%15.s\t%d\t%d\t%d\t%f\t%d\t%f\n",
      q_array[i]->name,
      q_array[i]->max_len,
      q_array[i]->cur_len,
      q_array[i]->total_wait,
      q_array[i]->count,
      (q_array[i]->count)
      ? q_array[i]->total_wait/q_array[i]->count
      : 0
      );
  exit(0);
  }
```

the macro's parameter list. Finally, it schedules a call to itself. Notice that the function makes no provision for rejecting the entity. The device must be a service with a short service time, a service with plenty of servers, or a queue. If the device is not a queue, there is room here for a subtle bug when it rejects entities and the create doesn't test for it.

QUEUE defines a function that accepts a pointer to an entity. When an entity pointer exists, QUEUE calls nq( ) to place the pointer on its queue. Then, if an entity pointer is on the top of its queue, it calls the service s_name, passing on the entity pointer. The service returns a positive number (or 0) when it has accepted the entity. QUEUE removes it from the queue and schedules a call to itself with a null entity pointer. When this call to itself is made, the queue attempts to pass another entity off the top of its queue to the service. The call is scheduled even if no entity is presently on the queue, because an entity may arrive before the service is ready to accept another. The nq( ) and dq( ) functions maintain some counters in the queue's QUEUE_STRUCT, but you may want to add to the QUEUE macro.

SERVICE accepts an entity pointer. This function allocates a static array of counters for the service times. DEFINE_SERVICE could include this array in the SERV_DATA structure in the same way that DEFINE_QUEUE builds its queue structures. It's a matter of preference. The now variable contains the virtual simulation time and is updated by the engine. The service function looks at the time remaining in all the slots in the srvtime array; if all servers are still busy, the service function rejects the entity. Otherwise, it computes a wait_time (the time the server will be free again) and schedules a call on the next device. The SCHEDULE call contains a pointer to the entity. When the engine calls the device, it passes this pointer.

Listing 3 is a simple example of decision devices, terminate devices, and the stop function. We used these macros in coding the example shown in listing 4.

We didn't use macros to define the decision and terminate devices and the stop function because these definitions seem to vary from model to model. These devices could make their choices based on anything in the model—on counts, calculated values, or events—not just on random numbers. The stop function only needs to display the simulation statistics.

In the example in listing 4, the engine calls decision_1( ), passing an entity pointer. Sixty percent of the time, decision_1( ) calls term( ); 40 percent of the time, it calls q_analyst. In both cases, control over the entity is passed. This is an example of a simple decision. In other models, the decision could be made based on a value carried by the entity (perhaps in feature) or based on something else in the model—the number of entities in a queue, for example.

The terminate's main job is to update counters that keep track of the number of entities successfully traversing the model and the time they take doing so. It is also responsible for freeing the memory allocated to the entities. The term( ) function could, if desired, call stop( ) when a certain number of entities arrive. The stop, whether called by term( ) or by the engine, prints the statistics and exits.

While analyzing your system and identifying the various processes, you will also decide how each process passes the entities on to the next process. In the same way, the tools will pass entities from one to another. In listing 2, we list the code for CREATE, QUEUE, and SERVICE macros and show a sample decision. In each of these, there is a next_device specified. The names here are used to connect one device to another.

Suppose you want to model a workstation that spools print jobs to a queue and a printer server. The workstation is modeled by the CREATE and the QUEUE, the printer server by the SERVICE. You would connect a CREATE named c_workstation_1 to a QUEUE named q_workstation_1 to a SERVICE named s_printer_server. The code would look like this:

```
CREATE(C_workstation_1,0,0,normal(10,5),
   q_workstation_1);
QUEUE(q_workstation_1,s_printer_server);
SERVICE(s_printer_server,1,unfrm(10,15),
   terminate_1);
```

Here, the distributions (normal and unfrm) describe how often a new entity is to be created or how long it will take to service the entity. The terminate_1 is another device used—in this case, to terminate the entity and free the allocated memory. You can give it other uses. Some of the tools are macros; others are C code. All assume the presence of a background scheduler activating tools and, perhaps, passing entities to them.

Coding a Model

When coding your own model, place the tools in the following order:

- *Includes.* Be sure to #include "sim.h" and "sim_lib.h". Sim.h contains the macros that #define some of the tools, as well as type definitions for various data structures. Sim_lib.h contains function prototypes for the scheduler, for some of the queuing primitives (nq, dq, and topq), for the random number generator (drand), and for some distributions (expon, normal, unfrm, and so on).
- *Prototypes.* These are C language function prototypes. However, there are macros to help write the create, queue, and service prototypes. You will need to write your own prototypes for decision, terminate, and stop functions.
- *Service data array.* If you use our style of coding, the following will work:

```
SERV_DATA *s_array[]={&service name_s, &service
 name_s, ... , NULL};
```

Each service collects data on the number of entities it processes and the time it takes to process them. When the DEFINE_SERVICE macro creates a prototype service function, it also creates a data structure to hold this data. The s_array holds pointers to these structures (the reason for the _s at the end of each service name). At the end of the simulation, the stop routine prints out the data from the service data structures. The NULL at the end of the list of service names controls looping.

- *Queue data array.* Like the service data array, the queue data array holds data about the number of entities on the queues and how long they stay there. The definition and syntax is similar to that of the service data array:

```
QUEUE_STRUCT *q_array[]={&queue name_q, &queue
 name_q, ... NULL};
```

- *Main function.* The main function just schedules starts for all the create devices, schedules a call to the stop function if you want the simulation stopped at a specific time, and then calls engine( ) to start the simulation. It should look like this:

```
void main(){
    SCHEDULE(create_name,0,start_time);
    SCHEDULE(create_name,0,start_time);
        %
        %
        %
    SCHEDULE(stop,0,stop time);
}
```

The create_names are the names of the creates declared in the prototypes above. The start_times are the times you want each create to start producing entities; if you want this to take place at the beginning of the simulation, use zero. Stop is the name of the stop function. (A stop function is any function that exits the program without returning to the calling function.)

- *Create, queue, service, decision, terminate, stop, and other functions.* The create, queue, and service functions are created by using the macros. When invoked, these macros define entire

continued

functions. The functions differ as their parameters differ. For example, create functions differ in their names, their start times, their frequency of creates, and the device to which they pass their created entities.

If decision devices are used, these functions will form an interconnected network. Place the macro calls and other function definitions in whatever order you please. (If you faithfully use prototype definitions of the functions, the order isn't important to C.) We usually start at one side of our picture of the system and continue across the picture to the other side. (Grouping functions by type makes it difficult to debug the model because its form is not as clear.)

Extending the Toolkit

The Toolkit has primitives for queuing system models. But what about other kinds of models? Can the Toolkit be extended to enable it to build others? In general, it can, though for some complex models the tools are specific to the particular model. But general-purpose techniques tend to be slow.

Aside from these exceptions, models are generally based on systems of mathematical equations. Often the model can be stated briefly, in less than a page of code. Other aspects of the model (such as routines for computing special mathematical functions, input routines, and display routines) may add many more pages of code to the model. The equations are difficult or impossible to solve exactly (otherwise, there would be no need for the model), and their solutions are approximated by using iteration. Systems of equations might model something as simple as the inventory in a store or as complex as a chemical reaction.

A mathematical model and a queuing model can interact through an event and a reaction. An event occurs in a queuing system when something in the system causes one or more variables to change value. A reaction is a decision made on the basis of the value of a variable.

Some Examples

The inventory level for an item in a store decrements when a customer buys one. The event is the change in the quantity in stock; the reaction is the decision to order more stock. This decision is usually based on an inventory threshold: The reaction occurs when the inventory level falls below the threshold. The same thing happens in a fast-food restaurant: The cook makes more hamburgers when the ready level falls below a threshold. The threshold may depend on the time of day or the season.

Customers might change lines (queues) based on the number in each queue or on the perceived service rate of each server. The events are the service variables or queue-length variables; the reaction is the jockeying from one line to another.

The number in a queue could cause the service rate to change. For example, in a crowded hospital, the arrival of more patients in dire need than the hospital can support might cause the decision to release patients who are nearly well.

The completion of a disk operation in a computer system might be modeled as an event and a reaction.

Some Methods of Modeling

All these examples have in common the change of state of a variable and a possible reaction to this change. Code to change these variables can be placed anywhere in the model. In the case of the inventory model previously mentioned, the inventory variables might be changed in a service module. The reaction to the change might also be in the same module.

One way for it to occur elsewhere is by writing a special service module. To model an inventory control person, you could write a module that periodically checks the inventory levels. You could then schedule an initial call to this module by calling the scheduler and passing the module's name during initialization. The module could schedule subsequent calls to itself. When called, the module would check the inventory levels and take appropriate action. In this situation, there is no direct connection between the event (the decrement of the inventory level) and the reaction (the ordering of more items), except through the value of the inventory variable.

In the inventory model, the variable changes by discrete amounts. In other models, the changes are continuous and can be complex. For example, in models of kinetic systems (e.g., solar systems and economic systems), there are several interdependent variables. Models of these continuously variable systems are usually stated in a few mathematical equations, though the equations are such that exact solutions are difficult or impossible. The SCoP modeling system (produced by the National Biomedical Simulation Resource of Duke University Medical Center in Durham, North Carolina) can be used to create continuous models of many kinds of systems, although it, too, has its limitations.

One way to solve complex systems of equations is to assign values to the variables and then iteratively increment the independent variable (or variables) by a small amount or feed back the results of the first computation into the second. The values assumed by the dependent variables eventually approximate the solutions. These can be plotted against the independent variables to show their relationship. These methods are used by SCoP and Borland's Eureka. The SCoP package contains examples of continuous models and their methods of solution.

You can make the changes in the independent variables (which drive the continuous model) using the independent service model described above. But the increments to the independent variables usually must be quite small (to keep the model sane). A variable that takes on values from 0 to 1 might be incremented by 0.001. Calling the service module to make each increment is inefficient. It is a good idea to call the service module the first time, let it iterate a fixed number of times or until it reaches an intermediate threshold, and then have it schedule the next call to itself. On the next call, it will iterate a maximum number of times or until it reaches a threshold. And so on.

Most models use only a few tools. But models of factory operations typically combine continuous-event, discrete-event, and queuing systems. For example, in a brewery, the concentration of alcohol in the beer or wine depends on both biological and chemical factors. The time to reach a threshold concentration would be modeled by a system of equations. Other factors of the brewing operation cause the beer or wine to be staged to various tanks and processes. These factors might also be modeled by systems of equations. The factory model will contain discrete variables: the inventory of bottles, carloads of raw product, and so forth. Finally, the model will have queuing elements: the conveyer system for the bottles, the cases of product, and the staging of the brewing process itself. All these elements must be integrated in a complete model. The elements are integrated through the events (variable changes through thresholds) and responses (reactions to the crossing of a threshold). ■

Editor's note: *The source code for Qsim is available in a variety of formats.* *See page 5 for further details.*

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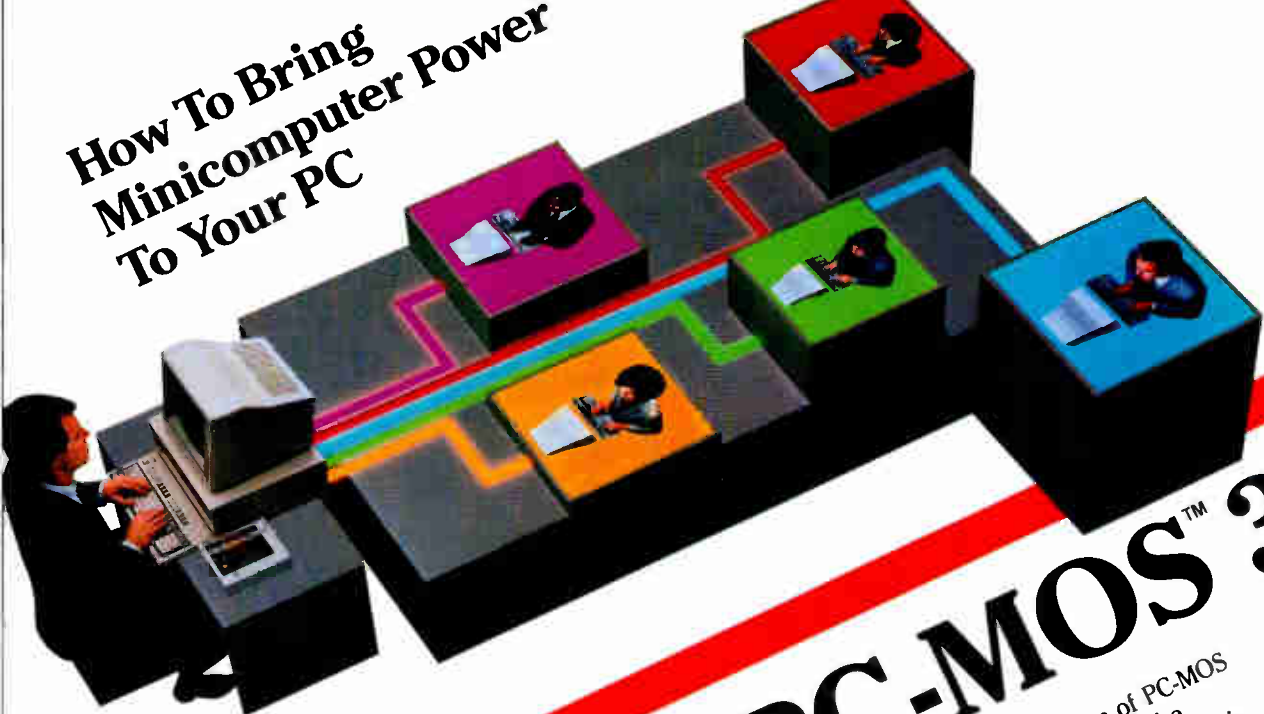
How To Bring Minicomputer Power To Your PC



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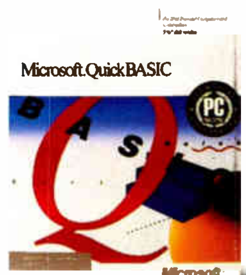

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THE LIGHT AT THE END OF THE LAN

A new standard lets optical LANs move more data more efficiently

The era of the LAN is now here. Ethernet, ARCnet, and Token Ring adapters are available for virtually every type of computer. You can walk into a computer store and walk out with a complete, easy-to-use kit that will interconnect an entire room (or building) full of machines. Still, some users require more speed and reliability than current LAN standards provide. The Fiber Distributed Data Interface (FDDI) standard addresses these needs.

Most current LAN standards (see table 1) have data rates in the range from 1 to 20 megabits per second. ARCnet, sporting a low clock rate but dependable and efficient, runs at 2.5 Mbps. Ethernet operates at 3 or 10 Mbps, Token Ring at 4 or 16 Mbps. But these speeds are not always fast enough.

Diskless Unix workstations, for instance, can slow to a crawl when they swap blocks of virtual memory to mass storage across a LAN. Database applications often "lock" areas of a file to preserve internal consistency; if a LAN isn't fast enough, every user may have to wait for a transaction to complete. A few channels of digitized audio and video—even with the best compression and decompression techniques—can strain a network to the breaking point. The bandwidth of a single ESDI hard disk drive, which can retrieve data at 10 to 15 Mbps, can swamp most current LANs.

The need for faster LANs was anticipated in the early 1980s, when ANSI assembled the X3T9.5 working group to develop higher-speed LAN standards. The first standard to come out of this group was the Locally Distributed Data Interface. LDDI was a broadband system that could span only 1 kilometer and connect only seven nodes, making it unsuitable for many applications where LANs are used today.

In 1986, ANSI published a draft of the most recent standard: FDDI. It supports up to 500 nodes distributed over a loop of up to 100 kilometers in circumference, and it runs over optical fiber at a signaling rate of 125 million baud, delivering 100 Mbps of data. (See the text box "Why Fiber?" on page 271.) The topology is a token-passing ring similar to the IEEE 802.5 Token Ring (see my column in the January BYTE). While the FDDI standard makes use of lessons learned in the development of the Token Ring standard, the signaling schemes and token-passing protocols are different.

FDDI and the OSI Model

Figure 1 shows the components of the FDDI standard, as well as the relationship of those components to the International Standards Organization's Open Systems Interconnection (OSI) model.

The Physical Medium Dependent (PMD) standard specifies the characteristics of the fiber-optic medium, the connectors used to attach the medium to each station, the wavelength used for transmission, the power requirements for the transmitters, and methods for optically bypassing inactive nodes.

The Physical (PHY) standard defines the 125-MHz clock speed, the clocking scheme, the data-encoding scheme, and the control symbols used in the network.

The Media Access Control (MAC) standard handles token passing, frame formation, addressing, error detection and recovery, and bandwidth allocation among the nodes.

Finally, the Station Management (SMT) standard handles station insertion and removal, ring configuration, error logging, and other network management services. Strictly speaking, SMT falls outside the OSI model; however, it is the "glue" that helps all the other layers play together.

continued

Table 1: *How the Fiber Distributed Data Interface standard stacks up against two other popular LAN standards: Token Ring and Ethernet.*

	FDDI	Token Ring	Ethernet
Medium	Fiber	Twisted-pair or fiber	Coaxial cable
Data rate	100 Mbps	4/16 Mbps	3/10 Mbps
Encoding efficiency	80%	50%	50%
Maximum station	2 km	300 m to medium-access unit	500-m separation
Maximum coverage	100 km	Varies with configuration	2.5 km
Maximum nodes	500	260	1024
Topology	Dual-ring	Single-ring	Bus
Access	Token passing	Token passing	CSMA/CD protocol

Perhaps this is the reason that SMT has been the slowest area of the standard to come together. It has the most global effect on how FDDI systems work. No link-level protocol is specified by FDDI. Most systems will probably use the IEEE 802.2 link-layer-control protocols or their equivalent.

The Physical Layer

According to the PMD standard, FDDI nodes transmit light at a wavelength of 1300 nanometers. FDDI uses multimode fiber. Single-mode fiber, while it has lower loss per unit distance, is more expensive and very tricky to couple. The core of the fiber can be either 62.5 or 85 microns thick; the outer cladding must be 125 microns thick. When assembled properly, an FDDI fiber link has a worst-case bit error rate of 1 in 1 billion.

FDDI nodes can include an optical bypass switch, which lets light pass through up to three consecutive inactive nodes unhindered. While FDDI has redundant loops that let data be routed around a disabled node, a bypass switch reduces the need to rely on these loops.

The standard FDDI connector is a duplex plug with incoming and outgoing fibers. A node can have either one or two of these connectors. If it has two connectors, it's called a Class A node. One fiber on each connector is used for normal operation; the other one is part of a backup ring that routes traffic around disabled nodes (see figure 2).

The backup ring runs in the opposite direction from the main ring; in the initial standard, it doesn't normally carry data (although proposals to let it do so are being considered). Its two main purposes are to aid in ring configuration and to route data around faults (see figure 3).

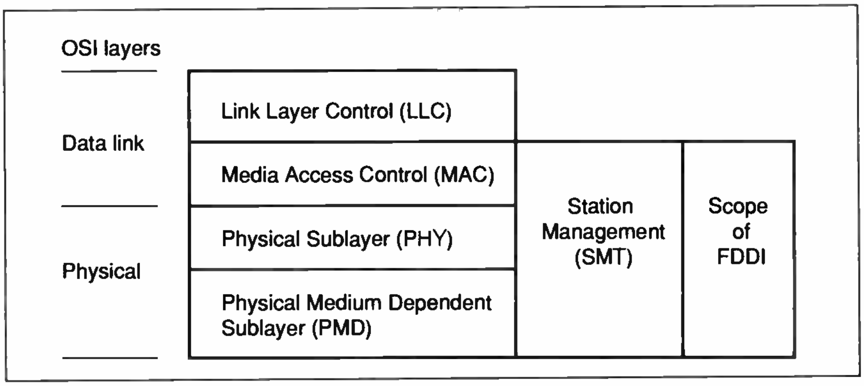

Figure 1: *The four key documents of the Fiber Distributed Data Interface specification include PMD, PHY, MAC, and SMT. FDDI does not specify a standard LLC protocol, but the IEEE 802.2 protocol is a likely candidate.*

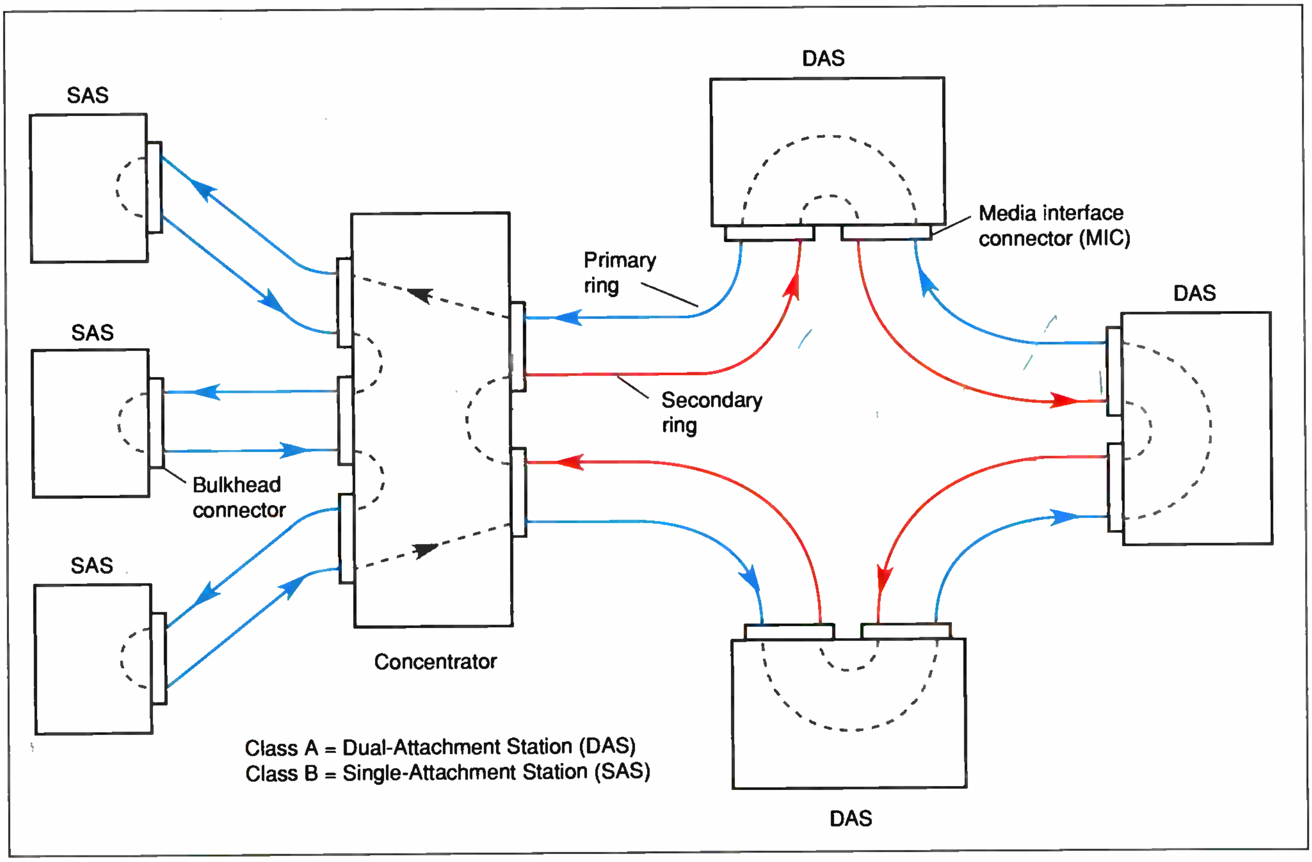

Figure 2: *A Fiber Distributed Data Interface network may consist of Class A or Class B nodes, or a mixture of the two types. Class B nodes must connect to the network through a wiring concentrator; Class A nodes can connect directly to the main ring and have provisions to reroute traffic around faults. Since Class B nodes attach only to the primary ring, they may not be able to continue working when certain kinds of faults occur.*

Token Ring and Ethernet both use Manchester encoding for data; in these schemes, it takes 2 transition times, or baud, to represent a single bit. FDDI is more efficient. It uses 5 baud to represent every 4 bits (see the text box "Group Encoding and FDDI" on page 272). The clock speed at each node is 125 MHz, resulting in a data rate of 100 Mbps.

Unlike the IEEE 802.5 Token Ring, where the active monitor provides the clock signal for the entire ring, FDDI uses a distributed clocking scheme. When a station repeats data, it reclocks it with an accuracy of ±50 parts per million. Every bit is decoded, checked, and reencoded at every station. An *elasticity buffer*—a first-in/first-out buffer that can compensate for differences between the input and output clock speeds—absorbs the jitter that may result from signal distortion in the multimode fiber. And a *smoother* adds "idle" bytes between frames to make sure that they are separated by a gap of at least 6 bytes. (This gap increases the chances that a

continued

Why Fiber?

Fiber-optic media are desirable for use in high-speed LANs. Fiber has high bandwidth (hundreds or even thousands of megabits per second), and it can carry signals for long distances without repeaters. Noise levels are up to a million times lower than those for coaxial cable, and fiber is difficult (although not impossible, as some believe) to tap.

Many of fiber's unique advantages are due to the facts that it's not metallic and it won't conduct electricity. Fiber is not affected by electromagnetic radiation, nor does it generate any—thus, no shielding is required to meet FCC requirements. You can't get a shock from an optical fiber, nor can it cause ground loops. (Most LANs must have isolation transformers to meet UL requirements; fiber-optic LANs don't need them.) Lightning won't send a deadly charge down a fiber to cripple all the stations on a network at one stroke. In addition, fiber can't corrode, which means that it's likely to last a long time in harsh environments.

The highest-performance fibers are made of glass and are no thicker than a human hair. However, the more common and economical varieties used in the Fiber Distributed Data Interface are about 10 times thicker. It's easier to handle and manufacture thicker fibers, but they have lower bandwidth and greater signal loss per unit distance.

Plastic fibers are more robust, but they are lower in performance than their glass counterparts. However, all varieties of fiber outperform conductive media by a wide margin, and they all are smaller and lighter than the coaxial cable or twisted-pair medium that they replace.

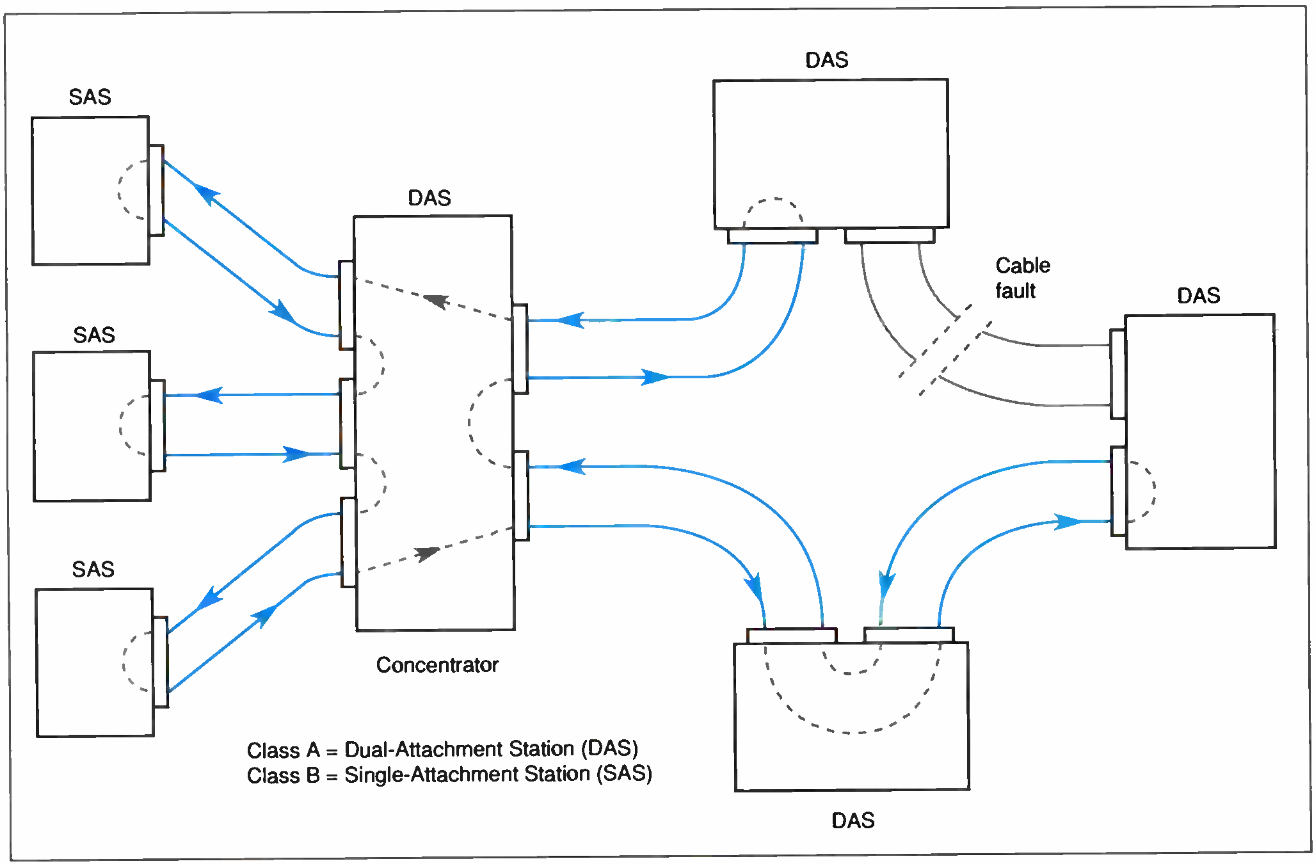

Figure 3: *The secondary ring in a Fiber Distributed Data Interface system is used to keep the network intact during a single-point fault. Here, the ring wraps to avoid a damaged section of cable.*

Group Encoding and FDDI

In the Manchester encoding schemes used by Ethernet and Token Ring, it takes 2 bauds—or potential transitions—to represent a single bit (see the text box "Encoding" on page 366 of the January BYTE). Thus, a 10-megabit-per-second Ethernet must send 20-MHz signals over the wire, and a 16-Mbps Token Ring must send 32-MHz signals. If the Fiber Distributed Data Interface standard used the same scheme, the fiber would need a bandwidth of 200 MHz to carry FDDI's 100 Mbps.

To make the best use of lower-cost fiber, FDDI uses *group encoding* instead. Group encoding is to Manchester encoding what run-length-limited encoding is to modified-frequency-modulation encoding in the world of hard disk drives (see the text box "RLL Encoding" on page 296 of the February BYTE). Like RLL, FDDI's 4b/5b group code gets more use out of the same bandwidth by allowing fewer transitions but limiting run lengths; no more than 3 bauds without a transition are allowed. The 4b/5b designation means that every 4 bits are represented by 5 bauds; some special groups of bauds are used to carry control information. The FDDI group codes are shown in table A.

This encoding scheme has sufficient symmetry between ones and zeros that the average value of the signal varies by less than 10 percent while the ring is functioning normally. This makes it easier to design the analog circuitry that recovers the data from the fiber.

Table A: *The Fiber Distributed Data Interface standard group codes. Some of the symbols in the second column, either alone or in combination, can violate the run-length constraints; this occurs only when something has gone wrong.*

Symbol	Encoded bits	Symbol	Encoded bits
0	1 1 1 1 0	C	1 1 0 1 0
1	0 1 0 0 1	D	1 1 0 1 1
2	1 0 1 0 0	E	1 1 1 0 0
3	1 0 1 0 1	F	1 1 1 0 1
4	0 1 0 1 0	Q (Quiet)	0 0 0 0 0
5	0 1 0 1 1	I (Idle)	1 1 1 1 1
6	0 1 1 1 0	H (Halt)	0 0 1 0 0
7	0 1 1 1 1	J (Start 1)	1 1 0 0 0
8	1 0 0 1 0	K (Start 2)	1 0 0 0 1
9	1 0 0 1 1	T (Terminate)	0 1 1 0 1
A	1 0 1 1 0	R (Reset)	0 0 1 1 1
B	1 0 1 1 1	S (Set)	1 1 0 0 1

node will be able to receive two consecutive frames addressed to it.)

The MAC Layer

The MAC layer of FDDI is very similar to that of the IEEE 802.5 Token Ring. Figure 4 shows the FDDI frame format, and figure 5 shows an FDDI token. Unlike the Token Ring, FDDI manipulates data as 4-bit symbols (i.e., nibbles) or as bytes, rather than as individual bits. This technique makes it easier to change parts of a frame, like an error indicator, on the fly. More can be done in parallel.

Another difference is that the token isn't changed into a frame on the fly. An FDDI node that wishes to transmit captures the token and sets up to transmit a frame. Because it never has to receive and transmit at the same time, an FDDI node can have a single half-duplex data path internally, instead of two paths, as a Token Ring node must.

FDDI also builds in a feature that is optional in most Token Ring systems: early token release. In ETR, a transmitting station can send a token before the data it sends can circulate completely around the ring and return. This feature greatly reduces ring latency, especially in large rings. FDDI frames, unlike Token Ring frames, have a fixed maximum size of 4500 bytes. This ceiling prevents a station from monopolizing the network.

Another difference is the presence of *fragments* on the ring. An FDDI station often repeats the beginning of a token or frame (i.e., sends it on to the next station) and then decides that it wants to capture the token or strip the frame from the ring. By the time the station makes this decision, it's too late to "catch" the data that has already been repeated. The downstream nodes must recognize and strip fragments of tokens and frames from the ring.

Neither the FDDI frame nor the FDDI token contains an AC (access control) field, as do their Token Ring equivalents. No token has a specific priority (although use of the token may be restricted, as I'll show shortly), and there is no reservation process. Instead of arbitrating for ring access as the token circulates, FDDI stations share ring bandwidth via the Timed Token Protocol.

The Timed Token Protocol

FDDI divides the bandwidth of the ring into two pools: *synchronous* bandwidth, devoted to communications that *must* happen at certain regular intervals, and *asynchronous* bandwidth, devoted to other communications. The allocation is performed by limiting the amount of time during which any station can hold the token and attempting to cause the token to return to each station within a certain amount of time (the target token rotation time, or TTRT).

As the ring is configured, each node asks for the amount of synchronous bandwidth it needs by specifying the minimum TTRT it will require to meet its needs for synchronous transmission. The node requiring the shortest TTRT wins the bidding. From this point on, time is divided between the nodes in such a way that

1. each node knows how long it can safely hold the token before passing it on;
2. the sum of these maximum holding times is less than or equal to the TTRT; and
3. the token is guaranteed not to take more than twice the TTRT to return to any node on the ring.

Each node may transmit a certain

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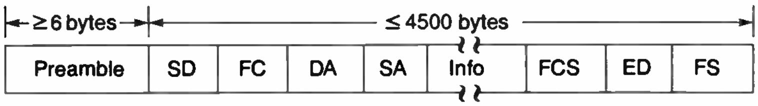
amount of synchronous data whenever it receives the token. Then, if there's time to keep the token longer without causing the TTRT to be exceeded, the node may transmit asynchronous traffic. Finally, when there is no more data to transmit, or when the token must be sent on its way to meet the TTRT, the token is passed to the next node. This strategy has the effect of making sure that every node gets its share of the synchronous bandwidth, while allowing the remaining time to be taken up by asynchronous transmissions.

All synchronous transmissions get top priority in FDDI, but asynchronous transmissions, which share the bandwidth that remains, are grouped into eight priority levels. Each level is associated with a time value inversely related to its importance. If the node can hold the token for at least the specified length of time, frames at that priority level can be transmitted. The result: Asynchronous bandwidth is fairly allocated to each level as needed.

FDDI adds one final twist to the protocol to support high-speed transactions between stations on the ring—a host and a disk drive, for instance. An FDDI token can be marked as restricted. In such a case, only certain nodes can use it for asynchronous transmissions (any node can still use it for synchronous transmissions). By temporarily devoting all the asynchronous bandwidth of the ring to one key exchange, FDDI can expedite that exchange and keep certain systems (e.g., distributed databases) running smoothly.



Preamble—At least 6 bytes of "I" (idle) symbols
Start delimiter (SD)—A "J" symbol followed by a "K" symbol
Frame control (FC)—Two symbols (1 byte) identifying frame type
Destination address (DA)—A 16- or 48-bit group or node address
Source address (SA)—A 16- or 48-bit source address
Information (Info)—Information conveyed by the frame
Frame check sequence (FCS)—A 32-bit cyclic redundancy check for the frame
End delimiter (ED)—A "T" symbol
Frame status (FS)—Three symbols, each "R" for 0 or "S" for 1, as follows:

- Error indicator
- Address-recognized indicator
- Frame-copied indicator

Figure 4: *The Fiber Distributed Data Interface frame format.*

Start delimiter (SD)—A "J" symbol followed by a "K" symbol
Frame control (FC)—Identifies "restricted" tokens
End delimiter (ED)—A "T" symbol

Figure 5: *The Fiber Distributed Data Interface token format.*

Table 2: *The Fiber Distributed Data Interface standard, while well on the way to approval, is not entirely complete. In particular, some aspects of the Station Management protocol need to be fleshed out, and other sections are still up for approval. (Table courtesy of AMD)*

	PMD	PHY	MAC	SMT
X3T9.5 (FDDI)	Approved	Approved	Approved	In committee
ANSI	Second public review	Published	Published	Not forwarded
ISO	Letter ballot	Approved	Approved	Not forwarded

FDDI Today and Tommorrow

The FDDI standard, while well on the way to approval, is not entirely complete. Table 2 shows the status of the parts of the standard as of January.

FDDI's creators expected that it would be used in one of three ways: as a front-end network, to connect workstations to file servers; as a back-end network, to connect peripherals to machines in computer rooms; or as a backbone, to connect computers over a campus-size area. All these are useful and desirable applications, but adoption may be initially limited by cost, typically $8000 or more per station. (To put things in perspective, it helps to remember that Ethernet was equally expensive when it was first developed.)

FDDI will probably appear first in large corporate and campus networks, but I hope it will only be a matter of time before FDDI adapters are as inexpensive and readily available as Ethernet and ARCnet are today. ■

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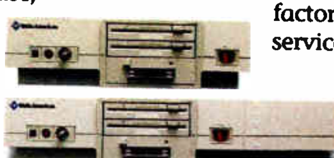
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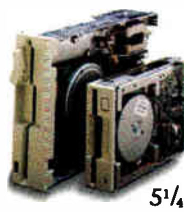

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OBJECT-ORIENTED MAC WINDOWS

Programming with Macintosh windows is a little less painful if you insulate with an object-oriented layer

Macintosh windows are wonderful to use, but programming them can be downright painful. Although the Macintosh Toolbox provides a wealth of powerful programming goodies, its complexity makes it hard to use.

I was writing a medium-size program that required more than one or two kinds of windows. With each new type of window I added, I found myself repeating the same cryptic incantations, modifying the same bloated procedures, and slowly going nuts. So the following invention was born out of necessity.

A Layer of Insulation

I put a layer of code between myself and the Mac window system, code that makes it possible to add and modify window behavior without complex, nonmodular fiddling about. The code supports a roughly objected-oriented style of programming: You define various window types, create windows that instantiate those types, and send the windows messages to get them to perform. This is a simple idea that requires some delicacy of execution. To appreciate some of the subtleties, you need to understand the Mac window system.

If you do some digging, you'll find that a Macintosh window is a data structure containing a `GrafPort`, the window's size, its position on the screen, visibility, and other important data fields. There's also a pointer-size field called the `refcon` (reference constant) for use by programmers.

The Macintosh operating system is event-driven: Anytime you press a key, click the mouse button, or insert a new disk, the system records the activity in an *event record* data structure and places the record in a queue (the *event queue*). As you'll see, the system also records other, less-obvious activities on the event queue. Fundamentally, Macintosh programs remove records from the event queue and use them to determine which code to dispatch. For example, pressing a key might cause the program to vector to a routine that reads the character and displays it on the screen.

Three events that bear directly on the window's behavior but are generated internally by the Mac's Window Manager are *activate*, *deactivate*, and *update*. The frontmost window on the Mac screen is known as the *active* window. It looks different from other windows on the screen: Among other things, its title bar is highlighted with horizontal stripes.

Most applications that allow multiple windows treat the active window specially. For example, a word processor will usually display any characters you type in the active window. Since keeping track of the active window is important, the Mac uses two events to orchestrate its maintenance. Whenever you activate a window, the Mac's Window Manager generates a deactivate event for the currently active window and an activate event for the newly active window. Whenever you move, resize, or hide a window, the action may reveal parts of other windows. To maintain the illusion that you're really looking at a desktop with pieces of paper on it, the newly revealed windows need to be redisplayed. To this end, the Window Manager generates an update event for each window that should be redrawn.

Keeping to the Guidelines

The Macintosh user guidelines specify that clicking on a deactivated window should activate it; clicking and dragging on a window's title bar should move the window; and clicking on the close box, zoom box, and resize box should produce the appropriate responses. Much of a program's event-handling code involves managing windows. And most of the time, the code will do the same thing for every window.

On occasion, however, the program might need to do something other than the default behavior. For example, when a window is activated or deactivated, the program may need to update certain global variables that track the currently active window. It's frustrating to have to rewrite the code for each program even though the code to handle typical behavior is common to almost every application. You end up distributing this code among nonwindow events such as menu selection and key presses. Worse, minor variations on the usual behavior require that you modify this code, and these modifications are typically nonmodular.

I Did It My Way

One solution to the problem would be to just write a new window system from scratch, but it would be a shame to junk all the existing Toolbox code. My solution is less revolutionary: First, separate each window operation—activating, updating, moving, and so on—into its own function. Second, collect these functions in a single place, called a `WindowType`.

A `WindowType` is a data structure containing an array of pointers to functions, one for each window operation. A `WindowType` is associated with every window created by the program. When your program performs an operation on a window, this system retrieves the appropriate function from the `WindowType` and invokes the function. Listing 1 gives you some idea of what it's like to use my window package.

To conform to object-oriented programming terminology, I call the individual functions that perform window

continued

operations "methods," and the process of selecting a function "sending a message." You actually select the function by calling the send_window function with WindowPtr (a pointer to a window) and a message (an integer) as arguments. Since I included the ANSI C facility for a variable number of arguments (see listing 2), you can pass any additional arguments of any type to send_window. It retrieves the WindowType data structure and uses the message (index) to select the function. Send_window then calls the function with the WindowPtr and the remaining arguments (see listings 3 and 4).

Listing 1: *An example of how to use my utilities. This program creates a new* WindowType *with new facilities; it does little else. (Listing 3 is of* window.h.*)*

```
#include "window.h"
WindowType qcw_struct;
WindowType *quit_on_close_window = &qcw_struct;
int do_free(), do_draw();

main()
{
   InitGraf(&thePort);
   InitFonts();
   InitWindows();
   FlushEvents(everyEvent, 0);
   InitCursor();

   init_windows(0);
   new_window_type(quit_on_close_window, 0, standard_window);
   put_method(quit_on_close_window, Free, do_free);
   put_method(quit_on_close_window, Draw, do_draw);
   test();
}

int do_free()
{
   ExitToShell();
}

int do_draw()
{
MoveTo(0, 0);
LineTo(thePort->portRect.right,
   thePort->portRect.bottom);
}

test()
{
   Rect r;

   SetRect(&r, 40, 40, 200, 150);
   ShowWindow(create_window(quit_on_close_window, &r, "Test", 0));
   for (;;)
      handle_event();
}

handle_event()
{
   EventRecord event;
   int doKeyDown(), doMenuBar();

   SystemTask();
   if (GetNextEvent(everyEvent, &event))
      handle_window_event(&event, doKeyDown, doMenuBar);
}

doKeyDown(event)
EventRecord *event;
{
}

doMenuBar(event)
EventRecord *event;
{
}
```

Built-in Messages

My window package has 13 defined messages that take care of all the operations you'll usually perform on windows. You can define as many additional messages as you wish. The 13 I've defined are as follows:

- Init: Sent when a window is created. The default implementation does nothing.
- Activate: Sent when an activate event occurs.
- Deactivate: Sent when a deactivate event occurs.
- Update: Sent when an update event occurs. In the default implementation, this calls the Macintosh BeginUpdate procedure, sends a Draw message to the window, and then calls the EndUpdate procedure.
- Grow: Sent when the mouse is pressed in the window's grow box.
- Move: Sent when the mouse is pressed in the window's title bar.
- Close: Sent when the mouse is pressed in the window's close box.
- ZoomOut: Sent when the mouse is pressed in the window's zoom box and the window is in its initial state.
- ZoomIn: As above, but when the window has already been zoomed out.
- Content: Sent when the mouse is pressed in the content region of an active window.
- InactiveContent: As above, but for an inactive window. In the default implementation, this merely brings the window to the front, activating it.
- Draw: Sent when the window's contents should be redrawn. This does nothing in the default implementation.
- Free: Sent when the window should be destroyed. In the default implementation, this just releases storage for the window.

Note that a single event can result in more than one message. This provides you with finer control over window behavior. For example, a mouse-click in the content region of an active window can result in a variety of behaviors, depending on what the window is being used for. But a click in the content region of an inactive window will nearly always result in the activation of that window. Since I've separated these two behaviors into separate messages, if you want to change one behavior, you needn't worry about reimplementing the other as well.

New Windows and Types

My window package has two window types defined: vanilla_window and standard_window. The first is just a rectangle on the screen: You can't move, close, grow, or zoom it, but it will handle activate, deactivate, and update events correctly. The second is the usual Macintosh document window, with a title bar and close, zoom, and grow boxes. Its methods implement the behaviors usually associated with mouse-clicks in those areas.

You create a new window by calling create_window, which returns a WindowPtr. The function takes four arguments: a window type, the window's title, the rectangle to be occupied by the window, and the number of bytes for the window's refcon (I'll discuss this last argument later). Using create_window is far simpler than using the Mac's NewWindow procedure with its bewildering eight arguments. The simplification is achieved by containing some of the information required by NewWindow, such as whether the window has a close box, in the WindowType. Also, create_window does not display the window, and it always puts the new window in the back of the window list.

The vanilla_window and standard_window types are useful starting places, but neither is fully functional because they lack a method for the Draw message. It's necessary to create a new WindowType in order to do anything really useful. If you create a new type that inherits from an old type, you need only define the differences in the types' behaviors.

For example, to create a WindowType that has the facility to actually draw, you create a new type that inherits from standard_window and add a method for the Draw message. To do this, you call the new_window_type procedure with three arguments: a pointer to the storage for the new WindowType, an integer denoting the number of bytes of local storage to reserve for each window, and a pointer to the old WindowType.

New methods are then added by calling the put_method function with the WindowType, the message name, and the new method. Say that my_draw_func is a function for drawing on a window, and my_window_type is a pointer to a WindowType. The following two lines will then create the new WindowType and install the drawing function:

```
new_window_type(my_window_type,
  0, standard_window);
put_method(my_window_type, Draw,
  my_draw_func);
```

Event Dispatching

The main loop of a typical Macintosh program removes the front event from

continued

Listing 2: *This include file provides the ANSI C variable argument functionality to development systems that don't have it.*

```
/* varargs.h */
/* This file defines the ANSI C standard
   macros for variadic functions.  Put it in the
   same directory subtree as the Lightspeed C application. */

typedef char *va_list;
# define va_dcl int va_alist;
# define va_start(list) list = (char *) &va_alist
# define va_end(list)
# define va_arg(list,mode) ((mode *)(list += sizeof(mode)))[-1]
```

Listing 3: *The file* window.h *defines the structures and lists the global functions of my package. You must reference it in any files that use my routines.*

```
/* window.h */

#ifndef _window_
#define _window_

#include <WindowMgr.h>
#include <EventMgr.h>

#define zoomDocProc 8
#define zoomNoGrow 12

typedef int (*intfuncp)();

typedef struct {
                int defProcID;
                Boolean closable, growable;
                int min_width, min_height;
                int inst_vars_size;
                intfuncp *method;
            } WindowType;

typedef struct {
                WindowType *type;
                char inst_vars;
            } WindowData;

typedef WindowData **WindowDataHandle;
extern WindowType *vanilla_window, *standard_window;
#define WITH_PORT(x) {GrafPtr _sp; GetPort(&_sp); SetPort(x);
#define END_PORT        SetPort(_sp);}
#define W_DATA_HANDLE(w) ((WindowDataHandle)((WindowPeek) w)->refCon)
#define W_TYPE(w)      ((*W_DATA_HANDLE(w))->type)
#define W_REFCONP(type,w) \
  ((type*) (&((*W_DATA_HANDLE(w))->inst_vars)\
  + W_TYPE(w)->inst_var_size))
#define W_REFCON(type,w) (*W_REFCONP(type,w))
#define W_INST_VARP(type,w,offset) \
  ((type*) (&((*W_DATA_HANDLE(w))->inst_vars) + offset))
#define W_INST_VAR(type,w,offset) (*W_INST_VARP(type,w,offset))
```

continued

```
/******** functions **************/
void init_windows(int);
/* number of user-defined messages  */
WindowPtr create_window(WindowType*, Rect*, char*, int);
/* type, rect, title, refConSize */
void free_window(WindowPtr);
int send_window(WindowPtr, int, ...);
/* window, message, args */
int vsend_window(WindowPtr, int, char*);
/* window, msg, args */
int send_window_event(WindowPtr, EventRecord*);
Boolean handle_window_event(EventRecord*, intfuncp, intfuncp);
/* event, key proc, menu proc */
int new_window_type(WindowType*, int, WindowType*);
void put_method(WindowType*, int, intfuncp);
/* window type, message, method */
void add_grow(WindowType*);
void add_close(WindowType*);
void add_zoom(WindowType*);
#define N_SYS_MESSAGES 13
enum {Init = -N_SYS_MESSAGES, Activate, Deactivate, Update, Draw, Move,
         Grow, Content, InactiveContent, Close, Free, ZoomIn, ZoomOut};
#endif
```

Listing 4: *Functions from my Macintosh window package.*

```
#include <WindowMgr.h>
#include <EventMgr.h>
#include <varargs.h>
#include "window.h"

#define W_MESSAGE_OFFSET N_SYS_MESSAGES
#define SCREEN_MARGIN 5
#define DEFAULT_MIN_WIDTH 5
#define DEFAULT_MIN_HEIGHT 5

#define COPY(type,old,new)  BlockMove((old), (new), sizeof(type))
#define MENU_BAR_HEIGHT 20
#define NULL 0L
#define SCREEN_WIDTH (screenBits.bounds.right - screenBits.bounds.left)
#define SCREEN_HEIGHT (screenBits.bounds.bottom - screenBits.bounds.top)

int w_init(), w_activate(), w_deactivate(), w_update(),
      w_move(), w_grow(),
      w_content(), w_close(), w_free(), w_inactive_content(),
      w_draw(), w_zoom_in(), w_zoom_out();

intfuncp basic_methods[] = {w_init,
                            w_activate,
                            w_deactivate,
                            w_update,
                            w_draw,
                            w_move,
                            w_grow,
                            w_content,
                            w_inactive_content,
                            w_close,
                            w_free,
                            w_zoom_in,
                            w_zoom_out};

WindowType vanilla_window_struct, standard_window_struct;
WindowType *vanilla_window = &vanilla_window_struct;
WindowType *standard_window = &standard_window_struct;

static int last_window_message, n_messages;
```

continued

the event queue and dispatches on the event type. Most events involve windows in some way, but key presses and menu selections do not. For event dispatching, I have a single function, handle_window_event. It takes three arguments: a pointer to the event, pointers to the function to be called when a key is pressed, and the function to be called for menu selections.

You might wonder why key presses and menu selections are involved in window events. Conceptually they aren't, of course, but their presence is strongly suggested by the structure of the event dispatch code. You could divide handle_window_event into two functions, one that merely checks to see if the event involves a window and another that actually does the dispatch, but you'd be duplicating code and doing a little extra work. Not my style.

The program in listing 1, which just puts a standard window on the screen, should now be comprehensible. It first calls init_windows to set things up. This function takes one argument, the number of user-defined messages. In this case, there are none. I then define a new WindowType that behaves just like standard_window, except for the addition of a Free message (for exiting the program) and a Draw message. The test routine uses create_window to create a window and displays it with the Toolbox procedure ShowWindow. It then enters the event-dispatching loop, using handle_window_event to take care of all the work. The key press and menu functions do nothing.

In Depth

In my description of the system, I've glossed over several important implementation decisions. How, for instance, is a WindowType associated with a window?

One method is to define a new data structure that has a window and type information embedded in it. This is probably not a good idea. The Mac has many procedures that expect pointers to windows as arguments, and using them might become complicated, requiring at least casts and possibly glue routines. Also, embedding a window in another structure would make it difficult to extend the window system to handle dialog boxes, which already have a window embedded inside them.

An alternative, the method I have adopted, uses the refcon field of the Macintosh WindowData structure. Recall that this pointer-size field is available for programmer use. I use it to hold a handle to a structure, called a window data record, that contains the WindowType.

Since I've used the refcon, you won't be able to if you use my routines, but that's why I have included room for another refcon in the WindowData structure. I've even improved somewhat on the original by allowing this refcon to be of any size: You specify the number of bytes you want as the fourth argument to create_window.

The WindowData structure also has room for data that is local to each window. The size of this local area is given as an argument to new_window_type.

Inheritance

Another important implementation issue involves inheritance. In some object-oriented languages, like Smalltalk, the methods that type A inherits from type B are stored only in B, and the inheritance chain is searched when a message is sent. This is a reasonable space/time trade-off for a system with many messages, which is an unlikely situation with my window system. So I chose the simpler and faster

continued

```
/************************************************************************/

void init_windows(n_msgs)
int n_msgs;
{
   last_window_message = n_msgs-1;
   n_messages = N_SYS_MESSAGES + n_msgs;
   new_window_type(vanilla_window, 0, NULL);
   new_window_type(standard_window, 0, vanilla_window);
   add_grow(standard_window);
   add_close(standard_window);
   add_zoom(standard_window);
}

WindowPtr create_window(type, rect, title, refcon_size)
WindowType *type;
Rect *rect;
char *title;
int refcon_size;
{
   WindowPtr w;
   WindowDataHandle wd;

   wd = (WindowDataHandle) NewHandle(sizeof(WindowType*)
        + type->inst_vars_size + refcon_size);
   (*wd)->type = type;
   CtoPstr(title);
   w = NewWindow(NULL, rect, title, FALSE, type->defProcID, -1L,
                 type->closable, (long) wd);
```

continued

```
    PtoCstr(title);
    vsend_window(w, Init, NULL);
    return(w);
}

void free_window(window)
WindowPtr window;
{
    DisposHandle((WindowDataHandle) GetWRefCon(window));
    DisposeWindow(window);
}

Boolean handle_window_event(event, keyProc, menuProc)
EventRecord *event;
int (*keyProc)(), (*menuProc)();
{
    WindowPtr window;

    switch (event->what) {
       case keyDown: return(keyProc? (*keyProc)(event): FALSE);

       case activateEvt:
       case updateEvt:
          return((Boolean) send_window_event((WindowPtr)
              event->message, event));

       case mouseDown:
             switch (FindWindow(event->where, &window)) {
                case inMenuBar:
                   return(menuProc ? (*menuProc)(event) : FALSE);
```

continued

alternative—having new_window_type copy the methods. The semantics of the two schemes are subtly different; in my system, unlike in Smalltalk, a changed method in a parent type will not propagate to the already-created children of that type.

For the sake of simplicity and speed, I implemented messages as integers. The hashed-string method used by Smalltalk requires additional code to do the hashing and searching. It cannot compete in speed with my scheme, which is a simple array index. To its credit, the hashed-string approach allows new messages to be added incrementally, while the integer scheme does not, and it saves space when objects of different types use very different messages.

The Bad News

I'd like to be able to say that my window method provides a simple, efficient, and fully modular way of adding different pieces of functionality to Macintosh windows, but that is not entirely true. Although it's easy enough to create a type that provides one feature, things begin to

continued

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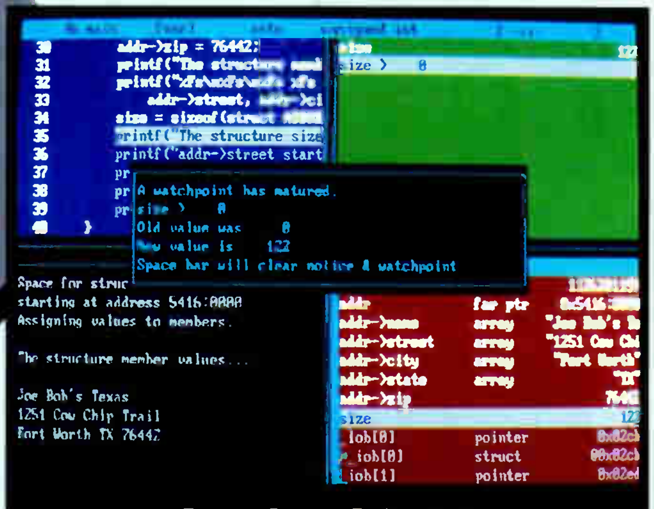
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```
            case inSysWindow:
               SystemClick(event, window); return(TRUE);
            case inDesk: return(TRUE);
            default: return(send_window_event(window, event));
         }

      default: return(FALSE);
   }
}

int send_window(window, message, va_alist)
WindowPtr window;
int message;
va_dcl
{
   va_list args;
   int result;

   va_start(args);
   result = vsend_window(window, message, args);
   va_end(args);
   return(result);
}

int vsend_window(window, message, args)
WindowPtr window;
int message;
char *args;
{
   WindowType *type = W_TYPE(window);

   return(*type->method[message+W_MESSAGE_OFFSET])(window, args);
}

int send_window_event(window, event)
WindowPtr window;
EventRecord *event;
{
   switch(event->what) {
      case activateEvt:
         if (event->modifiers & activeFlag)
            vsend_window(window, Activate, (char*) event);
         else
            vsend_window(window, Deactivate, (char*) event);
         return(TRUE);

      case updateEvt:
         vsend_window(window, Update, (char*) event);
         return(TRUE);

      case mouseDown:
         switch(FindWindow(event->where, &window)) {
            case inDrag:
               vsend_window(window, Move, (char*) event); return(TRUE);
            case inGrow:
               vsend_window(window, Grow, (char*) event); return(TRUE);
            case inGoAway:
               vsend_window(window, Close, (char*) event); return(TRUE);
            case inZoomIn:
               vsend_window(window, ZoomIn, (char*) event);
               return(TRUE);
            case inZoomOut:
               vsend_window(window, ZoomOut, (char*) event);
               return(TRUE);
            case inContent:
               if (window == FrontWindow())
                  vsend_window(window, Content, (char*) event);
               else
                  vsend_window(window, InactiveContent, (char*) event);
               return(TRUE);
```

continued

```
            default:
               return(FALSE);
         }

      default:
         return(FALSE);
   }
}

/*********************** Window Types **********************/

int new_window_type(wt, inst_vars_size, inherit_from)
WindowType *wt, *inherit_from;
int inst_vars_size;
{
   intfuncp *methods;
   int i;

   methods = (intfuncp*) NewPtr(n_messages*sizeof(intfuncp));
   if (inherit_from == NULL) {
      wt->defProcID = noGrowDocProc;
      wt->closable = FALSE;
      wt->growable = FALSE;
      wt->min_width = DEFAULT_MIN_WIDTH;
      wt->min_height = DEFAULT_MIN_HEIGHT;
      wt->inst_vars_size = inst_vars_size;
      wt->method = methods;
      for (i = 0; i < n_messages; i++)
         wt->method[i] = basic_methods[i];
      return(0);
   } else {
      BlockMove(inherit_from, wt, sizeof(WindowType));
      BlockMove(inherit_from->method, methods,
                n_messages*sizeof(intfuncp));
      /* must do this after BlockMove, so that it is not overwritten
         by inherit_from's method array */
      wt->method = methods;
      wt->inst_vars_size = inherit_from->inst_vars_size +
                           inst_vars_size;
      return(inherit_from->inst_vars_size);
   }
}

void put_method(wt, message, method)
WindowType *wt;
int message;
intfuncp method;
{
   wt->method[message+W_MESSAGE_OFFSET] = method;
}

void add_grow(type)
WindowType *type;
{
   if (!type->growable) {
      type->growable = TRUE;
      switch (type->defProcID) {
         case noGrowDocProc: type->defProcID = documentProc; break;
         case zoomNoGrow: type->defProcID = zoomDocProc; break;
         default: fatal("add_grow: can't add to this doc type");
      }
   }
}

void add_close(type)
WindowType *type;
{
   type->closable = TRUE;
}

void add_zoom(type)
WindowType *type;
```

continued

get messy when you start trying to combine types with different features. The different types tend to step on each other's toes.

Some of the problems can be remedied with a little effort, and some are inherently challenging, but none are mere idiosyncrasies of the Mac or of window systems—they are endemic to the object-oriented style of programming. A modest attempt to prettify a programming interface can generate some serious research problems, demonstrating once again that programming is sometimes like picking your way through a minefield.

The least problematic interaction between window types involves messages. I've explained why I chose to implement messages as simple integers, but using integers does make it difficult to combine messages.

Another interaction occurs between types' local storage areas. My save_window type inherits from vanilla_window, which itself uses no local storage, so the save_window methods assume that their local storage begins at offset 0 of the window's local storage area. But if there is some other type that also has local storage beginning at offset 0, how could the two types ever be used together? The problem is similar to that of messages, though more difficult to solve.

The final and most challenging problem concerns the methods themselves. Sometimes the only modification that's required for a method to be suitable for use with a new type is to perform some action after, or before, the original method. The only way to combine methods in my system is to copy and modify the source code, or to invoke methods from within other methods. It would be better if I could say, "Use the same method you usually would, but run this piece of code afterward." But to implement such an idea would require a great deal of work, and it would inevitably be messy to use.

The Flavors system, an object-oriented programming facility that runs on Symbolics Lisp machines, attempts to get around this problem. Flavors allows you to define methods that go before, after, or around other methods, and it provides a protocol that allows the passing of arguments and return values.

But Flavors is somewhat messy and complex, and subtle interaction bugs can still occur. It seems that the combining of methods remains an open research problem.

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AutoSketch .... $ 53
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Borland Turbo BASIC 69
Borland Turbo C 104
Borland Turbo PASCAL with 8087/BCD 103
Carbon Copy + (need two copies) 119
Copy II PC 21
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Laplink Plus 84
Microsoft Macro Assembler 5.1 99
Microsoft Quick BASIC Compiler 67
Microsoft Quick "C" Compiler 67
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CLONE VALUE CHART

		HERC MONO	VGA MONO	CGA COLOR	EGA COLOR	VGA COLOR
12MHz 640K RAM 1 WAIT STATE	32MB RLL 65ms	$1299	$1579	$1459	$1719	$1879
	42MB MFM 40ms	1399	1679	1559	1819	1979
	65MB RLL 40ms	1499	1779	1659	1919	2079
	122MB RLL 28ms	1799	2079	1959	2219	2379
12MHz 1MB RAM 0 WAIT STATE	32MB RLL 65ms	$1449	$1729	$1609	$1869	$2029
	42MB MFM 40ms	1549	1829	1709	1969	2129
	65MB RLL 40ms	1649	1929	1809	2069	2229
	122MB RLL 28ms	1949	2229	2109	2369	2529
16MHz 1MB RAM 0 WAIT STATE	32MB RLL 65ms	$1649	$1929	$1809	$2069	$2229
	42MB MFM 40ms	1749	2029	1909	2169	2329
	65MB RLL 40ms	1849	2129	2009	2269	2429
	122MB RLL 28ms	2149	2429	2309	2569	2729

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HI-REZ Logimouse with software, Bus 94
Logimouse with First Publisher 108
Hi-REZ Logimouse with First Publisher, CADD and Paint Show Plus 177
Microsoft Mouse w/sftwr, Bus or Serial 108
Microsoft Mouse with Windows 286 149
C-H Mach III Joystick 32
C+H Flight Stick 50
1200 Baud internal modem with software 59
2400 Baud internal modem with software 99

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Autoswitching Hercules graphics/color graphics video card w/printer port, smooth scroll .... $ 49
Generic EGA card, 640 x 350 resolution 159
Generic VGA card, 640 x 480 resolution 259
Math coprocessors. All types, speeds in stock.
Printer switch box, 2-position, 25 or 36 pin .. 29
Printer switch box, 4-position, 25 or 36 pin .. 39
25 pin cable, 10'. Molded ends. MM or MF ... 16
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Vertical CPU stand. Add $9 for wheels 24
AST Rampage 2MB EEMS memory board for ATs. Comes with 512K RAM. .... $ 439
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The Complete Fax 9600 449
The Complete Answering Machine Board .. 227
The Complete Hand Scanner (400 DPI) 162
The Complete Half-page Scanner 195
Logitech ScanMan (400 DPI) 219

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Star NX-1000 144cps, NLQ $179
Star NX-1000 Rainbow, as above w/color.... 239
Star NX-15 120/30 cps NLQ, wide.......... 319
Star ND-15 180/45 cps 389
Star NR-10 240/60 cps NLQ 349
Star NR-15 as above with wide carriage 449
Star NB-15 300/100 cps NLQ 759
Star NB24-10 216/72 cps LQ 469
Star NB24-15 as above with wide carriage .. 579
Star NX-2400 170/57 cps LQ 24, pin 359
Panasonic KX-P1124, 80/192 cps, 24 pin 359
Panasonic KX-P1191, 80 col/120 cps 269
Panasonic KX-P1180i, 80 col/144 cps 219
Panasonic KX-P1092i, 80 col/240 cps 329
IBM parallel printer cable molded ends 12

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- Also measures frequency and capacitance

M4650 only:
- Data Hold Switch
- 4.5 Digit

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M80....................$59.95

COMPUTER ACCESSORIES

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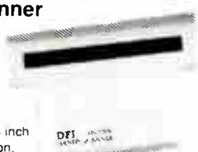

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The HS3000 offers a full 4 inch window at 400dpi resolution. Scan photos, logos, drawings, etc. Can be used with today's most popular applications.

HS3000 Pictured

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IBM Compatible Cases and Power Supplies

JE2010 Pictured

JE1030 Pictured

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JE1018	Slide Baby AT Case ~~$69.95~~	$59.95
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JE1032	200 watt Baby AT Power Supply	$89.95
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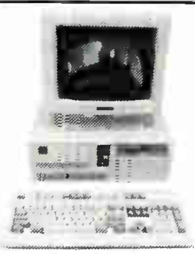
Jameco 12MHz IBM AT Compatible Kit With 512K RAM



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SALE

QC1478 Pictured

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Seagate 60MB Hard Disk Drives Also Available!

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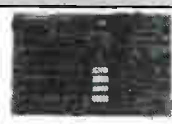

JE3025 Pictured

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JE1022 Pictured

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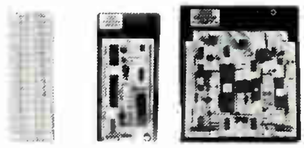

JE23 JE24 JE27

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE21	3.25x2.125	400	0	$4.95
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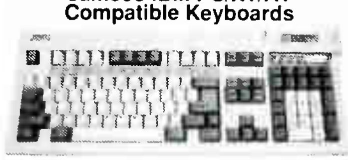
COMPUTER ACCESSORIES

Jameco IBM PC/XT/AT Compatible Keyboards



JE2016 Pictured

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JE1170 Pictured

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- 80 MB Hard Drive (28ms)
- 101 Enhanced Keyboard
- Vertical Case
- MS-DOS 3.3 GW Basic
- 1 Year Warranty
- Support: NOVELL/3COM/PC NET/LanLink/OS/2

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- Award bios
- 640K-120 ns
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- 2 Serial 1 Parallel
- Clock Calender
- 101 Enhance Keyboard
- ATI EGA Wonder Card
- **EGA MONITOR**
- MS-DOS 3.3 , GW Basic

$1799

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•Renaissance VGA card is 100% Hardware Register and BIOS compatible •Packard Bell 640x480 256,000 color Analog Monitor with Tilt/Swivel Base •VGA delivers up to 256 simultaneous colors at up to 640x480 resolution

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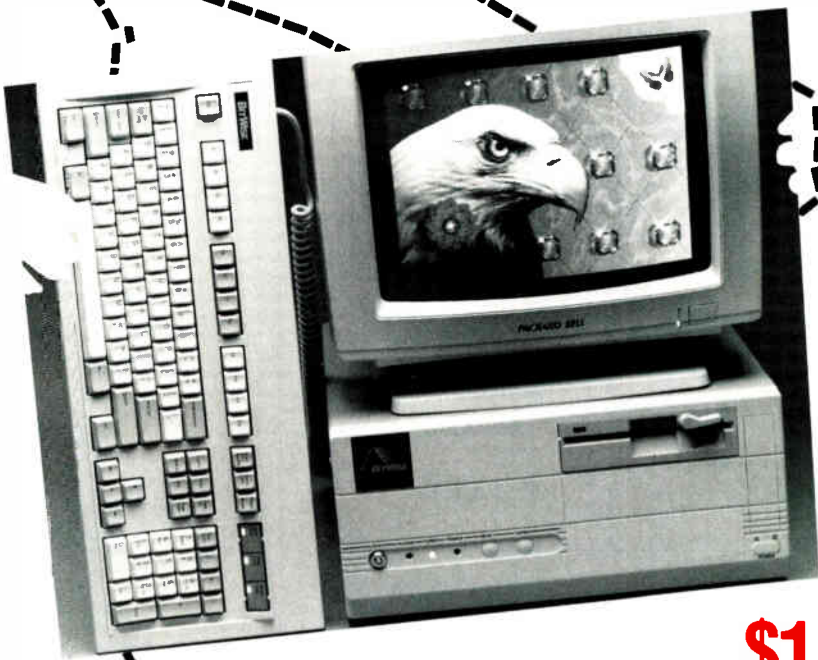
•US Made Keytronics 101 key Keyboard has superior feel •2 Serial Ports, 1 Parallel Printer Port Standard •200 Watt Power Supply •Real Time clock/calendar, ROM-based setup



$1,895

PRICE:

Monochrome Graphics System, 60 Meg or 40 Meg	$1,495
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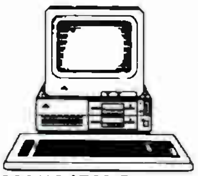

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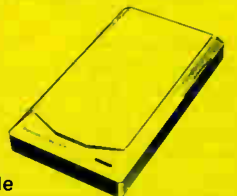

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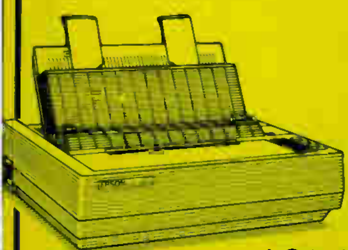

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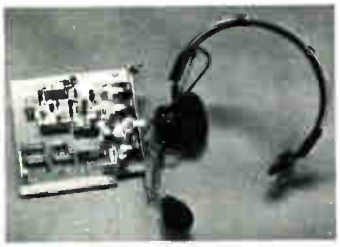

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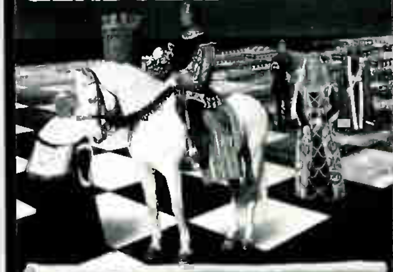

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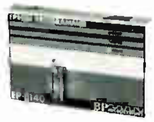

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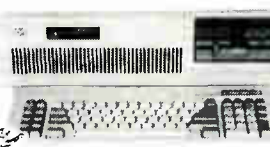

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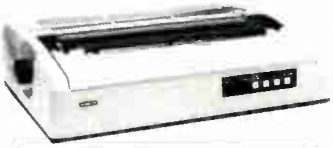

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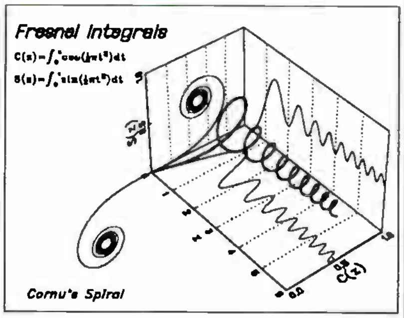

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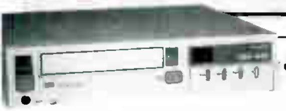

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80287-8	8 MHz	219.95
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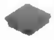
32-BIT COPROCESSORS



80387-16	16 MHz	397.95
80387-SX	16 MHz	389.95
80387-20	20 MHz	469.95
80387-25	25 MHz	589.95

5 YEAR WARRANTY

STATIC RAMS

PART	SIZE	SPEED	PRICE
2112	256 x4	450ns	2.99
2114	1024x4	450ns	.99
2114L-2	1024x4	200ns	1.49
TMS4044-3	4096x1	300ns	2.49
TMM2016-200	2048x8	200ns	2.95
TMM2016-150	2048x8	150ns	3.25
TMM2016-100	2048x8	100ns	3.95
HM6116-4	2048x8	200ns	2.95
HM6116-3	2048x8	150ns	3.95
HM6116-2	2048x8	120ns	4.95
HM6116LP-4	2048x8	200ns	3.95
HM6116LP-3	2048x8	150ns	4.49
HM6116LP-2	2048x8	120ns	5.49
HM6264LP-15	8192x8	150ns	8.95
HM6264LP-12	8192x8	120ns	9.95
HM43256LP-15	32768x8	150ns	24.95
HM43256LP-12	32768x8	120ns	29.95
HM43256LP-10	32768x8	100ns	34.95

■ CALL TO CONFIRM CURRENT PRICES ■

DYNAMIC RAMS

PART	SIZE	SPEED	PRICE
4116-150	16384x1	150ns	.99
4164-150	65536x1	150ns	2.49
4164-120	65536x1	120ns	2.89
4164-100	65536x1	100ns	3.39
TMS4416	16384x4	150ns	8.95
41128-150	131072x1	150ns	4.95
TMS4464-15	65536x4	150ns	14.95
TMS4464-12	65536x4	120ns	15.95
HM51258-100	262144x1	100ns	10.95
41256-150	262144x1	150ns	6.49
41256-120	262144x1	120ns	6.99
41256-100	262144x1	100ns	7.99
41256-80	262144x1	80ns	8.49
1 MB-120	1048576x1	120ns	19.95
1 MB-100	1048576x1	100ns	21.95
1 MB-80	1048576x1	80ns	24.95
414256-100	262144x4	100ns	29.95
414256-80	262144x4	80ns	36.95

■ CALL TO CONFIRM CURRENT PRICES ■

EPROMS

PART	SIZE	SPEED	Vpp	PRICE
2708	1024x8	450ns	25V	4.95
2716	2048x8	450ns	25V	3.49
2716-1	2048x8	350ns	25V	3.95
2732	4096x8	450ns	25V	3.95
TMS2532	4096x8	450ns	25V	5.95
2732A	4096x8	250ns	21V	3.95
2764	8192x8	450ns	12.5V	3.49
2764-250	8192x8	250ns	12.5V	3.69
2764-200	8192x8	200ns	12.5V	4.25
27C64	8192x8	250ns	12.5V	4.95
27128	16384x8	250ns	12.5V	4.25
27128A-200	16384x8	200ns	12.5V	5.95
27256	32768x8	250ns	12.5V	4.95
27256-200	32768x8	200ns	12.5V	5.95
27C256	32768x8	250ns	12.5V	5.95
27512	65536x8	250ns	12.5V	8.95
27C512	65536x8	250ns	12.5V	9.95
27C101-20	131072x8	200ns	12.5V	29.95

■ CALL TO CONFIRM CURRENT PRICES ■

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74 SERIES LOGIC

7400

7400	.19
7402	.19
7404	.19
7405	.25
7406	.29
7407	.29
7408	.24
7410	.19
7411	.25
7414	.49
7416	.25
7417	.25
7420	.19
7432	.29
7447	.89
7473	.34
7474	.33
7475	.45
7476	.35
7586	.35
7489	2.15
7490	.39
7493	.35
74121	.29
74123	.49
74151	.55
74154	1.49
74157	.55
74166	1.00

74LS00

74LS00	.16
74LS02	.17
74LS03	.18
74LS04	.16
74LS05	.18
74LS08	.18
74LS10	.16
74LS11	.22
74LS14	.39
74LS20	.17
74LS21	.22
74LS27	.23
74LS30	.17
74LS32	.18
74LS38	.26
74LS42	.39
74LS47	.75
74LS51	.17
74LS73	.29
74LS74	.24
74LS75	.29

74LS76	.29
74LS83	.49
74LS85	.49
74LS86	.22
74LS90	.39
74LS92	.49
74LS93	.39
74LS109	.36
74LS112	.29
74LS123	.49
74LS125	.39
74LS132	.39
74LS138	.39
74LS139	.39
74LS151	.39
74LS153	.39
74LS154	1.49
74LS155	.59
74LS156	.49
74LS157	.35
74LS158	.29
74LS161	.39
74LS163	.39
74LS164	.49
74LS165	.65
74LS166	.95
74LS175	.39
74LS192	.69
74LS193	.69
74LS197	.59
74LS221	.59
74LS240	.69
74LS241	.69
74LS244	.69
74LS245	.79
74LS251	.49
74LS257	.39
74LS258	.49
74LS259	1.29
74LS260	.49
74LS273	.79
74LS279	.39
74LS322	3.95
74LS323	2.49
74LS367	.39
74LS373	.79
74LS374	.79
74LS377	.79
74LS393	.79
74LS541	1.49
74LS670	.89
74LS682	3.20
74LS688	2.40

74S

74S00	.29
74S02	.29
74S04	.29
74S32	.35
74S74	.49
74S86	.35
74S112	.50
74S138	.79
74S240	1.49
74S244	1.49
74S287	1.69
74S288	1.69
74S373	1.69
74S374	1.69

74F

74F00	.35
74F04	.35
74F08	.35
74F32	.35
74F74	.39
74F138	.79
74F244	1.29

74HC

74HC00	.21
74HC04	.25
74HC08	.25
74HC14	.35
74HC32	.35
74HC74	.35
74HC138	.45
74HC139	.45
74HC154	1.09
74HC157	.55
74HC244	.85
74HC245	.85
74HC373	.69
74HC374	.69

74HCT

74HCT00	.25
74HCT04	.27
74HCT08	.25
74HCT32	.27
74HCT138	.35
74HCT240	.89
74HCT244	.89
74HCT245	.99
74HCT373	.99
74HCT374	.99

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42100A8B-10	1MB x 8-BIT	FOR MAC	100ns	$239.95
41256A9B-15	256K x 9-BIT	FOR PC	150ns	$79.95
41256A9B-12	256K x 9-BIT	FOR PC	120ns	$84.95
41256A9B-10	256K x 9-BIT	FOR PC	100ns	$94.95
41256A9B-80	256K x 9-BIT	FOR PC	80ns	$109.95
42100A9B-10	1MB x 9-BIT	FOR PC	100ns	$279.95
42100A9B-80	1MB x 9-BIT	FOR PC	80ns	$299.95

Derick's HIGH-TECH SPOTLIGHT

Here at JDR we are constantly reminded how difficult it is to keep up with new developments. Four years ago we could assure our customers that they needed 9 chips at a time to expand their PC. Then the AT became popular and we began saying 9 for PC's and 18 for 80286-based machines. Later we said that you added memory to an 80386 using 36 chips at a time.

When the available memory chips were designed so that one chip supported one bit on the data bus, it was easy to make rules like these. But the rules have changed, which can be very good as we shall shortly see. The number of chips is really determined by the width of the data bus AND the width of the Dynamic RAM memory chip.

For example, if you used a 1 Meg chip that is configured 256K by 4 bits wide, you could design an 80386 motherboard that is expandable in increments of 9 chips at a time. (256K by 4*9 = 256K by 1*36). The obvious advantage is the savings in board space, which makes room for more memory, and the lower cost for memory, since 1 Meg chips cost less.

Because the goal is to create products that are reliable, compatible, full featured and competitively priced, the new 1 Meg chips in both 1 Meg by 1 and 256K by 4 are very desirable. With that in mind, look for new products that take advantage of these more flexible memory options.

Derick Moore, Director of Engineering

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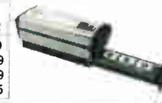
DATARASE II

SPECTRONICS CORPORATION

Model	Timer	# of Chips	Intensity (uW Cm²)	Unit Cost
PE-140	NO	9	8,000	$ 89
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189
PL-265T	YES	30	9,600	$255



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8035	1.49
8039	1.95
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8080	2.49
8085	1.95
8085A-2	3.75
8088	5.99
8088-2	7.95
8155	2.49
8155-2	3.95
8156	2.95
8741	9.95
8748	7.95
8749	9.95
8755	14.95

8200

8254	2.79
8255	1.99
8255-5	2.49
8256	15.95
8259	1.95
8259-5	2.29
8272	4.39
8274	4.95
8275	16.95
8279	2.49
8279-5	2.95
8282	3.95
8283	3.95
8284	2.25
8286	3.95
8287	3.95
8288	4.95

6500

6502	2.25
6502A	2.69
6502B	4.25
65C02*	7.95
6522	2.95
6526	13.95
6532	5.95
6551	2.95
6581	14.95

* CMOS

8200

8205	3.29
8212	1.49
8216	1.49
8224	2.25
8228	2.25
8237	3.95
8237-5	4.75
8238	4.49
8243	1.95
8250	6.95
8251	1.29
8251A	1.69
8253	1.59
8253-5	1.95

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Z80-CPU	1.25
Z80A-CPU	1.29
Z80B-CPU	2.75
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Z80A-DART	5.95
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Z80A-SIO/0	5.95
Z80A-SIO/1	5.95
Z80A-SIO/2	5.95
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6800	1.95
6802	2.95
6809	2.95
68B09	5.99
6809E	2.95
68B09E	5.49
6808	2.49
6810	1.95
6821	1.25
68B21	1.85
6840	3.95
6845	2.75
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V20-8	8.95
V20-10	11.95
V30	13.95

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16R6	2.95	20R6	4.95
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4016	.29	4069	.19
4017	.49	4093	.49
4024	.49	14411	9.95
4040	.69	4511	.69
4046	.69	4538	.95
4049	.29	4702	9.95

SHORTING BLOCKS

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DISCRETE

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IN4004	10/1.00	2N3906	.10
IN4148	25/1.00	2N4401	.25
KBP02	.55	4N26	.69
2N2222	.10	4N35	.89
2N2907	.25	JMBO RED	.10
2N3055	.79	JMBO GRN	.14

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.1UF	100/12.50

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6.0	1.95
8.0	1.95
10.0	1.95
12.0	1.95
14.31818	1.95
16.0	1.95
18.0	1.95
20.0	1.95
22.1184	1.95
24.0	1.95

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1.8432	5.95
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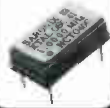
2.4576	5.95
4.0	4.95
5.0688	4.95
8.0	4.95
10.0	4.95
14.31818	1.95
16.0	4.95
18.432	4.95
20.0	4.95
24.0	4.95



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TL072	1.09	NE555	.29	LM3900	.49
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LM311K	3.49	NE570	2.95	7808T	.49
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LM319	1.25	LM741	.29	7905T	.59
LM323K	3.49	MC1330	1.69	7912T	.59
LM324	.34	MC1350	1.19	7915T	.59
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LM338K	4.49	LM1489	.49	ICM7207A	5.95
LM339	.59	LM1496	.85	ICM7208	15.95
LF353	.59	ULN2003	.79	75150	1.95
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LM358	.59	XR2211	2.95	75188	1.25
LM380	.89	CA3046	.89	75189	1.25
LM386	.89	CA3146	1.29	75451	.39
LM393	.45	MC3470	1.95	75452	.39

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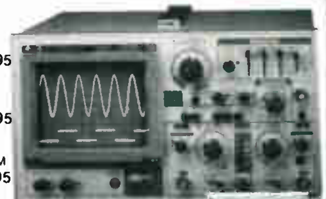

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	FEMALE	DBxxSR	.55	.75	--	.85	2.49	--
WIREWRAP	MALE	DBxxPWW	1.69	2.56	--	3.89	5.60	--
	FEMALE	DBxxSWW	2.76	4.27	--	6.84	9.95	--
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	--	2.25	4.25	--
	FEMALE	IDBxxS	1.45	2.05	--	2.35	4.49	--
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	--	--
	PLASTIC	HOODxx	.39	.39	--	.39	.69	.75

ORDERING INSTRUCTIONS: INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE : A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR

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WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.59	1.99
ZIF SOCKETS	ZIFxx	--	5.95	5.95	--	6.95	--	7.95	7.95	10.95
TOOLED SOCKETS	AUGATxx	.55	.59	.69	.79	.85	.85	.99	1.09	1.29
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	--	.85	1.49	1.59

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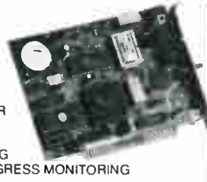

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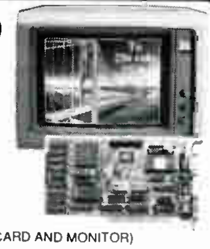

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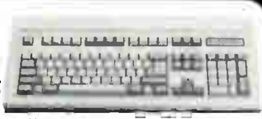

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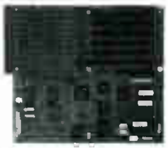

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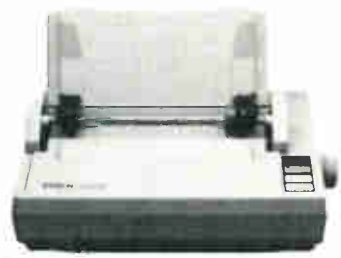

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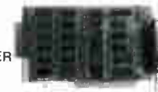

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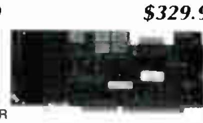

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Index of companies covered in articles, columns, or news stories in this issue
Each reference is to the first page of the article or section in which the company name appears

COMING UP IN BYTE

PRODUCTS IN PERSPECTIVE:

How do the most powerful MS-DOS laptop computers stack up? Our August **Product Focus** on 80386-based laptops will provide the answer. Speaking of **laptops**, we review NEC's diminutive yet powerful UltraLite—PC power that weighs less than 5 pounds. For **PS/2 users**, we evaluate Pixelworks' Ultra Clipper graphics board and three Modula-2 compilers from JPI, Stonybrook, and Logitech.

On the **Macintosh side**, we'll report on Shiva's TeleBridge, which allows your network to access remote computers or other networks, and Virginia Systems' Sonar Professional 2.0, a text-search program.

Finally, a **software review** looks at Traveling Software's much-ballyhooed ViewLink, an information management program with a unique approach.

IN DEPTH:

What are **neural networks**? How is data represented in neural networks, and what major applications is this type of processing technology being used for? Why are they good for solving problems that traditional computing isn't, and what's hidden in their hidden layers? All this and more in the August focus on neural networks.

FEATURES:

The lead feature article for the August issue is a piece on **digital signal processors**. DSPs are finding their way into every aspect of personal computing—in areas from fax transmission, to data encryption and compression, to voice digitization—in fact, anyplace where analog signals become digitized.

Increasingly, the Unix operating system is becoming an option for power users of personal computers. Another August feature will take a look at the **Unix shell**, a command programming language that provides the user interface to the operating system. In addition, we'll have a special article on **very long instruction word technology**, a new architecture considered by some to be the heir to RISC.

Brett Glass looks **Under the Hood** at disk snoopers, software packages that look at and attempt to "repair" problem hard disks. What do these programs actually do, and how well do they do it?

In his **Some Assembly Required** column, Rick Grehan will discuss a set of tools for the IBM PC that mimics the memory management of the Macintosh and lets you overcome some pesky barriers.

In the **Expert Advice** section, our columns will include Computing at Chaos Manor, Down to Business, Macinations, OS/2 Notebook, NetWorks, and Unix /bin. Further, in the back of the book, our new book-review column by Hugh Kenner, Print Queue, and the op-ed-type Stop Bit will continue to enliven the format for those of us who like to read from back to front instead of the other way around.

In our August **Macintosh Special Edition**, we'll have a full-featured lineup that will include Short Takes, First Impressions, and features.

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821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840
841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860
861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880
881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900
901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920
921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940
941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960
961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980
981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020
1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040
1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060
1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080
1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100
1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120
1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140
1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160
1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180
1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200

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What new technologies will emerge in the 1990's and how quickly can they be put to competitive use. Plenary Paper by: J.D. Kruehler, Vice Chairman of the Board, I.B.M. Corp. Participants include: Prof. N. Negroponte, M.I.T. Labs; Dr. R. Schmitt, President, R.P.I.

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What will be the role of the board of directors in the next decade. Participants include: Carl Icahn, Financier; Fred H. Joseph, CEO, Drexel Burnham Lambert; Larry Horner, Chairman, K.P.G. Peat Marwick.

Issue 4

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How will globalization, international competition, and restructuring impact on the corporation of the 90's. Participants include: Alfred DeCran, Chairman, Texaco; John C. Whitehead, Department of State.

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How will public sector activity in the 90's deal with trends such as privatization and special interest groups.

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Why some organizations have a reputation for being innovative while others do not. Plenary Paper by: Dr. Michael Porter, Harvard Business School.

Issue 7

The Financing of Business in the 1990's
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Have traditional methods of corporate financing become outdated by leveraged buyouts and new trading strategies. Plenary Paper by: Henry Kravis, Kohlberg, Kravis, Roberts.

Issue 8

Managing Human Resources in the 1990's
Chairman: Harry D. Garber, Vice Chairman, Equitable Life Assurance Society of America

What is the outlook for human resources management, particularly in the light of world competition, demographic changes and the need for a more skilled labor force. Participants include: Fredrick Salerno, President and CEO, New York Telephone.

Issue 9

Industrial Development in Third World Countries
Chairman: Maurice Strong
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```
{
   switch (type->defProcID) {
      case documentProc: type->defProcID = zoomDocProc; break;
      case noGrowDocProc: type->defProcID = zoomNoGrow; break;
      case zoomDocProc:
      case zoomNoGrow:
         /* do nothing */ break;
      default: fatal("add_zoom: can't add to this doc type");
   }
}

/******************************** Methods ****************************/

w_init(window)
WindowPtr window;
{
}

w_activate(window, event)
WindowPtr window;
EventRecord *event;
{
   SetPort(window);
   if (W_TYPE(window)->growable)
      DrawGrowIcon(window);
}

w_deactivate(window, event)
WindowPtr window;
EventRecord *event;
{
   if (W_TYPE(window)->growable) {
      WITH_PORT(window)
         DrawGrowIcon(window);
      END_PORT;
   }
}

w_update(window, event)
WindowPtr window;
EventRecord *event;
{
   WITH_PORT(window)
      BeginUpdate(window);
      EraseRect(&window->portRect);
      vsend_window(window, Draw, NULL);
      UpdtControl(window, window->visRgn);      /* for 128K ROM only */
      if (W_TYPE(window)->growable)
         DrawGrowIcon(window);
      EndUpdate(window);
   END_PORT;
}
```

continued from page 286

A Better Perspective

Now it's time to pull back from the depths of seeming tragedy and try to get some perspective. In the real world, a little code-copying and some careful attention to detail are not all that big a deal. Heck, if you program in C, a language that doesn't check array bounds, a language that would happily let you multiply a pointer to the disk driver by your mother's maiden name, you are used to being careful.

Whatever the horrors my window development tool engenders, they're nothing compared to what you have to go through if you don't use it. I've found that using these object-oriented methods makes programming a wonderful machine a little more wonderful to do—or, to put it another way, a little bit less painful. ■

Editor's note: *The entire source code for this package, with examples of its use and extension, is available in a variety of formats. See page 5 for further details.*

Jonathan Amsterdam is a graduate student in computer science at MIT and lives in Cambridge, Massachusetts. He can be reached on BIX c/o "editors."

PRINT QUEUE

Hugh Kenner

Predicting Chaos

DOES GOD PLAY DICE?:
The Mathematics of Chaos
by Ian Stewart

Editor's note: *Regular readers of our Book Review section will be familiar with Hugh Kenner. He is one of America's foremost literary critics; check out* Who's Who *or* Contemporary Authors *for a long list of his credits. He is currently a professor of English at Johns Hopkins University. His recent works include* A Sinking Island *and* Mazes.

Hugh also happens to be a computer-literate commentator. Those of you who haven't read his reviews have a treat in store. Beginning with this issue, Hugh will be commenting monthly on a significant book in the field of computers, computer science, or a related technology. We're honored and excited to have him on board as a member of the BYTE team.

Janus, the Johns Hopkins library's on-line catalog, is my best source of clues to what's hot at the moment. Under "Chaotic Behavior in Systems," Janus has just now listed me 16 books plus a surprising 27 volumes of conference proceedings. None dates from before 1982, not many from before 1986. And no point in my going over to sample a few. As of this morning, nearly every single one is checked out. A couple even had to be replaced after getting "lost."

Which confirms, if we hadn't guessed it from the long tenure of James Gleick's *Chaos: Making a New Science* on best-seller lists, that scientists of many stripes are reveling in a Chaos Decade. And although Gleick, first-rate reporter that he is, deserves credit for bringing the subject to lay attention, readers even a little removed from lay status will have sensed that from time to time he's slightly fuzzy about what he reports.

That is a fact I glossed over when I reviewed his book in the May 1988 BYTE, though it was, after all, inherent in his method. Writing from the outside, Gleick interviewed insider after insider. They spoke to him via analogies, which he duly relayed.

But Ian Stewart, a mathematician at the University of Warwick (England), writes from the inside. No dub hand at analogies, Stewart has written popularizing books with titles like *Oh! Catastrophe!* and *The Groups of Wrath*. His new exposition—*Does God Play Dice?: The Mathematics of Chaos*—clearly comes from a man who knows exactly what he's talking about; knows where each analogy starts and where it must stop; and knows when we'll be best served by just an oracular equation, like $vr = gn/4$.

Here's the example at hand: We're tossing a coin, and v is its vertical velocity, r is its rotation in turns per second, and g is gravity's acceleration. Then (I'm skipping steps) $vr = gn/4$ is "the head-tail boundary," and by controlling r and v exactly, I could force heads or tails at pleasure. But I can't control them exactly, so Stewart presents a nice graph to show why, as long as they vary within even narrow limits, the head-tail distribution looks "random." *Looks* random, though it's determined by r and v.

"With hindsight," Stewart writes, "you can often see things that weren't anything like as clear at the time. The trick is not so much to know something, but *to know that you know it*. That is, to appreciate that it's important, and to have a context in which to put it." Let's note, with hindsight, something not even Ian Stewart happens to discuss, that the question he shows everyone shunning a mere century ago—"can a simple deterministic system behave like a random one?"—was in fact addressed as long ago as 1948, when D. H. Lehmer outlined a simple pseudo-random-number generator, of the sort our software still uses. That is to say, a key to chaos theory was available 40 years back. It was one of the things countless people didn't know they knew.

Given suitable constants, Lehmer's algorithm can generate, for as long a span as you

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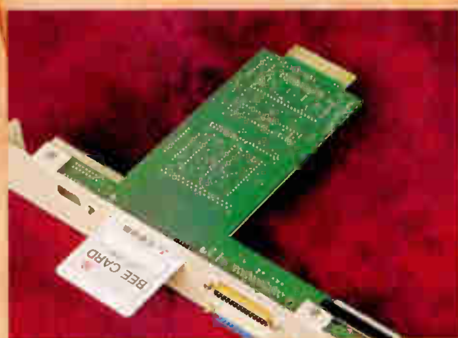

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like, numbers that pass whatever test for "randomness" you think to apply. Starting from a "seed," each iteration feeds the next. Yet start again with the same seed, and lo, the same series of outputs! So, being repeatable, those numbers cannot be random.

Likewise, as Stewart reminds us, many a kitchen gadget—cake-mixer, egg-whisk, Cuisinart—does something perfectly

Stewart reminds us that many a kitchen gadget does something perfectly regular, round and round, yet somehow randomizes the stuff it stirs.

regular, round and round, yet somehow randomizes the stuff it stirs. Traditional dynamics had no explanation for this, offering as it did two main possibilities:

1. Sit still.
2. Go round and round.

Chaos theory has a third to offer:

3. Stretch and fold. (Here, it's helpful to visualize someone pulling toffee.) Then, "Regular cause, irregular effect."

What's being stretched and folded gets a little esoteric, since we're moving back and forth between kitchen instances and phase-space graphs. Thus, a French astronomer named Hùnon starts worrying in 1962 about how stars move within a galaxy, gets anomalous numbers from his computer ("Meatballs of regularity in a stochastic spaghetti"), and by 1976 is pondering stretch-and-fold concepts that come "in layers, folded over each other like a puff pastry."

Or, "fold" a line back over itself with the help of a simple equation like

$x \to kx(1-x)$,

where, with k a constant between 0 and 4, we keep getting our line stretched or compressed nonuniformly, and then folded back on itself. And for values of k above 3, what we see is chaos, and we're immersed in the vagaries of a not-very-well-behaved Lehmer generator. Yet doesn't that equation look harmless?

But look, I'm tunneling deeper than I meant to. Let's go back to where our author takes off.

Stewart's fetching exposition starts with *Voyager 1*'s flyby of Saturn, where the moon Hyperion, "irregular in shape, a celestial potato," tumbles complexly around its regular orbit. The equations that brought *Voyager 1* into such precise proximity with that system, surely they could also compute Hyperion's attitude a few months hence? But no, they couldn't, not even if *Voyager 1* measured the observable tumbling clear to 10 decimal places (as it didn't, but never mind).

And why couldn't they? Because—my analogy, not Stewart's—calculations with Newton's austerely simple laws can sometimes act like a Lehmer generator. Feed in this instant's data to obtain the next instant's, repeat with the result, repeat, repeat.... Soon the output is so pseudorandom it's meaningless. A change in the tenth place, or the twentieth, of the initial seed (assuming enough precision to recognize it) would generate a different series entirely.

Stewart next offers a simple BASIC program:

```
10  INPUT K
20  X = 0.54321
30  FOR N = 1 TO 50
40  X = K*X*X-1
50  NEXT N
60  FOR N = 1 TO 100
70  X = K*X*X-1
80  PRINT X
90  NEXT N
100 STOP
```

Try that with K = 1.1, and then with K = 1.74. The first input (if your machine resembles mine) gives simple alternation. The second offers "well-developed chaos." Stewart's comment: "We started out not understanding Hyperion. Now we don't even understand $2x^2-1$. In mathematical terms that constitutes stunning progress." Precisely: We've moved the Hyperion problem into math, where we can examine it without space probes.

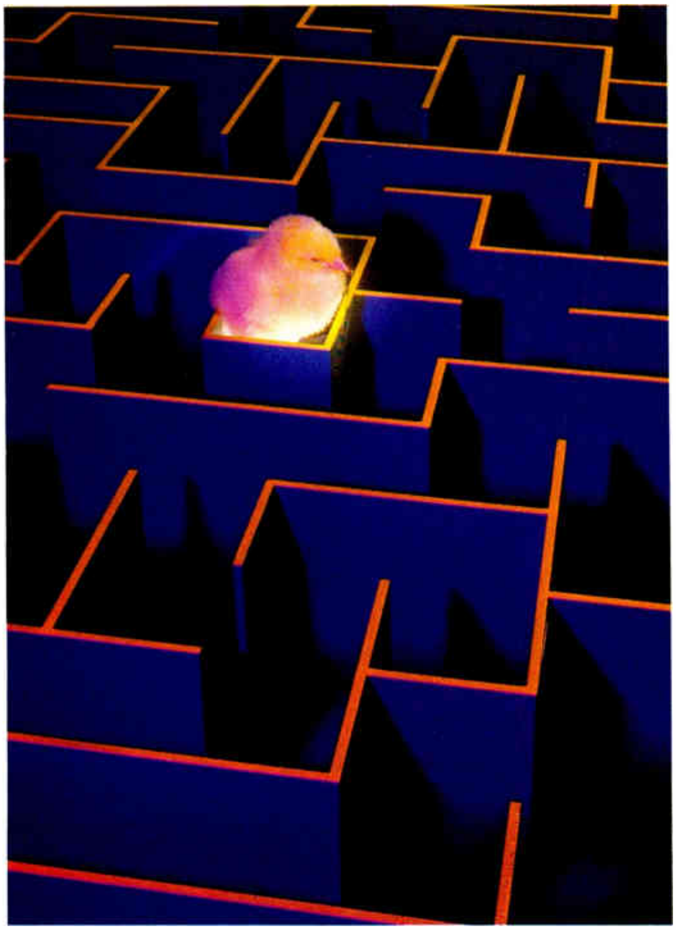
The sentence I last quoted is typical of Stewart: It sounds like offhand wit and turns out to have technical import. If the problem is mathematical, not dynamical, it's mathematicians who are going to have to address it. The real hero of his book is "the last universalist," Henri Poincaré (1854–1912), who on the way to chaos theory invented topology, and who stated almost a century ago what James Gleick found that various workers (e.g., meteorologists and population specialists) were chancing to rediscover in our generation.

"A very slight cause, which escapes us,"—Poincaré speaking—"determines a considerable effect which we cannot help seeing, and then we say this effect is due to chance." (Thus, the famous "butterfly effect"—a butterfly in Beijing affecting the weather months later in Dubuque.) "If we could know exactly...we should be able to predict exactly...." If we could know only approximately, we'd be happy to predict to the same degree of approximation. "But this is not always the case; it may happen that slight variances in the initial conditions produce very great differences in the final phenomena; a slight error in the former would make an enormous error in the latter. Prediction becomes impossible and we have the phenomenon of chance."

That's something mathematicians long knew but didn't know they knew. Its consequences now burst upon us. Witness Benoit Mandelbrot's fractals, Mr. Gleick a best-seller, and the Johns Hopkins library hard put to keep track of just which users at this moment are responsible for 43 volumes on chaotic behavior. ■

Basil Blackwell, New York: 1989, 317 pages, $19.95

Knowledge Processing



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Editor's note: *The newest addition to BYTE, Stop Bit will be a forum for our staff, readers, and industry leaders to take on the myths, shibboleths, and conventional wisdom of the computer industry. More than just a soapbox, this column will address serious, sometimes controversial issues, with hard-nosed facts, true experiences, and an occasional touch of humor. In the months to come, you'll see some highly recognizable names here and some names you've never seen before. The opinions offered here will be those of the author and not those of BYTE, McGraw-Hill, or its employees. We welcome your feedback.*

STOP BIT ■ Kenneth M. Sheldon

MOBY DICK 2.1

What if literature were published the way software is?

As a fan of great literature, I found myself wondering the other day, "What if novels were published the way software is?" If they were, the process might go something like this:

Herman Melville would announce the publication of *Moby Dick* a year before you could actually buy it. Reviewers would praise it, and several literary magazines would select it as "Editor's Choice" for best novel of the year—all before it ever appeared on bookstore shelves.

Eventually, the publisher would send out a press release to announce that copies of *Moby Dick* were actually shipping. The public, tantalized by the prepublication hype, would rush out to buy the book like sharks at a feeding frenzy. The novel would become an overnight bestseller, thereby confirming the media's amazing prophetic abilities.

The book would come wrapped in oilcloth, with a long parchment notice explaining when and where you could read it, that you couldn't loan the book to anyone, and that the publisher wasn't responsible if anything in the book were to cause damage to your life, liberty, or kidneys. If you violated the rules of the reader agreement, you would forfeit your firstborn child.

After struggling through the first few chapters of the book, two-thirds of *Moby Dick*'s readers would realize that they had no idea what it was about. Most of them would put the book away, haul it out now and then, and one day find a registration card that they had never bothered to send in. On sending in the card, they would receive the following letter:

Dear Registered *Moby Dick* Reader,

Enclosed you will find *Moby Dick* version 2.1, which replaces earlier versions.

1. Version 2.1 restores several key characters that readers reported were missing in version 2.0, which was subsequently recalled. We have also added several new characters to version 2.1. In particular, several readers reported that the character of Harold the bookkeeper, who was intended to act as a foil for Ishmael, simply did not work. This character has been replaced by Queequeg, a South Seas savage. Further modifications should not be necessary.

2. Version 2.1 contains corrections to errors reported by readers of earlier versions, most of whom were being too picky. However, one misprint on page 127 could make it difficult for you to follow the remainder of the story. Note that it is a "gold piece" that Ahab nails to the main mast, not a "cod piece." (Also note: If, beginning in this section, your version of *Moby Dick* refers consistently to "the Great White Tuna," you have the original version, 1.0.)

3. Early readers of *Moby Dick* commented that the hardcover modification (intended to discourage unauthorized copying of the book) made it impossible to install the book into their libraries. Version 2.1 contains a modified "key-type" protection. In the enclosed envelope, you will find a key that will open your copy (and only your copy) of the book. Attempting to open the book without using your key will invalidate your readership license.

4. With this version of *Moby Dick*, we are inaugurating our telephone support service, available free of charge to all registered readers. If you have a problem while reading the novel, please refer to the *Moby Dick Technical Reference Manual* (#MD-1024), which contains answers to the most commonly asked questions and includes a complete table of literary symbols used in the book. If you still cannot resolve the difficulty, call (800) BIG-FISH. The customer service representative will ask for the serial number of your book before assisting you.

5. Finally, it has come to our attention that certain unscrupulous publishers have pirated portions of the *Moby Dick* reader interface or are producing complete *Moby Dick* "clones." The most flagrant example involves a pirate captain whose hand has been swallowed (along with an alarm clock) by a large crocodile. We are suing the publisher of this work. If you buy it, you could become a codefendant in the lawsuit. You'll also receive a visit from large men with blunt instruments.

Please complete the enclosed registration card so that we can send you information on new versions of *Moby Dick*. We will also inform you of forthcoming products, such as our state-of-the-art novel, *Ambergris*, an integrated tale of daring and intrigue in the perfume and whaling industries, to be released in the fourth quarter of 1889.

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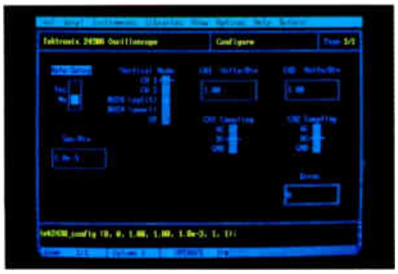

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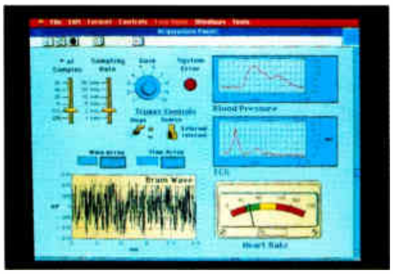

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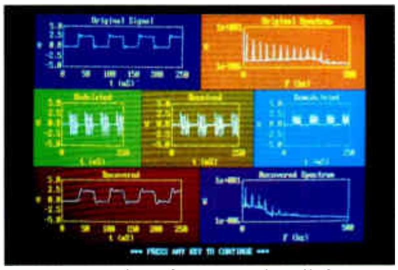

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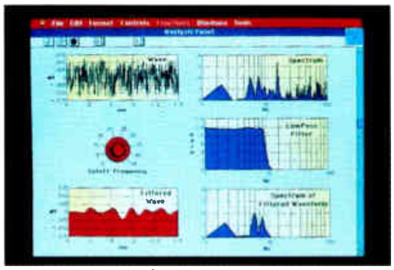

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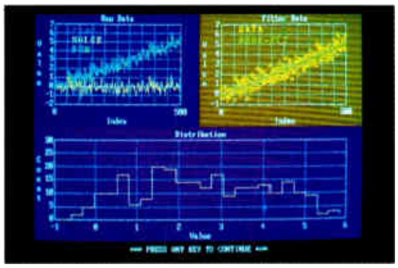

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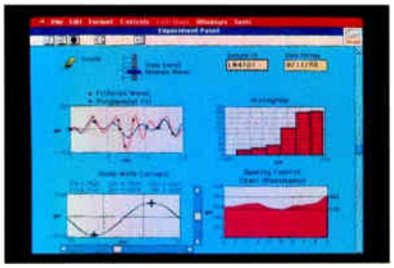

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